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GUIDE TO R2D2-RAPID RETRIEVAL DATA DISPLAY

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Guide to R2D2-Rapid Retrieval Data Display¹

By Carl A. Pearson²

ABSTRACT

R2D2 is a set of Fortran programs, linked by a procedure file, for rapid retrieval and display of hydrographic, current meter, and pressure gauge data. Data are stored as random access disk files for rapid access and sorting. Programs are interactive and have graphics capability. A wide range of display and analysis outputs are available, including time series plots, data listings, statistics, spectral and tide analysis, empirical orthogonal function analysis, and maps of properties. Routines are described from a user's point of view, with output examples.

I. INTRODUCTION

Since 1975 the Coastal Physics group of NOAA's Pacific Marine Environmental Laboratory has collected an extensive amount of physical oceanographic data in support of its involvement in projects such as the Outer Continental Shelf Environmental Assessment Program (OCSEAP) and Marine Ecosystem Analysis (MESA) program. To date this includes some 12000 CTD/STD hydrographic casts and 600 current meter and pressure gauge records from the Alaskan continental shelf waters and the Puget Sound region. As this collection of data grew it became increasingly difficult and time-consuming to manage and use. The situation required the development of a computer-based system for easy and efficient data storage, retrieval, analysis, and display.

The requirements of such a system were that: 1) data be readily accessible and capable of being sorted to the user's specification; 2) no programming be required of the user; 3) the programs be interactive and as "user proof" as

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²National Ocean Survey, assigned to PMEL

possible; and 4) a wide variety of graphical and printed output products be available for analysis. This system was named Rapid Retrieval Data Display, or "R2D2", and currently resides on the ERL CYBER 170/750 Computer in Boulder, Colorado. An early version is described in Pearson, Krancus and Charnell (1979).

FILES
Data are stored as two-level random access packed binary files. The files are divided by type (STD and current meter/pressure gage) and geographical area (Gulf of Alaska, Bering Sea, and Puget Sound). Thus there are 6 Master Data Files (MDFs). For each data set there is a header field, which contains information such as reference number, station name, date and times, latitude and longitude, depth, record length, and other information. The header information is used for sorting. The random access data storage location is keyed to the reference number, which is assigned when the data are originally loaded in the file.

MDF's are stored on a private disk pack. Six Master Header Files (MHFs) containing header information only, are stored as permanent files on NOAA family disks. The random access storage structure of the data and header files is identical, so that they may be used interchangeably by the program for sorting.

The user may access the data through a User Data File (UDF). A UDF is created by sorting a MHF and then selecting the R2D2 program option which creates and submits a batch job, which then reads the selected data sets from the MDF and writes them on the UDF permanent file under the user's number. Thereafter, the user may attach the UDF, then sort to select the desired data sets for further data analysis and display.

DATA
STD data are stored as 1-m averaged salinity and temperature. Depth is computed from the array subscript, and σ_t from the equation of state. Current meter data include hourly 2.86-hour filtered east and north velocity

components, temperature, pressure and salinity; and six-hourly 35-hour filtered east and north component velocities (see Krancus, Pearson, and Charnell (1979) for a description of current meter data processing). There are presently (1981) about 12000 STD casts and 600 current meter records on file.

The user accesses the R2D2 programs by remote terminal and executes a "procedure file" called R2D2. The procedure file is a series of control language commands which attach and execute the programs. Registers set from within the programs control flow through the procedure file (fig. 1).

Like the data files, programs have been divided by type to minimize central memory requirements. The main programs are: 1) R2START, which checks the user's access authorization, and allows the user to select the desired data type and file; 2) STDMAIN, which sorts and displays hydrographic data; 3) CMSORT, which sorts the current meter files and provides options for listing and plotting header information; 4) SPECT, which contains autospectral, cross spectral and tidal analysis routines; 5) CMLOOK, which has options for a variety of current meter data display and analysis routines, including data listings, PVD and time-series plots, cross correlation, empirical orthogonal functions, and others. All programs are written in FORTRAN.

Printed and plotted output may be through the user's terminal as well as routed to the PMEL RJE terminal (or with slight modification to any terminal linked to the central computer).

The remainder of this report will contain a detailed description and user's guide of the R2D2 programs (section II), associated programs such as R2PLOT and UPLT (section III), documentation of the data structure, and the loading and editing programs (section IV).

PROGRAMS

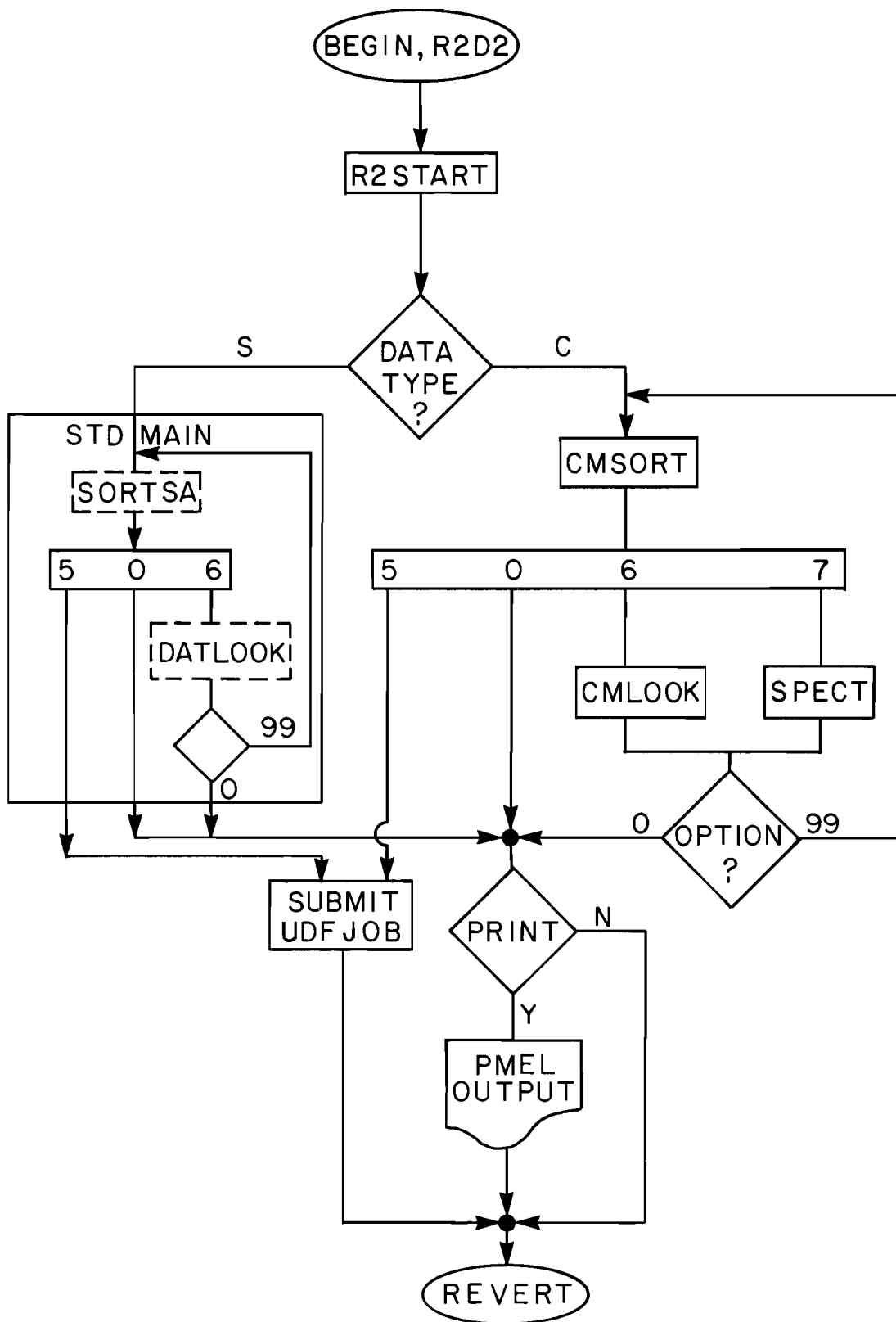


Figure 1. General R2D2 structure.

II. PROGRAM NOTES AND USER'S GUIDE

This section describes the R2D2 sorting, analysis, and display routines from the user's point of view. That is, each of the major options will be described with reference to how to get there, explanations of options available, some examples of output, and notes on algorithms used. It serves as a user's guide, giving directions and descriptions of available products. Accompanying this is a schematic of the detailed R2D2 structure (fig. 2), which may be thought of as a map, providing a quick reference on how to get from one point to another.

R2D2 is not static. Routines are occasionally changed or added to increase efficiency or expand versatility. Therefore this report should be put in a loose-leaf binder, so that pages may be replaced as changes are made. If you wish to receive updates, please notify the author of this report.

This section is subdivided as follows: Section II-A describes the general R2D2 program structure; II-B describes R2START, which checks the user access code, sets registers, and attaches data files; II-C describes STDMAIN, the STD sorting and display program; II-D describes the current meter/pressure gauge programs (CMSORT, CMLOOK, and SPECT); II-E describes ending R2D2; II-F describes miscellaneous routines such as those used for drawing maps and plotting.

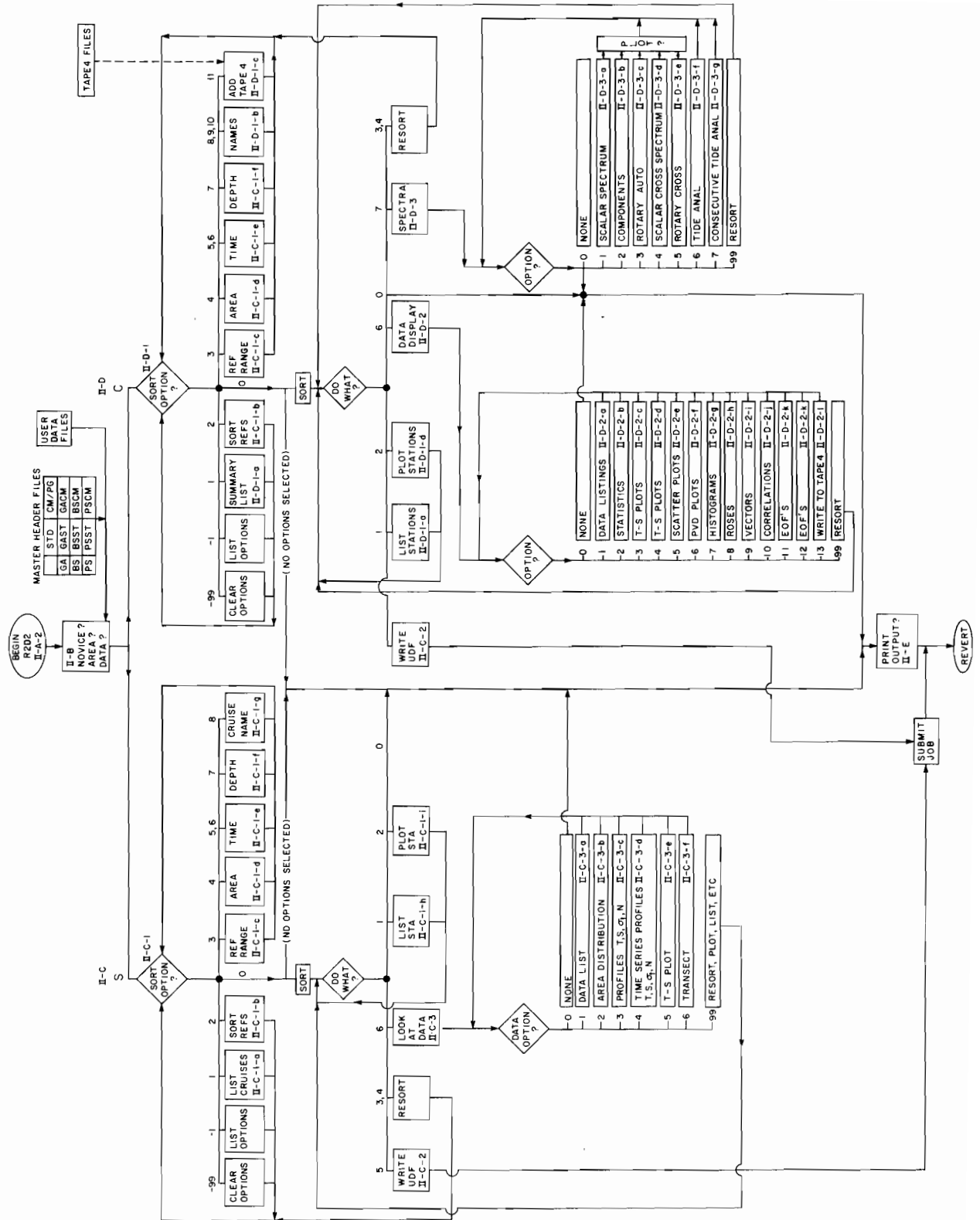


Figure 2. Detailed schematic of R2D2.

II-A GENERAL R2D2 STRUCTURE.

R2D2 is the name of a procedure file which resides as an indirect access file on "user number" RLC. Figure 1 shows the general R2D2 structure. R2D2 attaches and executes the programs, with flow controlled by registers R1, R2, and R3. The control registers are set both from within programs and in the procedure file. They are also used to transfer information from one program to another.

Programs are stored as core images. That is, programs and libraries have been previously loaded into core, and the core images have been saved as direct access permanent files, which may then be attached and executed.

II-A-1 External files used in R2D2 programs.

Several local files are used by R2D2 which will be read and/or written by the various programs. These files are:

- INPUT - used to read input through the user's interactive terminal (used in all programs)
- OUTPUT - used to print output to the user's terminal (all programs)
- TAPE1 - a scratch file used by the PLOT10 routines for plotting on Tektronix terminals (STDMAIN, CMSORT, CMLOOK, SPECT)
- TAPE2 - PLOT10 output file used for plotting on Tektronix terminals, equivalenced to OUTPUT (STDMAIN, CMSORT, CMLOOK, SPECT)
- TAPE3 - a permanent file containing mercator coordinates of coastline, of each of the three geographical areas used by the map drawing routine (STDMAIN, CMSORT, CMLOOK)
- TAPE4 - used to read or write data in the "TAPE4 format", an unformatted sequential type file which permits the use of R2D2 data in other programs, and non-R2D2 data in R2D2 (STDMAIN, CMSORT, CMLOOK, SPECT)
- TAPE5 - A scratch file which contains the header information of the selected data records (STDMAIN, CMORT, CMLOOK, SPECT)
- TAPE6 - A file containing formatted output which may be routed to a central printer (all programs)
- TAPE7 - The data permanent file, which may be either a Master Header File or a User Data File (all programs)
- TAPE98 - A direct access permanent file, defined in the program and used to store plots for offline plotting (STDMAIN, CMSORT, CMLOOK, SPECT)
- TAPE99 - A scratch file used for temporarily storing plots or data. Also used as the authorized user list in R2START, and as the Submit File which reads the Master Data File (all programs)

II-A-2 Units used in R2D2

LATITUDE, LONGITUDE - decimal degrees, positive north and west (latitudes and longitudes plotted on maps are degrees and minutes)

TIMES - All times are GMT. Times are given by a 9-digit integer in the form YYDDHHMM, where YY is the year, DDD is Julian day, HH is hour and MM is minutes.

SALINITY - gm kg^{-1} (‰)

TEMPERATURE - °C

DEPTH - meters positive downward from the surface (note: in the STD data files, depth is actually pressure in decibars. The depth may be calculated from

$$D = \frac{P}{\bar{\rho}g}$$

where P is pressure, $\bar{\rho}$ is mean density of the water column and g is gravity. Generally, depth in meters is approximately equal to pressure in decibars.

DENSITY - sigma-t

GEOPOTENTIAL - dynamic meter

SPEED - cm s^{-1} for currents
 m s^{-1} for winds

DIRECTION - compass degrees true, toward which current or wind is flowing.

PRESSURE - decibars for current meter data, millibars for pressure gauge,
weather data.

II-B GETTING STARTED

II-B-1 Beginning R2D2.

To begin R2D2, the user logs into the Boulder ERL CDC 750 computer and then enters the following commands, followed by a carriage return....

```
GET,R2D2/UN=RLC
```

```
R2D2
```

This begins execution of R2D2. The first control statement executed by R2D2 is to begin a procedure file called BANNER. This is a procedure file on the user's user number which writes a banner to TAPE6. If BANNER is not found, a message will be printed to that effect, and execution will continue. An example of a BANNER file is:

```
.PROC,BANNER,LIST.  
HEADING(LIST) H. SOLO
```

R2D2 then attaches and executes R2START.

II-B-2 R2START

After entering the command R2D2, the first output seen by the user should be....

THE COASTAL PHYSICS GROUP

PRESENTS

R RAPID

2 RETRIEVAL

D DATA

2 DISPLAY

BUILT A LONG TIME AGO

... ON A DATA BASE FAR, FAR AWAY

(At this point, the user's user number is checked against a list of authorized users. If not on the list, the following would be printed:

SORRY, INCORRECT PERMISSION

and execution terminated. If found, R2D2 then continues...)

GOOD MORNING (your name)

R2D2 AT YOUR SERVICE

message, if any

ARE YOU A NOVICE USER?

For this and all subsequent yes or no questions, enter a Y for yes, N for no, or just a carriage return for an explanation of the question. If the answer to this question is Y, a switch will be set to print instructions before each subsequent question is asked.

DATA TYPE?

Enter S if you are going to select an STD data set, or C for current meter/pressure gauge data.

FILE?

Enter 0 if no random access file is to be attached, i.e., only TAPE4 files are being used. In this case R2D2 proceeds to the next program immediately. To attach a Master Header File enter GA, BS, or PS for a Gulf of Alaska, Bering Sea, or Puget Sound header file, respectively. To attach a User Data File, enter the name of the data file. If a User Data File name is entered, the next question is...

ENTER DATA FILE USER NUMBER?

In this case enter the user number on which the User Data File resides. Do not, however, enter a password. If all goes well, R2D2 will print....

(file name) HAS BEEN ATTACHED ...

and proceed to the next program. If the file could not be attached an error message is printed and execution terminated.

Figure 3 is an example of an R2D2 start.

GET,R2D2/UN=RLC
/R2D2
THE COASTAL PHYSICS GROUP

PRESENTS

R RAPID
2 RETRIEVAL
D DATA
2 DISPLAY

BUILT A LONG TIME AGO
...ON A DATA BASE FAR FAR AWAY

GOOD MORNING CARL
R2D2 AT YOUR SERVICE

ARE YOU A NOVICE USER ? N
NOTE: FOR INSTRUCTIONS TO QUESTIONS, PRESS RETURN KEY
DATA TYPE ? S
FILE? NASTE
ENTER DATA FILE USER NUMBER ? CAP
NASTE HAS BEEN ATTACHED

Figure 3. Starting R2D2.

II-C HYDROGRAPHIC (STD) DATA ROUTINES

DATA TYPE: S (II-B)

If the user has selected data type S, R2D2 attaches and executes STDMAIN. The program STDMAIN contains the routines for sorting, analysis, and display of the STD data type.

Since the data files generally contain a large number of records, they must first be sorted to obtain the desired subject of the file before the data can be examined. Subroutine SORTSTA contains options for summary listings of file contents and sorting by reference number, geographical area, time period, depth range, and cruise name. The selected stations may be listed or plotted on a map.

Subroutine DATLOOK provides routines for analysis and display of the sorted data. A variety of output products are available, including data listings, maps of physical properties, property-depth profiles, temperature-salinity diagrams and transections.

STDMAIN serves primarily to call SORTSTA and DATLOOK, which in turn call the routines to perform the individual tasks. These routines are described in the following sections.

II-C-1 SORTING

DATA TYPE: S (II-B)

Subroutine SORTSTA includes options for summary listings of file contents; sorting the file by various criteria; listing and/or plotting the selected records; writing User Data Files; and transfer to DATLOOK, the main routine for data display.

The file is sorted by selecting any combination of the sort options 2-8 (see list of options, below). Option 2 selects the specified records immediately. For options 3-8, sorting is done only after the desired sort options are selected and sort option 0 is entered. The sort option routines simply set up the sort parameters. The most efficient sorting is done if option 3 is included, since only the specified range of reference numbers needs to be checked. Otherwise the whole file, which may be several thousand records in the case of a Master Header File, must be read in and sorted.

R2D2 continues...

YOU MAY NOW SORT

ENTER SORT OPTION?

The options are:

-99 CLEAR PREVIOUS OPTIONS

- 1 LIST OPTIONS CURRENTLY SELECTED

0 SORT WITH OPTIONS SELECTED

(If none selected, no sorting will be done)

1 SUMMARY LISTING OF FILE (II-C-1-a)

- 2 SELECT INDIVIDUAL REFERENCE NUMBERS (II-C-1-b)
- 3 SORT BY REFERENCE NUMBER RANGE (II-C-1-c)
- 4 SORT BY LATITUDE AND LONGITUDE (IIC-1-d)
- 5 SORT BY TIME PERIOD (JULIAN DATE) (II-C-1-e)
- 6 SORT BY TIME PERIOD (GREGORIAN DATE) (II-C-1-e)
- 7 SORT BY STATION DEPTH (II-C-1-f)
- 8 SORT BY CRUISE NAME (II-C-1-g)

These options are described in the following sections. When the desired sort options have been selected, option 0 is entered to initiate sorting.

Any stations which meet all the specified criteria are selected. A maximum of 600 stations may be used for subsequent data analysis, but any number may be selected for listing and/or plotting of the header information. When the sorting process is complete, the total number of stations selected is printed, e.g.,

```
128 STATIONS HAVE BEEN SELECTED
WHAT WOULD YOU LIKE TO DO?
```

Now the options are...

- 0 TO DO NOTHING MORE (II-E)
- 1 TO LIST STATIONS SELECTED (II-C-1-h)
- 2 PLOT LOCATIONS OF STATIONS SELECTED (II-C-1-i)
- 3 RESORT
- 4 SORT AGAIN, KEEPING STATIONS ALREADY SELECTED
- 5 WRITE SELECTED RECORDS FROM MASTER TAPE TO PF (II-C-2)
- 6 LOOK AT DATA FOR STATIONS SELECTED (II-C-3)

Options 3 and 4 clear the previously set sort options and reenter the sorting process. Option 4 retains those records already selected. This is useful when, for example, more than one time period or area is desired. Selection of option 6 is only possible if a User Data File has been attached and sorted.

II-C-1-a Summary listing of file (fig. 4)

DATA TYPE: S (II-B)

SORT OPTION: 1 (II-C-1)

This option prints a summary of all or part of the file contents by cruise name. For each cruise, output includes cruise name, ship name, Chief Scientist's name, the extreme latitudes and longitudes, start and end times, reference number ranges, and number of records.

R2D2 will ask...

ALL OF THEM?

If answer is Y the entire file will be summarized. If N the next question is...

ENTER REFERENCE NUMBER RANGE: FIRST, LAST?

If the reference number entered for LAST is larger than the actual last reference number in the file, LAST will be reset accordingly.

DO YOU WANT TO PRINT ON YOUR TERMINAL?

If the answer is N, output will be written on TAPE6 only.

Subroutine name: INDEX

Called from: SORTSTA (II-C-1)

Program: STDMAIN (II-C)

YOU MAY NOW SORT
ENTER SORT OPTION ? 1
ALL OF THEM ? Y
DO YOU WANT TO PRINT ON YOUR TERMINAL ? Y

RP4SU80AL4 SURVEYOR CURL
LATITUDES 53.46 TO 58.34
LONGITUDES 151.60 TO 169.41
802280128 TO 802491511
YOUR REFERENCE NO 1 TO 198
MASTER REFERENCE NO 2676 TO 2873
198 CASTS

TOTAL CASTS = 198

Figure 4. Summary listing of hydrographic file contents.

II-C-1-b Select individual reference number (fig. 5)

DATA TYPE: 5 (II-B)
SORT OPTION: 2 (II-C-1)

This option allows the user to select individual records by reference number, without regard to the actual order in the file. Since files are random access, this is the most efficient way to select a few records. Up to 600 records may be selected. Unlike the other sort options, this one immediately gets the records selected, rather than waiting for sort option 0 to be entered.

R2D2 will print...

ENTER N REF NUMBERS (IE REF1, REF2,...REFN)

FOLLOWED BY AN EXTRA CARRIAGE RETURN

The user now enters from 1 to 600 reference numbers, separated by commas. Two carriage returns in a row terminates entry.

The program continues...

YOU HAVE SELECTED:

(list of reference numbers)

IS THAT OK?

If not OK, the numbers may be reentered. Otherwise the desired records are selected. If a particular record cannot be found, a message to that effect is printed.

Subroutine name: SELECT

Called from: SORSTA (II-C-1)

Program: STDMAIN (II-C)

```

ENTER SORT OPTION ? 2
ENTER N REF NUMBERS (IE REF1,REF2,..REFN)
  FOLLOWED BY AN EXTRA CARRIAGE RETURN
? 44,45
?
YOU HAVE SELECTED:
44 45
IS THIS OK? Y
ENTER SORT OPTION ? 3
ENTER REFERENCE NUMBER RANGE: REF1,REF2 ? 10,100
REF NO. RANGE IS 10 TO 100
IS THIS OK? Y
ENTER SORT OPTION ? 4
ENTER: LAT1,LAT2,LON1,LON2
? 55,59,156,163

AREA IS BOUNDED BY:
LATITUDES 55.00 TO 59.00
LONGITUDES 156.00 TO 163.00
IS THIS OK? Y
ENTER SORT OPTION ? 5
IF YOU ENTER 0 FOR YEAR, THE YEAR WILL BE DISREGARDED
ENTER: STARTDAT,ENDDAY? 802200000,802302400

TIME PERIOD IS:
FROM 802200000 TO 802302400
IS THIS OK? Y
ENTER SORT OPTION ? 6
IF YOU ENTER 0 FOR YEAR, THE YEAR WILL BE DISREGARDED
ENTER: START YEAR,MON,DAY,END YEAR,MON,DAY
  (USE NUMBER FOR MON)
? 80,8,22,80,8,25
TIME PERIOD IS:
FROM 80 AUG 22 TO 80 AUG 25
IS THIS OK? Y
ENTER SORT OPTION ? 7
ENTER D1,D2 ? 10,100
UPPER DEPTH IS 10
LOWER DEPTH IS 100
IS THIS OK? Y
ENTER SORT OPTION ? 8
CRUISE NAME ? RP4SU80AL4
CRUISE = RP4SU80AL4
IS THIS OK? Y
ENTER SORT OPTION ? -1
LATS 55. 59. LONS 156. 163.
TIME PERIOD (JD) 802350000,TO 802382400
CRUISE RP4SU80AL4
STATION DEPTH RANGE 10. TO 100.
REFS 10 TO 100
ENTER SORT OPTION ? 0
56 RECORDS HAVE BEEN SELECTED
WHAT WOULD YOU LIKE TO DO ?

