

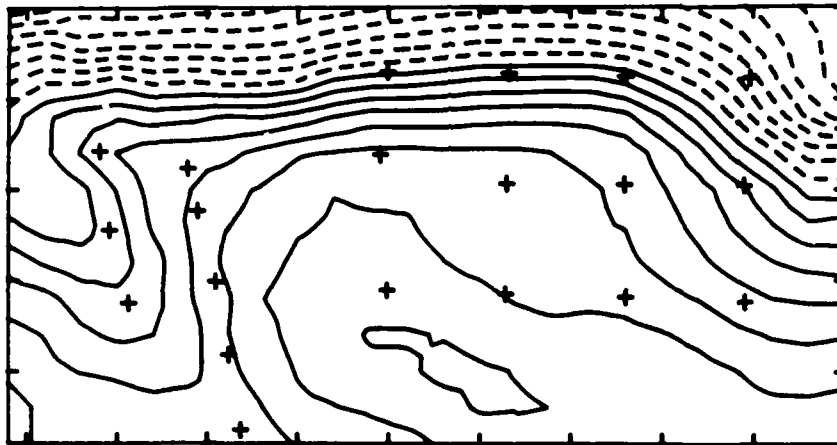
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# THE GULF STREAM DYNAMICS EXPERIMENT:

Inverted Echo Sounder Data Report  
for the  
April 1983 to June 1984  
Deployment Period

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by  
Karen L. Tracey

and

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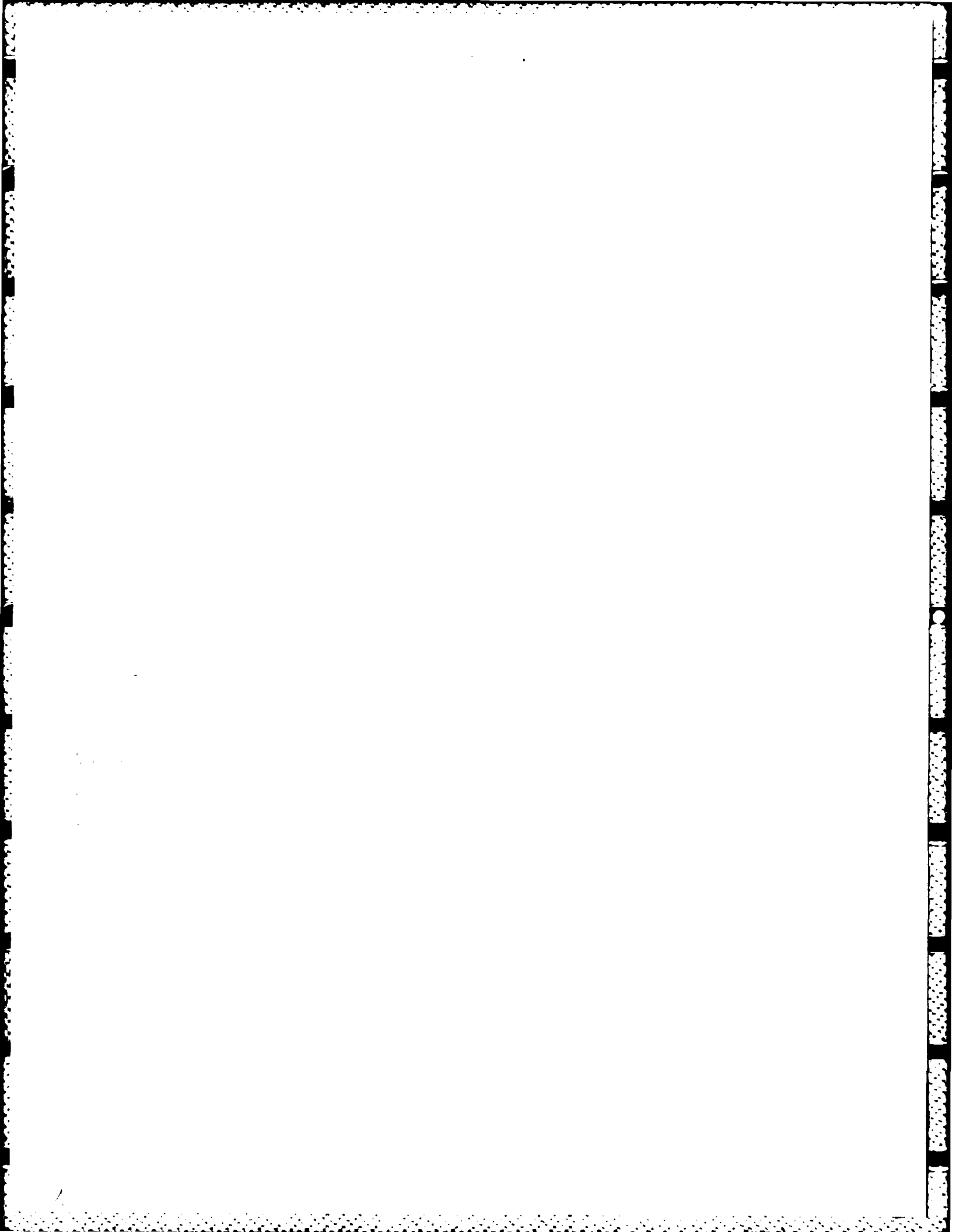
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GSO Technical Report Number 86-4

April 1986

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GRADUATE SCHOOL OF OCEANOGRAPHY  
UNIVERSITY OF RHODE ISLAND  
NARRAGANSETT, RHODE ISLAND

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**ABSTRACT**

The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from September 1983 to May 1985 to study the propagation and growth characteristics of Gulf Stream meanders. Data collected as part of the field experiment included inverted echo sounders, current meter moorings, and AXBT survey flights. This report documents the inverted echo sounder data collected from September 1983 to June 1984, as well as additional measurements made from April to September 1983. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for twenty-two instruments. Bottom pressure and temperature, measured at seven of the sites, are also plotted. Basic statistics are given for all the data records shown. Maps of the thermocline depth field in a 240 km by 460 km region are presented at daily intervals.

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## SECTION 1

### Experiment Description and Data Processing

#### 1.1 Introduction

This report documents data collected using inverted echo sounders (IES) in the Gulf Stream northeast of Cape Hatteras from April 1983 to June 1984. The measurements were made under the combined support of an NSF project entitled "The Dynamics of Gulf Stream Meanders" and an ONR project entitled "Observations on the Current Structure and Energetics of Gulf Stream Fluctuations Downstream of Cape Hatteras". Other data collected as part of a joint program conducted by the University of Rhode Island (D. R. Watts, P. I.) and the University of North Carolina (J. M. Bane, P. I.) included five current meter moorings with four levels instrumented from 500 m depth to 500 m above the bottom and seven AXBT flights over a larger geographical region. These other data will be documented in separate reports.

The principal objectives of the combined experiments were:

- 1) determining the propagation and growth characteristics of Gulf Stream meanders and how these vary downstream,
- 2) determining the detailed structure of the current and temperature fluctuations associated with Gulf Stream meanders in the study area,
- 3) investigating the baroclinic and barotropic energy transfers between the fluctuations and the mean field of Gulf Stream meanders in an area where meanders are known to be rapidly amplifying,
- 4) testing for possible generation of deep topographically trapped waves by shallower Gulf Stream meanders, and

5) determining the deep current structure and whether topographical control of Gulf Stream meandering occurs in the study area.

Additionally, these data will be used in cooperation with other ongoing investigations of the Gulf Stream in the same region. Collaboration with P. Cornillon's satellite imagery project (NSF supported) and H. T. Rossby's Rafos float project (ONR and NSF supported) is currently underway to obtain detailed descriptions of the meander characteristics.

To address these objectives, an array of inverted echo sounders and current meter moorings were deployed in the Gulf Stream approximately 200 km downstream of Cape Hatteras. Additionally, bottom pressure and temperature sensors were deployed at five of the sites. The study area, shown in Figure 1, was occupied from April 1983 to May 1985. This report presents the IES data collected between April 1983 and June 1984 and a companion report (Tracey *et al.*, 1985) documents the data collected from June 1984 to May 1985.

Initially, from April to September 1983, the array consisted of 13 IESs. It was increased to a maximum of 20 IESs in January 1984, and this large array was maintained until May 1985. The IESs were located on six lines in an approximately rectangular grid 130 km cross-stream by 360 km downstream. The instrument sites are shown in Figure 1 and listed in Table 1. Bottom pressure and temperature sensors were included at two sites along line B and three sites along line C; these sites are indicated in Figure 1 by the solid circles. The instruments were deployed and recovered during four cruises aboard the R/V ENDEAVOR

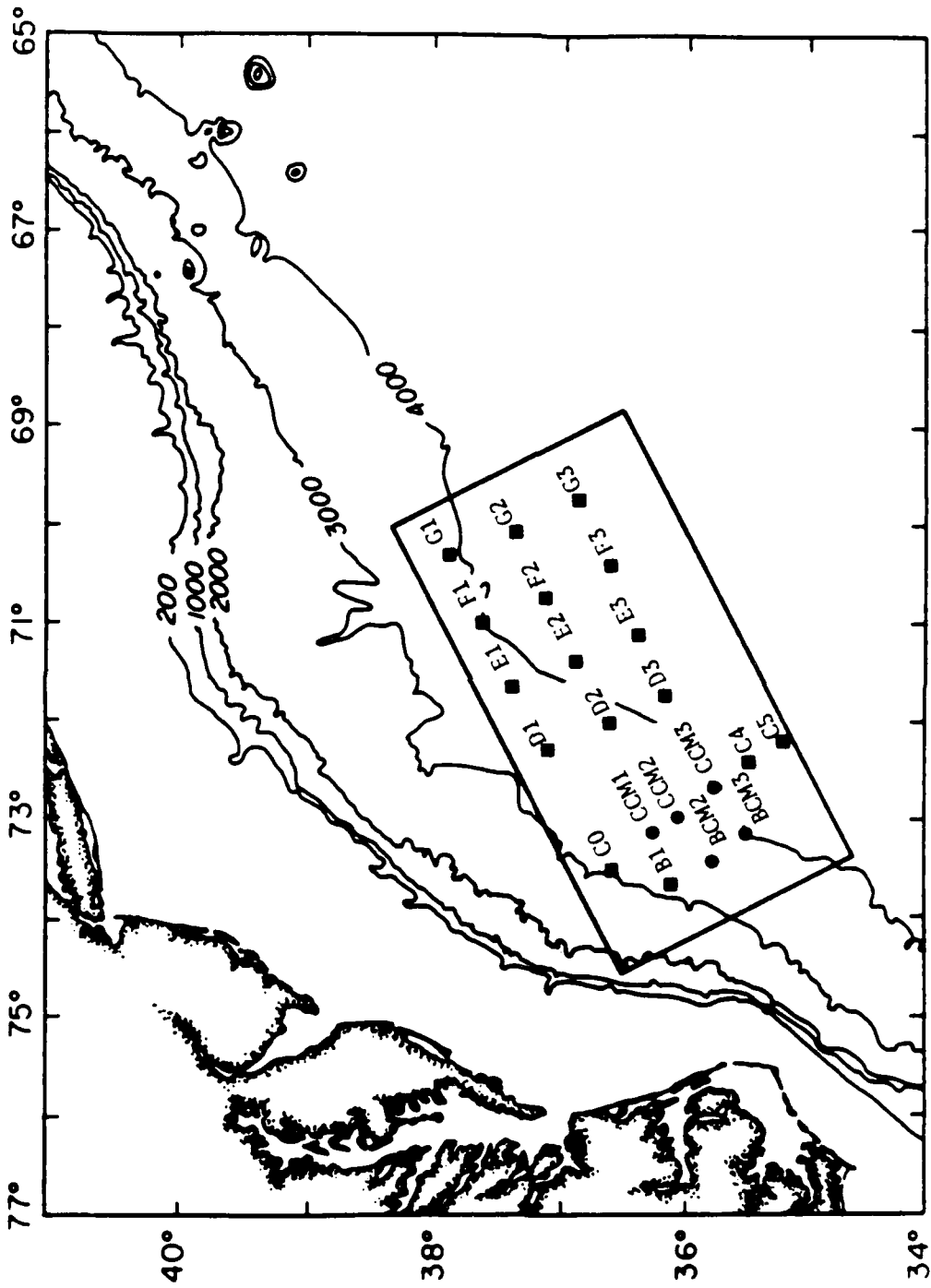


Figure 1. The Gulf Stream Dynamics Experiment Study Area. IES sites (solid squares and circles) along lines B through G were occupied during 1983-1985. IES with bottom pressure gauges and temperature sensors were located at the sites shown by the solid circles. The box outlines the 240 km by 460 km region, shown in Figure 12, which has been mapped by objective analysis. The data for sites C4 and C5 are documented in Tracey et al. (1985). Sites B2 and C1 were the same as BCM2 and CCM1, respectively, before the current meter moorings were deployed there.

Table 1. Instrument Site Locations and Data Returns.

SITE	LATITUDE (N)	LONGITUDE (W)	1983	1984	1985
			AMJJASONDJFMAMJJASONDJFMAM	AMJJASONDJFMAMJJASONDJFMAM	AMJJASONDJFMAM
IES84B1	36°08.24	73°41.76	XXXXXXXXXXXXXXXXXXXX	.....	
IES84B2	35°48.27	73°23.08	XXXXXX		
PIES84B2	35°47.81	73°26.99	XXX		
PIES85BCM2	35°48.09	73°25.88		XXXXXXXXXXXXXXXXXXXX	
PIES85BCM3	35°31.00	73°08.02		XXXXXXXXXXXXXXXXXXXX	
IES84C0	36°38.06	73°32.90	XXX		
PIES84C1	36°17.20	73°11.40	XXX		
PIES85CCM1	36°15.23	73°09.89		XXXXXXXXXXXXXXXXXXXX	....
PIES84CCM2	36°05.02	72°59.94		XXXXXXXXXX	.....
PIES84CCM3	35°48.22	72°42.55		XXXXXX	.....
IES85C4	35°30.32	72°26.51		.....	
IES85C5	35°11.80	72°10.19		.....	
IES84D1	37°07.79	72°19.13	XXXXXXXXXXXXXXXXXXXX	.....	
IES84D2	36°44.31	72°08.30	XXXXXXXXXXXXXXXXXXXX	.....	
IES84D3	36°08.65	71°44.45	XXXXXXXXXXXXXXXXXXXX	.....	
IES84E1	37°23.13	71°38.89	XXXXXXXXXXXXXXXXXXXX	.....	
IES84E2	36°52.98	71°21.85	XXXXXXXXXXXXXXXXXXXX		
IES84E3	36°23.11	71°04.64	XXXXXXXXXXXXXXXXXXXX	.....	
IES84F1	37°37.42	71°00.02	XXXXXXXXXXXXXXXXXXXX	.....	
IES84F2	37°08.11	70°43.02	XXXXXXXXXXXXXXXXXXXX	.....	
IES84F3	36°37.96	70°24.76	XXXXXXXXXXXXXXXXXXXX	.....	
IES84G1	37°53.46	70°18.99	XXXXXXXXXXXX	.....	
IES84G2	37°23.55	70°03.72	XXXXXXXXXXXX	.....	
IES84G3	36°52.34	69°44.90	XXXXXXXXXXXX	.	

X's denote data shown in this report. Dots denote data documented in Tracey *et al.*, 1985.

(EN106, 22-30 September 1983; EN107, 1-3 November 1983; EN118, 1-18 June 1984; EN124, 11-20 January 1985), one cruise aboard the R/V COLUMBUS ISELIN (CI8304, 16-27 April 1983), and one cruise aboard the R/V OCEANUS (OC144, 9-19 January 1984).

### 1.2 Site Naming Conventions

The six cross-stream lines are designated from west to east by the letters B through G. The IES sites along each line are numbered consecutively from 1 through 5, with site 1 located at the northwestern end of the line. Along line C, an additional instrument deployed on the northern edge of the line was assigned the number 0. In this report, each instrument site is referred to by both the line letter and site number. The site designator has a prefix of either IES, if it is a standard instrument, or PIES, if it is a combined IES, bottom pressure gauge, and temperature sensor. A two-digit code, either 84 or 85, is used to indicate the year in which the instrument was recovered. For example, IES84D2, the second site from the northern end of line D, was recovered during 1984. Additionally, if a current meter mooring was located at the same site as an IES, the letters CM were included between the line letter and site number (e.g., PIES85CCM1).

### 1.3 Inverted Echo Sounder Description

A detailed description of the IES is presented in Chaplin and Watts (1984) and will not be repeated here. Briefly, the IES is an instrument which is moored one meter above the ocean floor and which monitors the depth of the main thermocline acoustically. A sample burst of acoustic pulses is transmitted every half hour and the round trip travel times to the surface and back are recorded on a digital cassette

tape within the instrument. For the standard IES, a sample burst typically consists of twenty 10-kHz pings. Additionally, bottom pressure and temperature can be measured and recorded. For instruments with these optional sensors, the travel time burst consists of 24 pings. Bottom pressure and temperature are not sampled in bursts; they are average measurements over the whole sampling interval.

#### 1.4 Data Processing

The raw data is recorded within the IES on Sea Data model 610 recorders. The cassette tape contains the counts associated with travel time, pressure, and temperature measurements as a series of integer words of varying lengths. All processing was done on a PRIME 750 computer, except for the initial dumping of the data from the cassette tapes onto a 9-track magnetic tape. This was done on the Hewlett Packard 2000 series computer maintained by the URI Marine Technicians. The basic processing steps, which include transcription, editing, and conversion into scientific units, are illustrated by the flowchart in Figure 2. The data processing is accomplished by a series of routines specifically developed for the IES (Tracey and Watts, 1986) and these are outlined below.

CARP: Transfers the data from cassettes to 9-track magnetic tape for subsequent processing.

BUNS: Converts the series of integer words of varying lengths into standard length 32-bit integer words.

PUNS: Produces integer listings and histograms of the travel time sample bursts. Provides an initial look at data quality and travel time distributions. Used to determine the first (after launch) and last (before recovery) 'on bottom' samples.

MEMOD: Establishes the time base. Determines either the median or modal value (at the user's option) of the travel time burst as the representative measurement. Converts all travel time, pressure and

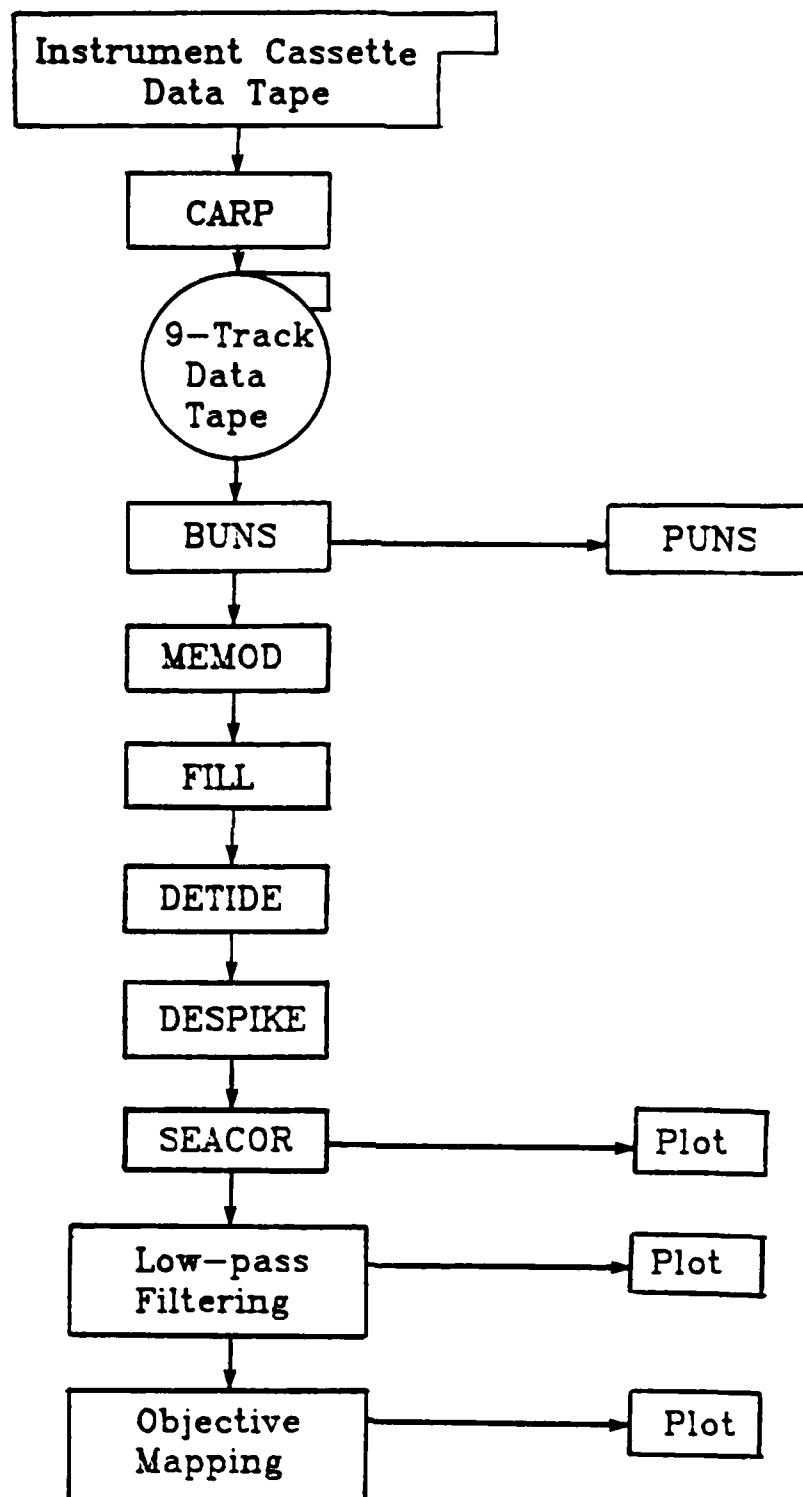


Figure 2. IES Data Processing Flowchart.

temperature counts into scientific units of seconds, decibars, and degrees Celsius, respectively.

FILL: Checks for proper incrementing of the time base. Missing data points are filled by inserting interpolated values.

DETIDE: From user-supplied tidal constituents specific to each site, determines the tidal contribution to the travel times and removes it from the measured values.

DESPIKE: Identifies and replaces travel time spikes with interpolated values.

SEACOR: Removes the effects of seasonal warming and cooling of the surface layers from the travel times. Plots of the half-hourly pressure, temperature and travel time are generated.

LOW-PASS FILTERING: Convolves the travel times, pressures, and temperatures with a 40-hour low-pass Lanczos filter. The smoothed series are subsampled at six-hour intervals and plotted.

OBJECTIVE MAPPING: Produces daily maps of the depth of the 12°C isotherm.

The FESTSA time series analysis package (Brooks, 1976), modified for the PRIME 750, was used to remove the higher frequency (tidal and inertial) motions from those with periods of several days or longer, which are the main focus of this project. The symmetric filter, with a Lanczos taper, was designed with the quarter power point at 0.025 cph and the tidal cycle attenuated by 60 dB. The half-hourly travel time, pressure, and temperature data were low-pass filtered and the smoothed output series (40 HRLP) had sampling intervals of six hours.

#### 1.4.1 Travel Time Calibration

Variations in the travel times have been shown to be proportional to variations in the thermocline depth (Watts and Rossby, 1977; Watts and Wimbush, 1981). Calibration XBTs were taken at each IES site in order to convert the travel times ( $\tau$ ) into thermocline depths ( $\xi$ ) according to the relation:  $\xi = M\tau + B$ , where  $M$  is -19.0 m/msec and the

intercept  $B$  depends on the depth of the instrument. Regressions of  $\tau$  versus  $\xi$ , performed for several instruments, show that a constant scale factor for  $M$  is appropriate for all these Gulf Stream sites. The values of  $B$  used for each instrument are listed in the tables in Section 2.

For practical purposes the main thermocline depth can be represented by the depth of an individual isotherm. For this work, we have chosen the  $12^{\circ}\text{C}$  isotherm since it is situated near the highest temperature gradient of the main thermocline and correlates well with  $\tau$  (Rossby, 1969; Watts and Johns, 1982). The low-pass filtered travel time records were scaled to the thermocline depths ( $Z_{1,2}$ ) and these records are shown in Section 4. The accuracy of the offset parameter  $B$  is estimated to be  $\pm 25$  m for most instruments, judged from the agreement between the several calibration XBTs taken at each site. Relative to this, the 40 HRLP  $Z_{1,2}$  values are resolved to  $\pm 2$  m.

#### 1.4.2 Thermocline Depth Mapping

Objective maps of the thermocline ( $Z_{1,2}$ ) field in the array region have been produced at daily intervals from these records. The boxed region in Figure 1, oriented  $064^{\circ}\text{T}$ , is the region which has been mapped. The objective mapping techniques were developed by E. Carter (1983) and special adaptations for their application to the Gulf Stream frontal zone are discussed in Watts and Tracey (1985). Two results presented in this latter work are of particular importance to the objective mapping performed here: 1) If the mean field is removed, the perturbations have essentially isotropic correlation fields. 2) They show the space-time correlation functions used for the objective analysis.

The objective analysis is performed on the "perturbation fields", which are obtained by removing the mean field from the input dataset and normalizing the standard deviation. To represent the mean field,  $\bar{Z}_{1,2}(x,y)$ , a third order polynomial was fitted to the mean values observed during the April 1983 to June 1984 deployment period. The function form of the polynomial was:

$$\bar{Z}_{1,2}(x,y) = B_0 + B_1x + B_2y + B_{1,1}x^2 + B_{1,2}xy + B_{2,2}y^2 + B_{1,1,1}x^3 + B_{1,1,2}x^2y + B_{1,2,2}xy^2 + B_{2,2,2}y^3$$

where (x,y) is the position in kilometers from the origin at 36°00'N, 73°30'W,  $B_0$  is 5.767184E+02,  $B_1$  is 5.752054E-02,  $B_2$  is -3.939068E+00,  $B_{1,1}$  is -1.113917E-03,  $B_{1,2}$  is 1.970595E-03,  $B_{2,2}$  is -9.249152E-03,  $B_{1,1,1}$  is 2.640075E-06,  $B_{1,1,2}$  is -2.609863E-06,  $B_{1,2,2}$  is 1.240944E-05, and  $B_{2,2,2}$  is 4.856306E-05. The standard deviation field,  $\sigma(x,y)$ , was defined as a function of the mean field depth, from a Gaussian form representative of all IES records:

$$\sigma(x,y) = A + B \exp - \left[ \frac{Z_{1,2}(x,y) - Z_0}{C} \right]^2$$

where A is 50 m, B is (200 m - A), C is 200 m,  $Z_0$  is 470 m, and  $\bar{Z}_{1,2}(x,y)$  is the mean value at that (x,y) location. Figure 10 shows both the mean and standard deviation fields in plan view.

For each output grid point, the objective mapping technique selects, from all the input data within a specified maximum time lag (T) and radial distance (R), the number of points (N) which have the highest correlations. The output fields in Figures 11 and 12 result from specifying  $N = 9$ ,  $T = \pm 4$  days, and  $R = 120$  km, and using the idealized correlation function (Watts and Tracey, 1985) with an assumed noise level  $E = 0.05$ .

The output of the objective mapping is the perturbation field (Figure 12) on a full grid of points, with 20 km grid spacing, within the mapped region. The thermocline depth maps (also shown in Figure 12) are obtained by renormalizing the perturbation field by the standard deviation and restoring the mean. In this report, three different sizes of regions are mapped, depending on the locations of the instrument sites. These are: 1) For the period from April to September 1983, the region mapped is 200 km cross-stream by 400 km downstream. 2) From September 1983 to January 1984, it is 200 km by 460 km. 3) From January to June 1984, it is 240 km by 460 km. The accuracy of these output fields can be obtained from the estimated error fields, which are shown in Figure 11. A detailed discussion of the accuracy is given in Watts and Tracey (1986).

#### 1.4.3 Temperature

Temperatures were measured using Sea Data DC-37B electronics and a Yellow Springs International Corporation thermistor (model 44032), in order to correct the pressure values for the temperature sensitivity of the transducer. The thermistor is inside the instrument, on the pressure transducer, rather than in the water. However, once the temperature probe has reached equilibrium with the surrounding waters, it also provides accurate measurements of the bottom temperature fluctuations (effectively low-pass filtered with a 4-hour e-folding equilibrium time). The first 24 half-hourly points were dropped prior to low-pass filtering, since the temperatures took 12 hours to reach equilibrium within  $0.001^{\circ}\text{C}$ . The accuracy of the temperature measurements is about  $0.1^{\circ}\text{C}$ , and the resolution is  $0.0002^{\circ}\text{C}$ .

#### 1.4.4 Bottom Pressure

Digiquartz pressure sensors (models 75K-002 and 76KB-032) manufactured by Paroscientific, Inc. were used to measure bottom pressure. They were powered and controlled by Sea Data Corporation model XP35 electronics cards, which were installed in the IESs. All pressure measurements were corrected for the temperature sensitivity of the transducer (Watts and Kontoyiannis, 1986a) using calibration coefficients purchased from the manufacturer. The half-hourly measured bottom pressures (Figures 4.1-4.4) are dominated by the tides; however, for some of the instruments, the pressures also drift [0(0.4 dbar)] monotonically with time. Processing of the pressure measurements includes removing the long-term drift and the tides as follows.