```

Figure 5. Hydrographic file sorting options.

II-C-1-c Sort by reference number range (fig. 5)

DATA TYPE: S,C (II-B)
SORT OPTION: 3 (II-C-1, II-D-1)

This option allows sorting on a range of reference numbers. Use of this option is more efficient because only the specified range of numbers is tested during sorting. No actual sorting is done until sort option 0 is selected

R2D2 will print...

ENTER REFERENCE RANGE: REF1, REF2?

The user enters the first and last reference numbers in the desired range, separated by commas. If the entered reference numbers are larger than the actual last reference number LAST on file, this is noted and REF2 is changed to LAST.

R2D2 continues...

REF NO RANGE IS (REF1) to (REF2)
IS THIS OK?

If not OK the reference number range may be reentered.

Subroutine name: REFSORT
Called from: SORTSTA (II-C-1), SORTSET (II-D-1)
Programs: STDMAIN (II-C), CMSORT (II-D-1)

II-C-1-d Sort by latitude and longitude (fig. 5)

DATA TYPE: S, C

(II-B)

SORT OPTION: 4

(II-C-1, II-D-1)

This routine sets up latitude and longitude boundaries for sorting and map drawing. Latitudes and longitudes are entered as decimal degrees, with latitude positive north and longitude positive west.

R2D2 prints...

ENTER: LAT1, LAT2, LON1, LON2?

LAT1, LAT2 are the latitude boundaries and LON1, LON2 are the longitude boundaries. After the user enters the latitudes and longitudes R2D2 prints out the boundaries and asks for an OK.

Subroutine name: AREA

Called from: SORTSTA (II-C-1), SORTSET (II-D-1), MCHART (II-F-1)

Programs: STDMAIN (II-C), CMSORT (II-D-1), CMLOOK (II-D-2)

II-C-1-e Sort by time period (fig. 5)

DATA TYPE: S,C (II-B)

SORT OPTION: 5,6 (II-C-1, II-D-1)

This routine sets up the parameters for sorting by time period. The time period may be entered either as a time word (option 5) or as year, month, day (option 6). In option 5 the time word is a nine digit integer in the form

YYDDDDHHMM

where YY is the year, DDD is Julian date, HH is hour (GMT) and MM the minute.

In option 6 the date is entered as YEAR, MON, DAY, where MON is the number of the month (e.g., 3 = March) and DAY is the day of the month. These are then converted to the YYDDDDHHMM form for sorting.

If 0 is entered for the year, the year will be disregarded in sorting. This is useful for selecting all records of a particular season, for example.

Subroutine name: TIMSORT

Called from: SORTSTA (II-C-1), SORTSET (II-D-1)

Programs: STDMAIN (II-C), CMSORT (II-D-1)

II-C-1-f Sort by Depth Range (fig. 5)

DATA TYPE: S,C (II-B)
SORT OPTION: 7 (II-C-1, II-D-1)

This option is used to sort on the basis of station depth. A range of depths from D1 to D2 is specified, where D1 is the upper depth and D2 the lower. Records are selected whose depth D fall within the range $D1 \leq D \leq D2$. Depth is measured positive downward from the surface in units of meters.

Subroutine name: DEPSORT

Called from: SORTSTA(II-C-1), SORTSET(II-D-1)

Programs: STDMAIN (II-C), CMSORT (II-D-1)

II-C-1-g Sort by cruise name (fig. 5)

DATA TYPE: S (II-B)

SORT OPTION: 8 (II-C-1)

This option is used to select STD records on the basis of cruise name. The cruise name must be entered exactly as it appears in the header field. If the exact name isn't known, option 1 (II-C-1-a) may be used to obtain a summary list by cruise name.

Subroutine name: CRUSORT

Called from: SORTSTA (II-C-1)

Program: STDMAIN (II-C)

II-C-1-h List stations selected (fig. 6)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT WOULD YOU LIKE TO DO? 1 (II-C-1)

This option lists the header information of the selected records. Information listed includes reference numbers, cruise name, cast number, station name, latitude, longitude, time, depth and master reference number. If more than 10 records have been selected, R2D2 prints.

YOU HAVE (n) STATIONS
DO YOU WANT TO PRINT ALL OF THEM?

If the answer is no...

TYPE IN THE NUMBERS I,J,K TO LIST EVERY KTH STATION FROM I THRU J

Then a subset of the records will be printed. For example if 100 have been selected, and I,J,K is entered as 30,50,5, the records 30,35,40,45,50 will be printed on the terminal. All 100 will be written on TAPE6.

Subroutine: IJK
Called from: SORTSTA (II-C-1)
Program: STDMAIN (II-C)

WHAT WOULD YOU LIKE TO DO ? 1
 YOU HAVE 56 STATIONS.
 DO YOU WANT TO PRINT ALL OF THEM? N
 TYPE IN NUMBERS I, J, K TO LIST EVERY K-TH STATION
 FROM I THRU J
 ? 1,56,5

REF	CRUISE	CAST	STA	LAT	LONG	DATE	DEP	MREF
44	RP4SU80AL4	44	NA-18	57.04	159.83	802360546	59.	2719
32	RP4SU80AL4	32	NA-8	57.67	158.50	802350836	38.	2707
37	RP4SU80AL4	37	NA-15	57.20	158.94	802351915	43.	2712
42	RP4SU80AL4	42	NA-17	57.19	160.01	802360307	60.	2717
47	RP4SU80AL4	47	NA-21	56.80	159.57	802360956	39.	2722
52	RP4SU80AL4	53	NA-23	56.82	160.48	802361938	65.	2727
57	RP4SU80AL4	58	NA-32	56.34	160.55	802370325	41.	2732
62	RP4SU80AL4	63	NA-38	56.22	160.93	802370922	35.	2737
67	RP4SU80AL4	68	NA-41	56.46	161.72	802371740	96.	2742
72	RP4SU80AL4	73	NA-45	56.09	161.35	802372257	35.	2747
77	RP4SU80AL4	78	NA-49	55.97	162.19	802380616	62.	2752
82	RP4SU80AL4	83	NA-40	56.05	160.75	802382326	17.	2757

WHAT WOULD YOU LIKE TO DO ?

Figure 6. List of hydrographic stations selected.

II-C-1-i Plot stations selected (fig. 7)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT WOULD YOU LIKE TO DO? 2 (II-C-1)

This option plots the locations of the selected stations on a Mercator chart. There are four plot options...

ENTER: 1 FOR STATION REFERENCE NUMBERS
2 FOR SHIP-ASSIGNED CAST NUMBERS
3 FOR STATION NAMES
4 FOR LOCATIONS ONLY

After the plot option is entered R2D2 either asks for the map boundaries (see II-C-1-d) or prints out the already entered boundaries and asks if they are OK. If necessary a new Mercator chart is computed (see II-F-1). Stations not within the map boundaries are not plotted. Stations which would plot within 0.05 inch of the previously plotted station also are not plotted.

Subroutines: GETSTA, CHARTEM
Called from: SORTSTA (II-C-1)
Program: STDMAIN (II-C)

WHAT WOULD YOU LIKE TO DO ? 2
 PLOT OPTION ? 1
 YOUR PRESENT MAP BOUNDARIES ARE:
 LATITUDES 55.00 TO 59.00
 LONGITUDES 156.00 TO 163.00
 IS THIS OK? Y
 WHICH MAP FILE? 2
 ENTER SCALE,ATLAT,TIC,YLEN
 ? 0,0,0.25,6
 SCALE = 2926296. AT LATITUDE 57.000
 TIC MARKS EVERY .25 DEGREE
 CHART HEIGHT = 6.00, LENGTH = 5.72
 IS THIS OK? Y
 ARE YOU USING A TEKTRONIX TERMINAL? Y
 ENTER BAUD RATE ? 1200
 DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ? Y

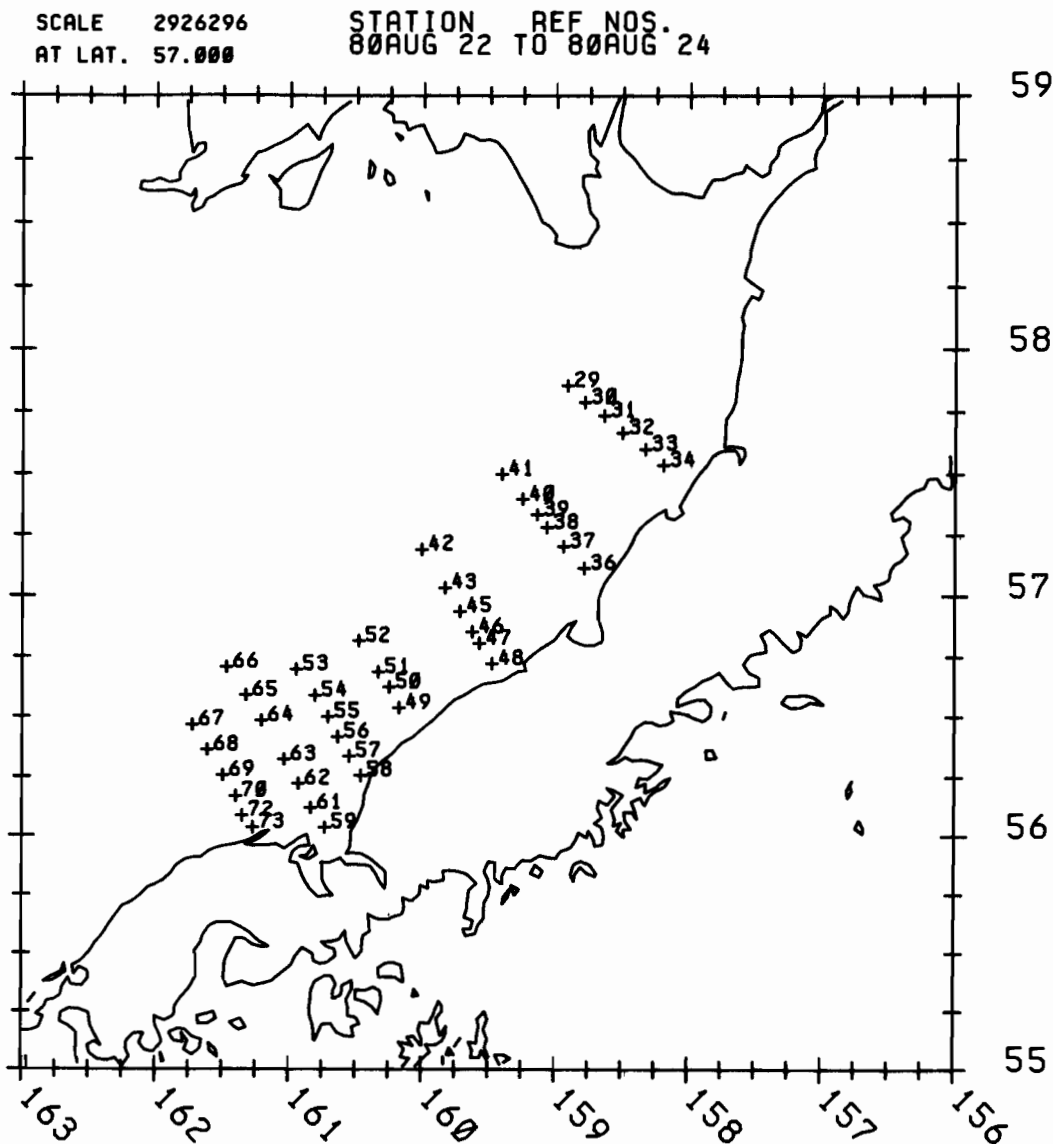


Figure 7. Plot of hydrographic stations selected.

II-C-2 WRITE SELECTED STATIONS FROM MASTER FILE TO PF

DATA TYPE: S, C (II-B)
SORT OPTION: 0 (II-C-1, II-D-1)
WHAT WOULD YOU LIKE TO DO? 5 (II-C-1, II-D-1)

In order to access the data analysis and display routines, the user must first create a User Data File. This is done by sorting the appropriate Master Header File to obtain the desired subset and then entering this option.

This option is used to create a submit file which will write records from a Master Data File to a User Data File. If a Master Header File has not been used for sorting, execution will terminate.

If all goes well, R2D2 will ask for user and charge numbers for the submit file...

USER,?

Enter user number, password under which the submit job will run, but not the word "USER". The User Data File will then be stored under that user number.

CHARGE,?

Similarly, enter the charge number, but not the word "CHARGE". R2D2 will then ask for an "OK" on the user and charge numbers. It is important that these are entered correctly, or the job will not run. An incorrect user number will result in automatic logoff when the job is submitted. R2D2 then continues...

ENTER PERMANENT FILE NAME?

This is the name of the direct access User Data File, one to seven characters.

The submit file is written on local file TAPE99. Upon completion of this routine, program execution stops and R2D2 REPLACES TAPE5 (the file containing the list of selected stations) as R2LIST, and then SUBMITs TAPE99. The job name will be printed. Since the Master Data File resides on a private disk pack which usually must be mounted, the job will take a few minutes or more to run. The user may check job status by entering...

STATUS,JN.

Upon completion, job output is REPLACEed, again under the permanent file name R2LIST. This file may be examined by typing in...

GET,R2LIST

LNH,F=R2LIST

If the job ran correctly there will be a list of records selected followed by the dayfile. If the job did not run, the user and charge numbers may have been incorrectly entered, or the permanent file name may have already existed.

Subroutine: WRITFIL

Called from: SORTSTA (II-C-1), CMSORT (II-D-1)

Program: STDMAIN (II-C), CMSORT (II-D-1)

II-C-3 DATA ANALYSIS AND DISPLAY

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT WOULD YOU LIKE TO DO? 6 (II-C-1)

Selection of this option gives access to the STD data analysis and display routine DATLOOK. A User Data File must have been attached and sorted.

A variety of output products are available. These include: data listings (printed outputs of the 1-meter-averaged temperature, salinity, density, and dynamic height anomaly), either in abbreviated form or the complete record; area distributions, which gives listings and plots (maps) of a selected property for each station; profiles, which does plots of temperature, salinity and density, or Brunt-Väisälä vs. depth; time-series profiles, which does several records on the same plot; T-S (temperature-salinity) diagrams; and transections, plots of a cross-section of temperature, salinity, or density with depth.

Often it is necessary to resort the file after using one of the data options. For example, one may wish to do profiles for a particular station after doing area distributions for a whole cruise. For this reason an option (99) is included to return to the sorting routine (II-C-1) at the point of "WHAT WOULD YOU LIKE TO DO?" From there the user may resort and then reenter DATLOOK.

On entering this routine, R2D2 will ask...

TYPE OF DATA OUTPUT?

The options available are...

- | | | |
|----|--------------------------|------------|
| 0 | END R2D2 SESSION | (II-E) |
| 1 | DATA LISTINGS | (II-C-3-a) |
| 2 | AREA DISTRIBUTIONS | (II-C-3-b) |
| 3 | PROFILES | (II-C-3-c) |
| 4 | TIME SERIES PROFILES | (II-C-3-d) |
| 5 | T-S DIAGRAMS | (II-C-3-e) |
| 6 | TRANSECTIONS | (II-C-3-f) |
| 99 | RESORT, LIST, PLOT, ETC. | |

Subroutine: DATLOOK

Program: STDMAIN (II-C)

II-C-3-a Data listings (fig. 8)

DATA TYPE	S	(II-B)
SORT OPTION:	0	(II-C-1)
WHAT WOULD YOU LIKE TO DO?	6	(II-C-1)
TYPE OF DATA OUTPUT:	1	(II-C-3)

This option provides a full or abbreviated listing of the 1-m average temperature (TEMP), salinity (SAL), sigma-t (SIGT), and dynamic height anomaly in meters (DYN M) of each record selected.

The program asks...

DO YOU WANT TO PRINT ON YOUR TERMINAL?

and then...

ENTER 0 FOR NONE

1 FOR COMPLETE LIST

2 FOR SHORT LIST

The short list prints the data at intervals of 1 meter for depths 0-100 m, at 5-m intervals for depths 100-500 m, and at 25-m intervals for over 500 m depth. Since data for 4 depths are printed on each line of TAPE6, a 1500-m-depth cast will be printed on one standard computer page using the short list, or 7 pages using the complete list.

If the uppermost depth Z_0 of the cast is not at 0 m, temperature and salinity will be extrapolated to 0 m by assuming that T and S above Z_0 are equal to T and S at Z_0 . Extrapolated values are denoted by an "*".

Subroutine: DATLIST

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

TYPE OF DATA OUTPUT ? 1
 DO YOU WANT TO PRINT ON YOUR TERMINAL ? Y
 ENTER 1 FOR COMPLETE LIST, 2 FOR SHORT LIST, 0 FOR NONE
 ? 1
 ENTER MAXIMUM DEPTH, OR -2 FOR BOTTOM
 ? 40

REF	CRUISE	CAST	STA	LAT,N	LOH,W	DATE	DEP	MREF	PG
45	RP4SU80AL4	45	NA-19	56.94	159.72	802360710	44	2720	1
DEP	TEMP	SAL	SIGT	DYN M	DEP	TEMP	SAL	SIGT	DYN M
0	9.49	31.49	24.32	0.000	1	9.49	31.49	24.32	.004
2	9.49	31.49	24.32	.007	3	9.49	31.49	24.32	.011
4	9.49	31.49	24.32	.014	5	9.49	31.49	24.32	.018
6	9.49	31.49	24.32	.022	7	9.49	31.49	24.32	.025
8	9.48	31.48	24.32	.029	9	9.48	31.49	24.32	.033
10	9.47	31.48	24.31	.036	11	9.46	31.49	24.33	.040
12	9.46	31.49	24.33	.043	13	9.47	31.49	24.32	.047
14	9.45	31.49	24.32	.051	15	9.43	31.48	24.32	.054
16	9.41	31.48	24.33	.058	17	9.38	31.45	24.32	.061
18	9.22	31.48	24.36	.065	19	9.08	31.45	24.35	.069
20	8.90	31.47	24.39	.072	21	8.80	31.47	24.41	.076
22	8.65	31.45	24.41	.079	23	8.55	31.52	24.49	.083
24	8.53	31.53	24.50	.086	25	8.51	31.52	24.50	.090
26	8.48	31.53	24.51	.093	27	8.47	31.53	24.51	.097
28	8.46	31.53	24.51	.100	29	8.45	31.53	24.51	.103
30	8.43	31.53	24.51	.107	31	8.43	31.53	24.51	.110
32	8.38	31.52	24.51	.114	33	8.35	31.53	24.53	.117
34	8.34	31.54	24.53	.121	35	8.33	31.54	24.53	.124
36	8.32	31.53	24.53	.127	37	8.30	31.54	24.54	.131
38	8.30	31.55	24.55	.134	39	8.30	31.54	24.54	.138
40	8.28	31.54	24.54	.141					

TYPE OF DATA OUTPUT ?

Figure 8. Hydrographic data listing.

II-C-3-b Area distributions (fig. 9)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT WOULD YOU LIKE TO DO?: 6 (II-C-1)
TYPE OF DATA OUTPUT: 2 (II-C-3)

This option lists and plots various parameters of the selected stations.

The options are ...

- 0 TO ESCAPE
- 1 TEMPERATURE AT DEPTH D
- 2 SALINITY AT DEPTH D
- 3 SIGMA-T AT DEPTH D
- 4 TEMP DIFFERENCE BETWEEN DEPTHS D1 & D2
- 5 SALIN DIFFERENCE BETWEEN D1 & D2
- 6 SIGMA-T DIFFERENCE BETWEEN D1 & D2
- 7 TEMP AVERAGE BETWEEN D1 & D2
- 8 SALIN AVERAGE BETWEEN D1 & D2
- 9 SIGMA-T AVERAGE BETWEEN D1 & D2
- 10 DYNAMIC HEIGHT BETWEEN D1 & D2
- 11 DEPTH OF A SIGMA-T SURFACE
- 12 TEMPERATURE OF A SIGMA-T SURFACE
- 13 SALINITY OF A SIGMA-T SURFACE
- 14 MIXED LAYER DEPTH (MLD)

Options 1-3 require entry of depth D, and options 4-10 require upper depth D1 and lower depth D2. A "-1" entered for a depth D or D1 means the topmost depth of the cast and "-2" for D or D2 means deepest depth. Options 11-13 require entry of a σ_t value of the isopycnal.

If option 14 is selected, the user must enter...

- 1 FOR MLD DEFINED BY SIGMA-T DIF, TOP TO DEP
- 2 FOR MLD DEFINED BY SIGMA-T GRADIENT PER M
- 3 FOR MLD DEFINED BY TEMP DIF, TOP TO DEP

That is, 1 gives the depth D at which σ_t exceeds σ_t at the surface by a given amount, 2 gives the depth D at which σ_t exceeds σ_t at D-1 by a given amount, and 3 gives the depth D at which the temperature difference between the surface and D exceeds a given amount.

Once the option number and required input have been entered, R2D2 asks for verification.

If option = 10 and D1 = -1 the user has the choice of whether or not to extrapolate to the surface if the actual topmost depth of the cast is below the surface. Extrapolated values are indicated by a "*", and are computed by assuming that the temperature and salinity values above the topmost depth are equal to those at the topmost depth.

Finally, the user has the option of whether to print on the terminal or only on TAPE6 (see II-C-1-h). R2D2 then proceeds to compute the requested parameter for each station, as well as the mean and standard deviation for the entire set. The station parameters may then be plotted on a chart if desired, as described in II-C-1-i.

Subroutine: DEPDATA

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

TYPE OF DATA OUTPUT ? 2
 ENTER OPTION? 1
 ENTER DEPTH D ? -1

 YOU HAVE SELECTED TEMP AT SURFACE
 IS THIS OK? Y
 DO YOU WANT TO PRINT ON YOUR TERMINAL ? Y
 YOU HAVE 45 STATIONS.
 DO YOU WANT TO PRINT ALL OF THEM? N
 TYPE IN NUMBERS I,J,K TO LIST EVERY K-TH STATION
 FROM I THRU J
 ? 1,45,5

REF.	CRUISE	STA.	TEMP AT SURFACE	
29	RP4SUB00AL4	NA-5	11.08	0.
34	RP4SUB00AL4	NA-10	10.89	0.
39	RP4SUB00AL4	NA-13	9.59	0.
44	RP4SUB00AL4	NA-18	8.49	0.
49	RP4SUB00AL4	NA-26	10.11	0.
54	RP4SUB00AL4	NA-29	9.27	0.
59	RP4SUB00AL4	NA-40	10.68	0.
64	RP4SUB00AL4	NA-35	8.98	0.
69	RP4SUB00AL4	NA-43	9.56	0.

MEAN = 9.89 STANDARD DEVIATION = .86
 DONE
 DO YOU WANT A PLOT?

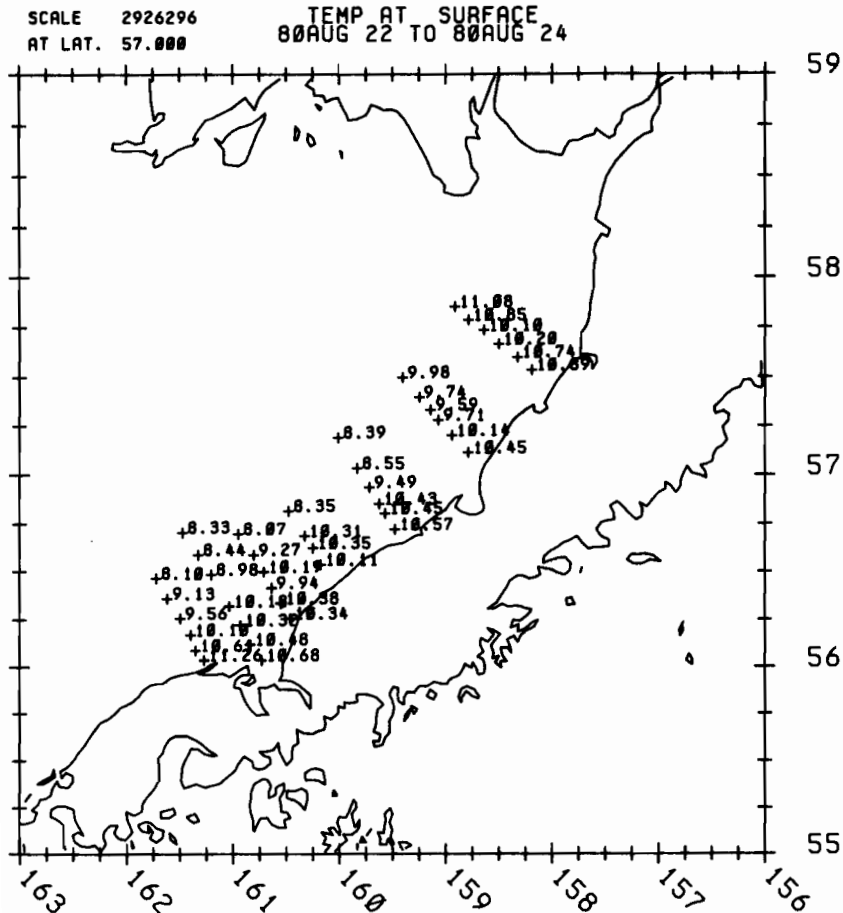


Figure 9. Hydrographic data distributions.

II-C-3-c Profiles (fig. 10)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT DO YOU WANT TO DO? 6 (II-C-1)
TYPE OF DATA OUTPUT: 3 (II-C-3)

This option plots temperature, salinity and sigma-t versus depth, or Brunt-Väisälä frequency (N) versus depth. If more than 2 records have been selected, R2D2 prints...

YOU HAVE (n) STATIONS, DO YOU WANT TO DO THEM ALL?

If the answer is no, the program returns to the main subroutine (II-C-3). Otherwise it continues...

PROFILE TYPE, MAXIMUM DEPTH?

Profile type 1 gives the T, S, σ_t vs depth plot and type 2 gives N vs depth. Maximum depth is the maximum depth, in meters, to which the cast will be plotted. Enter a -2 for actual cast depth. The plot will be scaled to depths of 40, 80, 200, 400, 800, 1600, 3200, or 6400 meters, whichever is greater than or equal to the entered depth.