Tidal response analysis (Munk and Cartwright, 1966) was used to determine the tidal constituents for each instrument. The calculated tides were then removed from the pressure records. The amplitudes,  $H$  (dbar), and phases,  $G^\circ$  (Greenwich epoch), of the constituents are given in the tables in Section 2.

In order to estimate and remove the long-term drift from the measurements, we least-squares fitted a logarithmic function to our data (Watts and Kontoyiannis, 1986a and b). The functional form was:

$$\text{DRIFT} = P_1 \ln(t - t_0) + P_2$$

where  $t$  is the time,  $t_0$  is the time of initial pressurization, and  $P_1$  and  $P_2$  are free parameters. For all instruments,  $t_0$  was chosen to be a specific time after launch, one half hour before the first bottom sample. The parameters  $P_1$  and  $P_2$  were determined for each instrument using the non-linear regression subroutine P3R of BMDP-79, a package of

computer programs developed at the Health Science Computing Facility, UCLA (Dixon and Brown, 1979). These coefficients are listed in Section 2 for each record which had a measureable drift.

The half-hourly pressures are resolved to 0.001 dbar, and the mean pressure is accurate to within 1.5 dbar. We estimate that the residual (drift and tide removed) bottom pressure records have an accuracy (relative to their mean pressures) of at least 0.05 dbar (Watts and Kontoyannis, 1986b). The residual bottom pressure records were low-pass filtered as mentioned above.

#### 1.4.5 Time Base

The date and time were assigned to each sampling period. The tables in Section 2 report the hour, minutes, and seconds associated with the first and last sampling period as a six-digit number. All times are given as Greenwich Mean Time (GMT). For processing convenience, the times were converted into yearhours. Table 2 lists the yearhour which corresponds to 0000 GMT of each day for non-leap years. (For leap years, the yearhours can be determined by adding 24 to each day after February 28.) There are a total of 8760 hours in a standard year and 8784 hours in a leap year. The yearhours given in this report are referenced to 0000 GMT on either January 1, 1984 or January 1, 1985, depending on the year in which the IES was recovered; the two-digit number of the site name indicates which date is the reference. Positive yearhours correspond to sampling periods which occur during the same calendar year as the reference date; negative yearhours correspond to those which occur in the calendar year prior to the reference.

Table 2. Yearhour Calendar for Non-Leap Years. Only the yearhour corresponding to 0000 GMT is listed for each day.

JAN			FEB			MAR			APR			MAY			JUNE		
DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!
1	01	0	1	321	744	1	601	1416	1	911	2160	1	1211	2890	1	1521	3624
2	21	24	2	331	768	2	611	1440	2	921	2184	2	1221	2904	2	1531	3648
3	31	48	3	341	792	3	621	1464	3	931	2208	3	1231	2928	3	1541	3672
4	41	72	4	351	816	4	631	1488	4	941	2232	4	1241	2952	4	1551	3696
5	51	96	5	361	840	5	641	1512	5	951	2256	5	1251	2976	5	1561	3720
6	61	120	6	371	864	6	651	1536	6	961	2280	6	1261	3000	6	1571	3744
7	71	144	7	381	888	7	661	1560	7	971	2304	7	1271	3024	7	1581	3768
8	81	168	8	391	912	8	671	1584	8	981	2328	8	1281	3048	8	1591	3792
9	91	192	9	401	936	9	681	1608	9	991	2352	9	1291	3072	9	1601	3816
10	101	216	10	411	960	10	691	1632	10	1001	2376	10	1301	3096	10	1611	3840
11	111	240	11	421	984	11	701	1656	11	1011	2400	11	1311	3120	11	1621	3864
12	121	264	12	431	1008	12	711	1680	12	1021	2424	12	1321	3144	12	1631	3888
13	131	288	13	441	1032	13	721	1704	13	1031	2448	13	1331	3168	13	1641	3912
14	141	312	14	451	1056	14	731	1728	14	1041	2472	14	1341	3192	14	1651	3936
15	151	336	15	461	1080	15	741	1752	15	1051	2496	15	1351	3216	15	1661	3960
16	161	360	16	471	1104	16	751	1776	16	1061	2520	16	1361	3240	16	1671	3984
17	171	384	17	481	1128	17	761	1800	17	1071	2544	17	1371	3264	17	1681	4008
18	181	408	18	491	1152	18	771	1824	18	1081	2568	18	1381	3288	18	1691	4032
19	191	432	19	501	1176	19	781	1848	19	1091	2592	19	1391	3312	19	1701	4056
20	201	456	20	511	1200	20	791	1872	20	1101	2616	20	1401	3336	20	1711	4080
21	211	480	21	521	1224	21	801	1896	21	1111	2640	21	1411	3360	21	1721	4104
22	221	504	22	531	1248	22	811	1920	22	1121	2664	22	1421	3384	22	1731	4128
23	231	528	23	541	1272	23	821	1944	23	1131	2688	23	1431	3408	23	1741	4152
24	241	552	24	551	1296	24	831	1968	24	1141	2712	24	1441	3432	24	1751	4176
25	251	576	25	561	1320	25	841	1992	25	1151	2736	25	1451	3456	25	1761	4200
26	261	600	26	571	1344	26	851	2016	26	1161	2760	26	1461	3480	26	1771	4224
27	271	624	27	581	1368	27	861	2040	27	1171	2784	27	1471	3504	27	1781	4248
28	281	648	28	591	1392	28	871	2064	28	1181	2808	28	1481	3528	28	1791	4272
29	291	672	29	881	2088	29	881	2088	29	1191	2832	29	1491	3552	29	1801	4296
30	301	696	30	891	2112	30	891	2112	30	1201	2856	30	1501	3576	30	1811	4320
31	311	720				31	901	2136				31	1511	3600			

JULY			AUG			SEPT			OCT			NOV			DEC		
DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!	DATE!YEAR!	HR	DAY!(0000Z)!
1	1971	4344	1	2131	5089	1	2441	5932	1	2741	6552	1	3051	7296	1	3351	8016
2	1931	4368	2	2141	5112	2	2451	5956	2	2751	6576	2	3061	7320	2	3361	8040
3	1891	4392	3	2151	5136	3	2461	5980	3	2761	6600	3	3071	7344	3	3371	8064
4	1851	4416	4	2161	5160	4	2471	5904	4	2771	6624	4	3081	7368	4	3381	8088
5	1811	4440	5	2171	5184	5	2481	5928	5	2781	6648	5	3091	7392	5	3391	8112
6	1811	4464	6	2181	5208	6	2491	5952	6	2791	6672	6	3101	7416	6	3401	8136
7	1811	4488	7	2191	5232	7	2501	5976	7	2801	6696	7	3111	7440	7	3411	8160
8	1811	4512	8	2201	5256	8	2511	6000	8	2811	6720	8	3121	7464	8	3421	8184
9	1901	4536	9	2211	5280	9	2521	6024	9	2821	6744	9	3131	7488	9	3431	8208
10	1911	4560	10	2221	5304	10	2531	6048	10	2831	6768	10	3141	7512	10	3441	8232
11	1921	4584	11	2231	5328	11	2541	6072	11	2841	6792	11	3151	7536	11	3451	8256
12	1931	4608	12	2241	5352	12	2551	6096	12	2851	6816	12	3161	7560	12	3461	8280
13	1941	4632	13	2251	5376	13	2561	6120	13	2861	6840	13	3171	7584	13	3471	8304
14	1951	4656	14	2261	5400	14	2571	6144	14	2871	6864	14	3181	7608	14	3481	8328
15	1961	4680	15	2271	5424	15	2581	6168	15	2881	6888	15	3191	7632	15	3491	8352
16	1971	4704	16	2281	5448	16	2591	6192	16	2891	6912	16	3201	7656	16	3501	8376
17	1981	4728	17	2291	5472	17	2601	6216	17	2901	6936	17	3211	7680	17	3511	8400
18	1991	4752	18	2301	5496	18	2611	6240	18	2911	6960	18	3221	7704	18	3521	8424
19	2001	4776	19	2311	5520	19	2621	6264	19	2921	6984	19	3231	7728	19	3531	8448
20	2011	4800	20	2321	5544	20	2631	6288	20	2931	7008	20	3241	7752	20	3541	8472
21	2021	4824	21	2331	5568	21	2641	6312	21	2941	7032	21	3251	7776	21	3551	8496
22	2031	4848	22	2341	5592	22	2651	6336	22	2951	7056	22	3261	7800	22	3561	8520
23	2041	4872	23	2351	5616	23	2661	6360	23	2961	7080	23	3271	7824	23	3571	8544
24	2051	4896	24	2361	5640	24	2671	6384	24	2971	7104	24	3281	7848	24	3581	8568
25	2061	4920	25	2371	5664	25	2681	6408	25	2981	7128	25	3291	7872	25	3591	8592
26	2071	4944	26	2381	5688	26	2691	6432	26	2991	7152	26	3301	7896	26	3601	8616
27	2081	4968	27	2391	5712	27	2701	6456	27	3001	7176	27	3311	7920	27	3611	8640
28	2091	4992	28	2401	5736	28	2711	6480	28	3011	7200	28	3321	7944	28	3621	8664
29	2101	5016	29	2411	5760	29	2721	6504	29	3021	7224	29	3331	7968	29	3631	8688
30	2111	5040	30	2421	5784	30	2731	6528	30	3031	7248	30	3341	7992	30	3641	8712
31	2121	5064	31	2431	5808				31	3041	7272				31	3641	8736

### 1.5 Data Recovery

Table 1 summarizes the data returns from each of the inverted echo sounders. All 22 instruments documented in this report were recovered, giving an instrument recovery rate of 100%. The travel time detectors on these instruments performed successfully, resulting in a 100% data return rate. The electronics card controlling one pressure sensor malfunctioned during its deployment, and the data record from another pressure sensor had large jumps (both positive and negative), indicating that its sensor malfunctioned. Thus the recovery rate for the bottom pressure data was only 72%. Seven complete records were obtained for temperature sensors; thus the return rate was 100% for these data.



## SECTION 2

### Individual Site and Record Information Tables

The following tables provide information about the location, dates, and basic statistics of the data records, which are plotted in Sections 3 and 4. Each table documents a single instrument site.

General site information, such as position, bottom depth, and launch and recovery times, are given first. Subsequently, details about the travel time, bottom pressure and temperature records plotted in Sections 3 and 4 are tabulated. For each plot, the times associated with the first and last data point are supplied. All yearhours are referenced to 0000 GMT on either January 1, 1984 or January 1, 1985. The two-digit number (84 or 85) of the site name indicates which date is the reference. Measurements made during the calendar year prior to the reference date are given as negative yearhours.

The first order statistics (minimum, maximum, mean, and standard deviation) were calculated for the half-hourly and the 40 HRLP records for each variable. These are also presented in the following tables.

## IES84B1

Serial Number: 012  
 Type of Travel Time Detector: TTB  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 36°08.24 N                      Depth: 3160 m  
 73°41.76 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 25, 1983	1804	CI8304
RECOVERY:	Jun 7, 1984	0904	EN118

## TRAVEL TIME RECORDS

(Fig. 3.1)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 25, 1983	185555	-6005.0681
LAST DATA POINT:	Jun 7, 1984	085555	3800.9319

Number of Points: 19613  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 4.17667 s                      Mean = 4.19142 s  
 Maximum  $\tau$  = 4.20758 s                      Standard Deviation = 0.00833 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.1)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 80023.55$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 27, 1983	060000	-5970.00
LAST DATA POINT:	Jun 6, 1984	000000	3768.00

Number of Points: 1624  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 109.05 m                      Mean = 386.01 m  
 Maximum  $Z_{1,2}$  = 650.09 m                      Standard Deviation = 160.33 m

## IES84B2

Serial Number: 014  
 Type of Travel Time Detector: TTB  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 35°48.27 N                      Depth: 3625 m  
           73°23.08 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 25, 1983	2130	CI8304
RECOVERY:	Sep 24, 1983	0759	EN106

## TRAVEL TIME RECORDS

(Fig. 3.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 25, 1983	222210	-6001.6306
LAST DATA POINT:	Sep 24, 1983	075210	-2368.1306

Number of Points: 7268  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 4.82774 s  
 Maximum  $\tau$  = 4.84007 s

Mean = 4.83279 s  
 Standard Deviation = 0.00183 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.1)

$Z_{1,z}$  Conversion Equation:  $Z_{1,z} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 92468.44$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 27, 1983	060000	-5970.00
LAST DATA POINT:	Sep 23, 1983	000000	-2400.00

Number of Points: 596  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,z}$  = 525.63 m  
 Maximum  $Z_{1,z}$  = 729.71 m

Mean = 644.95 m  
 Standard Deviation = 49.92 m



## PIES84B2 (continued)

## MEASURED PRESSURE RECORDS

(Fig. 4.1)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Sep 24, 1983	112952	-2364.5025
LAST DATA POINT:	Nov 18, 1983	052952	-1050.5025

Number of points: 2629  
 Sampling Interval: 0.50 hrs

Minimum = 3623.79 dbar	Mean = 3624.43 dbar
Maximum = 3625.18 dbar	Standard deviation = 0.33 dbar

## RESIDUAL PRESSURE RECORDS

(Fig. 5.1)

$$P_{\text{residual}} = P_{\text{measured}} - \text{MEAN} - \text{DRIFT} - \text{TIDE}$$

$$\text{DRIFT} = P_1 \ln(t - t_0) + P_2$$

where  $t$  = Time of sample in yearhours  
 $t_0$  = -2365.0025 hrs  
 $P_1$  = -0.037278 dbar  
 $P_2$  = 0.231444 dbar

TIDE calculated from the following constituents:

	<u>M2</u>	<u>N2</u>	<u>S2</u>	<u>K2</u>	<u>K1</u>	<u>O1</u>	<u>P1</u>	<u>O1</u>
H (dbar):	.42427	.10616	.08304	.01971	.09128	.06666	.02991	.01460
G°:	353.50	335.77	20.90	21.65	183.08	186.63	182.51	194.59

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Sep 24, 1983	232952	-2352.5025
LAST DATA POINT:	Nov 18, 1983	052952	-1050.5025

Number of points: 2605  
 Sampling Interval: 0.50 hrs

Minimum = -0.1155 dbar	Mean = 0.0000 dbar
Maximum = 0.1216 dbar	Standard deviation = 0.0421 dbar



## PIES85BCM2

Serial Number: 055  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 24  
 Additional Sensors: Pressure and Temperature  
 Pressure Sensor Serial Number: 8181

Position: 35°48.09 N                      Depth: 3560 m  
 73°25.88 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Jan 16, 1984	2344	OC144
RECOVERY:	Jan 17, 1985	0104	EN124

## TRAVEL TIME RECORDS

(Fig. 3.4)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	003122	-8399.4772
LAST DATA POINT:	Jan 17, 1985	013122	384.5228

Number of Points: 17569  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 0.35622 s                      Mean = 0.36169 s  
 Maximum  $\tau$  = 0.37611 s                      Standard Deviation = 0.00258 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.1)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 7543.76$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 18, 1984	060000	-8370.00
LAST DATA POINT:	Jan 15, 1985	180000	354.00

Number of Points: 1455  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 418.56 m                      Mean = 671.53 m  
 Maximum  $Z_{1,2}$  = 754.77 m                      Standard Deviation = 47.53 m



## PIES85BCM2 (continued)

## 40HRLP PRESSURE RECORDS

(Fig. 8.1)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 15, 1985	180000	354.0000

Number of points: 1452  
 Sampling Interval: 6.00 hrs

Minimum = -0.1835 dbar  
 Maximum = 0.1275 dbar  
 Mean = 0.0000 dbar  
 Standard deviation = 0.0444 dbar

## TEMPERATURE RECORDS

(Fig. 6.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	125927	-8387.0092
LAST DATA POINT:	Jan 16, 1985	235927	383.9908

Number of points: 17543  
 Sampling Interval: 0.50 hrs

Minimum = 2.166 °C  
 Maximum = 2.435 °C  
 Mean = 2.234 °C  
 Standard deviation = 0.052 °C

## 40HRLP TEMPERATURE RECORDS

(Fig. 9.1)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 15, 1985	180000	354.0000

Number of points: 1452  
 Sampling Interval: 6.00 hrs

Minimum = 2.168 °C  
 Maximum = 2.433 °C  
 Mean = 2.234 °C  
 Standard deviation = 0.051 °C

## PIES85BCM3

Serial Number: 034  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 24  
 Additional Sensors: Pressure and Temperature  
 Pressure Sensor Number: 18426

Position: 35°31.00 N                      Depth: 3930 m  
 73°08.02 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Jan 15, 1984	0352	OC144
RECOVERY:	Jan 3, 1985	0419	Timed Release
	(Recovered in Bermuda on Feb 8, 1985)		

## TRAVEL TIME RECORDS

(Fig. 3.5)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 15, 1984	045125	-8443.1431
LAST DATA POINT:	Jan 3, 1985	035125	51.8569

Number of Points: 16991  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 0.03772 s                      Mean = 0.04442 s  
 Maximum  $\tau$  = 0.06289 s                      Standard Deviation = 0.00278 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.1)

$Z_{12}$  Conversion Equation:  $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 1609.34$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 16, 1984	120000	-8412.00
LAST DATA POINT:	Jan 1, 1985	180000	18.00

Number of Points: 1406  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{12}$  = 439.15 m                      Mean = 765.44 m  
 Maximum  $Z_{12}$  = 870.84 m                      Standard Deviation = 51.70 m

## PIES85BCM3 (continued)

No PRESSURES are shown due to the poor quality of the data.

## TEMPERATURE RECORDS

(Fig. 6.3)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 15, 1984	164930	-8431.1750
LAST DATA POINT:	Jan 3, 1985	034930	51.8250

Number of points: 16967  
 Sampling Interval: 0.50 hrs

Minimum = 2.441 °C

Mean = 2.468 °C

Maximum = 2.558 °C

Standard deviation = 0.013 °C

## 40HRLP TEMPERATURE RECORDS

(Fig. 9.1)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	000000	-8400.0000
LAST DATA POINT:	Jan 1, 1985	180000	18.0000

Number of points: 1404  
 Sampling Interval: 6.00 hrs

Minimum = 2.441 °C

Mean = 2.468 °C

Maximum = 2.525 °C

Standard deviation = 0.013 °C







## PIES84C1 (continued)

TEMPERATURE RECORDS  
(Fig. 6.4)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Nov 2, 1983	080406	-1431.9317
LAST DATA POINT:	Jan 11, 1984	143406	254.5683

Number of points: 3374  
Sampling Interval: 0.50 hrs

Minimum = 2.220 °C  
Maximum = 2.349 °C

Mean = 2.258 °C  
Standard deviation = 0.028 °C

40HRLP TEMPERATURE RECORDS  
(Fig. 9.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jan 10, 1984	060000	222.0000

Number of points: 271  
Sampling Interval: 6.00 hrs

Minimum = 2.221 °C  
Maximum = 2.348 °C

Mean = 2.258 °C  
Standard deviation = 0.028 °C

## PIES85CCM1

Serial Number: 056  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 24  
 Additional Sensors: Pressure and Temperature  
 Pressure Sensor Number: 17848

Position: 36°15.23 N                      Depth: 3475 m  
           73°09.89 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Jan 17, 1984	0505	OC144
RECOVERY:	Jan 14, 1985	0029	EN124

TRAVEL TIME RECORDS  
 (Fig. 3.8)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	054530	-8394.2417
LAST DATA POINT:	Jan 14, 1985	001530	312.2583

Number of Points: 17414  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 0.21649 s                      Mean = 0.22576 s  
 Maximum  $\tau$  = 0.24212 s                      Standard Deviation = 0.00409 s

40HRLP THERMOCLINE DEPTH RECORDS  
 (Fig. 7.2)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 4912.21$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 18, 1984	120000	-8364.00
LAST DATA POINT:	Jan 12, 1985	180000	282.00

Number of Points: 1442  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 344.32 m                      Mean = 623.01 m  
 Maximum  $Z_{1,2}$  = 745.13 m                      Standard Deviation = 76.39 m

## PIES85CCM1 (continued)

No PRESSURES were measured due to the failure of the electronics card.

TEMPERATURE RECORDS  
(Fig. 6.5)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	174335	-8382.2736
LAST DATA POINT:	Jan 14, 1985	001335	312.2264

Number of points: 17390  
Sampling Interval: 0.50 hrs

Minimum = 2.160 °C  
Maximum = 2.488 °C

Mean = 2.251 °C  
Standard deviation = 0.070 °C

40HRLP TEMPERATURE RECORDS  
(Fig. 9.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 19, 1984	000000	-8352.0000
LAST DATA POINT:	Jan 12, 1985	120000	276.0000

Number of points: 1439  
Sampling Interval: 6.00 hrs

Minimum = 2.162 °C  
Maximum = 2.468 °C

Mean = 2.251 °C  
Standard deviation = 0.070 °C





## PIES84CCM2 (continued)

40HRLP PRESSURE RECORDS  
(Fig. 8.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jun 6, 1984	060000	3774.0000

Number of points: 863  
Sampling Interval: 6.00 hrs

Minimum = -0.1920 dbar  
Maximum = 0.1057 dbar  
Mean = 0.0000 dbar  
Standard deviation = 0.0503 dbar

TEMPERATURE RECORDS  
(Fig. 6.6)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Nov 2, 1983	110740	-1428.8722
LAST DATA POINT:	Jun 7, 1984	150740	3807.1278

Number of points: 10473  
Sampling Interval: 0.50 hrs

Minimum = 2.244 °C  
Maximum = 2.483 °C  
Mean = 2.319 °C  
Standard deviation = 0.058 °C

40HRLP TEMPERATURE RECORDS  
(Fig. 9.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Nov 3, 1983	180000	-1398.0000
LAST DATA POINT:	Jun 6, 1984	060000	3774.0000

Number of points: 863  
Sampling Interval: 6.00 hrs

Minimum = 2.246 °C  
Maximum = 2.476 °C  
Mean = 2.319 °C  
Standard deviation = 0.057 °C

## PIES84CCM3

Serial Number: 036  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 24  
 Additional Sensors: Pressure and Temperature  
 Pressure Sensor Serial Number: 17911

Position: 35°48.22 N                      Depth: 3900 m  
 72°42.55 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Jan 15, 1984	0822	OC144
RECOVERY:	Jun 7, 1984	2109	EN118

TRAVEL TIME RECORDS  
 (Fig. 3.10)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 15, 1984	093148	345.5300
LAST DATA POINT:	Jun 7, 1984	210148	3813.0300

Number of Points: 6936  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 0.39461 s                      Mean = 0.40035 s  
 Maximum  $\tau$  = 0.41225 s                      Standard Deviation = 0.00260 s

40HRLP THERMOCLINE DEPTH RECORDS  
 (Fig. 7.2)

$Z_{1z}$  Conversion Equation:  $Z_{1z} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 8370.70$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 16, 1984	180000	378.00
LAST DATA POINT:	Jun 6, 1984	120000	3780.00

Number of Points: 568  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1z}$  = 568.73 m                      Mean = 746.25 m  
 Maximum  $Z_{1z}$  = 851.59 m                      Standard Deviation = 48.67 m



## PIES84CCM3 (continued)

TEMPERATURE RECORDS  
(Fig. 6.7)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 15, 1984	212953	357.4891
LAST DATA POINT:	Jun 7, 1984	205953	3812.9981

Number of points: 6912  
Sampling Interval: 0.50 hrs

Minimum = 2.365 °C  
Maximum = 2.494 °C

Mean = 2.397 °C  
Standard deviation = 0.017 °C

40HRLP TEMPERATURE RECORDS  
(Fig. 9.2)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Jan 17, 1984	060000	390.0000
LAST DATA POINT:	Jun 6, 1984	120000	3780.0000

Number of points: 566  
Sampling Interval: 6.00 hrs

Minimum = 2.367 °C  
Maximum = 2.486 °C

Mean = 2.397 °C  
Standard deviation = 0.016 °C



## IES84D2

Serial Number: 011  
 Type of Travel Time Detector: TTB  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 36°44.31 N                      Depth: 3685 m  
 72°08.30 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 25, 1983	0422	CI8304
RECOVERY:	Jun 8, 1984	1636	EN118

## TRAVEL TIME RECORDS

(Fig. 3.12)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 25, 1983	053028	-6018.4922
LAST DATA POINT:	Jun 8, 1984	163028	3832.5078

Number of Points: 19703  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 4.82440 s                      Mean = 4.84233 s  
 Maximum  $\tau$  = 4.86390 s                      Standard Deviation = 0.01139 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.3)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 92492.77$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 26, 1983	120000	-5988.00
LAST DATA POINT:	Jun 7, 1984	060000	3798.00

Number of Points: 1632  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 115.50 m                      Mean = 488.33 m  
 Maximum  $Z_{1,2}$  = 805.00 m                      Standard Deviation = 218.62 m

## IES84D3

Serial Number: 043  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 36°08.65 N                      Depth: 4125 m  
 71°44.45 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 18, 1983	1856	CI8304
RECOVERY:	Jun 8, 1984	0347	EN118

TRAVEL TIME RECORDS  
 (Fig. 3.13)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 18, 1983	200133	-6171.9741
LAST DATA POINT:	Jun 8, 1984	032608	3819.4356

Number of Points: 19984  
 Sampling Interval: 0.49999548 hrs

Minimum  $\tau$  = 5.47534 s                      Mean = 5.48389 s  
 Maximum  $\tau$  = 5.49621 s                      Standard Deviation = 0.00326 s

40HRLP THERMOCLINE DEPTH RECORDS  
 (Fig. 7.3)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 104953.98$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 20, 1983	060000	-6138.00
LAST DATA POINT:	Jun 6, 1984	180000	3786.00

Number of Points: 1655  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 552.50 m                      Mean = 759.54 m  
 Maximum  $Z_{1,2}$  = 893.30 m                      Standard Deviation = 61.52 m

## IES84E1

Serial Number: 047  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 37°23.13 N                      Depth: 3600 m  
 71°38.89 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 23, 1983	0240	CI8304
RECOVERY:	Jun 12, 1984	1723	EN118

## TRAVEL TIME RECORDS

(Fig. 3.14)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 23, 1983	035433	-6068.0908
LAST DATA POINT:	Jun 12, 1984	171904	3929.3178

Number of Points: 19996  
 Sampling Interval: 0.49999543 hrs

Minimum  $\tau$  = 4.75069 s                      Mean = 4.77517 s  
 Maximum  $\tau$  = 4.78800 s                      Standard Deviation = 0.01114 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.4)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 91036.13$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 24, 1983	120000	-6036.00
LAST DATA POINT:	Jun 11, 1984	120000	3900.00

Number of Points: 1657  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 84.11 m                      Mean = 307.85 m  
 Maximum  $Z_{1,2}$  = 748.26 m                      Standard Deviation = 214.36 m



## IES84E3

Serial Number: 045  
 Type of Travel Time Detector: TTC  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 36°23.11 N                      Depth: 4320 m  
 71°04.64 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Apr 22, 1983	1344	CI8304
RECOVERY:	Jun 8, 1984	0834	EN118

## TRAVEL TIME RECORDS

(Fig. 3.16)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 22, 1983	143829	-6081.3586
LAST DATA POINT:	Jun 8, 1984	082815	3824.4708

Number of Points: 19813  
 Sampling Interval: 0.49999139 hrs

Minimum  $\tau$  = 5.73065 s                      Mean = 5.73992 s  
 Maximum  $\tau$  = 5.76060 s                      Standard Deviation = 0.00476 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.4)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 109786.05$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Apr 24, 1983	000000	-6048.00
LAST DATA POINT:	Jun 7, 1984	000000	3792.00

Number of Points: 1641  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 370.74 m                      Mean = 726.91 m  
 Maximum  $Z_{1,2}$  = 883.93 m                      Standard Deviation = 90.85 m











## IES84G3

Serial Number: 015  
 Type of Travel Time Detector: TTB  
 Number of Pings per Sampling: 20  
 Additional Sensors: None

Position: 36°52.34 N                      Depth: 4373 m  
 69°44.90 W

	<u>DATE</u>	<u>GMT</u>	<u>CRUISE</u>
LAUNCH:	Sep 26, 1983	1827	EN106
RECOVERY:	Jun 14, 1984	2016	EN118

## TRAVEL TIME RECORDS

(Fig. 3.22)

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Sep 26, 1983	194313	-2308.2797
LAST DATA POINT:	Jun 14, 1984	201313	3980.2203

Number of Points: 12578  
 Sampling Interval: 0.50 hrs

Minimum  $\tau$  = 5.80866 s                      Mean = 5.81469 s  
 Maximum  $\tau$  = 5.82762 s                      Standard Deviation = 0.00327 s

## 40HRLP THERMOCLINE DEPTH RECORDS

(Fig. 7.6)

$Z_{1,2}$  Conversion Equation:  $Z_{1,2} = (-19000\text{ms}^{-1})(\tau_d) + B$   
 where  $B = 111240.86$  m  
 $\tau_d$  = Travel Time (sec) with tide removed

	<u>DATE</u>	<u>GMT</u>	<u>YEARHOUR</u>
1st DATA POINT:	Sep 28, 1983	060000	-2274.00
LAST DATA POINT:	Jun 13, 1984	120000	3948.00

Number of Points: 1038  
 Sampling Interval: 6.00 hrs

Minimum  $Z_{1,2}$  = 529.41 m                      Mean = 760.75 m  
 Maximum  $Z_{1,2}$  = 863.23 m                      Standard Deviation = 65.52 m



### SECTION 3

#### Half-hourly Data For Each Instrument

Plots of the travel time records from each instrument are presented first. These are followed by the measured and residual pressure records and the temperature data for the instruments which had those additional sensors.