The Brunt-Väisälä frequency in cycles per hour is calculated from

$$N = \left(\frac{g}{\rho_0} \frac{\delta\rho}{\delta z} \right)^{\frac{1}{2}} \frac{3600}{2\pi}$$

where $g = \text{gravity} = 980 \text{ cm s}^{-2}$

ρ_0 reference density = 1.026 gm cm^{-3}

$\frac{\delta\rho}{\delta z}$ = the density gradient at depth z , estimated from a least square fit of σ_t over $z \pm 5 \text{ m}$. The sign of N depends on the sign of $\frac{\delta\rho}{\delta z}$. In the program the algorithm is

$$N \cong \left(\frac{g}{\rho_0} \frac{\Delta\sigma_t/1000}{100\text{cm}} \right)^{1/2} \frac{3600}{2\pi} = 56 (\Delta\sigma_t)^{1/2} \text{ cph.}$$

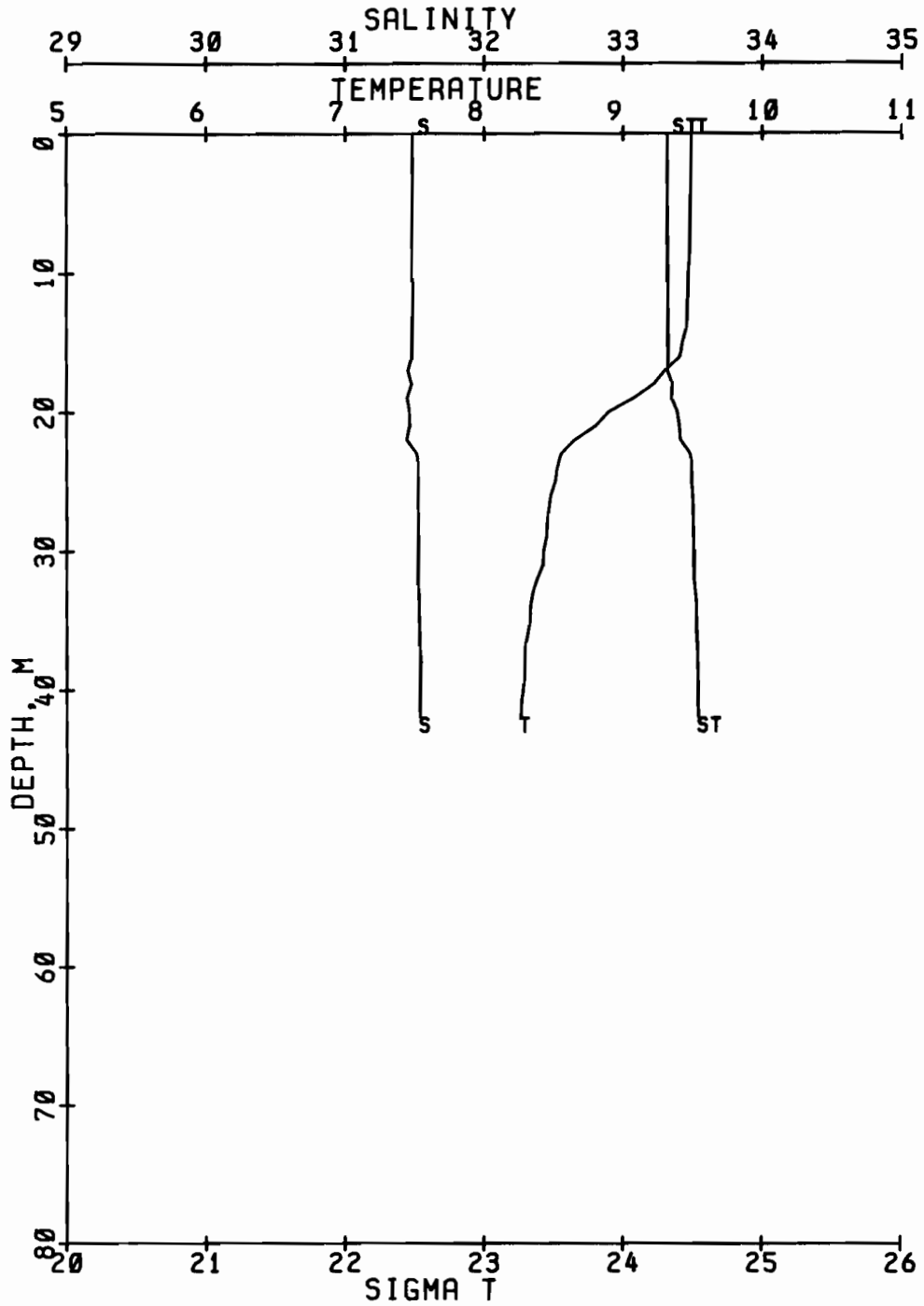
where $\Delta\sigma_t$ is the slope of the least square fit.

Subroutine: PROFILE

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

TYPE OF DATA OUTPUT ? 3
 PROFILE TYPE, MAXIMUM DEPTH ? 1,-2
 DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?



REF. NO. 45 2720 STA. NA-19 56.94 N
 TIME = 802360710 RP4SU80AL4-45 159.72 W

Figure 10. Hydrographic data profile.

II-C-3-d Time series profiles (fig. 11)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT DO YOU WANT TO DO? 6 (II-C-1)
TYPE OF DATA OUTPUT: 4 (II-C-3)

This option plots temperature, salinity, density or Brunt-Väisälä frequency of one or more records on a single plot. This is especially useful for time series stations, i.e. several casts at the same location. Plots may be on top of each other or separated by a specified offset. R2D2 will ask...

PARAMETER, PLOT HEIGHT, DEPTH SCALE, OFFSET?

where

PARAMETER = 1 FOR TEMPERATURE
 2 FOR SALINITY
 3 FOR SIGMA-T
 4 FOR BRUNT-VÄISÄLÄ FREQUENCY

PLOT HEIGHT = DEPTH AXIS IN INCHES

DEPTH SCALE = METERS/INCH

OFFSET = INCHES BETWEEN PROFILES

Total depth = (plot height) x (depth scale). For parameters 1, 2, and 3, one inch offset = one unit. For parameter 4, one inch offset = 10 cph. (see II-C-3-c for description of the Brunt-Väisälä frequency algorithm.)

Subroutine: PROFILS

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

TYPE OF DATA OUTPUT ? 4
 PARAMETER, PLOT HEIGHT, DEPTH SCALE, OFFSET ? 1,6,10,.5
 YOU HAVE SELECTED TEMP., C PROFILES FOR 6 STATIONS
 PLOT HEIGHT = 6. INCHES, LENGTH = 9.
 MAXIMUM DEPTH = 60. METERS
 OFFSET = .50 INCHES
 IS THIS OK? Y
 DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

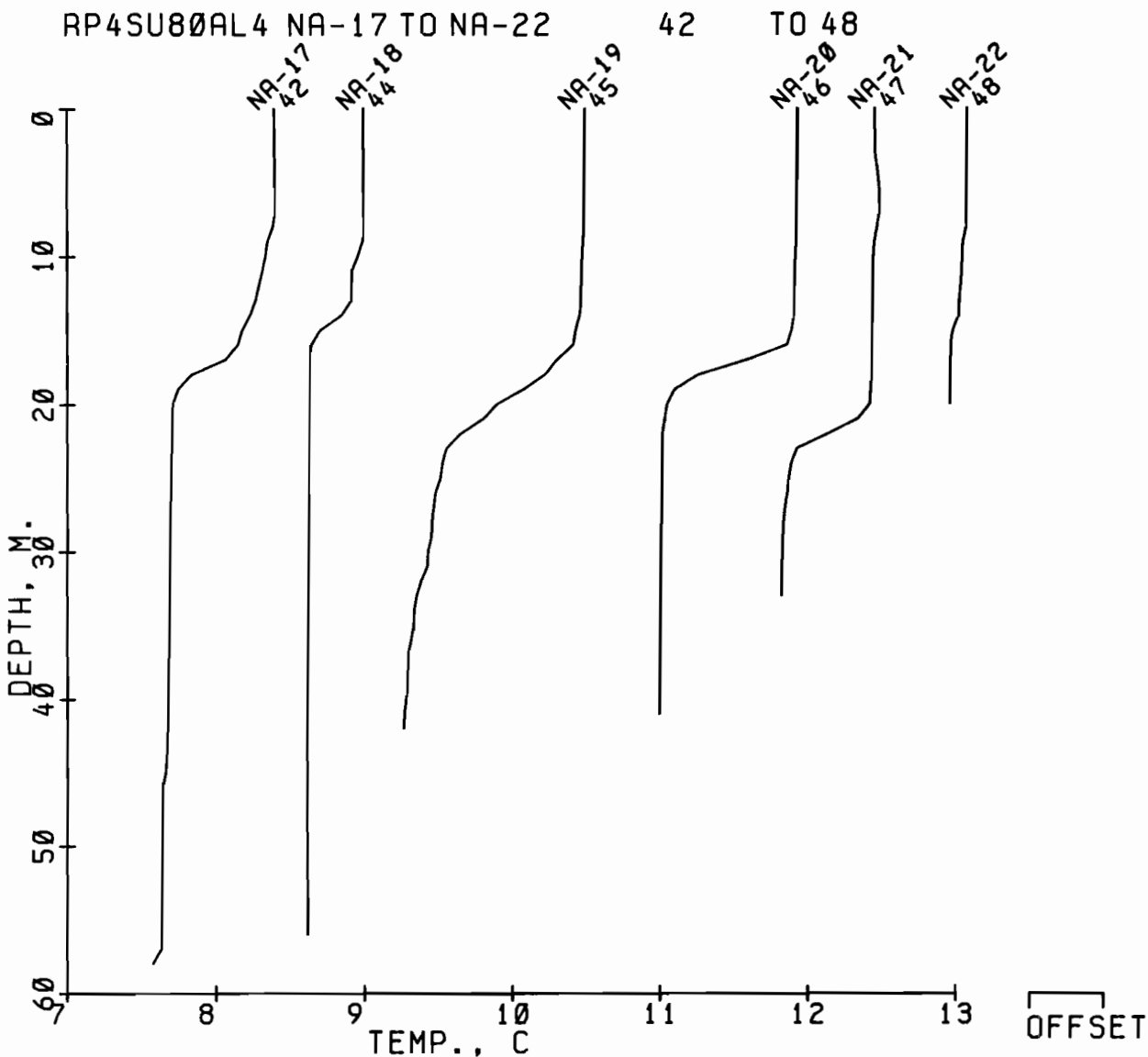


Figure 11. Hydrographic data time series profile.

II-C-3-e T-S diagrams (fig. 12)

DATA TYPE: S (II-B)
SORT OPTION: 0 (II-C-1)
WHAT WOULD YOU LIKE TO DO? 6 (II-C-1)
TYPE OF DATA OUTPUT: 5 (II-C-3)

T-S diagrams are plots of temperature vs. salinity, with lines of equal density superimposed. Options available include: all stations on the same plot or each on a different plot; variable temperature and salinity scales; depth ticks; and variable maximum depth. The routine will begin...

ENTER 0 TO ESCAPE

1 FOR ALL ON THE SAME PLOT

2 FOR INDIVIDUAL PLOTS

and then...

DO YOU WANT THE DEFAULT TS DIAGRAM?

The default plot is a rectangle 9 inches (temperature axis, -2°C to 16°C) by 6 inches (salinity axis, $24^{\circ}/\text{oo}$ to $36^{\circ}/\text{oo}$), to the deepest depth, with no depth tick marks. If the default is not desired, R2D2 continues...

ENTER: TMIN, DT, TLEN, SMIN, DS, SLEN, DMAX, TICKS

where...

TMIN = MINIMUM TEMP
DT = DEGREES/INCH ON PLOT
TLEN = LENGTH OF TEMP AXIS, INCHES
SMIN = MINIMUM SALINITY
DS = PPT/INCH ON PLOT
SLEN = LENGTH OF SALINITY AXIS, INCHES
DMAX = MAXIMUM DEPTH (-2 GIVES BOTTOM)
TICKS = INTERVAL (METERS) OF DEPTH TICKS
(TICKS = 0 MEANS NO TICKS)

After asking for an "OK" on the input parameters, the plots are computed. If the data exceed the specified plot boundaries a "*" is plotted at the boundary.

Subroutine: TS

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

```

TYPE OF DATA OUTPUT ? 5
YOU HAVE 6 STATIONS
ENTER 0 TO ESCAPE
    1 FOR ALL ON THE SAME PLOT
    2 FOR INDIVIDUAL PLOTS
? 2
DO YOU WANT THE DEFAULT TS DIAGRAM? N
ENTER: TMIN,DT,TLEN,SMIN,DS,SLEN,DMAX,TICK
? 7,.5,6,30,.5,6,-2,0
TEMP RANGE IS 7.0 TO 10.0
SALIN RANGE IS 30.0 TO 33.0
ON A 6.0 BY 6.0 INCH PLOT
MAXIMUM DEPTH = -2.
NO DEPTH TICKS
IS THIS OK? Y
STATION 42
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

```

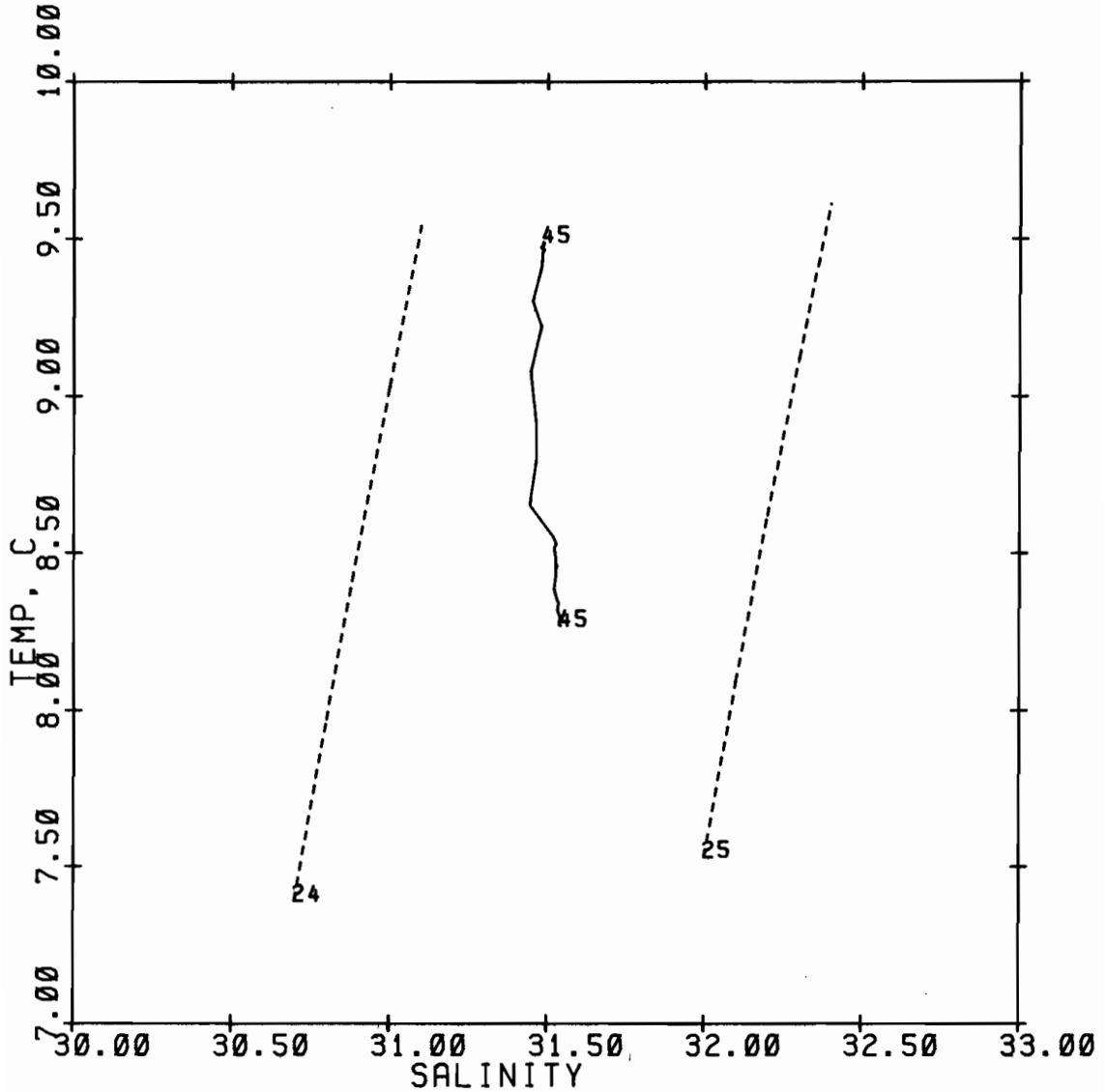


Figure 12. Hydrographic data temperature-salinity diagram.

II-C-3-f Transections (fig. 13)

DATA TYPE: S	(II-B)
SORT OPTION: 0	(II-C-1)
WHAT WOULD YOU LIKE TO DO? 6	(II-C-1)
TYPE OF DATA OUTPUT: 6	(II-C-3)

This option plots vertical sections of temperature, salinity or sigma-t for a selected line of stations. After selecting the parameter to plot, R2D2 prints...

ENTER PLOT HEIGHT, LENGTH (IN INCHES), SCALE, DEPTH INTERVAL (METERS/INCH ON Y AXIS), AND DATA CONTOUR INTERVAL

NOTE: IF SCALE IS 0, SCALE IS COMPUTED FROM LENGTH.

IF SCALE IS GIVEN, LENGTH IS COMPUTED FROM SCALE.

The station spacing is determined by the distance between individual stations. Thus if the line of stations is not straight, the distance between nonadjacent stations may be misrepresented. The maximum depth plotted is the product of the plot height and depth interval, e.g., a plot height of 6 and a depth interval of 20 gives a total depth of 120 m. Scale is the ratio of real distance to plot distance, so that a scale of 100,000 means 1 cm = 1 km. The data contour interval is the interval at which values will be plotted for contouring. For example, if the data contour interval is 0.1, an annotation will be made at each depth where the parameter increases or decreases by 0.1. Surface and bottom values are also plotted, and a "*"

is plotted at the station bottom depth. When reversals are encountered, i.e., the same value as before is found, a tick mark is made but the value number is not plotted. Parameter values and depths are also written on TAPE6.

Subroutine: SECTION

Called from: DATLOOK (II-C-3)

Program: STDMAIN (II-C)

TYPE OF DATA OUTPUT ? 6
 ENTER: 1 FOR TEMP, 2 FOR SALINITY, 3 FOR SIGMA T
 OR 0 TO ESCAPE
 ? 1
 ENTER PLOT HEIGHT, LENGTH (IN INCHES), SCALE,
 DEPTH INTERVAL (METERS/INCH ON Y AXIS),
 AND DATA CONTOUR INTERVAL
 NOTE: IF SCALE IS 0, SCALE IS COMPUTED FROM LENGTH,
 IF SCALE IS GIVEN, LENGTH IS COMPUTED FROM SCALE
 ? 6, 6.0, 10, .5
 YOU HAVE 6 STATIONS ON A 6.0" HIGH
 BY 6.0" LONG PLOT; MAXIMUM DEPTH IS 60.M
 TEMP CONTOUR INTERVAL IS .50
 SCALE = 409190.
 IS THIS OK? Y

42 DEPTH TEMP
 0.0 8.39 17.5 8.00
 44 DEPTH TEMP
 0.0 8.49
 45 DEPTH TEMP
 0.0 9.49 19.5 9.00 25.5 8.50
 46 DEPTH TEMP
 0.0 10.43 17.5 10.00 38.5 9.50 39.5 9.50 40.5 9.50
 47 DEPTH TEMP
 0.0 10.45 22.5 10.00
 48 DEPTH TEMP
 0.0 10.57 14.5 10.50
 DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

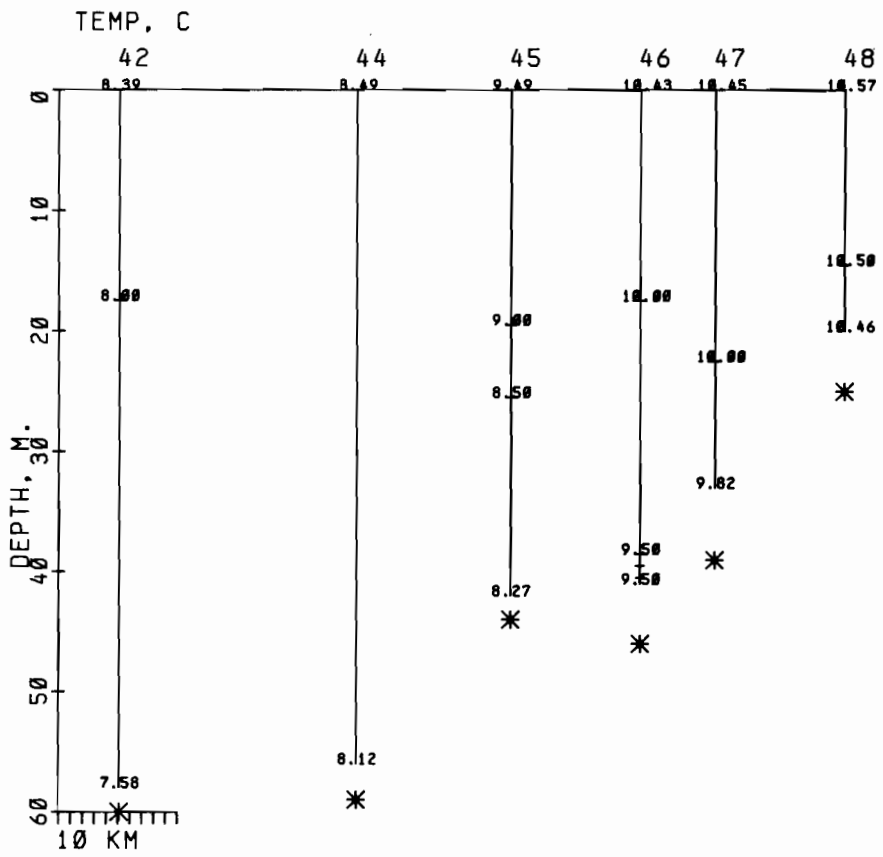


Figure 13. Hydrographic data transection.

II-D THE CURRENT METER/PRESSURE GAUGE PROGRAMS

The current meter/pressure gauge data analysis and display package consists of three main programs: CMSORT, which does the sorting, listing, and plotting of the header information; CMLOOK, which contains routines for data listing, statistics, time series plots, progressive vector diagrams, scatter diagrams, histograms, current roses, summary current vector plots, correlations, empirical orthogonal functions, and writing data to TAPE4; and SPECT, which does scalar and rotary autospectral and cross spectral analysis, and 29-day harmonic tide analysis. Program CMSORT corresponds to subroutine SORTSTA in STDMAIN, and CMLOOK and SPECT correspond to subroutine DATLOOK. The current meter routines have been divided into three separate programs because of the greater amount of central memory required by larger arrays and more subroutines. Control registers set from within the programs allow the procedure file to transfer between the three programs.

II-D-1 SORTING CURRENT METER/PRESSURE GAUGE FILES

DATA TYPE: C

(II-B)

Current meter Master Header files contain a large number of records, and even User Data Files often contain more records than one wants to examine at one sitting. Therefore it is necessary to have a means of sorting the file to obtain a subset containing the desired records. For example, the user may be interested only in records from a particular geographical area, or time period, or from a certain instrument. Program CMSORT provides the means for doing the sorting, and also for summary listings of file contents, plotting of station locations, writing a User Data File, and for transfer to the data analysis and display programs CMLOOK and SPECT.

The most efficient method of sorting is by reference number, either reference number range (option 3) or selection of individual reference numbers (option 2). This is because the files are random access with data storage locations keyed to the reference number (see IV-B-1); and therefore the specified records may be retrieved directly. This is the sort method most often used, since the user, having previously obtained a summary listing of the file contents, generally knows the reference numbers of the desired records.

CMSORT begins by asking...

ENTER SORT OPTION?

The options are...

- 99 = CLEAR PREVIOUS OPTIONS
- 1 = LIST OPTIONS CURRENTLY SELECTED
- 0 = END ENTERING OPTIONS AND SORT
- 1 = SUMMARY LISTING OF HEADER FILE (II-D-1-a)
- 2 = GET INDIVIDUAL RECORDS BY REFERENCE NUMBER (II-C-1-b)
- 3 = SORT BY REFERENCE NUMBER RANGE (II-C-1-c)
- 4 = SORT BY LATITUDE AND LONGITUDE (II-C-1-d)
- 5 = SORT BY JULIAN DATE (II-C-1-e)
- 6 = SORT BY GREGORIAN DATE (II-C-1-e)
- 7 = SORT BY DEPTH RANGE (II-C-1-f)
- 8 = SORT BY PROJECT NAME (II-D-1-b)
- 9 = SORT BY MOORING NAME (II-D-1-b)
- 10 = SORT BY METER NAME (II-D-1-b)
- 11 = ADD YOUR TAPE4 FILES (II-D-1-c)

Options 3-10 set up keys which are used for sort criteria. These options are described in the referenced sections. Option -99 clears previously set sort keys. Option -1 lists the currently selected keys.

Selection of option 0 ends the entering of sort options and initiates sorting, if any of the sort keys have been set. The number of records which have been selected is printed...

(n) RECORDS HAVE BEEN SELECTED

WHAT DO YOU WANT TO DO?

The options now are...

- 0 END R2D2 SESSION (II-E)
- 1 LIST RECORDS SELECTED (II-D-1-a)
- 2 PLOT MOORING LOCATIONS (II-D-1-d)
- 3 RESORT
- 4 SORT AGAIN, KEEPING STATIONS ALREADY SELECTED
- 5 WRITE SELECTED RECORDS FROM MASTER FILE TO PF (II-C-2)
- 6 DATA PLOTS, LISTINGS, CORRELATIONS, EOF, ETC (II-D-2)
- 7 SPECTRAL, TIDE ANALYSIS (II-D-3)

Option 3 clears the sort keys and previously selected records, and restarts the sort process. Option 4 also clears the sort keys, but retains the records previously selected.

Options 6 and 7 transfer to the CMLOOK and SPECT routines respectively. The user may return to this point (WHAT DO YOU WANT TO DO?) by selecting option 99 in those programs. Selection of 6 or 7 is possible only if a Data File or TAPE4 is attached. If 6 or 7 are selected when a Master Header Files is attached, R2D2 will print...

MASTER FILES DO NOT CONTAIN DATA

...and request another option.

In the special case when FILE = 0 (II-B), user selection of sort options is skipped, and sort option 11 automatically selected.

Program: CMSORT

II-D-1-a Summary listing of header file (fig.14)

or LIST RECORDS SELECTED

DATA TYPE: C (II-B)

SORT OPTION: 1 or 0 (II-D-1)

WHAT DO YOU WANT TO DO? 1 (II-D-1)

This option does a short or complete listing of the header information for either the complete file or the selected records. The short, or summary, list option prints: the reference number; mooring name; meter number; meter depth; start and end times and length of the 2.86-hr filtered data; latitude; longitude; mooring depth; master reference number; and comments, if any. The complete list includes the above plus information on the 35-hr filtered data and some statistics (calculated during initial loading of the data - see IV-B-2). This expanded listing takes 15 lines per record, or 4 records per page. R2D2 will print...

ENTER LIST OPTION?

the options are...

ENTER 0 TO ESCAPE

1 FOR A SUMMARY LISTING

2 FOR A COMPLETE LISTING

ENTER A NEGATIVE NUMBER TO SUPPRESS TERMINAL LISTING

Subroutine: CMHSUM

Program: CMSORT (II-D-1)

ENTER SORT OPTION ? 1
 ENTER LIST OPTION ? 1

REF	MOORING	METER	DEP	START	END	LEN	LAT	LOM	DEP	MREF
1	UP-1	1811	64	800821400	802292100	3536	54.56	165.40	84.	42
2	UP-2	1827	59	800821000	802291700	3536	54.30	164.76	80.	43
3	UP-3	1815	47	800820400	802291300	3538	54.16	164.01	69.	44
4	TP3A	N99	5	802320500	802461200	344	56.40	161.66	654.	46
5	TP3A	N98	10	802320500	802461200	344	56.40	161.66	654.	47
6	TP3A	N90	15	802320500	802461200	344	56.40	161.66	654.	48
7	TP3A	N89	19	802320500	802461200	344	56.40	161.66	654.	49
8	TP3A	N100	29	802320500	802461200	344	56.40	161.66	654.	50
9	TP3A	N87	39	802320500	802461200	344	56.40	161.66	654.	51
10	TP3A	N88	50	802320500	802461200	344	56.40	161.66	654.	52

ENTER LIST OPTION ? 2

DATA SET 1 UNIMAK PAS UP-1 1811 64 MASTER REF.= 42
 LAT, LONG, BOTDP= 54.56 165.40 84.00

2.86 HR START-STOP, NUMBER OF POINTS= 800821400 - 802292100 3536
 35.0 HR START-STOP, NUMBER OF POINTS= 800830600 - 802270600 569

	TEMPERATURE	PRESSURE	SALINITY	2.86 HR SPD	35.0 HR SPD
MEANS =	4.18	170.21	29.03	35.85	9.18
VARIANCES =	.57	1.32	.07	317.93	48.93
MINIMUMS =	2.76	166.70	28.21		
MAXIMUMS =	6.61	173.65	31.34		
DRIFTS =				5.64 @ 312.0	5.77 @ 311.2

Figure 14. Summary listing of CM/PG file contents and list of records selected.

II-D-1-b Sort by project name

" " mooring name

" " meter number

DATA TYPE: C (II-B)

SORT OPTION: 8,9,10 (II-D-1)

Options 8, 9 and 10 allow sorting by project name, mooring name, or meter number, respectively. Up to 5 names may be selected for each option, but they must match exactly those in the headers. If the exact name is unknown, sort option 1 (II-D-1-a) may be used to get a list. To end entering names, type in the word "END". R2D2 will ask for an OK on the entered names before returning.

Subroutine: NAMSORT

Program: CMSORT (II-D-1)

II-D-1-c Add your TAPE4 files

DATA TYPE: C (II-B)

SORT OPTION: 11 (II-D-1)

This option permits the use of current meter, pressure gauge or wind data which are not in the R2D2 data files. To use this option, TAPE4 must have been made a local file prior to beginning R2D2. If only TAPE4 files are to be used, enter 0 for "FILE?" (II-B) and this option will be automatically selected. There may be any number of records on TAPE4, but only one file. The TAPE4 format is described in II-D-4

Subroutine: SET4

Program: CMLOOK

II-D-1-d Plot mooring locations (fig. 15)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 2 (II-D-1)

This option plots station locations on a mercator chart (II-F-1) with user defined map boundaries (II-C-1-d). Locations are denoted by a "*". If the station location is outside the map boundaries it is not plotted.

Subroutine: MORPLT

Program: CMSORT

WHAT DO YOU WANT TO DO? 2
ENTER: LAT1,LAT2,LON1,LON2
? 53,55,163,167

AREA IS BOUNDED BY:
LATITUDES 53.00 TO 55.00
LONGITUDES 163.00 TO 167.00
IS THIS OK? Y
WHICH MAP FILE? 2
ENTER SCALE,ATLAT,TIC,YLEN
? 0,0,.25,6
SCALE = 1461066. AT LATITUDE 54.000
TIC MARKS EVERY .25 DEGREE
CHART HEIGHT = 6.00, LENGTH = 7.07
IS THIS OK? Y
ARE YOU USING A TEKTRONIX TERMINAL? Y
ENTER BAUD RATE ? 300
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ? Y

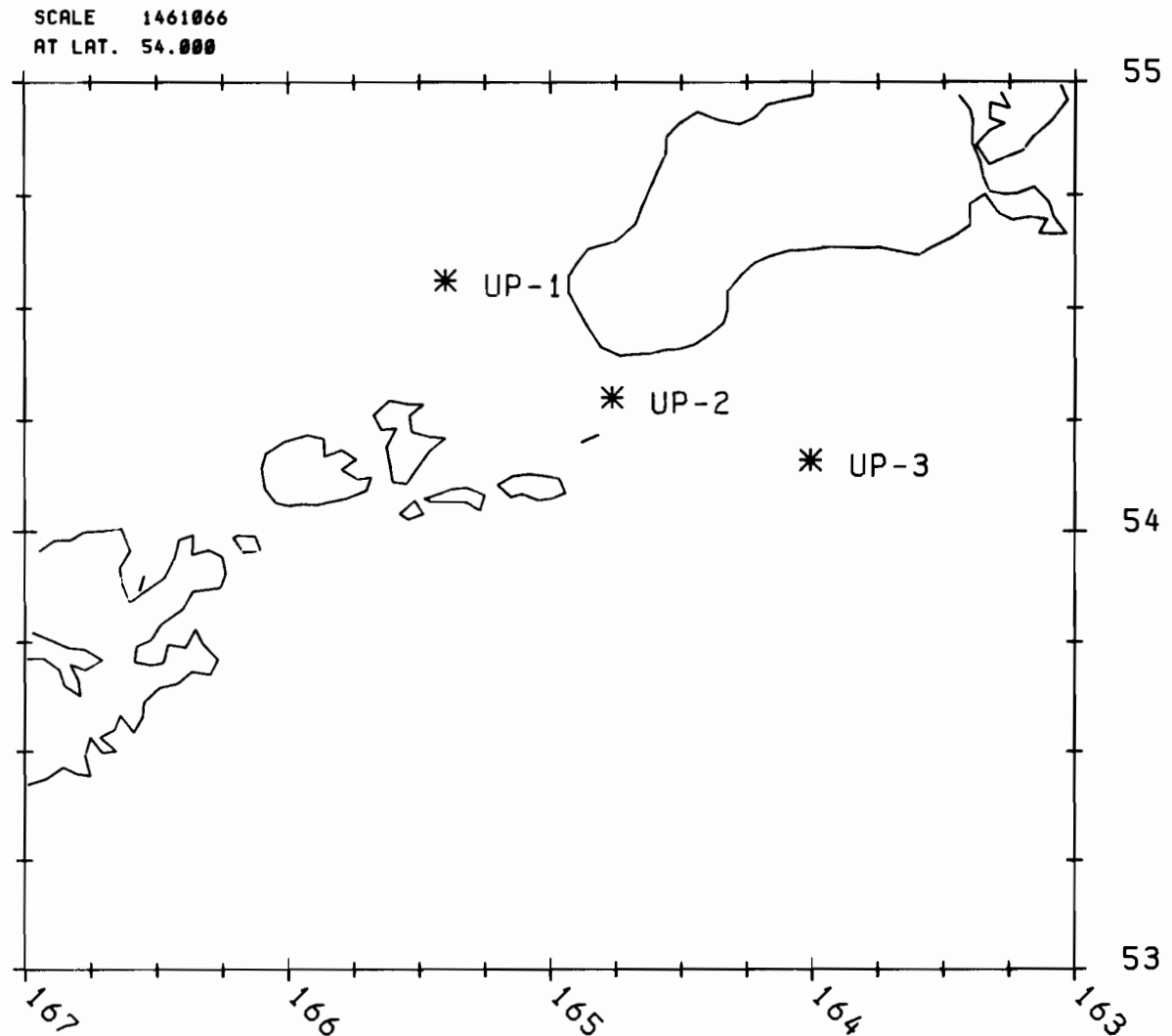


Figure 15. Plot of CM/PG mooring locations.

II-D-2 DATA PLOTS, LISTINGS, CORRELATIONS, EOF, ETC

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)

Having sorted a User Data File, the user may access the current meter/pressure gauge data analysis and display program CMLOOK. This program contains routines for a large variety of products, including data listings, summary statistics, time series plots, scatter diagrams, progressive vector diagrams, histograms, current roses, summary current vectors, lagged linear correlations, and empirical orthogonal functions. It also provides a means of writing selected records from the User Data File to a permanent file in the TAPE4 format. If resorting is necessary, or to access the spectral and tide analysis program SPECT (II-D-e), the user may return to CMSORT (II-D-1) by entering option 99.

CMLOOK begins with...

ENTER DATA OPTION?

and the options are...

0 = END R2D2	(II-E)
1 = DATA LISTINGS	(II-D-2-a)
2 = STATISTICS ON DATA SEGMENTS	(II-D-2-b)
3 = TIME SERIES PLOTS (ALL PARAMETERS, ONE RECORD)	(II-D-2-c)
4 = TIME SERIES PLOTS (ONE PARAMETER, ALL RECORDS)	(II-D-2-d)
5 = UV SCATTER DIAGRAMS	(II-D-2-e)
6 = PVD PLOTS	(II-D-2-f)
7 = HISTOGRAMS	(II-D-2-g)
8 = CURRENT ROSES	(II-D-2-h)
9 = SUMMARY CURRENT VECTORS	(II-D-2-i)
10 = LAGGED LINEAR CORRELATIONS	(II-D-2-j)
11 = EMPIRICAL ORTHOGONAL FUNCTIONS (EOF)	(II-D-2-k)
12 = EOF WITH USER SUPPLIED MATRIX	(II-D-2-k)
13 = WRITE DATA TO TAPE4	(II-D-2-l)
99 = RESORT, LIST, PLOT ETC HEADER INFO	

Options 1-13 are described in the following sections. After each option is completed, the program returns to "ENTER DATA OPTION". Selection of option 99 returns to CMSORT at "WHAT DO YOU WANT TO DO?" (see II-D-1).

Program: CMLOOK

II-D-2-a Data listings (fig. 16)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 1 (II-D-2)

After asking for filter type and start and end times (see II-D-2-m) and major axis direction (II-D-2-o), R2D2 will print...

LIST OPTION?

The options are...

0 TO ESCAPE

1 FOR FULL DATA LIST

2 FOR AVERAGES

3 FOR BOTH 1 AND 2

(USE NEGATIVE NUMBER TO SUPPRESS TERMINAL OUTPUT)

Option 1 provides a complete list of all data on the record. This includes: time; hourly component speeds; vector speed and direction; temperature; pressure and salinity for 2.86-hr filtered current meter data; and 6-hourly component speeds and vector speed and direction for the 35-hour filtered data. Weather data substitutes wind gust for salinity. Pressure gauges have pressure in millibars and some have temperature. TAPE4 data may contain some or all of the above parameters.

Option 2 prints only averages computed for a specified time period. If option 2 or 3 is selected, R2D2 will ask...

HOW MANY HOURS DO YOU WANT TO AVERAGE?

Averaging is done over this time interval, starting at the specified start time. Averages are also computed for the entire record length.

If terminal output was not suppressed by entering a negative option number, R2D2 will estimate the number of lines of output which will be printed on the terminal. If there will be over 200 lines, R2D2 will ask if the user wants to reconsider. If so, the parameters may be reentered.

Subroutine: CMDAT

Program: CMLook (II-D-2)


```

ENTER DATA OPTION ? 1
1 UP-1 1811 64
FILTER TYPE ? 1
START,END=800821400 802292100 LEN=3536
NEW START, END TIME ? 0,800822400
NEW START,END=800821400 800822400 LEN=11
MAJOR AXIS DIRECTION? 0
LIST OPTION ? 3
HOW MANY HOURS DO YOU WANT TO AVERAGE ? 6

```

```

UP-1 1811 DEPTH = 64 LAT = 54.56 LON = 165.40
AVERAGING INTERVAL = 6. HOURS

```

TIME	90 T	0 T	TEMP	PRESS	SAL	SPEED	DIR	TIME
800821400	12.0	3.3	3.36	172.58	28.96	12.5	74.7	
800821500	6.2	24.5	3.44	172.56	29.03	25.2	14.2	
800821600	-11.4	42.4	3.35	172.83	28.96	43.9	345.0	
800821700	-20.8	53.5	3.29	173.27	28.92	57.4	338.7	
800821800	-11.8	53.7	3.28	173.62	28.88	54.9	347.6	
800821900	2.7	37.5	3.29	173.62	28.88	37.6	4.1	
MEANS, 800821400 TO 800821900								
	-3.8	35.8	3.33	173.08	28.94	38.6		
				NET VELOCITY =		36.0	353.9	T
800822000	15.6	9.1	3.27	173.65	28.90	18.1	59.9	
800822100	24.0	-19.0	3.22	173.62	28.87	30.6	128.4	
800822200	31.5	-46.0	3.19	172.97	28.86	55.7	145.6	
800822300	38.5	-67.6	3.33	172.24	28.99	77.8	150.3	
MEANS, 800822000 TO 800822400								
	28.6	-39.3	3.30	172.83	28.94	52.5		
				NET VELOCITY =		48.7	144.0	T
MEANS, 800821400 TO 800822400								
	10.9	1.6	3.32	172.96	28.94	44.9		
				NET VELOCITY =		11.0	81.5	T

Figure 16. CM/PG data listing.

II-D-2-b Statistics on data segments (fig. 17)

DATA TYPE: C (II-B)
 SORT OPTION: 0 (II-D-1)
 WHAT DO YOU WANT TO DO? 6 (II-D-1)
 DATA OPTION: 2 (II-D-2)

After asking for time period and filter type (II-D-2-m) and major axis direction (II-D-2-o), this routine computes the mean, minimum, maximum, standard deviation, variance, skewness, and kurtosis for each parameter. If the input series is not pressure gauge data, it goes on to compute net velocity and direction and the axis of greatest variance.

The statistics are computed as follows:

$$\text{mean} = \bar{x} = \frac{1}{n} \sum_{i=1}^n x_i$$

$$\text{maximum} \geq x_n$$

$$\text{minimum} \leq x_n$$

$$\text{standard deviation} = s = \left(\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n} \right)^{\frac{1}{2}}$$

$$\text{variance} = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$$

$$\text{skewness} = \frac{\sum_{i=1}^n (x_i - \bar{x})^3 / n}{s^3}$$

$$\text{kurtosis} = \frac{\sum_{i=1}^n (x_i - \bar{x})^4 / n}{s^4}$$

$$\text{net velocity} = (\bar{u}^2 + \bar{v}^2)^{\frac{1}{2}} \quad u = \text{east}, v = \text{north}$$

$$\text{direction} = \tan^{-1} (\bar{u} / \bar{v})$$

The axis of greatest variance is defined by the first mode eigenvector of the velocity component covariance matrix. The variance on the axis of greatest variance is the first mode eigenvalue. (See also the EOF option description, II-D-2-k)

Subroutine: DATSTAT

Program: CMLOOK (II-D-2)

```

ENTER DATA OPTION ? 2
1 UP-1 1811 64
FILTER TYPE ? 1
START,END=800821400 802292100 LEN=3536
NEW START, END TIME ? 0,0
NEW START,END=800821400 802292100 LEN=3536
MAJOR AXIS DIRECTION? 300

```

```

UP-1 1811 64 800821400 TO 802292100 LEN = 3536 2.9 FILTER DATA

```

PARAMETER	MEAN	MINIMUM	MAXIMUM	ST DEV	VARIANCE	SKEWNESS	KURTOSIS
30 T	1.18	-62.00	56.05	22.72	516.26	.13	2.22
300 T	5.52	-83.08	81.22	32.49	1055.29	-.47	2.48
TEMP	4.18	2.76	6.61	.76	.57	.26	2.04
PRESS	170.21	166.70	173.65	1.15	1.32	-.48	2.95
SAL	29.03	28.21	31.34	.26	.07	-.29	5.08
SPEED	35.85	.75	91.25	17.83	317.93	.43	2.56

```

NET VELOCITY = 5.64 AT 312.0T
AXIS OF GREATEST VARIANCE = 330.2 T
VARIANCE = 1332.58 = 84.79 0/0

```

Figure 17. CM/PG data statistics.

II-D-2-c Time series plots (all parameters, one record) (fig. 18)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 3 (II-D-2)

This option does time series plots. For 2.86-hr current meter data this includes major and minor axes, speed, temperature, pressure, and salinity. The 35-hr data plot has component speeds and stick (vector speeds) plots. Pressure gauge records plot pressure and temperature. TAPE4 records with only one parameter should be plotted with option 4 (II-D-2-d).

After asking for time period and filter type (II-D-2-m) R2D2 will ask for scale parameters...

DAYS PER INCH, SCALE?

Days per inch sets the time scale and the SCALE parameter sets the speed (or pressure in millibars for pressure gauge records) axis. Defaults, set by entering "0,0", are 2 days and 100 units per inch for 2.86-hr filtered data, and 2 days and 40 units per inch for 35-hr filtered data. (For wind data SCALE = 20 units per inch.)

Next the major axis direction is requested (II-D-2-o). If a parameter is not plotted, the user may infer that there is data of that type on the record.

Subroutine: TSPLT

Program: CMLOOK (II-D-2)

```

ENTER DATA OPTION ? 3
1 UP-1 1811 64
FILTER TYPE ? 1
START,END=80021400 802292100 LEN=3536
NEW START, END TIME ? 0,800920000
NEW START,END=80021400 800920000 LEN=227
DAYS PER INCH, SCALE? 2,100
MAJOR AXIS DIRECTION? 0
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

```

```

STATION: UP-1
PROJECT: UNIMAK PAS
LATITUDE: 54.56N
LONGITUDE: 165.40W
DEPTH: 84.0 METERS

METER: 1811
DEPTH: 64 METERS

MEAN SPEED: 33.78 CM/S
NET SPEED: 3.48 CM/S
DIRECTION: 261.8 T
VARIANCE: 1350.39

```

2.86 HOUR DATA PLOT

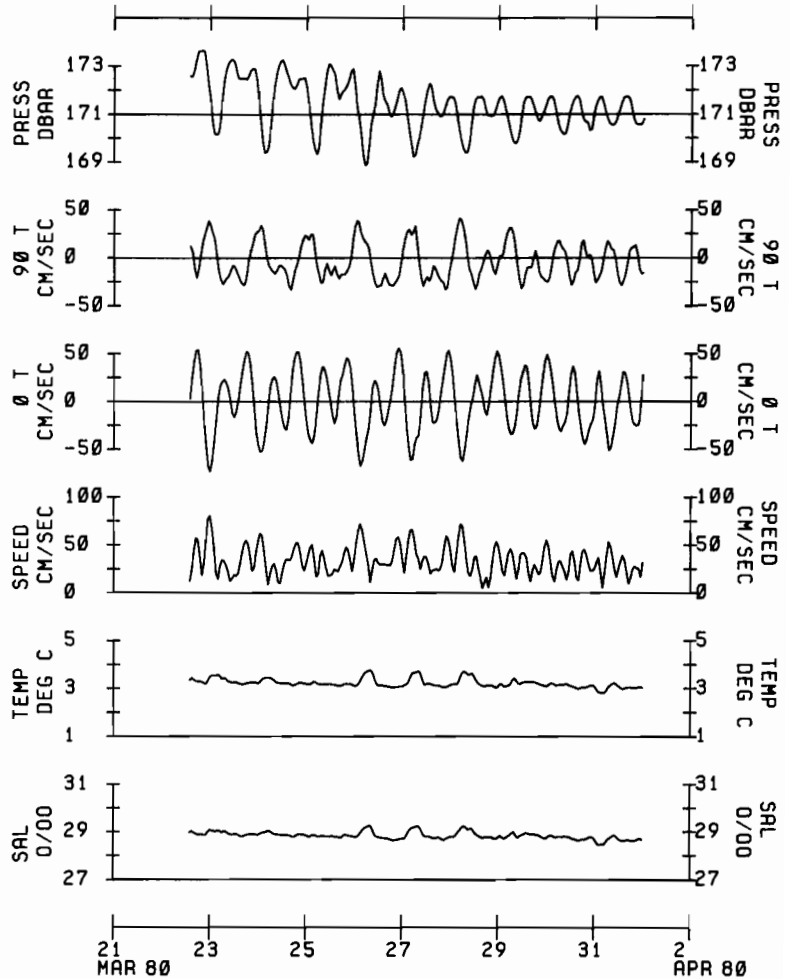


Figure 18. CM/PG data time series plots (all parameters for one record).

II-D-2-d Time series plots (one parameter, all records) (fig.19)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 4 (II-D-2)

This option does time series plots of one parameter for each record selected. Up to 20 records may be plotted at one time. To plot n parameters for a particular record, that record should be selected n times. For six or less records, plot height is 9.5 inches, and is plotted on 11-inch paper. More than six records are plotted on 34-inch paper. R2D2 first asks for time period and filter type (II-D-2-n), and then....

DAYS PER INCH?

which is the number of days per inch on the X (time) axis, entered as a whole number. Next R2D2 will ask for each record...

PARAMETER, SCALE?

where...

PARAMETER = 0 TO ESCAPE
1 FOR COMPONENT SPEED
2 FOR VECTORS (STICKS)
3 FOR TEMPERATURE

4 FOR PRESSURE

5 FOR SALINITY

6 FOR SPEED

7 FOR DIRECTION

SCALE = UNITS PER INCH ON Y AXIS

If the data are 35-hr filtered, 3, 4, and 5 are omitted. If the data are from a pressure gauge...

PARAMETER = 1 FOR PRESSURE

2 FOR TEMPERATURE

When current meter parameters 1 or 2 have been selected, the major axis direction (II-D-2-o) will also be requested. After each record has been processed, plotting proceeds (II-F-2). If a parameter is not plotted, it may be inferred that there is no data of that type on the record.

Subroutine: TSPLTS

Program: CMLook (II-D-2)


```

ENTER DATA OPTION ? 4
FILTER TYPE ? 2
YOUR FILES ARE:
UP-1      1811   64 800850600 TO 802270600 LEN= 569 DT= 6.00 HR
UP-2      1827   59 800850000 TO 802270000 LEN= 569 DT= 6.00 HR
UP-3      1815   47 800841800 TO 802262400 LEN= 570 DT= 6.00 HR
NEW START, END TIME ? 0,801200000
DAYS PER INCH ? 5
UP-1      1811 AT 64 M
PARAMETER, SCALE ? 2,50
MAJOR AXIS DIRECTION? 300
UP-2      1827 AT 59 M
PARAMETER, SCALE ? 2,50
MAJOR AXIS DIRECTION? 285
UP-3      1815 AT 47 M
PARAMETER, SCALE ? 2,50
MAJOR AXIS DIRECTION? 280
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ? Y

```

35.0 FILTER DATA

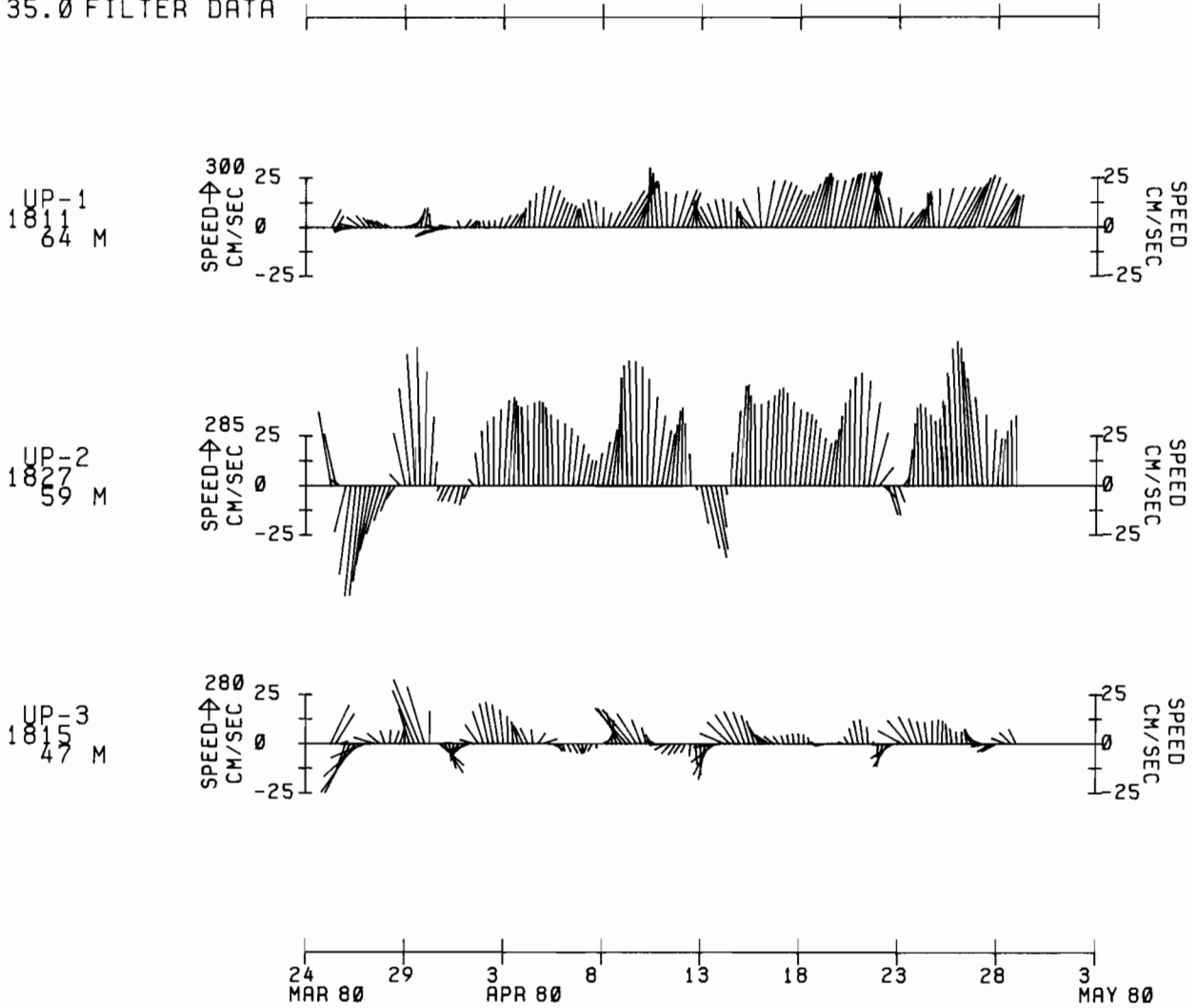


Figure 19. CM/PG data time series plots (one parameter for each record).