The time scale is the same for all plots, with each increment corresponding to 5 days. The axis begins on 0000 GMT of the first date labelled.

Vertical scale for each variable is consistent between instruments. Each increment corresponds to 5 msec for the travel time records, 0.5 dbar for the bottom pressure measurements, 0.05 dbar for the residual bottom pressure data, and  $0.02^{\circ}\text{C}$  for the temperatures.

The sampling interval is nominally 0.5 hours; the actual interval for each instrument is listed in Section 2. The length and the start and end times of the data records are also tabulated in the previous section.

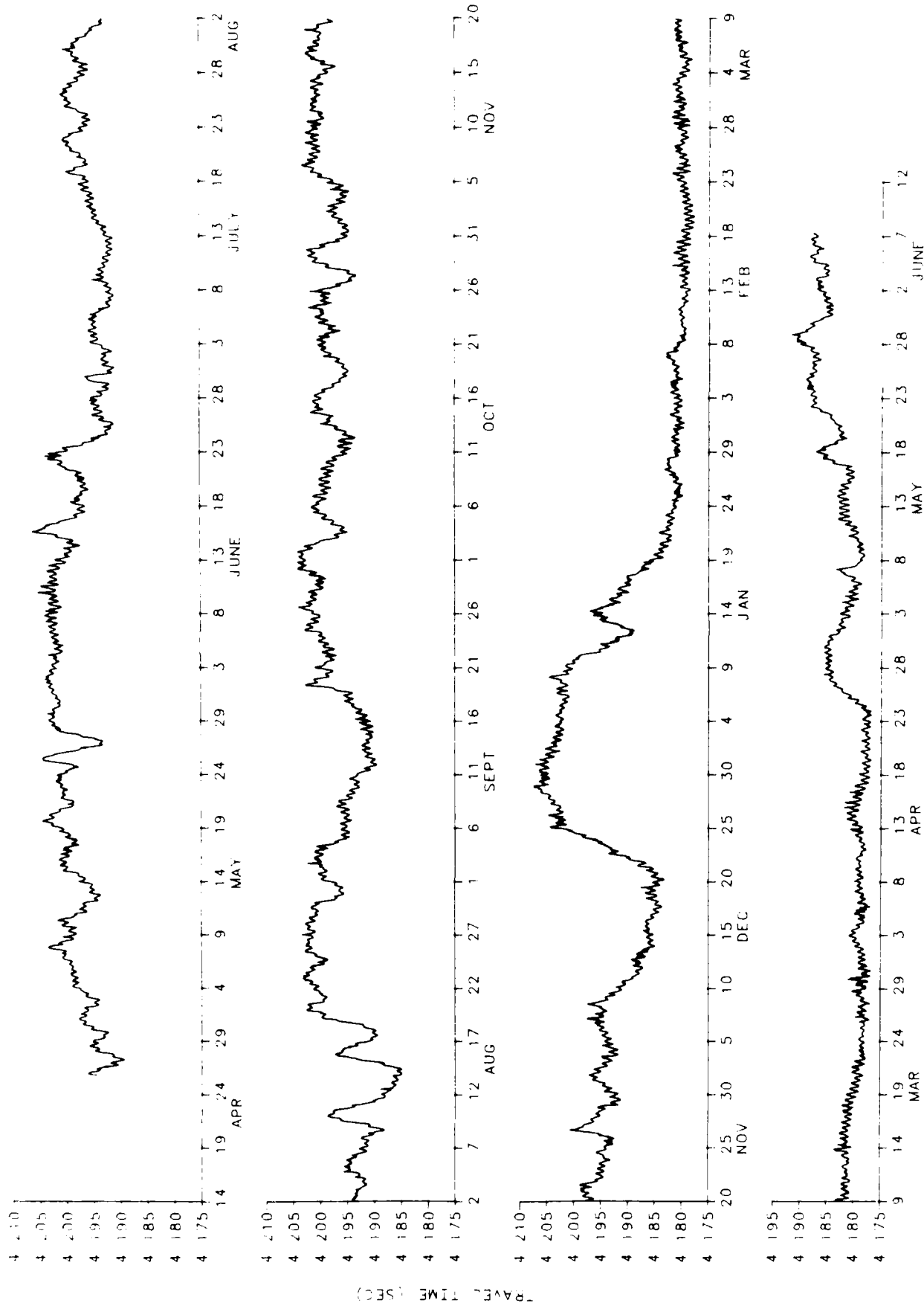


Figure 5.1

Figure 5.1-22. Full travel time records for each IFS at half-hourly intervals.