II-D-2-e U-V scatter diagrams (fig. 20)

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 6	(II-D-1)
DATA OPTION: 5	(II-D-2)

This routine does scatter plots of u (east-west) component velocity vs. v (north-south) component velocity. Two plot types are available: a linear scale (option 1), or a square root speed scale, which preserves area (i.e., the area of a quadrant of 0 to 10 cm s^{-1} is equal to the area of a 90 to 100 cm s^{-1} quadrant). The plots are self-scaled, depending on the maximum component speed of the record time period. The record mean vector is also computed and plotted.

The program first requests plot type, filter type, and desired time period (II-D-2-m) and then does the plot (II-F-2). Plot size is about 8 inches high x 6 inches wide.

Subroutine: SCAPLT

Program: CMLOOK (II-D-2)

ENTER DATA OPTION ? 5
PLOT OPTION ? 1
1 UP-1 1811 64
FILTER TYPE ? 2
START,END=800850600 802270600 LEN=569
NEW START, END TIME ? 0,801200000
NEW START,END=800850600 801200000 LEN=140
ARE YOU USING A TEKTRONIX TERMINAL?

UP-1 1811 AT 64M
FROM 800850600 TO 801200000
LAT 54.56N LON 165.40W
35. HR FILTER DATA N= 140

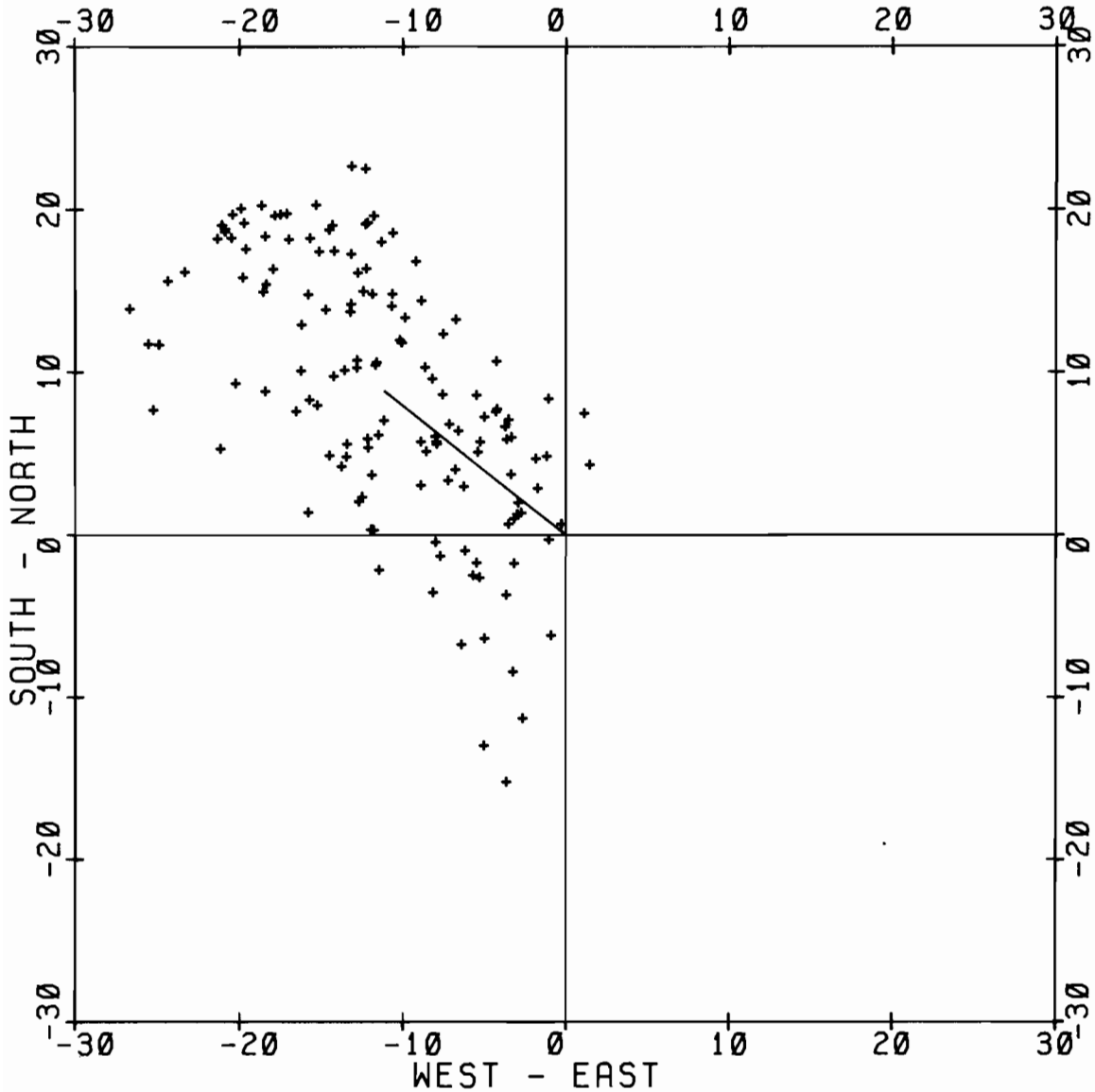


Figure 20. CM data U-V scatter diagram.

II-D-2-f PVD plots (fig. 21)

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 6	(II-D-1)
DATA OPTION: 6	(II-D-2)

This routine does PVD (progressive vector diagram) plots. These are plots of successive current or wind vectors connected end to end, simulating a Lagrangian path from Eulerian measurements. Plots are either self-scaled to 2, 5 or 10×10^n kilometers per inch, or the user may define the scale. A + symbol is plotted every 5 days. The program requests filter type and time period (II-D-2-m), and then the scale in km/inch. A 0 is entered for self-scaling. R2D2 then plots (II-F-2). Plot size is about 8 inches high by 7 inches wide.

Subroutine: PVDPLT

Program: CMLOOK (II-D-2)

```

ENTER DATA OPTION ? 6
1 UP-1 1811 64
FILTER TYPE ? 2
START,END=800850600 802270600 LEN=569
NEW START, END TIME ? 0,0
NEW START,END=800850600 802270600 LEN=569
ENTER SCALE (KM/INCH) OR 0 FOR SELF-SCALING ? 0
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

```

```

UP-1 1811 AT 64M
FROM 800850600 TO 802270600
LAT 54.56N LON 165.40W
35. HR FILTER DATA N= 569

```

+ EVERY 5 DAYS

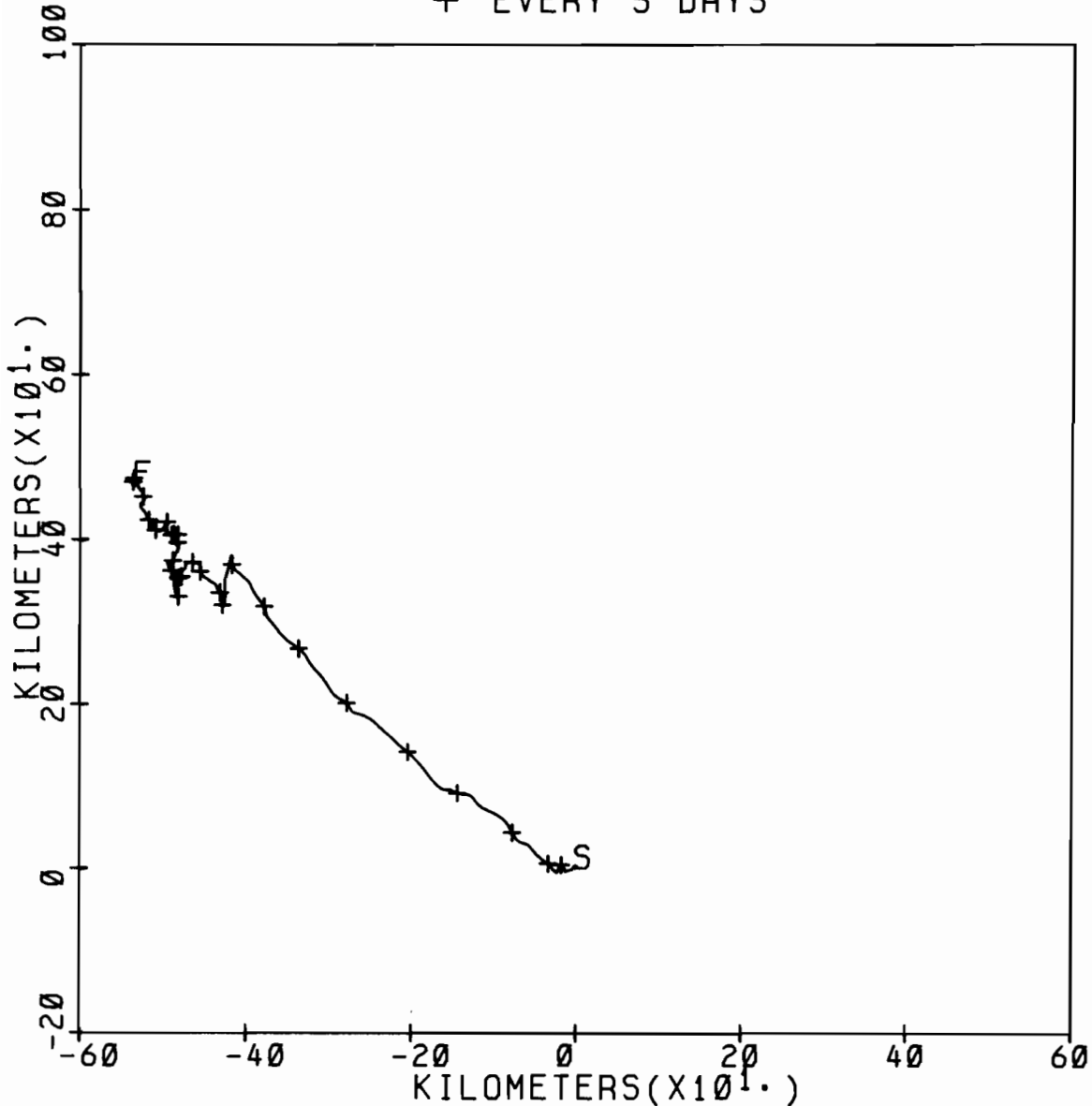


Figure 21. CM data progressive vector diagram.

II-D-2-g Histograms (fig. 22)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 7 (II-D-2)

This routine does histograms of selected parameters. Either relative frequency or cumulative frequency plots may be done. The standard statistics (see II-D-2-b) are also computed and written on the plot.

The histogram is divided into 36 bins and the percentage of observations per bin computed. Bin width is determined by the standard deviation of the parameter to be plotted. A bin width is approximately 1/3 standard deviation, with a minimum of 0.1 and maximum of 20. The histogram is centered approximately at the mean. If any values exceed the bounds of the histogram, they are plotted in extra bins just outside the plot axes. The scale of the Y axis (percent observations) is determined by the bin with the maximum percentage.

R2D2 will first ask for filter type and time period (II-D-2-m), then parameter and histogram type, where...

PARAMETER = 0 FOR NONE

1 FOR COMPONENT SPEED

2 FOR SPEED

3 FOR DIRECTION

4 FOR TEMPERATURE

5 FOR PRESSURE

6 FOR SALINITY

HISTOGRAM TYPE: 1 FOR RELATIVE FREQUENCY DISTRIBUTION

2 FOR CUMULATIVE FREQUENCY DISTRIBUTION

After selecting parameter and histogram type the plot will be done (II-F-2) and output printed on TAPE6. Plot size is about 7 inches x 7 inches.

Subroutine: HISTO

Program: CMLOOK (II-D-2)

ENTER DATA OPTION ? 7

2 UP-2 1827 59

FILTER TYPE ? 2

START,END=800850000 802270000 LEN=569

NEW START, END TIME ? 0,0

NEW START,END=800850000 802270000 LEN=569

PARAMETER, HISTOGRAM TYPE ? 1,1

MAJOR AXIS DIRECTION? 285

UP-2 1827 AT 59M
FROM 800850000 TO 802270000
LAT 54.30N LON 164.76W
35. HR FILTER DATA N= 569

MEAN 12.70
MINIMUM -59.73
MAXIMUM 73.15
ST-DEV 20.38
VARIANCE 415.40
SKEWNESS -0.10
KURTOSIS 3.96

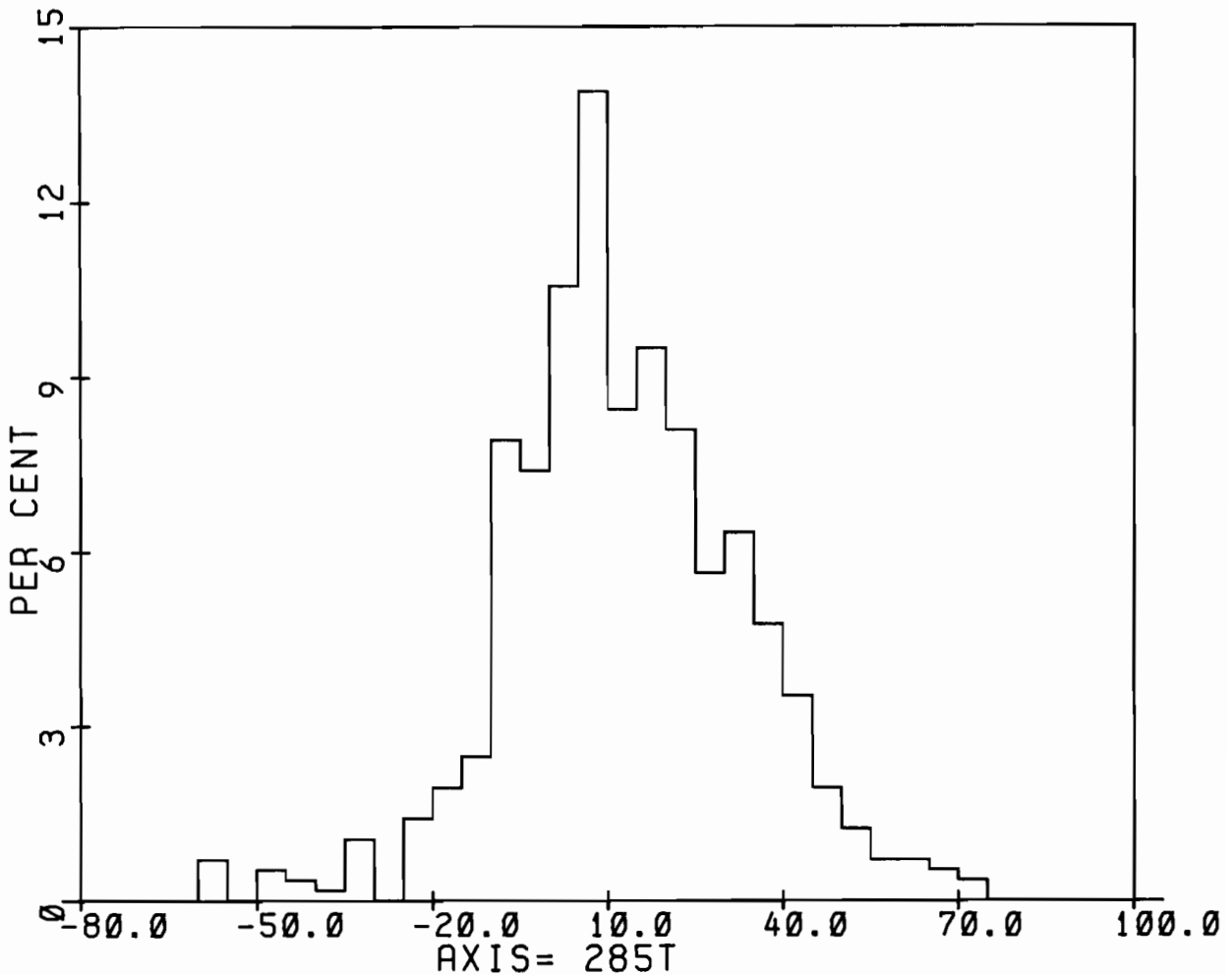


Figure 22. CM/PG data histogram.

II-D-2-h Current roses (fig. 23)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 8 (II-D-2)

This option does current (or wind) roses, with or without a map, with an optional number of bins. The routine begins by asking...

ENTER NUMBER OF BINS (4 to 36)?

The compass is sectioned into the number of bins, NBIN, each section centered on $n \times 360^\circ / \text{NBIN}$, $n=0,1,\dots, \text{NBIN}-1$. A line will be plotted in the direction of the section with lengths proportional to the mean speed of the observations in the bin. The percentage of observations represented by each bin is printed next to its line.

Next R2D2 asks...

DO YOU WANT THESE PLOTTED ON A MAP?

if so...

ENTER 1 TO PLOT ALL ON ONE MAP

2 TO PLOT SEPARATELY BUT USING SAME MAP

3 TO PLOT EACH ON A DIFFERENT MAP

Then the map parameters are requested (see II-F-1).

If plotting is to be done on a map the speed scale is $20 \text{ cm s}^{-1}/\text{inch}$.
If not, the scale is $10 \text{ cm s}^{-1}/\text{inch}$ on a plot 7 inches high x 6 inches wide.

For each record selected, R2D2 asks for filter type and time period (II-D-2-m) and does the plot (II-F-2).

Subroutine: ROSE

Program: CMLOOK (II-D-2)

ENTER DATA OPTION ? 8
 ENTER NUMBER OF BINS (4 TO 36)? 12
 DO YOU WANT THESE PLOTTED ON A MAP? N
 2 UP-2 1827 59
 FILTER TYPE ? 2
 START,END=800850000 802270000 LEN=569
 NEW START, END TIME ? 0,0
 NEW START,END=800850000 802270000 LEN=569
 DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

UP-2 1827 AT 59M
 FROM 800850000 TO 802270000
 LAT 54.30N LON 164.76W
 35. HR FILTER DATA N= 569

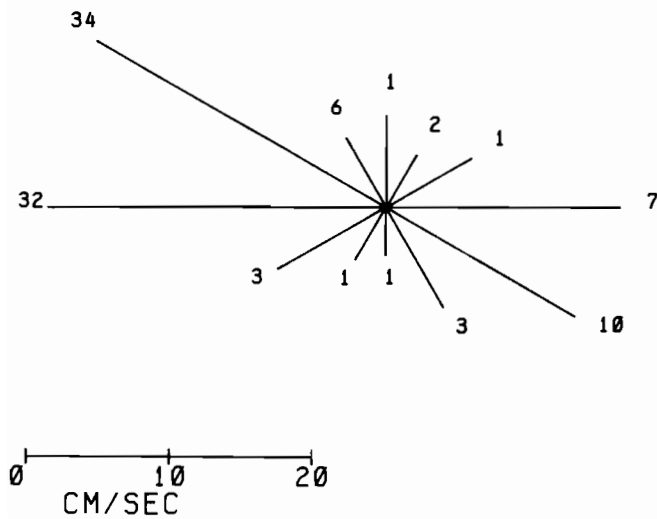


Figure 23. CM data current rose plot.

II-D-2-i Summary current vectors (fig. 24)

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 6	(II-D-1)
DATA OPTION: 9	(II-D-2)

This option plots a mean velocity vector on the end of which are plotted the axes of greatest and least variance. R2D2 will ask whether to plot on a map (see II-D-2-h) and for filter type and time period (II-D-2-m).

If done on a map, the scale is $20 \text{ cm s}^{-1}/\text{inch}$ on a 7-inch-high x 6-inch-wide plot. The axis of greatest variance is defined by the direction of the first mode eigenvector of the velocity component covariance matrix (see also II-D-2-k). The axis length is proportional to the square root of the first mode eigenvalue, which is the standard deviation along the axis of greatest variance. The orthogonal axis length is proportional to the square root of the second mode eigenvalue. The values for the mean velocity and axis of greatest variance are printed and written on TAPE6, and then plotted (II-F-2).

Subroutine: VECPLT

Program: CMLOOK (II-D-2)

```

ENTER DATA OPTION ? 9
DO YOU WANT THESE PLOTTED ON A MAP? Y
ENTER 1 TO PLOT ALL ON ONE MAP
      2 TO PLOT SEPARATELY BUT USING SAME MAP
      3 TO PLOT EACH ON A DIFFERENT MAP
? 1
WHICH MAP FILE? 2
ENTER: LAT1,LAT2,LON1,LON2
? 53.5,55.5,163,167

AREA IS BOUNDED BY:
LATITUDES 53.50 TO 55.50
LONGITUDES 163.00 TO 167.00
IS THIS OK? Y
ENTER SCALE,ATLAT,TIC,YLEN
? 0,0,.25,6
SCALE = 1461199. AT LATITUDE 54.500
TIC MARKS EVERY .25 DEGREE
CHART HEIGHT = 6.00, LENGTH = 6.98
IS THIS OK? Y
1 UP-1 1811 64
FILTER TYPE ? 2
START,END=800850600 802270600 LEN=569
NEW START, END TIME ? 0,0
NEW START,END=800850600 802270600 LEN=569

FOR UP-1 AT 64 METERS 35.0 HR FILTERED DATA
MEAN SPEED = 5.77 DIRECTION T = -48.8
STANDARD DEVIATIONS: MAJOR AXIS = 8.88 @ -31.5 T
MINOR AXIS = 4.58
DO YOU WANT TO PLOT THIS ON YOUR TERMINAL ?

```

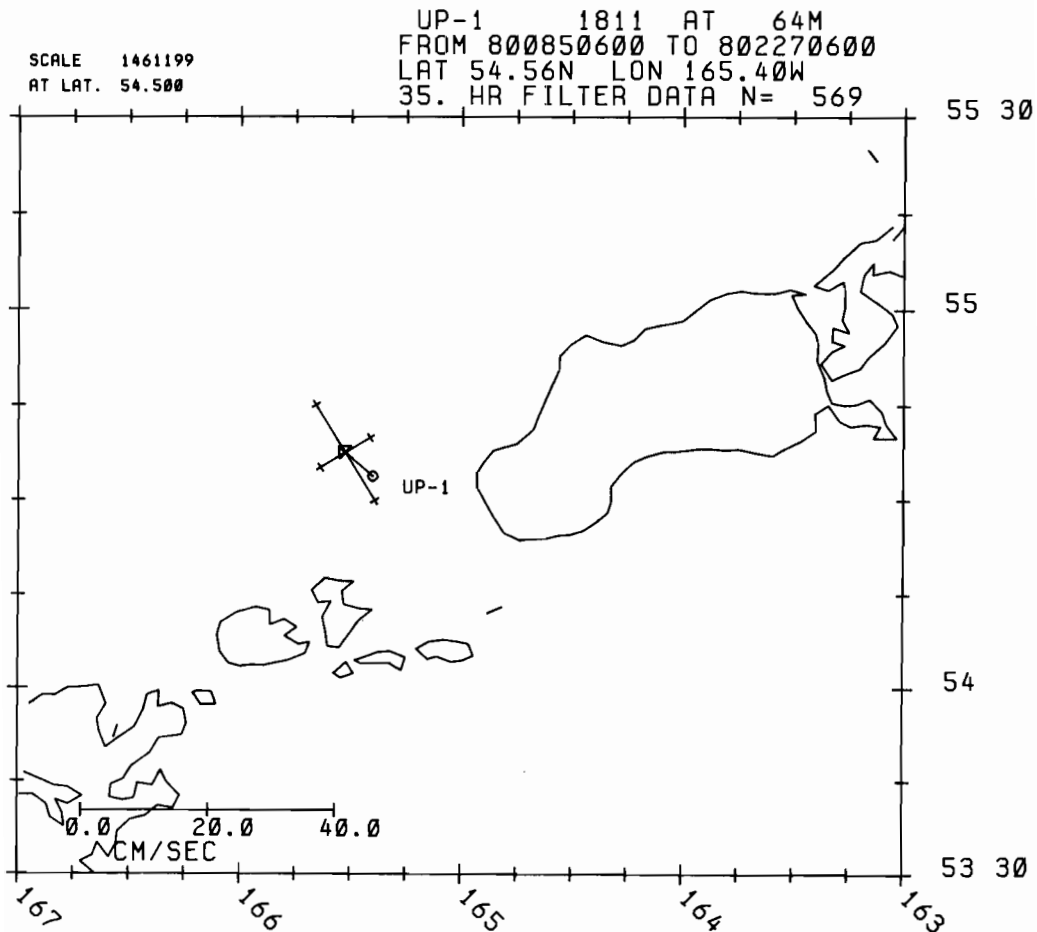


Figure 24. CM data summary current vector plot.

II-D-2-j Lagged linear correlations (fig. 25)

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 6	(II-D-1)
DATA OPTION: 10	(II-D-2)

This option computes linear covariance and correlation matrices for up to 16 records at 0 to n lags, where a lag is equal to a time unit. It also computes the integral time scale matrix and matrix of confidence levels for the correlations.

The routine begins by asking for filter type, listing the selected records, and asking for desired time interval (II-D-2-n). If more than 16 records are selected, only the first 16 are used. The total number of data points may not exceed 12000 (i.e., number of records x data per record \leq 12000).

Next the number of lags is requested. Each lag is one time step in length, i.e., 1 hour for the 2.86-hr-filtered data or 6 hours for 35-hr-filtered data. Covariance and correlation matrices will be computed and printed for each lag.

After asking for an OK on the time interval and number of lags, the program proceeds to set up the data in the common time base. Any records which do not fall within the time window or whose data interval is not the common data interval (defined by the data interval of the last record of the set) are not included. R2D2 will ask for parameter number, where the user should...

ENTER 1 FOR COMPONENT SPEED
2 FOR SPEED
3 FOR TEMPERATURE
4 FOR PRESSURE
5 FOR SALINITY

or if a pressure gauge record...

ENTER 1 FOR PRESSURE
 2 FOR TEMPERATURE

If component speed is the option, major axis direction is requested (II-D-2-o). The data are then loaded into arrays, record information printed, R2D2 asks if output is to be printed on the terminal, and then the correlation computations proceed. The cross-correlations are computed from:

$$r_{xy} = \frac{\frac{1}{N-K} \sum_{i=1}^{N-K} (x_i - \bar{x})(y_{i+K} - \bar{y})}{\left[\frac{1}{N-K} \sum_{i=1}^{N-K} (x_i - \bar{x})^2 \cdot \frac{1}{N-K} \sum_{i=1}^{N-K} (y_{i+K} - \bar{y})^2 \right]^{\frac{1}{2}}} \quad (1)$$

where $\bar{x} = \frac{1}{N-K} \sum_{i=1}^{N-K} x_i$ = mean of series x

$\bar{y} = \frac{1}{N-K} \sum_{i=1}^{N-K} y_i$ = mean of series y

N = number points

K = lag

and the numerator is the lagged covariance. Note that for each lag, new means and autocovariances are computed for both the lagged and nonlagged series. For example, if x and y have 100 points, at lag 3 the means and covariances are computed for x_{1-97} and y_{4-100} . This method is discussed in Jenkins and Watts (1968), p. 182.

After computing and printing the correlations for all requested lags the integral, or independent, time scale (Allen and Kundu, 1978) matrix is computed:

$$\tau_{xy} = \Delta t + \sum_{K=1}^{N-1} 2r_{xx}(K)r_{yy}(K)\Delta t$$

where r_{xx} and r_{yy} are the lagged autocorrelation coefficients for series x and y.

The lagged autocorrelations are computed using:

$$r_{xx} = \frac{\frac{1}{N} \sum_{i=1}^{N-K} (x_i - \bar{x})(x_{i+K} - \bar{x})}{\frac{1}{N} \sum_{i=1}^N (x_i - \bar{x})^2} \quad (2)$$

where $\bar{x} = \frac{1}{N} \sum_{i=1}^N x_i = \text{mean of series } x.$

Means and autocovariances are computed just once. This method of computing the autocorrelation is discussed on pp. 180-82 of Jenkins and Watts.

Finally, the 95% confidence levels for the correlation matrix are computed from:

$$CL_{xy} = \pm 1.96 \left(\frac{N\Delta t}{\tau_{xy}} \right)^{-\frac{1}{2}}$$

Linear regression coefficients for slope (a) and intercept (b) may be derived from the means and covariance matrix, viz:

$$y = ax + b$$

where

$$a = \frac{C_{xy}}{C_{xx}}$$

$$b = \bar{y} - a\bar{x}$$

$$C_{xy} = \text{covariance between series } x \text{ and } y$$

C_{xx} = variance of series x

\bar{x} = mean of series x

\bar{y} = mean of series y

The means and covariance matrix may also be used to calculate an estimate of flux. For example, if series x is velocity on some axis, and series y is salinity, salt flux per unit time in the x direction is

$$\begin{aligned}\frac{1}{n} \sum_{n} xy &= \frac{1}{n} \sum_{n} (\bar{x}+x') (\bar{y}+y') \\ &= \frac{1}{n} (\sum \bar{x}\bar{y} + \sum \bar{x}y' + \sum \bar{y}x' + \sum x'y') \\ &= \bar{x} \cdot \bar{y} + C_{xy}\end{aligned}$$

That is, the flux is the product of the means plus the covariance. The $\sum \bar{x}y'$ and $\sum \bar{y}x'$ terms drop out because the sum of products of a constant and a fluctuating term of zero mean is zero.

Subroutines: LINCOR, GET5, LODDAT, CROSSC

Program: CMLOOK (II-D-2)

ENTER DATA OPTION ? 10
 FILTER TYPE ? 2
 YOUR FILES ARE:
 UP-1 1811 64 800850600 TO 802270600 LEN= 569 DT= 6.00 HR
 UP-2 1827 59 800850800 TO 802270800 LEN= 569 DT= 6.00 HR
 UP-3 1815 47 800841800 TO 802262400 LEN= 570 DT= 6.00 HR
 NEW START, END TIME ? 0,0

ENTER THE NUMBER OF LAGS? 0

NUMBER OF LAGS IS 0 (0 HOURS)

TIME INTERVAL IS FROM 800850600 TO 802262400
 DT= 6.00 HR, 568 POINTS
 IS THIS OK? Y

UP-1 1811
 PARAMETER ? 1
 MAJOR AXIS DIRECTION? 330

UP-2 1827
 PARAMETER ? 1
 MAJOR AXIS DIRECTION? 285

UP-3 1815
 PARAMETER ? 1
 MAJOR AXIS DIRECTION? 280

NUMBER 1 IS UP-1 METER 1811 AT 64 M 330 T
 NUMBER 2 IS UP-2 METER 1827 AT 59 M 285 T
 NUMBER 3 IS UP-3 METER 1815 AT 47 M 280 T

THE RESULTS WILL BE WRITTEN ON TAPE6
 DO YOU WANT THEM PRINTED ON YOUR TERMINAL ALSO? Y

MEANS OF SERIES
 1 2 3
 5.47 12.66 1.33

F O R L A G = 0 (568 POINTS)
 (COLUMN LAGS ROW)

COVARIANCE MATRIX
 1 2 3
 1 78.89 119.19 21.71
 2 119.19 415.38 98.56
 3 21.71 98.56 51.77

CORRELATION MATRIX
 1 2 3
 1 1.000 .658 .348
 2 .658 1.000 .672
 3 .348 .672 1.000

TIME SCALE MATRIX, HOURS (ALLEN AND KUNDU,78)
 1 2 3
 1 167.34 89.97 32.07
 2 89.97 74.44 41.37
 3 32.07 41.37 48.07

95 0/0 CONFIDENCE LEVEL OF CORRELATIONS
 1 2 3
 1 .434 .318 .198
 2 .318 .298 .216
 3 .198 .216 .233

Figure 25. CM/PG lagged linear correlations.

11-D-2-k Empirical orthogonal functions (EOF) (fig. 26)

DATA TYPE: C (11-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (11-D-1)
DATA OPTION: 11, 12 (II-D-2)

This option does empirical orthogonal function analysis using either the covariance or correlation matrix for 0 lag as described in II-D-2-j (option 11), or a user-supplied matrix (option 12).

This routine uses the IMSL (International Mathematical and Statistical Libraries) subroutines EHOUSS, EQRT2S and EHOBKS, described in IMSL Reference Manual Edition 7, vol 1, to compute the eigenvalues and eigenvectors of the symmetric correlation or covariance matrix.

Use of the covariance matrix gives greatest weight to the series with greatest variance. The correlation matrix is equal to a normalized covariance matrix (as if each data series is divided by its standard deviation so that it has unit variance), and therefore gives equal weight to each series, regardless of the original units.

If option 12 is selected, the user supplies the covariance or correlation matrix. R2D2 will ask for the order of the matrix, which should be an integer from 2 to 16. Then the lower part of a symmetric diagonal matrix is entered, N values for the Nth row, beginning with row 1 (fig. 26). After listing the complete matrix and asking for an OK on the input matrix, the program proceeds with the solution of the eigenvalue problem.

The eigenvalues and columns of eigenvectors are ranked in descending order; i.e., mode 1 (which contains the greatest variance) is first, mode 2 second, etc. The eigenvalue is equal to the variance of the mode, and the sum of the eigenvalues equals the sum of the variance of all series. The eigenvectors are mutually orthogonal and the modes are uncorrelated with each other. Mode 1 contains the greatest correlated variance, mode 2 the greatest correlated amount of the remaining variance, etc.

Output includes: eigenvalues and the percentage of total variance represented by each mode; the eigenvector matrix, columns representing the mode and rows the data series; and the matrix of percentage variance explained by each mode for each series.

If option 11 is selected, the user may also write up to N modes as amplitude time series to a permanent file in the "TAPE4 format" (see II-D-4) for further analysis and plotting. The amplitudes of the EOF modes are computed from:

$$Y_{M,t} = \sum_{n=1}^N x_{n,t} E_{n,M}$$

where $x_{n,t}$ is the demeaned data series n (divided by the standard deviation if the correlation matrix was used for the EOF analysis), $E_{n,M}$ is the eigenvector component for series n, mode M, and N is the total number of records used in the analysis.

Subroutines: LINCOR, GET5, LODDAT, CROSSC, EOFS

Program: CMLOOK (II-D-2)

```

ENTER DATA OPTION ? 12
ENTER 1 FOR EOF BASED ON COVARIANCE MATRIX
      2 FOR EOF BASED ON CORRELATION MATRIX
? 2
ORDER OF MATRIX ? 3
ENTER LOWER PART OF SYMMETRIC MATRIX
ENTER N VALUES FOR NTH ROW
ROW 1 ? 1
ROW 2 ? .658,1
ROW 3 ? .34,.672,1

CORRELATION MATRIX
      1      2      3
1    1.000   .658   .340
2    .658   1.000   .672
3    .340   .672   1.000
IS THIS OK? Y

EOF ANALYSIS BASED ON CORRELATION MATRIX

EIGENVALUES
      MODE 1  MODE 2  MODE 3
0/0    2.13   .66   .21
      70.86  22.00   7.14

EIGENVECTORS
      MODE 1  MODE 2  MODE 3
1    -.540  -.717   .441
2    -.641   .010  -.767
3    -.546   .697   .465

MODE/INPUT VARIANCE EXPLAINED (PERCENT)
      MODE 1  MODE 2  MODE 3
1    61.89   33.94   4.17
2    87.38    .01  12.61
3    63.30   32.06   4.64

```

Figure 26. CM/PG data empirical orthogonal function analysis.

II-D-2-1 Write data in TAPE4 format (fig. 27)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 6 (II-D-1)
DATA OPTION: 13 (II-D-2)

This option writes data from selected records to a permanent file in the "TAPE4 format" (see II-D-4). This enables records from the R2D2 data base to be read by other programs.

The TAPE4 records have a header field and from 1 to 5 sets of data arrays. The current meter data arrays are written in order of east velocity, north velocity, temperature, pressure, and salinity. Pressure gauge records have pressure and temperature.

After asking for filter type and time interval (II-D-2-m), R2D2 asks for the number of parameters to write, where the user should ...

ENTER 2 FOR u,v
3 FOR u,v,T
4 FOR u,v,T,P
5 FOR u,v,T,P,S

or if it is a pressure gauge record...

ENTER 1 FOR P
2 FOR P,T

After all selected records have been written R2D2 will ask for permanent file name and save (using the REPLACE command) the file as an indirect access permanent file.

Subroutine: WRITE4

Program: CMLOOK

```

ENTER DATA OPTION ? 13
  1 UP-1      1811   64
FILTER TYPE ? 1
  START,END=800821400 802292100 LEN=3536
NEW START, END TIME ? 0,0
NEW START,END=800821400 802292100 LEN=3536
NUMBER OF PARAMETERS? 2
  2 UP-2      1827   59
FILTER TYPE ? 1
  START,END=800821000 802291700 LEN=3536
NEW START, END TIME ? 0,0
NEW START,END=800821000 802291700 LEN=3536
NUMBER OF PARAMETERS? 2
  3 UP-3      1815   47
FILTER TYPE ? 1
  START,END=800820400 802291300 LEN=3538
NEW START, END TIME ? 0,0
NEW START,END=800820400 802291300 LEN=3538
NUMBER OF PARAMETERS? 2
ENTER PERMANENT FILE NAME ? UP123

UP123  HAS BEEN SAVED!

```

Figure 27. Write CM/PG data in TAPE4 format.

II-D-2-m Selecting filter type, time period for individual records

This routine is called by many of the current meter data routines described in II-D-2. It sets up parameters which tell the other routines which data type the record currently under examination is, and the time period to examine. If the record is from the R2D2 data base (as a User Data File), the program will ask for filter type, where the user will...

ENTER 0 FOR NO DATA

1 FOR 2.86-HR-FILTERED DATA

2 FOR 35-HR-FILTERED DATA

Entering 0 will cause the record to be skipped.

Next the record start and end times are printed, and new start and end times requested. This allows a particular record segment to be retrieved. The times are nine digit integers in the form...

YYDDHHMM

where YY is the year, DDD Julian day, HH is hour (GMT) and MM the minutes. By entering 0 for start and/or end time, the original start and/or end time is retained. Entering a "-1" for start time causes the record to be skipped.

A message will be printed if the times are incorrectly entered, e.g., if the new start time is earlier than the original, etc.

After the times have been established, the meter number word is examined to determine data type. If the first two characters of meter number are PG or TG, it is pressure gauge data. If they are DL or WX it is wind data. Otherwise current meter data is assumed.

Subroutine: TIMES

Program: CMLook

II-D-2-n Selecting filter type, time period for all records

This option sets up a common time base for a group of records, as required by option 4, 10, and 11.

As in II-D-2-m, filter type and start and end times are entered. If 0 is entered for start and/or end time the latest original start time is used as the common start time, and the earliest end time is used as the common end time. This gives the longest possible common time period for all records. Selection of an earlier start time or later end time has different results, depending on option selected: for option 4 (II-D-2-d) it merely extends the time axis of the plot; for 10 (II-D-2-j) and 11 (II-D-2-k) it causes records not within the common time base to be rejected. Entering a -1 for start time causes the entire set of records to be rejected.

Subroutine: TIMES2

Program: CMLOOK

II-D-2-o Major axis direction

This routine allows for axis rotation of vector series. It will ask...

MAJOR AXIS DIRECTION?

where one should...

ENTER MAJOR AXIS DIRECTION IN COMPASS DEGREES

MINOR AXIS = MAJOR +90

FOR STANDARD u,v ENTER 0

(v = 0, u = 90)

The north and east component series will be transformed by:

$$y_t = u_t \sin(A) + v_t \cos(A)$$

$$x_t = u_t \cos(A) - v_t \sin(A)$$

where y = major axis component

x = minor axis component

u = east component

v = north component

A = major axis direction.

Subroutine: AXIS

Program: CMLOOK

II-D-3 SPECTRAL, TIDE ANALYSIS

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 7 (II-D-1)

Having sorted a User Data File, the user may access the current meter/pressure gauge spectral and tide analysis program SPECT. This program provides routines for scalar and rotary component autospectral and cross spectral, and 29-day harmonic tide analysis. The spectral analysis routines use a Fast Fourier Transform, with variable-width boxcar averaging in frequency. Listings and plots are available. The user may return to program CMSORT for resorting or to access CML00K by entering TS option 99.

The program will begin by asking...

ENTER TS OPTION?

where the user should...

ENTER 0 TO END R2D2 SESSION (II-E)
1 FOR SCALAR SPECTRA (II-D-3-a)
2 FOR COMPONENTS, TOTAL SPECTRA (II-D-3-b)
3 FOR ROTARY SPECTRA (II-D-3-c)
4 FOR SCALAR CROSS SPECTRA (II-D-3-d)
5 FOR ROTARY CROSS SPECTRA (II-D-3-e)
6 FOR 29-DAY HARMONIC TIDE ANALYSIS (II-D-3-f)
7 FOR SUCCESSIVE TIDE ANALYSES (II-D-3-g)
99 TO RESORT

If the option is entered as a negative number, terminal output will be suppressed. In either case, all output will be written on TAPE6. Option 99 returns to the CMSORT program where it asks, "What do you want to do?" (II-D-1).

After the option is entered, the program begins to process each of the selected records. Options 1, 2, 3, 6, and 7 require one record per analysis, 4 and 5 two. R2D2 will ask for an OK on each record until the required number has been accepted. When a record has been accepted, R2D2 will ask for parameter if the record is 2.86-hr-filtered current meter data, where...

DATA TYPE = 2 FOR U & V
= 3 for TEMPERATURE
= 4 FOR PRESSURE
= 5 FOR SALINITY

or if a pressure gauge record

DATA TYPE = 1 FOR PRESSURE
= 2 FOR TEMPERATURE

NOTE: In the SPECT program, temperature ($^{\circ}\text{C}$), pressure (dbar) and salinity ($^{\circ}/\text{oo}$) are multiplied by 100 prior to analysis.

Next the start time is requested as a YYDDHHMM time word (e.g., see II-D-2-m). If 0 is entered the original start time is retained.

After checking the time base the program prints the series length in units of the time interval (the length from the new start time to the end, or 6000, whichever is less) and asks...

ENTER LEN, NAVE, T

where...

LEN = LENGTH OF SERIES TO BE ANALYZED (MUST BE EVEN)

NAVE = NUMBER OF PERIODOGRAM BANDS TO AVERAGE

T = SHORTEST PERIOD DESIRED, HOURS

The Fast Fourier Transform (FFT) algorithm used requires an even series length LEN, where the largest prime factor in LEN cannot exceed 47. If necessary, LEN will be truncated accordingly. The periodogram produced by the FFT will be averaged by a boxcar of length NAVE, from the fundamental period to T. The FFT and averaging is described in II-D-3-i. The program then prints the starting frequency f_1 , bandwidth Δf , number of bands NB and degrees of freedom N where

$$f_1 = f_0 \cdot \frac{(NAVE+1)}{2} \text{ cpd}$$

$$\Delta f = f_0 \cdot NAVE \text{ cpd}$$

$$NB = \frac{\frac{24}{T} - f_1}{\Delta f} + 1$$

$$N = 2 \cdot NAVE \text{ (} 4 \cdot NAVE \text{ if summed components)}$$

$$f_0 = \frac{24}{LEN \cdot \Delta t} \text{ cpd}$$

Δt = time interval, hours.

and asks for an OK. If not OK, the program returns to the point of entering LEN, NAVE, T.

Then the log confidence interval (Jenkins & Watts, 1968 p. 255) is computed and printed, using a chi square distribution for N degrees of freedom.

Finally the selected spectral analysis option is performed (II-D-3-a thru e) and plotted (II-D-3-h) if desired.

After all selected records have been processed for the option, the program returns to ask for a new TS option.

Program: SPECT

II-D-3-a Scalar spectra (fig. 28)

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 7	(II-D-1)
TS OPTION: ±1	(II-D-3)

This option does autospectra on scalar series. If a u-v vector series (parameter = 2) had been selected, R2D2 will ask for axis direction, and the series will be resolved into that direction (compass degrees). Output includes some header information, series mean and variance, and for each frequency: frequency (cycles per day), period (days) and variance in units squared, or (100 x units) squared if T, P, or S from a current meter. Series mean and variance are computed from the data series. See II-D-3-i for discussion of calculation of the spectrum. Plotting is described in II-D-3-h.

Subroutine: SPEC1

Program: SPECT (II-D-3)

ENTER TS OPTION ? 1
 FILTER TYPE ? 2
 UP-2 1827 59 800850000 TO 802270000 LEN = 569 DT = 6.00HR
 IS THIS OK? Y
 ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
 LENGTH IS 569
 ENTER: LEN,NAVE,T ? 500,5,50
 STARTING FREQUENCY = .024000 BANDWIDTH = .040000
 12 BANDS, 10 DEGREES OF FREEDOM
 IS THIS OK? Y
 LOG 95% CONFIDENCE INTERVAL = .49 TO -.31
 AXIS DIRECTION? 300

UP-2 1827 59 54 18N 164 46W 35.0 AXIS= 300

125 DAYS STARTING 800850000
 MEAN = 13.77 VAR = 404.19

F,CPD	T,DAYS	VARIANCE
.02400	41.667	127.311
.06400	15.625	30.665
.10400	9.615	50.738
.14400	6.944	30.631
.18400	5.435	34.864
.22400	4.464	22.845
.26400	3.788	12.017
.30400	3.289	11.104
.34400	2.907	16.092
.38400	2.604	12.228
.42400	2.358	7.634
.46400	2.155	1.703

TOTAL = 357.834
DO YOU WANT A PLOT?

UP-2 1827 59 54 18N 164 46W 35.0 AXIS= 300

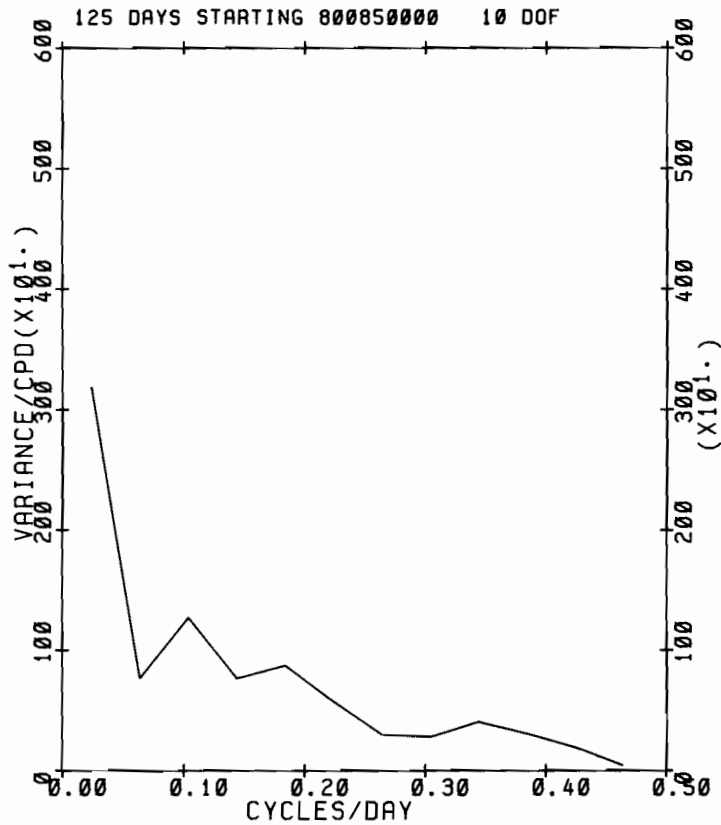


Figure 28. Scalar autospectral analysis, plot. Plot options were for linear frequency scale, variance preserving plot.

II-D-3-b Components, total spectra (fig. 29)

DATA TYPE: C	(II-D)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 7	(II-D-1)
TS OPTION ±2	(II-D-3)

This option does autospectra on orthogonal components of a vector series. R2D2 will ask for axis direction, in compass degrees, which will be the major axis. The minor axis is 90° to the right of the major. Entering 0 for axis direction gives the usual north and east components. (see also II-D-2-o).

Outputs include major and minor axis series means and variances, and the major, minor, and summed variance for the desired range of frequencies (II-D-3-i). Plots (II-D-3-h) may be done for the summed component spectrum (plot option 1) or the major and minor components together (plot option 2).

Subroutine: SPEC2

Program: SPECT

ENTER TS OPTION ? 2
 FILTER TYPE ? 2
 UP-2 1827 59 800850000 TO 802270000 LEN = 569 DT = 6.00HR
 IS THIS OK? Y
 ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
 LENGTH IS 569
 ENTER: LEN,NAVE,T ? 500,5,50
 STARTING FREQUENCY = .024000 BANDWIDTH = .040000
 12 BANDS, 10 DEGREES OF FREEDOM
 IS THIS OK? Y
 LOG 95% CONFIDENCE INTERVAL = .49 TO -.31
 AXIS DIRECTION? 285

UP-2 1827 59 54 18N 164 46W 35.0MAJOR= 285
 MINOR= 15

125 DAYS STARTING 800850000
 285 AXIS MEAN = 14.29 VAR = 431.82
 15 AXIS MEAN = -.13 VAR = 12.10

F, CPD	T, DAYS	285 VAR	15 VAR	SUM
.02400	41.667	137.170	1.810	138.980
.06400	15.625	31.062	2.642	33.704
.10400	9.615	54.344	.267	54.611
.14400	6.944	33.535	.658	34.194
.18400	5.435	37.874	1.359	39.234
.22400	4.464	24.668	.177	24.844
.26400	3.788	12.808	.360	13.168
.30400	3.289	12.226	.230	12.456
.34400	2.907	18.811	.257	18.269
.38400	2.604	13.242	.420	13.670
.42400	2.358	8.432	.304	8.737
.46400	2.155	1.810	.628	2.438

TOTAL = 385.183 9.122 394.304

UP-2 1827 59 54 18N 164 46W 35.0MAJOR= 285
 MINOR= 15

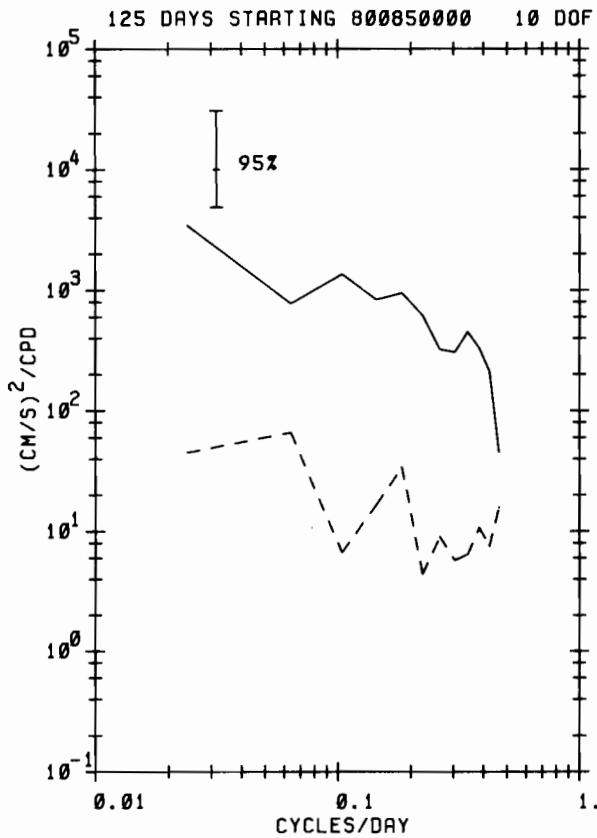


Figure 29. Vector series autospectral analysis, plot. Plot options were for energy components, log frequency scale, spectral density plot.