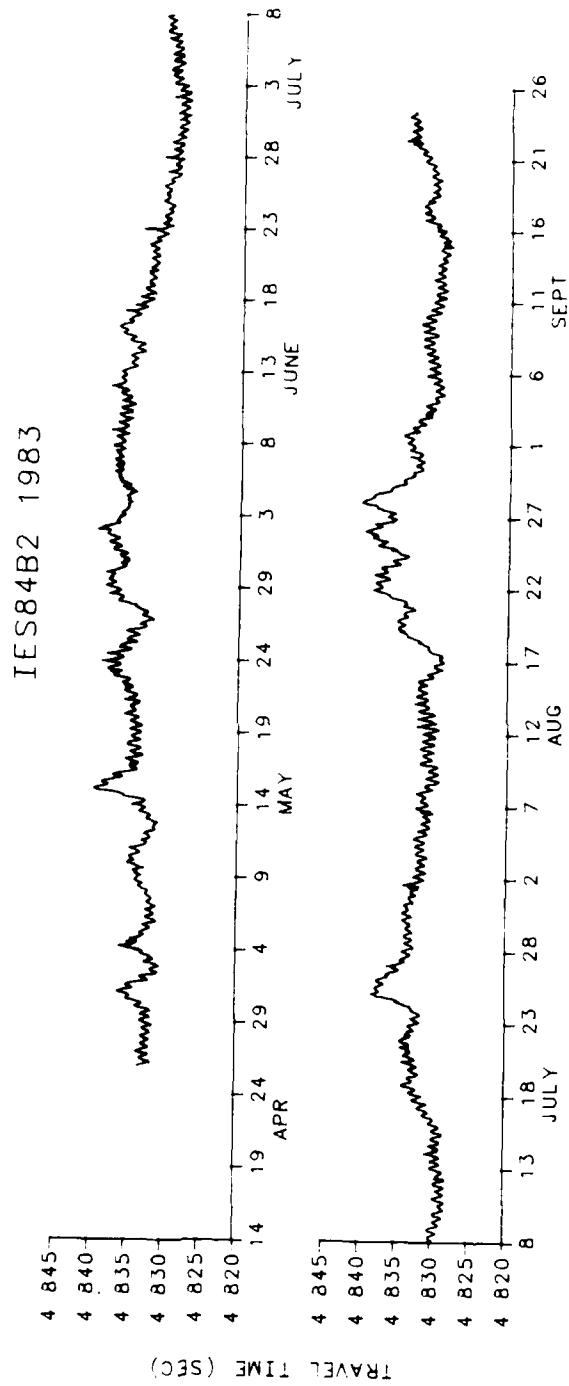


Figure 3.2

PIES84B2 1983

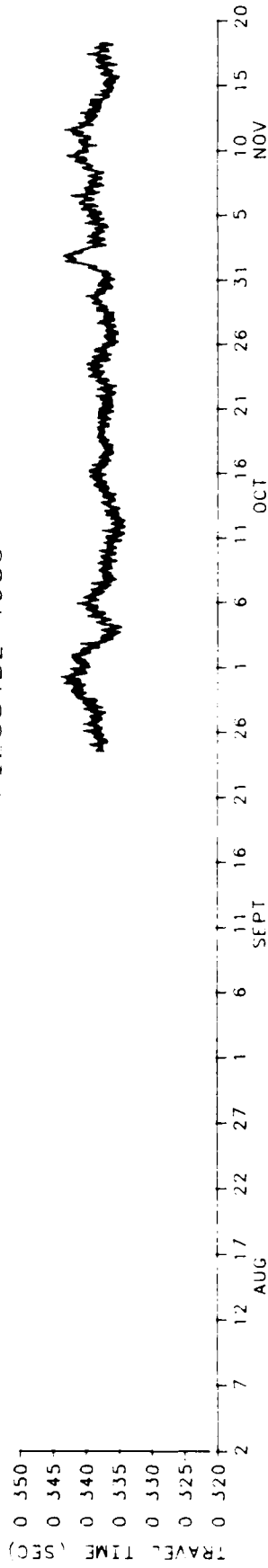


Figure 5.3

PIES85BCM2 1984-1985

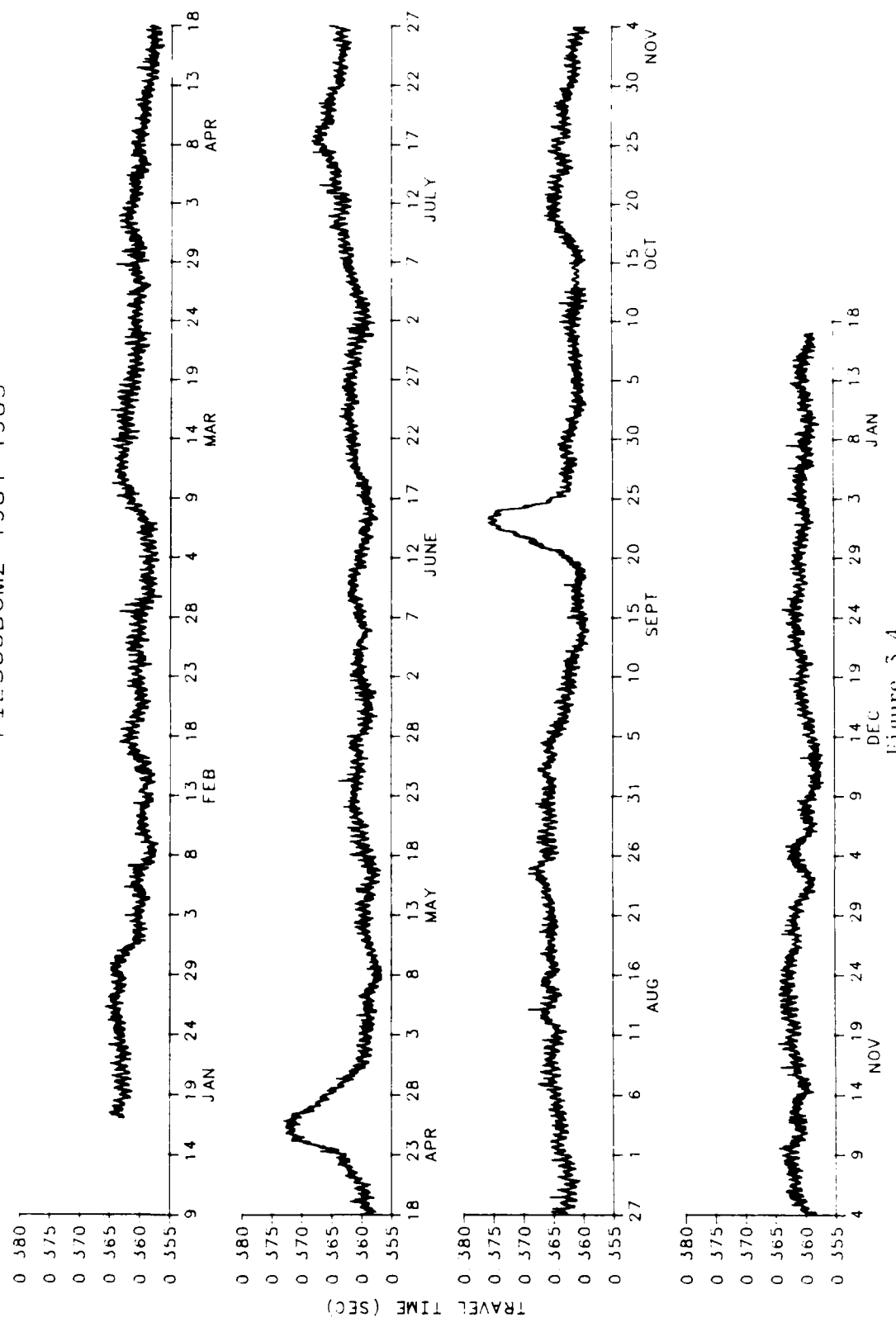


Figure 5.4

PIES85BCM3 1984-1985

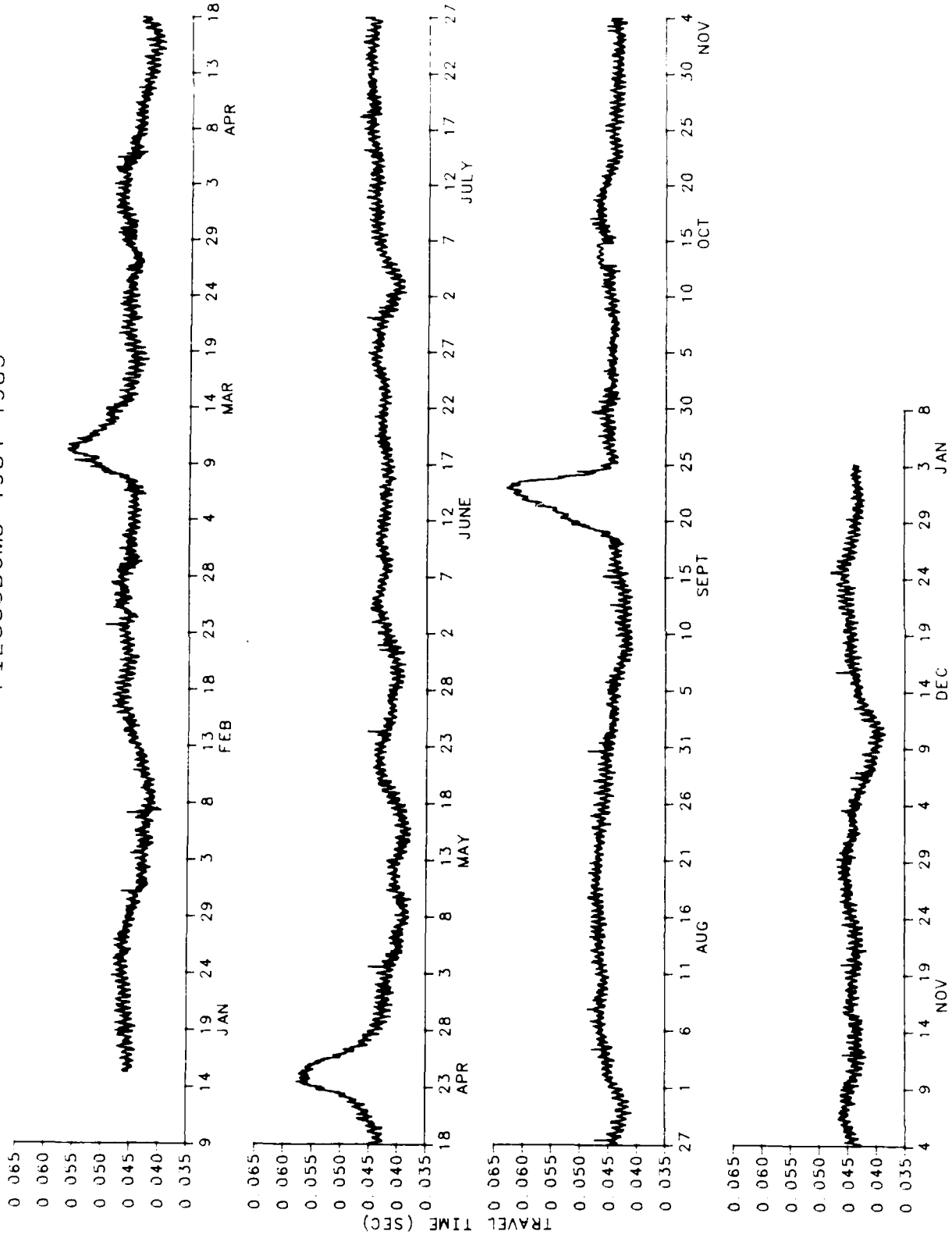


Figure 3.5

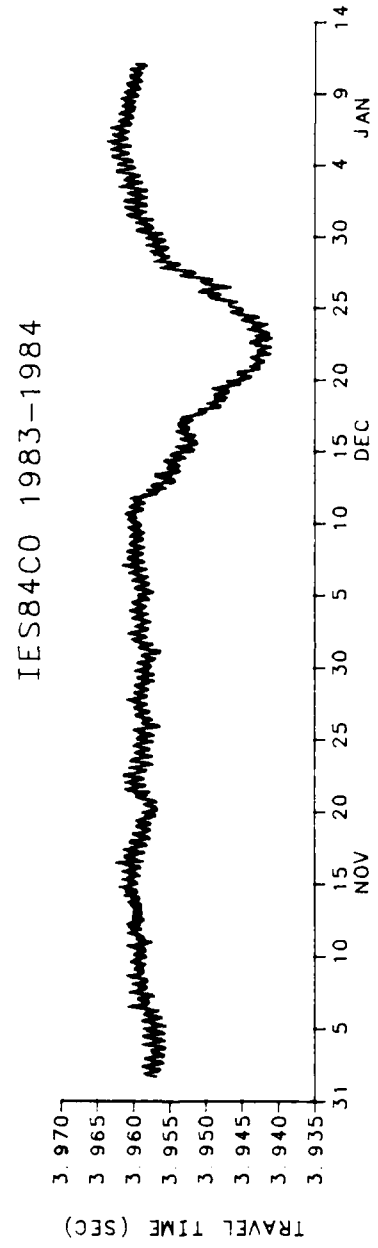


Figure 3.6

PIES84C1 1983-1984

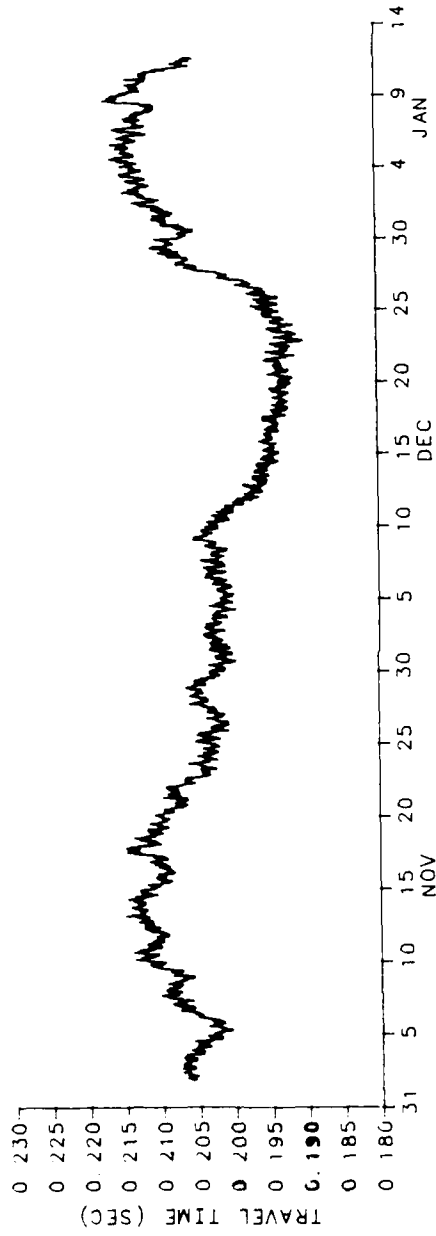
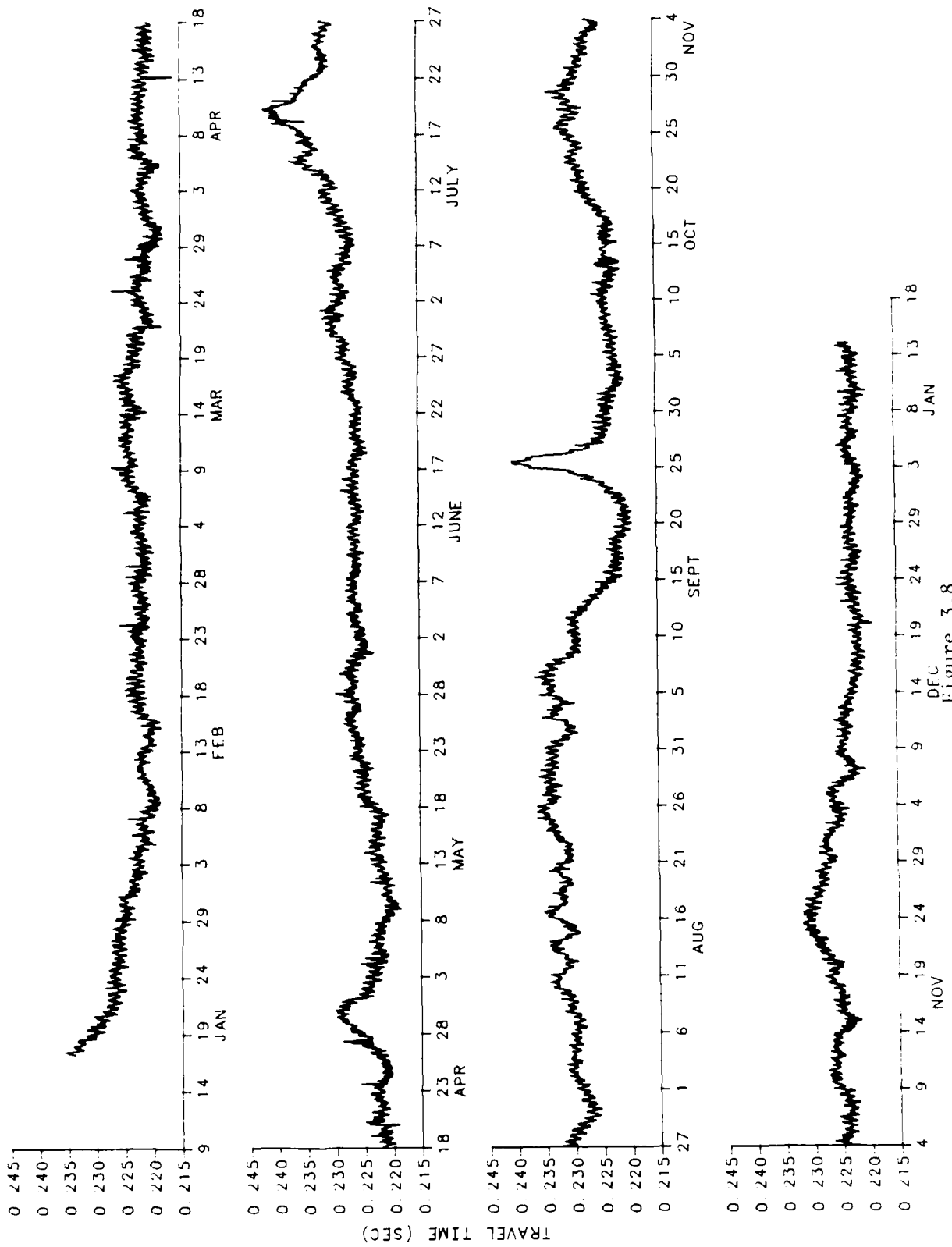