II-D-3-c Rotary spectra (fig. 30)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 7 (II-D-1)
TS OPTION: ±3 (II-D-3)

This option does rotary component autospectra, as discussed by Mooers (1973). Briefly, the u and v component Fourier coefficients (see II-D-3-i) are transformed to clockwise and anticlockwise rotary component Fourier coefficients by:

$$\begin{aligned}C_R &= (V_I - U_R) / \sqrt{2} = \text{real clockwise} \\C_I &= (V_R + U_I) / \sqrt{2} = \text{imaginary clockwise} \\A_R &= (V_I + U_R) / \sqrt{2} = \text{real anticlockwise} \\A_I &= (V_R - U_I) / \sqrt{2} = \text{imaginary anticlockwise}\end{aligned}$$

and

$$\begin{aligned}C^2 &= C_R^2 + C_I^2 = \text{clockwise variance} \\A^2 &= A_R^2 + A_I^2 = \text{anticlockwise variance} \\Co &= C_R A_R + C_I A_I = \text{covariance} \\Q &= C_R A_I - A_R C_I = \text{quadrature variance}\end{aligned}$$

The rotary components may be used to define an ellipse, where...

$$C+A = \text{semimajor axis}$$

$$|C-A| = \text{semiminor axis}$$

$$\tan^{-1}(-Q/Co) = \text{major axis direction}$$

$$\frac{Co^2+Q^2}{C^2 \cdot A^2} = \text{squared coherence between the rotary components, or ellipse axis stability}$$

Outputs include total series variance, and for each frequency: the clockwise, anticlockwise, and summed variances; semimajor and semiminor axes; major axis direction; and axis stability. Plots (II-D-3-h) may be done of the summed variance spectrum (plot option 1) or the rotary components (plot option 2)

Subroutine: SPEC3

Program: SPECT

```

ENTER TS OPTION ? 3
FILTER TYPE ? 2
UP-2 1827 59 800850000 TO 802270000 LEN = 569 DT = 6.00HR
IS THIS OK? Y
ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
LENGTH IS 569
ENTER: LEN,NAVE,T ? 500,5,50
STARTING FREQUENCY = .024000 BANDWIDTH = .040000
12 BANDS, 10 DEGREES OF FREEDOM
IS THIS OK? Y
LOG 95% CONFIDENCE INTERVAL = .49 TO -.31

```

```

UP-2 1827 59 54 18N 164 46W 35.0 CLOCKWISE
ANTICKLWS
125 DAYS STARTING 800850000
TOTAL VARIANCE = 443.92

```

F,CPD	T,DAYS	CLOCKW	ANTICL	SUM	MAJ	MIN	DIR	STABILITY
.0240	41.667	66.74	72.24	138.98	16.67	.33	-75.7	.951
.0640	15.625	18.41	15.30	33.70	8.20	.38	-69.0	.749
.1040	9.615	26.37	28.24	54.61	10.45	.18	-75.0	.982
.1440	6.944	17.69	16.50	34.19	8.27	.14	-77.4	.932
.1840	5.435	21.16	18.07	39.23	8.85	.35	-76.8	.875
.2240	4.464	12.76	12.09	24.84	7.05	.09	-75.9	.973
.2640	3.788	7.20	5.97	13.17	5.13	.24	-74.6	.982
.3040	3.289	6.23	6.23	12.46	4.99	.00	-78.0	.938
.3440	2.907	9.32	8.95	18.27	6.04	.06	-79.7	.970
.3840	2.604	5.95	7.72	13.67	5.22	.34	-76.4	.896
.4240	2.358	4.83	3.90	8.74	4.17	.22	-78.6	.889
.4640	2.155	1.44	1.00	2.44	2.20	.20	-77.7	.245
TOTAL =		198.09	196.21	394.30				

PLOT TYPE ?

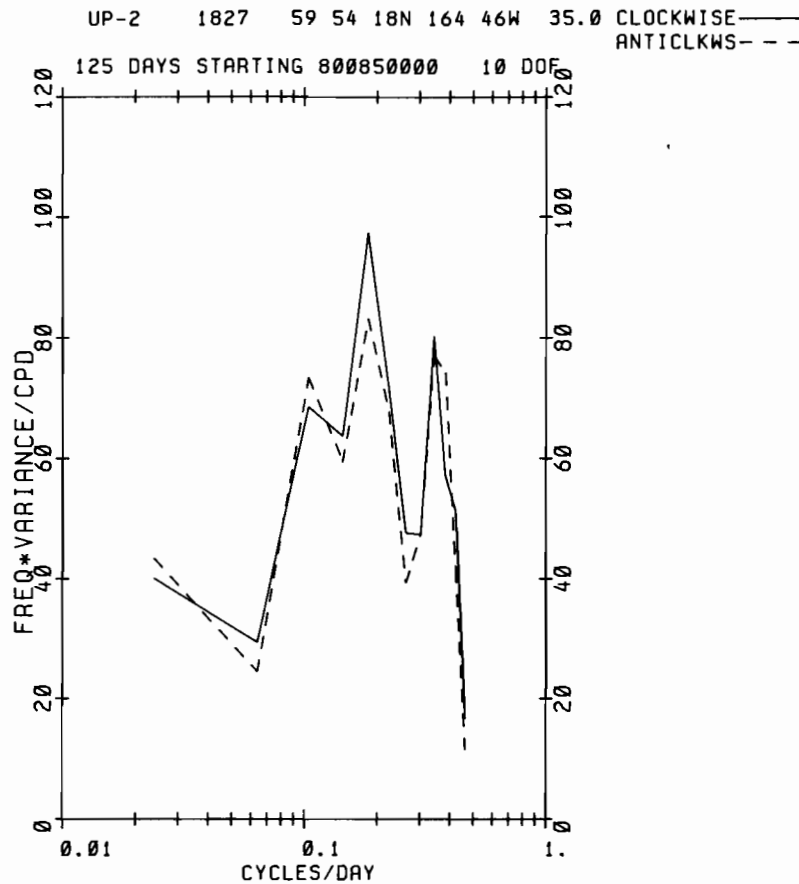


Figure 30. Rotary autospectral analysis, plot. Plot options were for energy components, log frequency scale, spectral density plot.

II-D-3-d Scalar cross spectra (fig. 31)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 7 (II-D-1)
TS OPTION: ±4 (II-D-3)

This option does cross spectral analysis between two scalar series. If the input series are vectors, R2D2 will request the axis direction into which to resolve the series (see II-D-3-a).

Outputs include variance of each of the input series, and for each frequency: autovariances, covariance, cross variance, phase, and coherency (coherence squared) (see also II-D-3-i). The 95% significance level of coherency for N degrees of freedom is (Bloomfield, 1976, p. 227):

$$1 - .05^{[2/(N-2)]}$$

If the Fourier coefficients of series X and Y are defined by X_R , X_I and Y_R , Y_I

$$X^2 = X_R^2 + X_I^2 = \text{variance of X}$$

$$Y^2 = Y_R^2 + Y_I^2 = \text{variance of Y}$$

$$Co = X_R Y_R + X_I Y_I = \text{covariance}$$

$$Q = X_R Y_I - Y_R X_I = \text{quadrature variance}$$

$$(Co^2 + Q^2)^{1/2} = \text{cross variance}$$

$$\tan^{-1}(Q/C) = \text{phase (X leads Y)}$$

$$k^2 = \frac{Co^2 + Q^2}{X^2 Y^2} = \text{coherency}$$

Plots may be done for the cross spectrum (plot option 1), phase spectrum (plot option 2) and coherency spectrum (plot option 3), as discussed in II-D-3-h.

Subroutine: SPEC4

Program: SPECT

```

ENTER TS OPTION ? 4
FILTER TYPE ? 2
UP-1 1811 64 800850600 TO 802270600 LEN = 569 DT = 6.00HR
IS THIS OK? Y
UP-2 1827 59 800850900 TO 802270900 LEN = 569 DT = 6.00HR
IS THIS OK? Y
ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
LENGTH IS 568
ENTER: LEN,NAVE,T ? 500,5,50
STARTING FREQUENCY = .024000 BANDWIDTH = .040000
12 BANDS, 10 DEGREES OF FREEDOM
IS THIS OK? Y
LOG 95% CONFIDENCE INTERVAL = .49 TO -.31
UP-1 1811 64
AXIS DIRECTION? 300
UP-2 1827 59
AXIS DIRECTION? 285

```

```

UP-1 1811 64 54 34N 165 24W 35.0 AXIS= 300
UP-2 1827 59 54 18N 164 46W 35.0 AXIS= 285
125 DAYS STARTING 800850600
SERIES 1 VARIANCE = 70.54
SERIES 2 VARIANCE = 431.26
PHASE: SERIES 1 LEADS SERIES 2
95% SIGNIFICANCE LEVEL OF COHERENCY = .527

```

F, CPD	T, DAYS	VAR1	VAR2	COSPEC	VAR1X2	PHASE	CON2
.0240	41.667	54.75	136.82	81.42	81.69	-4.7	.891
.0640	15.625	6.27	30.87	11.27	12.38	-24.5	.792
.1040	9.615	4.68	54.58	10.32	13.96	-42.3	.763
.1440	6.944	1.71	33.45	.49	1.71	-73.2	.851
.1840	5.435	2.81	37.35	7.69	7.73	-6.2	.798
.2240	4.464	2.09	24.60	2.71	4.95	-56.8	.476
.2640	3.788	.56	12.64	.68	1.13	57.7	.177
.3040	3.289	.59	12.86	-.34	2.16	99.0	.649
.3440	2.907	.99	18.11	-.75	1.73	-115.6	.167
.3840	2.604	1.82	13.20	1.82	1.85	-15.2	.883
.4240	2.358	1.26	8.40	1.71	2.39	44.4	.539
.4640	2.155	.33	1.84	.03	.37	85.5	.231

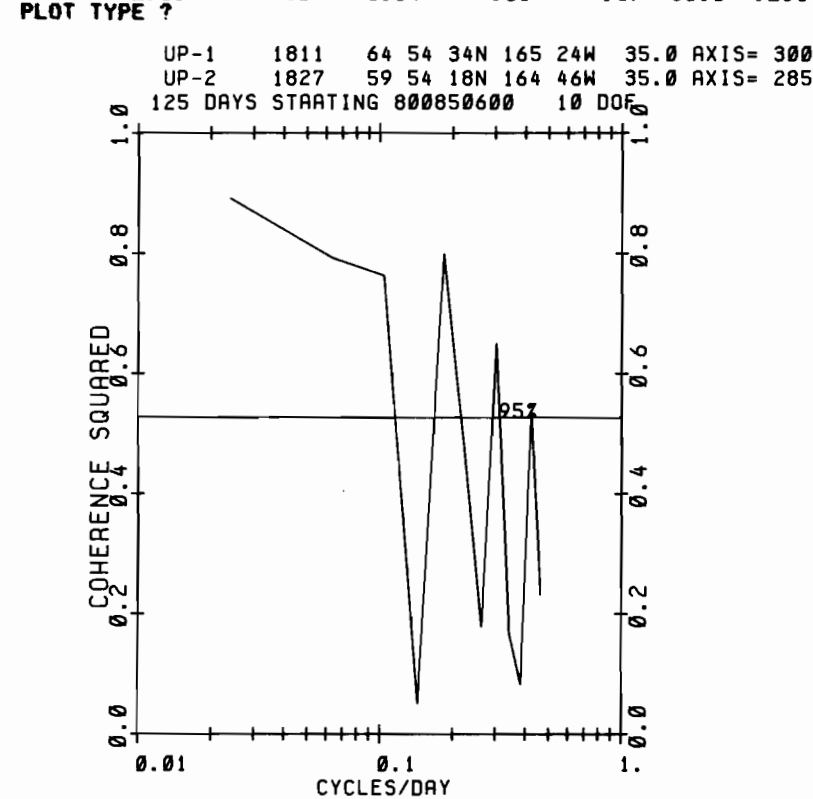


Figure 31. Scalar cross spectral analysis, plot. Plot options were for coherency spectrum, log frequency scale.

II-D-3-e Rotary cross spectra (fig. 32)

DATA TYPE: C (II-B)
 SORT OPTION: 0 (II-D-1)
 WHAT DO YOU WANT TO DO? 7 (II-D-1)
 TS OPTION: ±5 (II-D-3)

This option does rotary inner cross spectra, as discussed by Mooers (1973). (See II-D-3-c for a description of the rotary autospectra and definition of terms).

Output includes input series variances and for each frequency: variance, phase and coherency for the clockwise, anticlockwise and combined components, and axis orientation difference. The 95% significance levels of coherency for N degrees of freedom are computed from (Bloomfield, 1976, p. 227)

$$1 - .05^{[2/(N-2)]}$$

Note that for the combined coherency (phasor in Mooers, 1973) the number of degrees of freedom is twice that for the components.

For the clockwise component

X_c^2 = clockwise variance of series X

Y_c^2 = clockwise variance of series Y

Co_c = clockwise covariance

Q_c = clockwise quadrature variance

$XY_c = (Co_c^2 + Q_c^2)^{1/2}$ = clockwise cross variance

$\phi_c = -\tan^{-1} (-Q_c/Co_c)$ = clockwise phase (X leads Y)

$k_c^2 = \frac{(XY_c)^2}{X_c^2 Y_c^2}$ = clockwise coherency

and similarly for the anticlockwise component, except that

$$\phi_A = -\tan^{-1}(+Q_A/Co_A)$$

For the combined spectra

$$XY_S = XY_C + XY_A = \text{summed variance}$$

$$\Delta\alpha_S = -(\phi_A + \phi_C)/2 = \text{axis difference, X clockwise from Y}$$

$$\phi_S = (\phi_A - \phi_C)/2 = \text{phase difference (X leads Y)}$$

Plots may be made of component cross variance, phase and coherence, and combined cross variance phase and coherence spectra (plot options 1-6 respectively). Section II-D-3-h describes the plots and II-D-3-i describes the FFT.

Subroutine: SPEC5

Program: SPECT (II-D-3)

```

ENTER TS OPTION ? 5
FILTER TYPE ? 2
UP-1 1811 64 800850600 TO 802270600 LEN = 569 DT = 6.00HR
IS THIS OK? Y
UP-2 1827 59 800850000 TO 802270000 LEN = 569 DT = 6.00HR
IS THIS OK? Y
ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
LENGTH IS 568
ENTER: LEN, HAV, T ? 500, 5, 50
STARTING FREQUENCY = .024000 BANDWIDTH = .040000
12 BANDS, 10 DEGREES OF FREEDOM
IS THIS OK? Y
LOG 95% CONFIDENCE INTERVAL = .49 TO -.31

UP-1 1811 64 54 34N 165 24W 35.0 CLOCKWISE
UP-2 1827 59 54 18N 164 46W 35.0 ANTICLKWS
125 DAYS STARTING 800850600
SERIES 1 VARIANCE = 106.99
SERIES 2 VARIANCE = 443.48
INNER CROSS SPECTRA (MOOERS, 1973)
PHASE: SERIES 1 LEADS SERIES 2
95% SIGNIFICANCE LEVEL OF COMPONENT COHERENCY = .527
DAX: AXIS DIFFERENCE, SERIES 1-SERIES 2, DEG. TRUE
TOTAL COHERENCY = PHASOR; 95% SL = .283

```

F, CPD	T, DAYS	CLOCKWISE			ANTI-CLOCKWISE			TOTAL			
		VAR	PHASE	COH	VAR	PHASE	COH	VAR	DAX	PHASE	COH
.024	41.67	42.0	-27.	.796	42.1	-38.	.771	84.1	33.	-5.	.783
.064	15.63	8.2	-28.	.687	8.3	-64.	.652	16.5	46.	-18.	.661
.104	9.62	5.0	-29.	.448	12.2	-78.	.629	17.2	53.	-25.	.517
.144	6.94	2.3	-92.	.168	3.3	-111.	.396	5.6	101.	-10.	.266
.184	5.43	3.9	-25.	.553	4.1	-25.	.537	8.1	25.	-8.	.538
.224	4.46	2.7	-1.	.359	3.4	-108.	.506	6.1	54.	-53.	.438
.264	3.79	2.3	-112.	.732	1.2	-64.	.210	3.6	88.	24.	.438
.304	3.29	1.8	-129.	.643	.5	21.	.164	2.3	54.	75.	.483
.344	2.91	1.2	-145.	.188	2.6	-114.	.781	3.7	129.	16.	.381
.384	2.68	2.0	-148.	.482	3.3	-58.	.729	5.3	99.	41.	.578
.424	2.36	2.9	-188.	.669	2.8	-47.	.987	4.9	77.	31.	.731
.464	2.16	.6	-185.	.417	.1	-163.	.015	.6	134.	-29.	.198

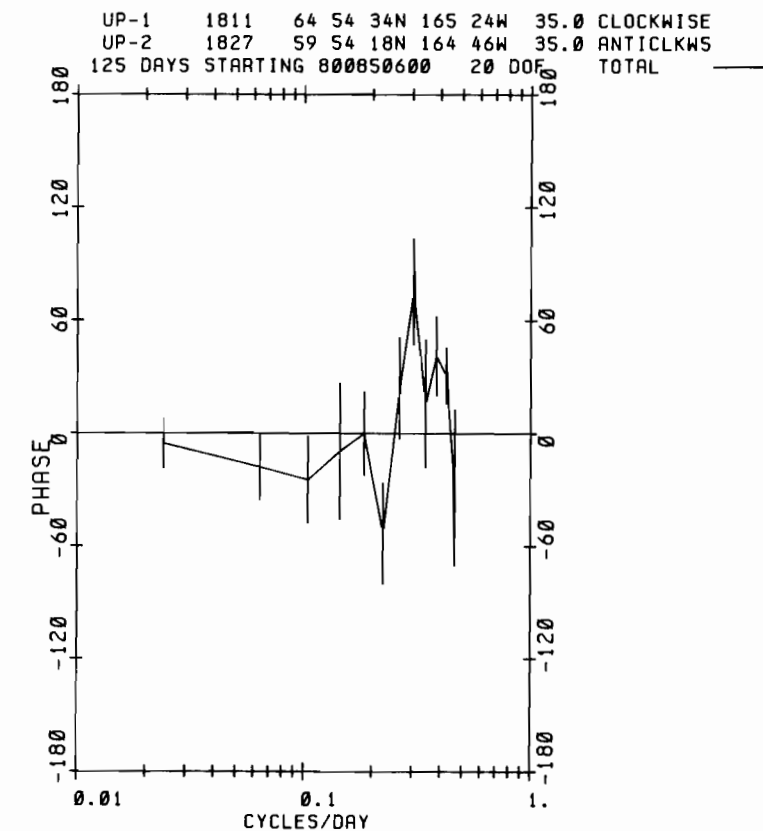


Figure 32. Rotary cross spectral analysis, plot. Plot options were for phase spectrum, log frequency scale.

II-D-3-f 29-day harmonic tide analysis (fig. 33)

DATA TYPE: C (II-B)
SORT OPTION: 0 (II-D-1)
WHAT DO YOU WANT TO DO? 7 (II-D-1)
TS OPTION: ± 6 (II-D-3)

This option does a 29-day harmonic tide analysis based on Schureman (1958) and Dennis & Long, (1971). A brief description of the method, as used in the program, follows.

The analysis begins by computing the primary orbital elements h , p_1 , s , p and N for the beginning of the observation time period, from formulas based on Table 1 of Schureman. The secondary orbital functions are calculated from formulas in table 2 of Dennis & Long. Then Greenwich equilibrium arguments, E , and node factor reciprocals, f , are computed from the formulas in Table 2 of Schureman and Table 3 of Dennis & Long, respectively.

Next a Fourier transform is performed at the exact frequencies of the primary constituents O_1 , K_1 , N_2 , M_2 , S_2 and M_4 , from which is derived the amplitude $R'(A)$ and phase $\zeta'(A)$ of constituent A for the period of observation.

K_1 may be disturbed considerably by the nearby constituent P_1 and likewise S_2 by K_2 and T_2 . Therefore K_1 and S_2 are corrected using equations 359-364 in Schureman, adjusted for the 29-day analysis by correction factors derived from Tables 21-26. Then the amplitudes and phases of secondary constituents Q_1 , M_1 , P_1 , J_1 , $2N_2$, μ_2 , ν_2 , T_2 and K_2 are inferred from the primary constituents using the formulas 325-343 in Schureman, which are based on the equilibrium tide relationships.

Now that preliminary amplitudes and phases have been calculated, the disturbing effects on the primary constituents by the other constituents of the same species must be eliminated. This is done through the use of equations 389 and 390 in Schureman.

Finally, the observed amplitudes and phases of the primary constituents are converted to harmonic constants

$$H(A) = R(A) \cdot f(A) \quad \text{amplitude}$$

$$G(A) = \zeta(A) + E(A) \quad \text{Greenwich phase}$$

and the secondary constituents are inferred from these.

After entering the start time (II-D-3) R2D2 determines whether there are 696 hourly observations available (if not, a message will be printed and the program goes on to the next record) and then asks...

DO YOU WANT TO SAVE THE DETIDED SERIES?

If so, the detided series, as discussed below, will be saved as a permanent file in the TAPE4 format (see II-D-2-1 and II-D-4).

The tide analysis is performed on either a scalar series (i.e., pressure, temperature, salinity) or a vector current series. If it is a vector current series...

ENTER 1 FOR ANALYSIS ON AXIS

2 FOR U,V ANALYSIS WITH ELLIPSES

If 1 is entered the u, v current series will be resolved along the selected axis. Option 2 does the analysis on the u (east) component and the v (north) component, and then computes tidal ellipses for each of the constituents (described below).

Output includes Greenwich equilibrium arguments E and node factor reciprocals f for each of the constituents and the harmonic constants. The variance within the tidal bands for the observed and residual series are also computed. This is done by performing an FFT (see II-D-3-i) on the series and then summing the variance over the frequencies:

$$n \text{ cycle per lunar day} \pm 4 \text{ cycles per lunar month}$$

where $n = 1, 2, 3, 4$, a lunar day is 24.84 solar hours and a lunar month is 27.3 solar days.

The residual (detided) series is formed by computing a predicted series from the derived harmonic constants, and then subtracting the predicted series from the observed series.

95% confidence intervals of the harmonic constant amplitude H and phase G are computed from:

$$CI(H) = \pm 1.96 \left(\frac{V_r}{9} \cdot \frac{27.3}{29} \right)^{\frac{1}{2}}$$

$$CI(G) = \pm \frac{CI(H)}{H} \text{ radians}$$

where V_r is the variance in the tidal band of the residual series. It should be noted that this applies to the primary constituents, and since the secondary constituents are inferred from them, the confidence intervals for the secondary constituents should be proportional to those of the primary constituents.

Ellipses are computed from the U and V component harmonic constants by

$$C_R = H_V \sin G_V - H_U \cos G_U$$

$$C_I = H_V \cos G_V + H_U \sin G_U$$

$$A_R = H_V \sin G_V + H_U \cos G_U$$

$$A_I = H_V \cos G_U - H_U \sin G_U$$

$$C = \frac{1}{2} (C_R^2 + C_I^2)^{\frac{1}{2}} = \text{clockwise amplitude}$$

$$A = \frac{1}{2} (A_R^2 + A_I^2)^{\frac{1}{2}} = \text{anticlockwise amplitude}$$

$$\theta = \tan^{-1}(C_I/C_R) = \text{clockwise phase}$$

$$\phi = \tan^{-1}(A_I/A_R) = \text{anticlockwise phase}$$

$$\text{semimajor axis} = C+A$$

$$\text{semiminor axis} = |C-A|$$

$$\text{major axis direction} = -\frac{1}{2}(\phi-\theta)$$

$$\text{major axis phase} = 90^\circ - \frac{1}{2}(\phi+\theta)$$

and the sense of rotation is determined by whether C or A is greater.

Subroutine: TIDES, TIHAR

Program: SPECT (II-D-3)

ENTER TS OPTION ? 6
 UP-2 1827 59 800021000 TO 802291700 LEN = 3536 DT = 1.00HR
 IS THIS OK? Y
 PARAMETER ? 2
 ENTER DESIRED START TIME OR 0 FOR SAME TIME ? 0
 DO YOU WANT TO SAVE THE DETIDED SERIES? H
 ENTER: 1 FOR ANALYSIS ON AXIS
 2 FOR U, V ANALYSIS WITH ELLIPSES
 ? 2

UP-2 1827 59 54 18N 164 46W 2.9 U + V
 29 DAY HARMONIC TIDE ANALYSIS
 STARTING 800021000
 Q1, K1, M2, N2, S2, M4 FROM ANALYSIS, OTHERS INFERRED
 PHASES ARE REFERRED TO GREENWICH

MODE FACTOR RECIPRICALS AND GREENWICH EQUILIBRIUM ARGUMENTS

	F	E
Q1	1.10035	-146.83
O1	1.18035	-74.46
M1	.61424	-195.27
P1	1.00000	-300.07
K1	1.10318	234.51
J1	1.15422	303.92
2N2	.96937	-347.66
MU2	.96937	-344.66
N2	.96937	-275.29
MU2	.96937	-272.29
M2	.96937	-202.91
L2	1.16310	-307.33
T2	1.00000	-137.47
S2	1.00000	300.00
K2	1.27237	289.06

ANALYSIS FOR EAST

OBSERVED SERIES MEAN = -20.41 VARIANCE = 4742.12
 SPECIES 1 VARIANCE = 888.15
 SPECIES 2 VARIANCE = 2654.20
 SPECIES 3 VARIANCE = 4.60
 SPECIES 4 VARIANCE = 4.02

RESIDUAL SERIES

SPECIES 1 VARIANCE = 27.95
 SPECIES 2 VARIANCE = 12.27
 SPECIES 3 VARIANCE = 4.59
 SPECIES 4 VARIANCE = 3.27

CONST	F, CPD	H	+-	G	+-
Q1	.89324	5.81	3.35	71.2	33.0
O1	.92954	29.96	3.35	84.0	6.4
M1	.96645	2.13	3.35	96.8	90.3
P1	.99726	17.97	3.35	107.8	10.7
K1	1.00274	54.29	3.35	109.7	3.5
J1	1.03903	2.37	3.35	122.4	81.2
2N2	1.85965	2.45	2.22	89.1	52.0
MU2	1.86455	2.94	2.22	97.0	43.2
N2	1.89598	10.39	2.22	148.2	6.9
MU2	1.90004	3.57	2.22	156.1	35.7
M2	1.93227	68.49	2.22	207.3	1.9
L2	1.96857	1.92	2.22	233.3	66.3
T2	1.99726	.88	2.22	253.9	145.1
S2	2.00000	14.86	2.22	255.9	0.6
K2	2.00548	4.04	2.22	259.8	31.5
M4	3.06455	1.05	1.15	172.8	62.4

ANALYSIS FOR NORTH

OBSERVED = 5.26 VARIANCE = 758.22
 SPECIES 1 VARIANCE = 133.01
 SPECIES 2 VARIANCE = 437.24
 SPECIES 3 VARIANCE = 5.73
 SPECIES 4 VARIANCE = 4.05

RESIDUAL SERIES

SPECIES 1 VARIANCE = 7.45
 SPECIES 2 VARIANCE = 4.31
 SPECIES 3 VARIANCE = 5.76
 SPECIES 4 VARIANCE = 3.35

CONST	F, CPD	H	+-	G	+-
Q1	.89324	2.73	1.73	220.9	36.3
O1	.92954	14.06	1.73	239.9	7.1
M1	.96645	1.00	1.73	259.0	99.3
P1	.99726	5.91	1.73	275.3	16.0
K1	1.00274	17.07	1.73	278.1	5.5
J1	1.03903	1.11	1.73	297.1	89.3
2N2	1.85965	1.00	1.32	237.2	69.7
MU2	1.86455	1.30	1.32	265.3	58.0
N2	1.89598	0.13	1.32	317.6	9.3
MU2	1.90004	1.58	1.32	325.6	47.8
M2	1.93227	27.70	1.32	17.9	2.7
L2	1.96857	.70	1.32	46.3	97.2
T2	1.99726	.26	1.32	68.7	291.4
S2	2.00000	4.30	1.32	78.9	17.2
K2	2.00548	1.19	1.32	75.2	63.2
M4	3.06455	.93	1.16	351.0	71.6

CONST	MAJOR	MINOR	DIR	PHASE	ROTATION
Q1	6.29	1.27	113.0	66.3	ANTI-CLOCKWISE
O1	32.67	5.26	113.0	79.9	ANTI-CLOCKWISE
M1	2.33	.28	114.4	93.7	ANTI-CLOCKWISE
P1	18.88	1.22	107.9	106.6	ANTI-CLOCKWISE
K1	57.05	3.41	107.9	100.6	ANTI-CLOCKWISE
J1	2.61	.09	115.1	121.5	ANTI-CLOCKWISE
2N2	2.67	.20	113.5	87.2	ANTI-CLOCKWISE
MU2	3.21	.24	113.5	95.1	ANTI-CLOCKWISE
N2	20.06	1.30	113.6	146.5	ANTI-CLOCKWISE
MU2	3.89	.26	113.6	154.4	ANTI-CLOCKWISE
M2	73.76	4.22	-68.2	26.0	ANTI-CLOCKWISE
L2	2.07	.09	-68.1	52.3	ANTI-CLOCKWISE
T2	.91	.02	-73.6	73.5	ANTI-CLOCKWISE
S2	15.49	.37	-73.6	75.5	ANTI-CLOCKWISE
K2	4.21	.09	-73.6	79.4	ANTI-CLOCKWISE
M4	1.40	.02	-48.6	-8.0	ANTI-CLOCKWISE

ENTER TS OPTION ?

Figure 33. 29-day harmonic tide analysis for east and north velocity components, with ellipse representation.

II-D-3-g Successive tide analyses

DATA TYPE: C	(II-B)
SORT OPTION: 0	(II-D-1)
WHAT DO YOU WANT TO DO? 7	(II-D-1)
TS OPTION: ±7	(II-D-3)

This option performs 29-day harmonic tide analyses (as described in II-D-3-f) on successive segments of the data series, starting at the specified time (II-D-3). After each segment is analysed, 15 days is added to the start time, and another analysis performed. This continues until there are less than 696 hours remaining. The detided series cannot be saved using this option. Since the output from this option is often length, it may be wise to suppress terminal output by entering -7 for TS option (II-D-3).

Subroutines: TIDES, TIHAR

Program: SPECT

II-D-3-h Plotting the spectra (figs. 28-32)

Output from each of the spectral analysis option (TS options 1-5, section II-D-3-a thru e) may be plotted. This includes variance spectra (all) and phase and coherency spectra (TS options 4 and 5). Plots may be on either linear or log frequency scale.

If a variance spectrum is to be plotted, the computed variance spectrum (units²/band) is normalized by dividing by the bandwidth (in cycles per day) to get variance in units²/cpd. Either energy density or variance preserving plots may be done. Energy density plots are done on a log energy scale, with 95% confidence intervals derived from a chi square distribution. Variance preserving spectra (e.g. Hayes, 1979) are normalized so that the area under the curve is proportional to the variance. Therefore the Y (variance) axis is linear, and may be either automatically scaled so that the largest variance fits within the plot boundaries, or the user may specify the scale. If a log frequency scale had been selected, the variances are multiplied by the frequency.

Phase spectra are plotted on an axis of $\pm 180^\circ$. A 95% confidence interval of the phase, for N degrees of freedom, is calculated from:

$$\bar{F} = \pm \tan^{-1} \left(1.96 \cdot \left(\frac{1}{N} \left(\frac{1}{k^2} - 1 \right) \right)^{\frac{1}{2}} \right)$$

where k^2 is the coherency (Jenkins & Watts, 1968, p.380).

A 95% significance level for the coherence squared (coherency) for N degrees of freedom is calculated from (Bloomfield, 1976, p. 227):

$$SL = 1 - .05^{[2/(N-2)]}$$

Subroutine: PLTSPC

Program: SPECT

II-D-3-i The FFT and spectral averaging

The FFT used by the routines in SPECT is, according to the program documentation, a Cooley-Tukey Fast Fourier Transform written by Norman Brenner of M.I.T. and is described in the IEEE Audio and Electroacoustics Transactions of June 1967 and June 1969 special FFT issues. Series length is limited to an even number whose largest prime factor does not exceed 47.

Before entering the FFT, the series is demeaned and tapered. The taper is a 10% cosine taper, where the first and last 10% of the data series of length n is multiplied by weights

$$W_i = 0.5 \left[1 - \cos \frac{i\pi}{n/10} \right] \quad i = 0, 1, \dots, n/10$$

The variances subsequently computed are then divided by 0.875 to make up for the energy lost by the taper.

The spectra are averaged by a boxcar of length NAVE to produce NB bands of width Δf , starting at f_1 (see II-D-3). For example, if the series length was 100 hours and NAVE=5, the frequencies would be .03, .08, .13cph, where the variance of the first frequency .03 cph is the sum over frequencies .01, .02, .03, .04, and .05. The spectral variances in the printed output are in accordance with Parseval's theorem, so that the sum of the variances over all frequencies (f_1 to the Nyquist frequency) equals the total variance. Of course there will be discrepancies because of the tapering done on the original series.

Subroutine: FFT, TAPER, FOURT

Program: SPECT

II-D-4 THE TAPE4 FORMAT

Perhaps a user wants to use R2D2 with data that is not in the R2D2 data base, or it may be desirable to use data from the data base in some other program. For these reasons the "TAPE4" format was developed for current meter, pressure gauge, or wind data.

TAPE4 consists of an unformatted 9 word header field and from 1 to 5 sets of unformatted data arrays. The header field, with suggested output format is:

- 1) mooring name (A10) MOOR
- 2) meter number (A5) MET
- 3) meter depth, m (I5) MDEP
- 4) start time (I10) IST
- 5) end time (I10) IET
- 6) series length (I5) NPT
- 7) data time interval, minutes(F5.0) DT
- 8) latitude, decimal degrees (F8.3) ALAT
- 9) longitude, decimal degrees (F8.3) ALON

Start time and end time are written as 9 digit integers YYDDDDHHMM where YY is year, DDD Julian day, HH hour, and MM minutes.

The data arrays are written in order of east velocity, north velocity, temperature, pressure, and salinity. Pressure gauge data has pressure and temperature. Data are written in arrays of maximum size 2000. If the actual series length is larger than 2000, the first 2000 of each parameter are written, then the next 2000, etc.

For example, if a current meter record of length 3500 is written, and

U, V, T are the parameters, the "TAPE4" file would be:

```
MOOR,MET,MDEP,IST,IET,NPT,DT,ALAT,ALON
```

```
U(I),I=1,2000
```

```
V(I),I=1,2000
```

```
T(I),I=1,2000
```

```
U(I),I=2001,3500
```

```
V(I),I=2001,3500
```

```
T(I),I=2001,3500
```

```
EOR
```

All selected records are written on one file, separated by end-of-records.

To write data from the data base to a TAPE4 file see II-D-2-1. To use a TAPE4 file in R2D2 see II-D-1-c.

II-E ENDING R2D2

The R2D2 session may be ended by entering a 0 for "WHAT DO YOU WANT TO DO?" (II-C-1, II-D-1) or for the options in the main data programs (II-C-2, II-D-2, II-D-3). After 0 is entered, R2D2 will ask one final question...

DO YOU WANT OUTPUT PRINTED AT PMEL?

If the answer is yes, TAPE6 will automatically be routed to the PMEL RJE terminal (or with minor modification of the procedure file, to any other terminal). Otherwise it will remain as a local file until routed, returned or the user logs off.

Another way to end R2D2 is to enter the word STOP for any input request. This is a NOS command which will immediately terminate program execution.

II-F MISCELLANEOUS ROUTINES

Several routines which require user input appear in many different options. They are described in this section.

II-F-1 Map drawing (fig. 7, 15)

This routine draws a Mercator projection map, with user specified boundaries and scale and optional coastline.

When first entering this routine during execution of one of the main programs, it will ask...

WHICH MAP FILE?

where one should

ENTER 0 FOR NONE

1 FOR GULF OF ALASKA

2 FOR BERING SEA

3 FOR PUGET SOUND

The Gulf of Alaska coastline extends from Cape Spencer to the Aleutians; the Bering Sea file includes the Aleutians and parts of Siberia and extends from the Alaskan Peninsula to Kotzebue Sound; and the Puget Sound file includes Puget Sound, Strait of Juan de Fuca to the Pacific coast, San Juan Islands and southern Strait of Georgia. Coastline resolution is about 5 km for the Alaska

files and 1 km for Puget Sound. If 0 is entered (for NONE) no file will be attached, but if TAPE3 already exists as a local file it will be read as a coastline file. Each record on TAPE3 constitutes a geographical position and consists of 3 unformatted words:

DLAT,DLON,IFLAG

where DLAT = meridional parts of latitude, decimal degree (positive north)
= M/60 (real number)

DLON = longitude, decimal degrees (positive west) (real number)

IFLAG = 2 pen down when moving to this point (integer)

3 pen up " " " " "

Latitude is converted to meridional parts using Bowditch's (1962, p.1187) formula

$$M = 7915.704468 \log \tan \left(45 + \frac{L}{2} \right) - 23.268932 \sin L - 0.0525 \sin^3 L - 0.000213 \sin^5 L$$

where L is degrees of latitude.

After attaching the coastline file, R2D2 will ask for latitude and longitude boundaries (II-C-1-d) if necessary, and then ask...

ENTER SCALE,ATLAT,TICK,YLEN

where

SCALE = CHART SCALE

ATLAT = LATITUDE OF SCALE

TICK = SPACING OF TICK MARKS IN DEGREES

YLEN = LENGTH OF LATITUDE AXIS IN INCHES

Scale may be entered as the scale from a Mercator nautical chart, accompanied by the latitude for that scale. If scale is entered, the parameter YLEN is ignored and the map is drawn to scale, and may be overlaid on a nautical chart. If scale is entered as 0, ATLAT is ignored and the scale is computed from YLEN and the latitude boundaries. TICK specifies the spacing of the latitude and longitude tick marks. For example TICK = .25 will cause a tick mark every 15' on the plot. Values of latitude and longitude are written every whole degree and at the corners.

After the parameters are entered R2D2 will print the scale and plot dimensions, ask for an OK, and proceed with the plot.

Subroutine: MCHART

II-F-2 Plotting

Plotting is done for the most part using standard Calcomp calls. An exception is the AXIS routine, which has been modified to accept a variable number of digits to the right of the decimal point, as in the NUMBER routine. The Calcomp routines write a plot file on TAPE99 of X,Y,IP

where X and Y are the pen coordinates in inches and IP is the pen position (2 = move with pen down, 3 = move with pen up).

After a plot file is written subroutine PLOTR is called. On the first call to PLOTR, R2D2 will ask...

ARE YOU USING A TEKTRONIX TERMINAL?

If not, R2D2 will proceed to save the plot on TAPE98 (see below). If the answer is yes...

ENTER BAUD RATE?

This enables plotting on a Tektronix graphic terminal, using the PLOT10 library routines. Plots are scaled in the vertical to fit a Tektronix 4012 screen (780 x 1023 screen coordinates). If the horizontal dimension of the plot is too large to fit the screen, the leftmost segment will be plotted first, then the next segment, and so on until the entire plot has been drawn. After each segment is plotted, a "?" will appear in the upper left corner accompanied by a "beep," which stops execution until something is entered. If an "E" is entered the plot will be ended. If carriage return or any other character is entered, the plot will continue.

When the plotting has been completed R2D2 will ask...

DO YOU WANT TO SAVE THIS FOR OFFLINE PLOTTING?

If the answer is yes, or if one is not using a Tektronix terminal, the plot will be saved as a permanent file for later offline (Calcomp) plotting. Before the first plot is saved, R2D2 will attempt to DEFINE TAPE98 as a direct access permanent file. If an old TAPE98 already existed, it may be purged or its name changed, so that a new TAPE98 may be DEFINED, viz

TAPE98 ALREADY PERMANENT. DO YOU WANT IT PURGED?

If one does not wish to purge the old TAPE98, its name may be changed...

DO YOU WANT TO CHANGE ITS NAME?

If answer is NO, new plots may not be saved. If YES...

NEW NAME?

Now enter the name to which the old TAPE98 will be changed. If another permanent file already exists by that name, R2D2 will so state and request another name.

The plot is then written from TAPE99 to TAPE98 in arrays of 300, where 1 to 100 are X, 101 to 200 are Y, and 201 to 300 are IP (written as a real number). The value of IP following the last point plotted is set to -99, signifying the end of plot. Successive plots are separated by end-of-records, and all plots from one session are on one file. TAPE98 may be used later as input to procedure file R2PLOT for plotting on the PMEL Calcomp plotter (see III-A), or as input to any other plotting program.

Subroutines: PLOTR, TEKPLT

III. ASSOCIATED USER PROGRAMS

III-A. R2PLOT: OFFLINE PLOTTING

Procedure file R2PLOT reads a TAPE98 plot file (II-F-2) and writes a file which is routed to the PMEL RJE terminal for plotting on the Calcomp plotter. The user executes R2PLOT by entering...

```
GET,R2PLOT/UN=RLC
```

```
R2PLOT, pfn
```

where pfn is the name (usually TAPE98) of the TAPE98 direct access permanent file. All plots saved from one R2D2 session are on one file. Several TAPE98 files may be merged prior to executing R2PLOT using COPYBF.

R2PLOT begins by attempting to execute a BANNER file (see II-A-2), and then executes the program R2PLOT. R2PLOT uses subroutines PLOTS,SYMBOL,and PLOT from the Calcomp library CCLIB on UN=PMELIB. The user number and date are plotted first, and then the plots from the TAPE98 file, each separated by 2 inches. The output file is named PLOTS, which is REPLACE'd and then routed to the PMEL RJE. If the maximum plot dimension in the vertical exceeds 10.5", FC=PW. Otherwise FC=PN. When execution is complete, the final portion of the dayfile is printed.

Program: R2PLOT

III-B UPLT

UPLT is a procedure file which executes a program to plot positions on a Mercator projection (see II-F-1). The user executes UPLT by entering

```
GET,UPLT/UN=RLC
```

The program reads local file TAPE4, which contains station name, latitude, longitude, symbol code, and pen position. TAPE4 format is:

columns	format	
1-10	A10	name
11-14	F4.0	degrees latitude (+north)
15-20	F6.2	minutes latitude
21-24	F4.0	degrees longitude (+west)
25-30	F6.2	minutes longitude
31	1X	blank
32-33	I2	calcomp SYMBOL code
34	I1	calcomp PLOT pen position (3 = default)

Plotting of the station name is optional. Plotting proceeds until an end-of-record is encountered. Then TAPE4 may either be rewound, or the next record plotted.

If a station falls outside the map boundaries, a message is printed and it is not plotted.

Plotting is done using the R2D2 routines (II-F-2 and III-A).

Program: UPLOT

IV. DATA STRUCTURE, MAINTENANCE PROGRAMS

IV-A STD

IV-A-1 Data structure

The R2D2 STD files are stored as two-level random access packed binary files. The master header files, stored as direct access permanent files on NOAA family disks, contain header information only. The Master Data Files contain headers and data, and are stored on a private disk pack.

The random access storage location is keyed to the unique station reference number, which is assigned sequentially when the data are loaded. The first level of indexing points to the locations of the second level of indexing, which has addresses of the data. The first level index is

$$IA = (IREF-1)/100 + 1 \text{ (truncated)}$$

where IREF is the reference number. IA is the subscript of array INDA (size 100) which contains the address for the array INDB. INDB contains 200 values, the first 100 of which are addresses for the header information for 100 casts, and the second 100 the packed data.

Thus, the header address subscript is...

$$IND = IREF - (IA - 1) \cdot 100$$

and the data address subscript = $IND + 100$.

The header field consists of 13 words: reference number (I), cruise name (A), cast number (I), station name (A), decimal latitude (F), decimal longitude (F), time word (I), station depth (F), series length (I), depth of first data (F), ship name (A), chief scientist name (A), and master reference number (I).

The time word is described in II-C-1-e. In master files the reference number equals the master reference number. New reference numbers, starting with 1, are assigned sequentially when creating User Data Files.

The data are packed temperature-salinity words in arrays of variable length, defined in the header. The first 30 bits of the data word contains temperature and the last 30 are salinity. Temperature is recovered by masking the last 30 bits using logical AND. Salinity is recovered by shifting the salinity bits to the temperature space and then masking the last 30 bits.

IV-A-2 Data loading

The STD data loading is done using submit file STDLOAD, which attaches the data and header files and runs program STDMS2.

TAPE1 contains one-meter averaged STD data in the Coastal Physics format. TAPE2 is the Master Header File and TAPE3 the Master Data File. The first input card contains the previous last reference number LAST in I5 format (i.e., the first of the new set will be LAST+1). If the input number is less than or equal to 0, the LAST will be read from TAPE2. The effect of entering LAST on the input card is to redefine LAST and overwrite subsequent data. The next input card contains ship name, chief scientist name and comments, in 8A10 format. A new card is read whenever a new cruise name is read from TAPE1.

The TAPE1 header information is read and printed, a reference number assigned, and header fields written on TAPE2 and TAPE3. Temperature and salinity are packed into one word and written in the data arrays on TAPE3. See II-A-1 for data structure. The full header information from TAPE1 is printed and the output stored in room 304 Showboat.

Program: STDMS2

IV-A-3 Editing header files

Occasionally the header information has been entered incorrectly when processing the STD data, or data must be deleted from R2D2. In those cases program STDEDIT is used to correct the R2D2 header file.

The header file is attached in the write mode as TAPE7. On execution, STDEDIT will ask....

```
ENTER 0 TO END EDITING
      1 TO DELETE CASTS
      2 TO EDIT CRUISE NAME
      3 "  "  CAST NUMBER
      4 "  "  STATION NAME
      5 "  "  LATITUDE
      6 "  "  LONGITUDE
      7 "  "  TIME
      8 "  "  STATION DEPTH
      9 "  "  ND
     10 RESTORE DELETED CAST
```

Options 1 and 2 are done on a range of reference numbers, the rest one at a time. After each change the program will ask for an OK. Deletions are made by changing the reference numbers to 0.

Note that only the header file is changed. The Master Data File retains the original headers. The new header information is carried to the User Data Files via TAPE5, the list of selected stations (see II-C-2).

This program should be used only by the person responsible for maintaining the data base.

Program: STDEDIT

IV-B CURRENT METER/PRESSURE GAUGE DATA

IV-B-1 Data structure

Like the STD files, the current meter/pressure gauge files are stored as two-level random access packed binary files. The Master Header Files, stored as direct access permanent files on NOAA Family disks, contain header information only. The Master Data Files contain headers and data, and are stored on a private disk pack.

The random access storage location is keyed to the unique station reference number, which is assigned sequentially when the data are loaded. The first level of indexing points to the locations of the second level of indexing, which has the addresses of the data. The first level index is

$$IA=(IREF)/10+1 \text{ (truncated)}$$

where IREF is the reference number. IA is the subscript of array INDA (size 100) which contains the address for the array INDB. INDB contains 100 values, the first 10 of which contain addresses of header information for 10 records, and the next 90 for data of the 10 records.

The header address subscript is...

$$IND=IREF-(IA-1)\cdot 10$$

and the data address subscripts= $IND+10\cdot n$, where n is determined by data type, filter type, and data segment.

The header field consists of a 15-word integer array IVAR and 30-word real array FVAR, where

IVAR(1) = reference number (I)
IVAR(2) = project name (A)
IVAR(3) = mooring name (A)
IVAR(4) = meter number (A)
IVAR(5) = meter depth (I)
IVAR(6) = 2.86 hr filtered data start time (I)
IVAR(7) = 2.86 hr filtered data end time (I)
IVAR(8) = 2.86 hr filtered data length (I)
IVAR(9) = 35 hr filtered data start time (I)
IVAR(10) = 35 hr filtered data end time (I)
IVAR(11) = 35 hr filtered data length (I)
IVAR(12) = master reference number
IVAR(13-15) used internally by R2D2 routines, comments
FVAR(1) = latitude, decimal degrees
FVAR(2) = longitude, decimal degrees
FVAR(3) = bottom depth
FVAR(4)-(23) data statistics computed during loading
FVAR(24)-(30) used internally by R2D2 routines, comments

The 2.86- and 35-hour filtered velocity components U & V are packed into one word. Basically, the least significant 30 bits of the original 60 bit words are masked off. Then the 30 most significant bits are left justified. The resulting words contain a sign bit, an 11-bit biased exponent and an 18-bit integer coefficient (see Control Data Corp. Fortran Extended Version 4 reference

manual #60305601, p.III-4-1). The u word is left in place and the v word is then shifted 30 bits to the right. A new 60 bit u-v word is then formed by taking the logical product of the two.

The 2.86-hr filtered temperature, pressure, and salinity words are packed in a somewhat different way. Each are multiplied by 1000 and rounded to the nearest integer. Then they are shifted and logically combined so that each occupies 20 bits of a 60 bit T-P-S word.

Up to 8000 2.86-hour filtered hourly data points may be stored, and 2000 35-hr filtered 6-hourly data. Storage location array subscripts are as follows:

IND	Headers					
IND+10	2.86-hr filtered U-V points 1-2000					
IND+20	"	"	"	T-P-S	"	"
IND+30	"	"	"	U-V	"	2001-4000
IND+40	"	"	"	T-P-S	"	"
IND+50	"	"	"	U-V	"	4001-6000
IND+60	"	"	"	T-P-S	"	"
IND+70	"	"	"	U-V	"	6001-8000
IND+80	"	"	"	T-P-S	"	"
IND+90	35-hr filtered U-V					

Pressure gauge pressure and temperature data are packed in the same way as the U-V current meter data. Up to 16000 2.86-hr filtered P-T words may be stored, using both the U-V and T-P-S data areas.

IV-B-2 Data loading

Loading of the current meter data is a two-step process. Step one filters the data and step two loads the filtered records.

The filtering program, FILTR, applies two separate low-pass filters to the data. Input data are in the Coastal Physics "edited data format". Data processing is described in Krancus, Pearson, and Charnell (1979). The filters are symmetrical Lanczos filters derived from the GENER1 routine in the FESTSA library.

The 2.86-hr filter is so called because the half-amplitude response of the filter is at a period of 2.86 hours. Over 99% of the amplitude is passed at a period of five hours and less than 0.1% at 2 hours. Filtered data are resampled at 1-hour intervals and interpolated to whole hours using a second-order polynomial. All parameters are 2.86-hr filtered. Kernel half-width is 4 hours.

The 35-hr filter has half amplitude response at 35 hrs, passes 99% at 55 hours and less than 0.1% at 25 hours. This effectively removes the tides. U and V components are 35-hr filtered (pressure and temperature for pressure gauges) resampled at 6-hourly intervals and interpolated to 00, 06, 12, 18 hours GMT. Kernel half-width is 60 hours.

Program CMLOAD adds the filtered data (TAPE9) to the Master Header File (TAPE2) and Master Data File (TAPE3). Statistics are computed (means, maxima, minima, and variances of the parameters), stored in the header FVAR array, and printed. Data are packed and stored as described in IV-B-1.

IV-B-3 Editing header files

Errors in the Master Header File may be corrected using program CMEDIT. Header information may be edited or records may be deleted. Only the Master Header File is changed. Corrections are transferred via TAPE5 to User Data Files when they are created.

The Master Header File is attached in the write mode as TAPE7. CMEDIT begins by asking...

ENTER 1 TO EDIT THE HEADERS
2 TO DELETE DATA SETS

Records are deleted by changing the reference numbers of the sets to be deleted to 0.

If editing the headers, the program will ask...

ENTER REFERENCE NUMBER OR 0 TO END EDITING?

then...

ENTER INDEX?

where...

INDEXES ARE: 0 TO END ENTERING INDEXES

1 TO CHANGE PROJECT NAME

2 TO CHANGE MOORING NAME

3 TO CHANGE METER NUMBER

4 TO CHANGE METER DEPTH

5 TO CHANGE LATITUDE

6 TO CHANGE LONGITUDE

7 TO CHANGE BOTTOM DEPTH

8 TO CHANGE COMMENTS

When 0 is entered the new header is printed and if OK, will be written in place of the old header.

Note that times may not be changed. This is because the start and end times are computed in the filter program and are different for each filter. To correct the time base, the start time should be changed in the "edited data" record, and then refiltered and loaded.

This program should only be used by the person responsible for maintaining the data base.

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REFERENCES

- Allen, J.S. and P.K. Kundu, 1978. On the momentum, vorticity and mass balance on the Oregon Shelf, Journal of Physical Oceanography, 8, pp.13-27.
- Bloomfield, P., 1976. Fourier Analysis of time series: An introduction, Wiley, New York, 258 pp.
- Bowditch, N., 1962. American Practical Navigator, U.S. Navy Hydrographic Office, Wash. D.C., 1524 pp.
- Dennis, R.E., and E.E. Long, 1971. A user's guide to a computer program for harmonic analysis of data at tidal frequencies, NOAA Tech. Report NOS 41, U.S. Dept. of Commerce, Wash. D.C., 31 pp.
- Hayes, S.P., 1979. Benthic current observation at DOMES sites A, B, and C in the tropical North Pacific Ocean, from Marine Geology and Oceanography of the Pacific Marganese Nodule Province, J.L. Bischoff and D.Z. Pipes ed., Plenum Publishing, pp 83-112.
- Jenkins, G.M. and D.G. Watts, 1968. Spectral Analysis and Its Applications, Holden-Day, San Francisco, 525 pp.
- Krancus, G.A., C.A. Pearson and R.L. Charnell, 1979. A one-pass processing system for Aanderaa current meter data, in Proceedings Second Working Conference on Oceanographic Data Systems 1978, C.D. Tollios ed., pp 96-111.

Mooers, C.N.K., 1973. A technique for the cross spectrum analysis of pairs of complex-valued time series, with emphasis on properties of polarized components and rotational invariants, Deep-Sea Research, 20, pp. 1129-1141.

Pearson, C.A., G.A. Krancus and R.L. Charnell, 1979. R2D2: An interactive graphics program for rapid retrieval and display of oceanographic data. In: Proceedings Second Working Conference on Oceanographic Data Systems, 1978, C.D. Tollios ed., pp. 318-329.

Schureman, P.W., 1958. Manual of harmonic analysis and prediction of tides, C&GS Special Publication No. 98, Revised(1940) Edition, U.S. Dept. of Commerce, Wash. D.C., 317 pp.