Figure 3.7

PIES85CCM1 1984-1985



DFC  
Figure 3.8

PIES84CCM2 1983-1984

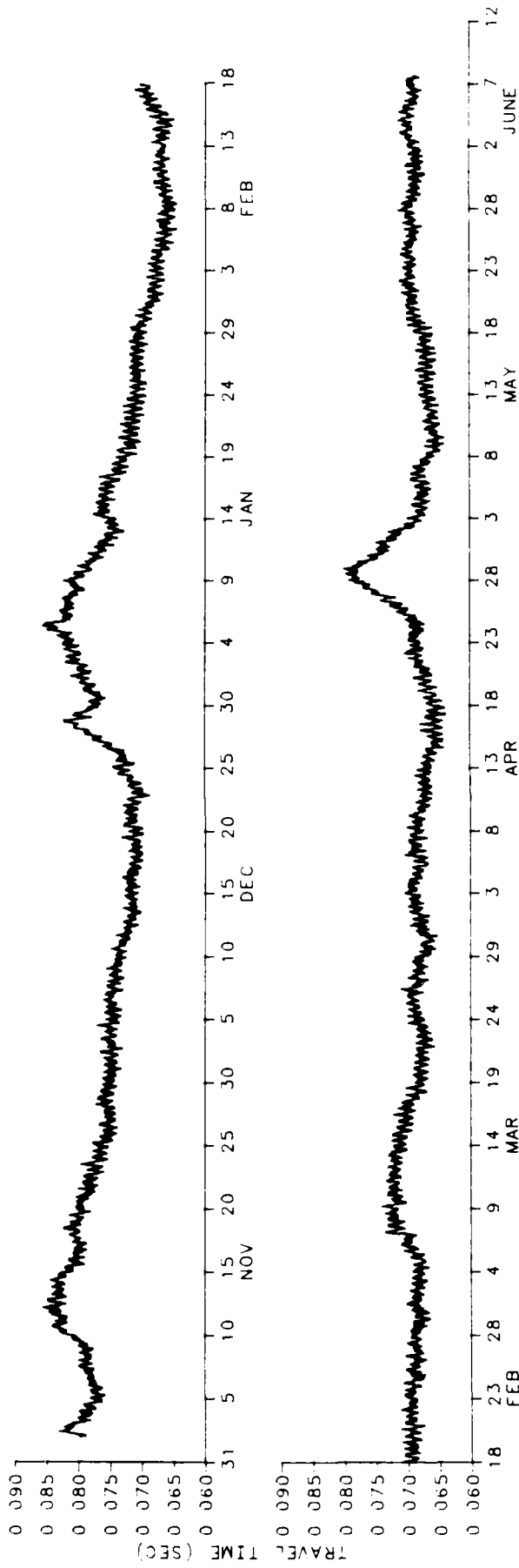


Figure 3.9

PIES84CCM3 1984

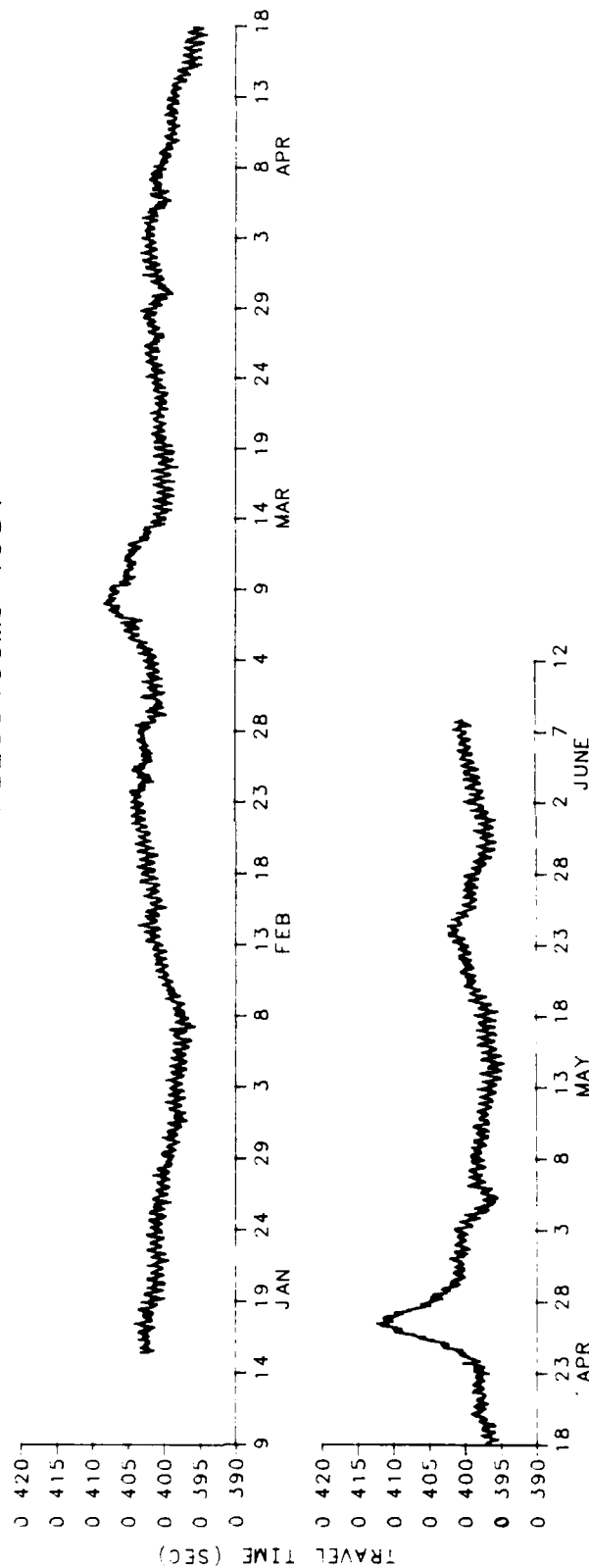


Figure 3.10

IES84D1 1983-1984

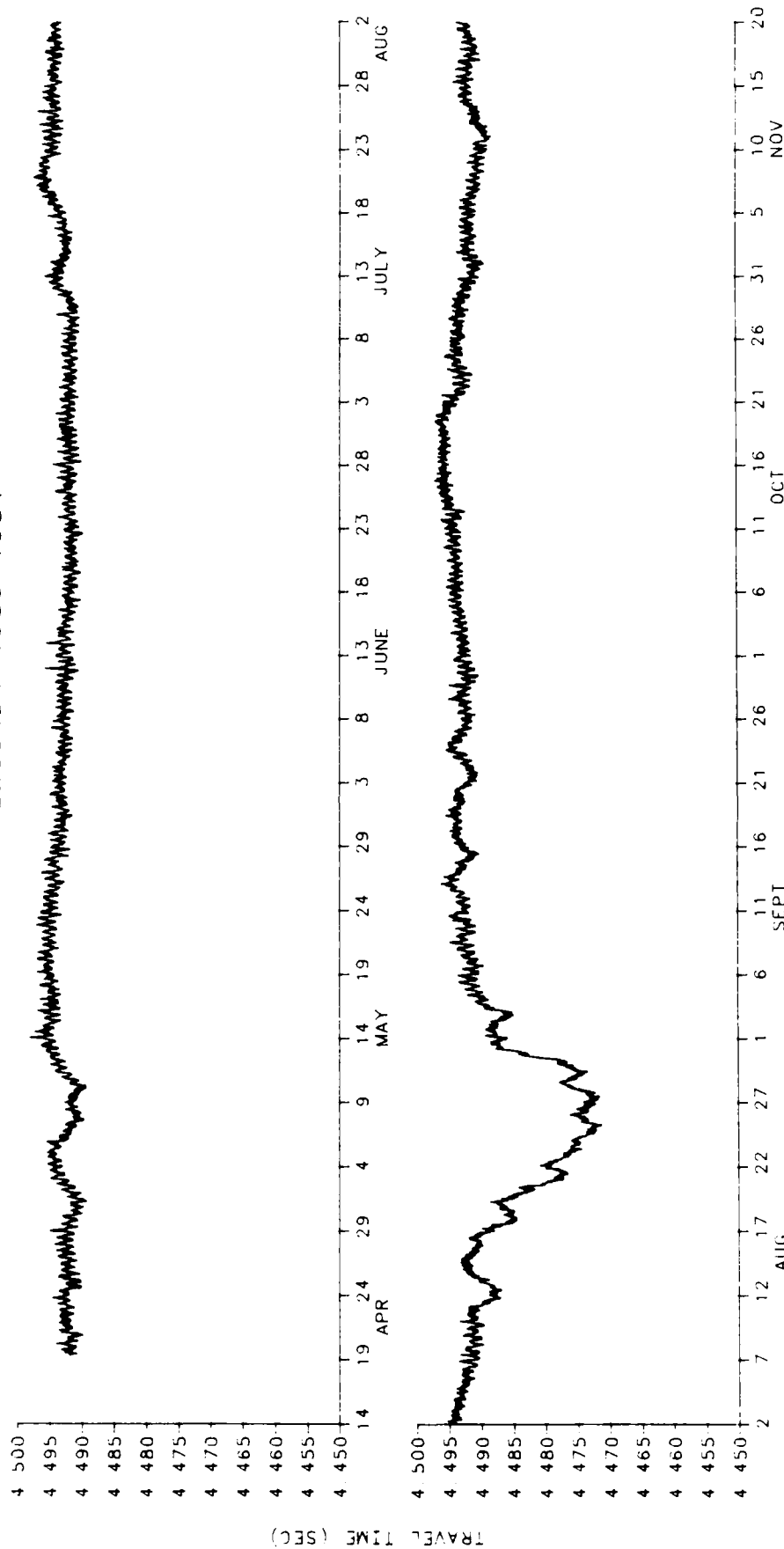


Figure 3.11

IES84D1 1983-1984

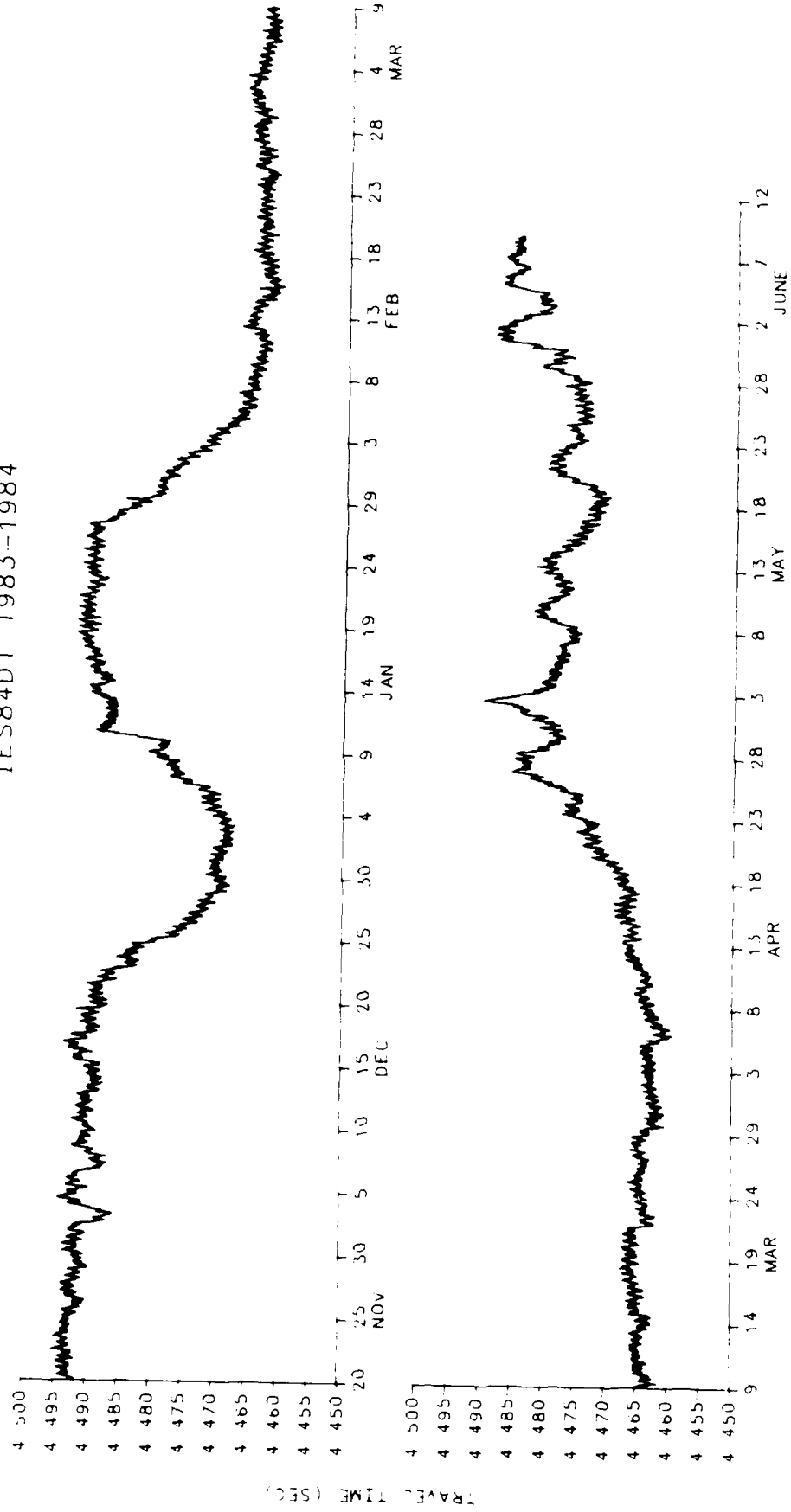


figure 3.11 (continued)

IES84D2 1983-1984

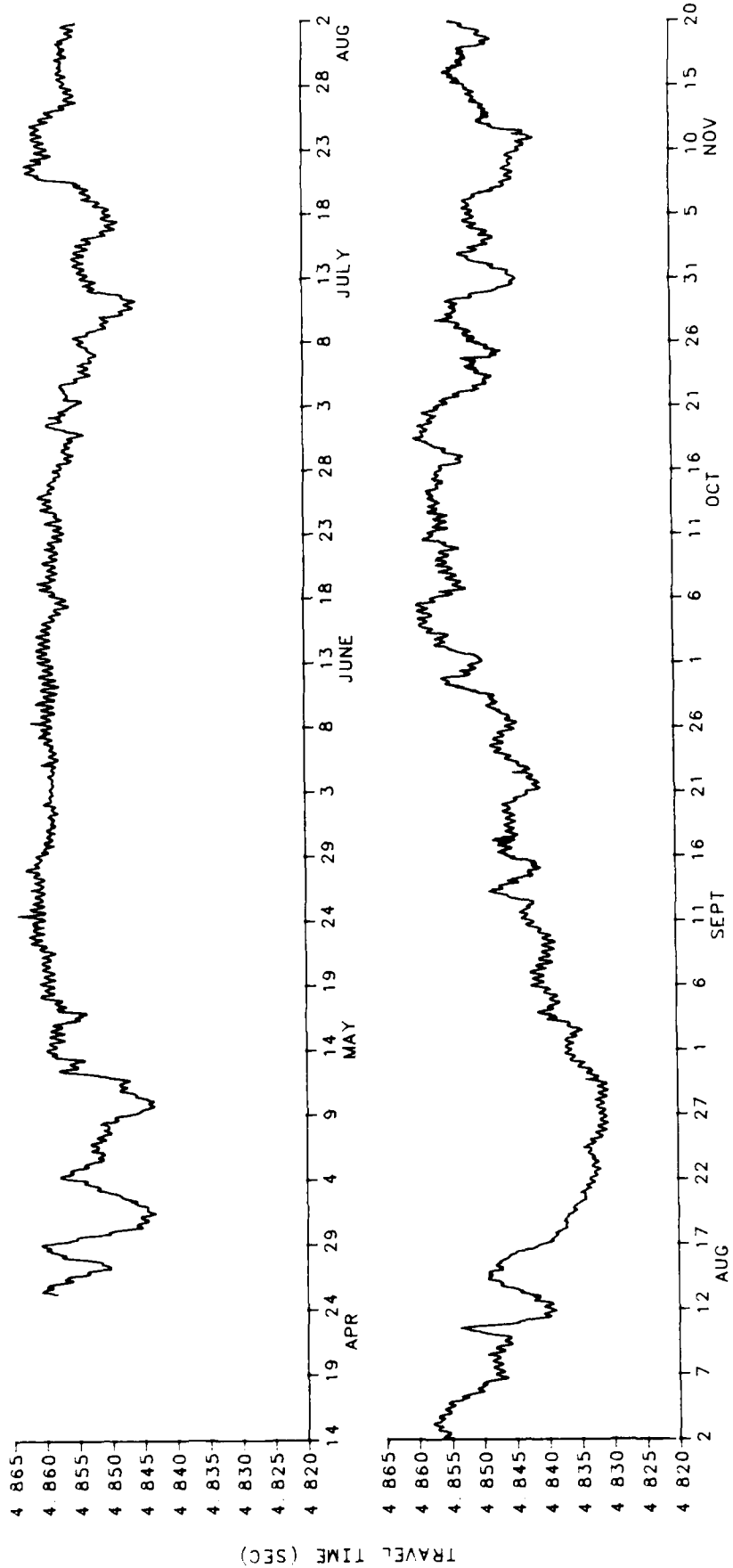


Figure 3.12

IES84D2 1983-1984

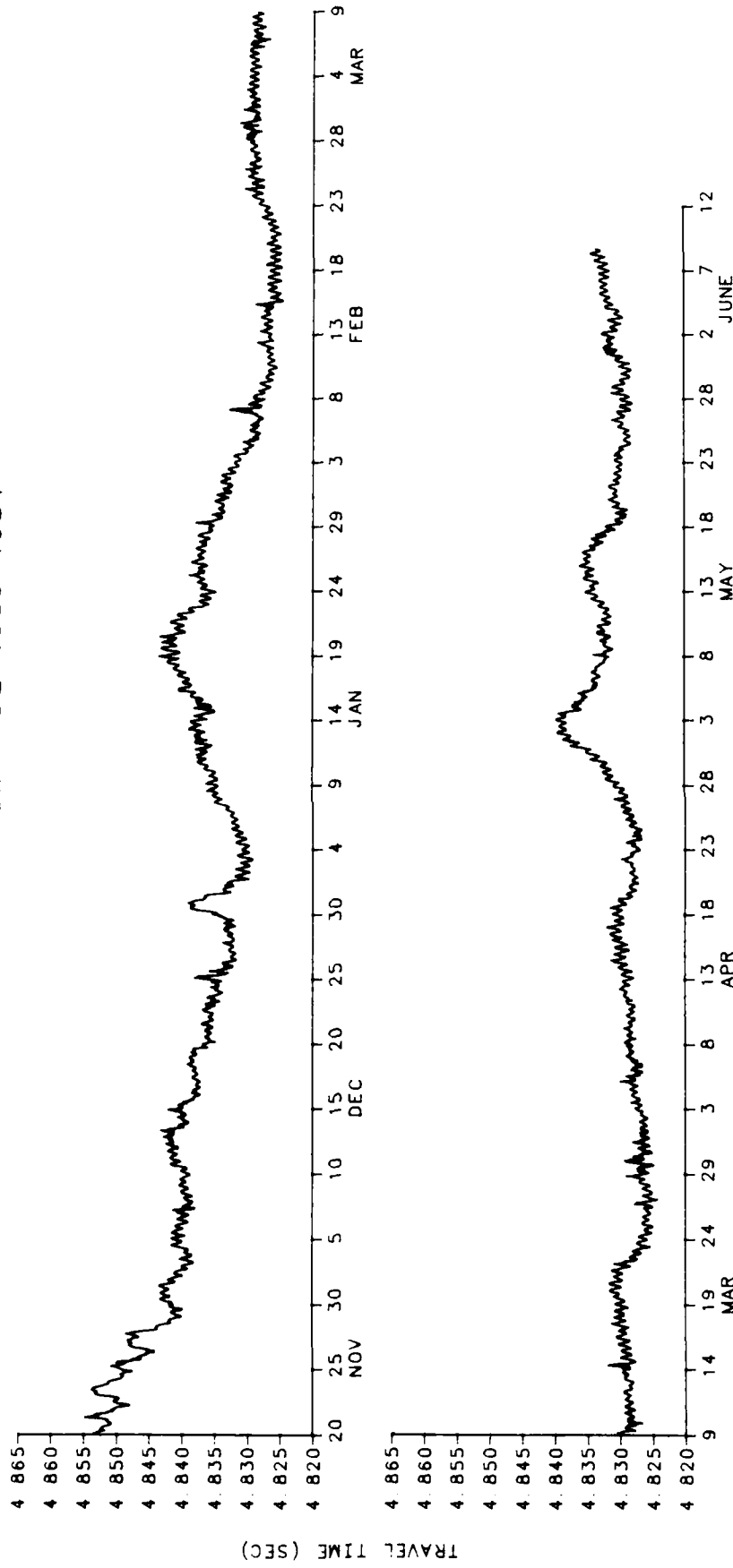


Figure 3.12 (continued)

IES84D3 1983-1984

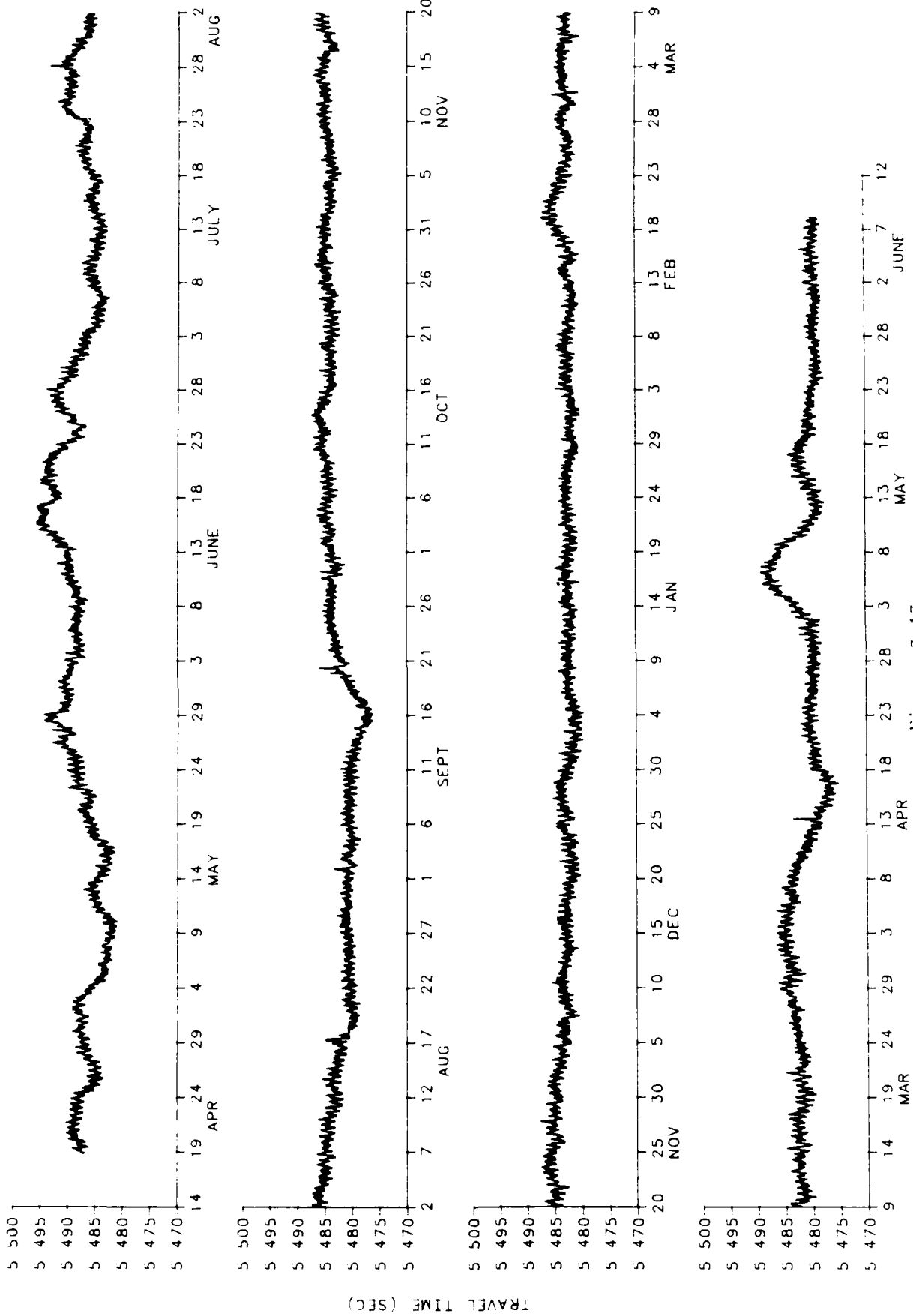


Figure 3.13

IES84E1 1983-1984

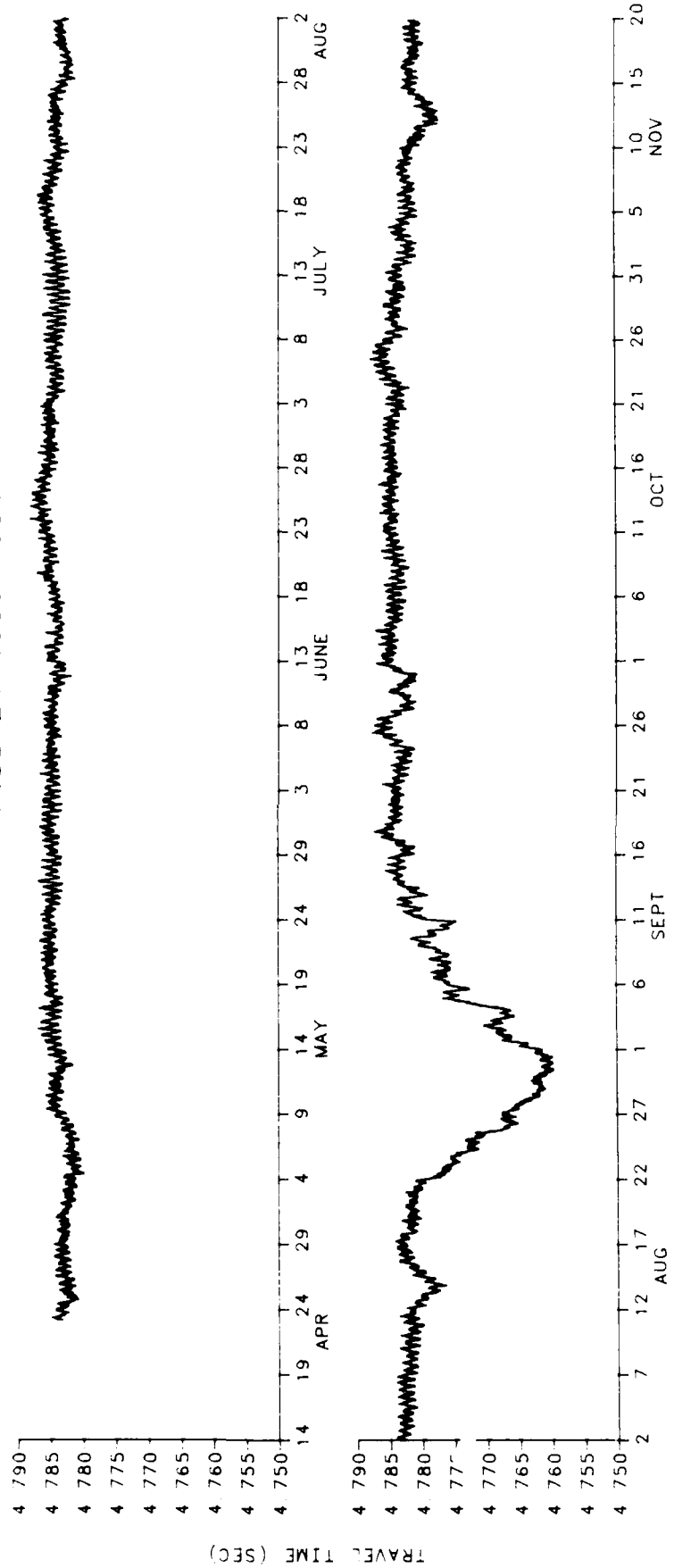


Figure 3.14

IES84E1 1983-1984

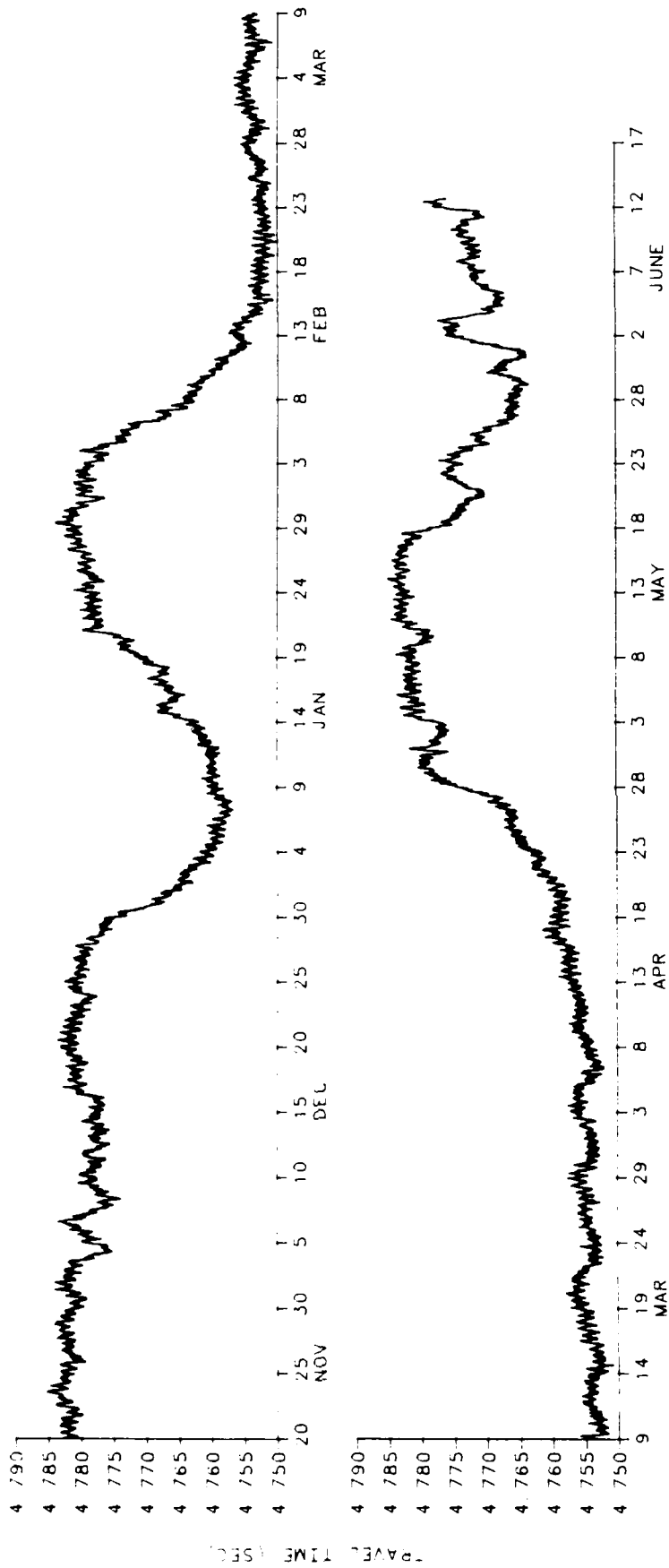


Figure 3.14 (continued)

IES84E2 1983-1984

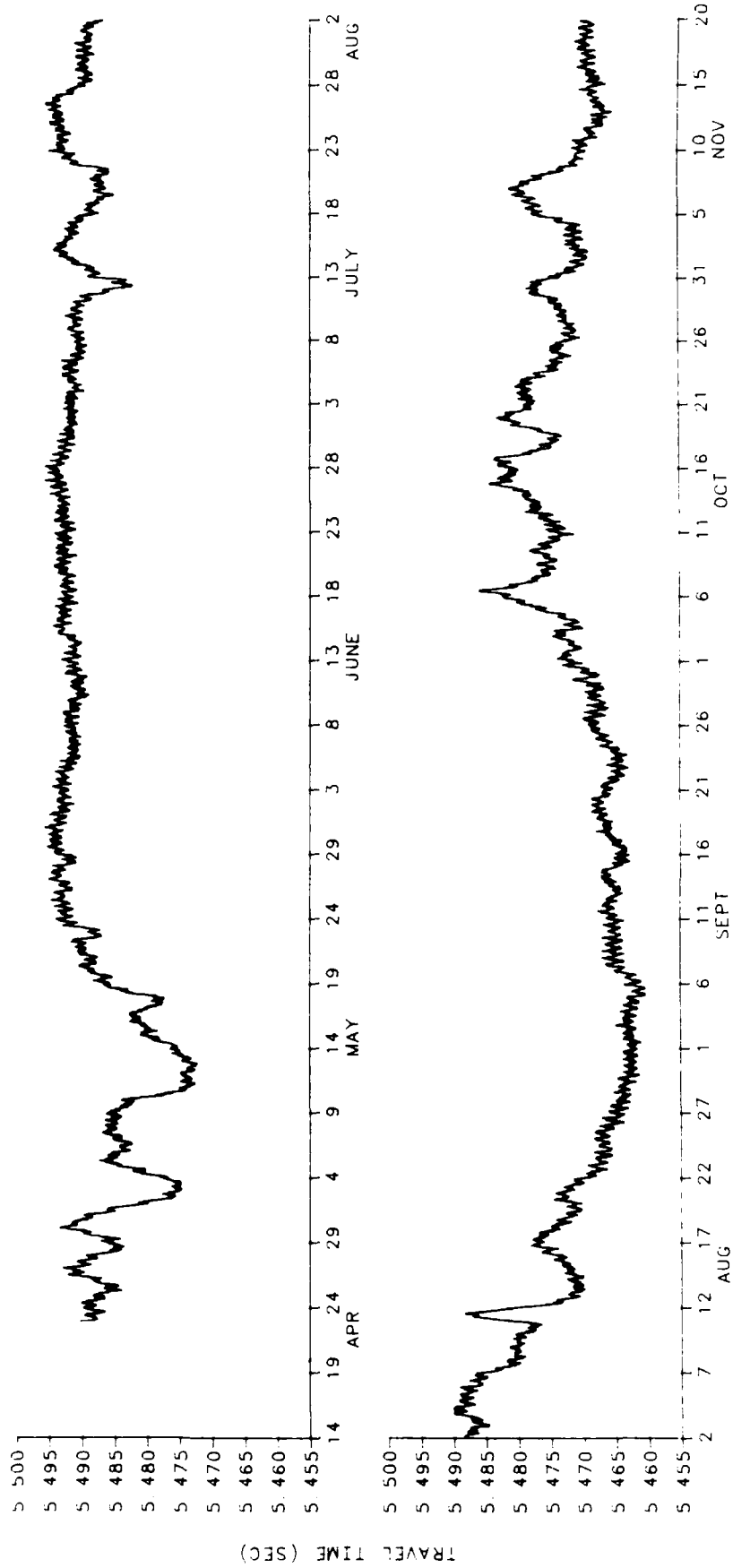


Figure 3.15

IES84E2 1983-1984

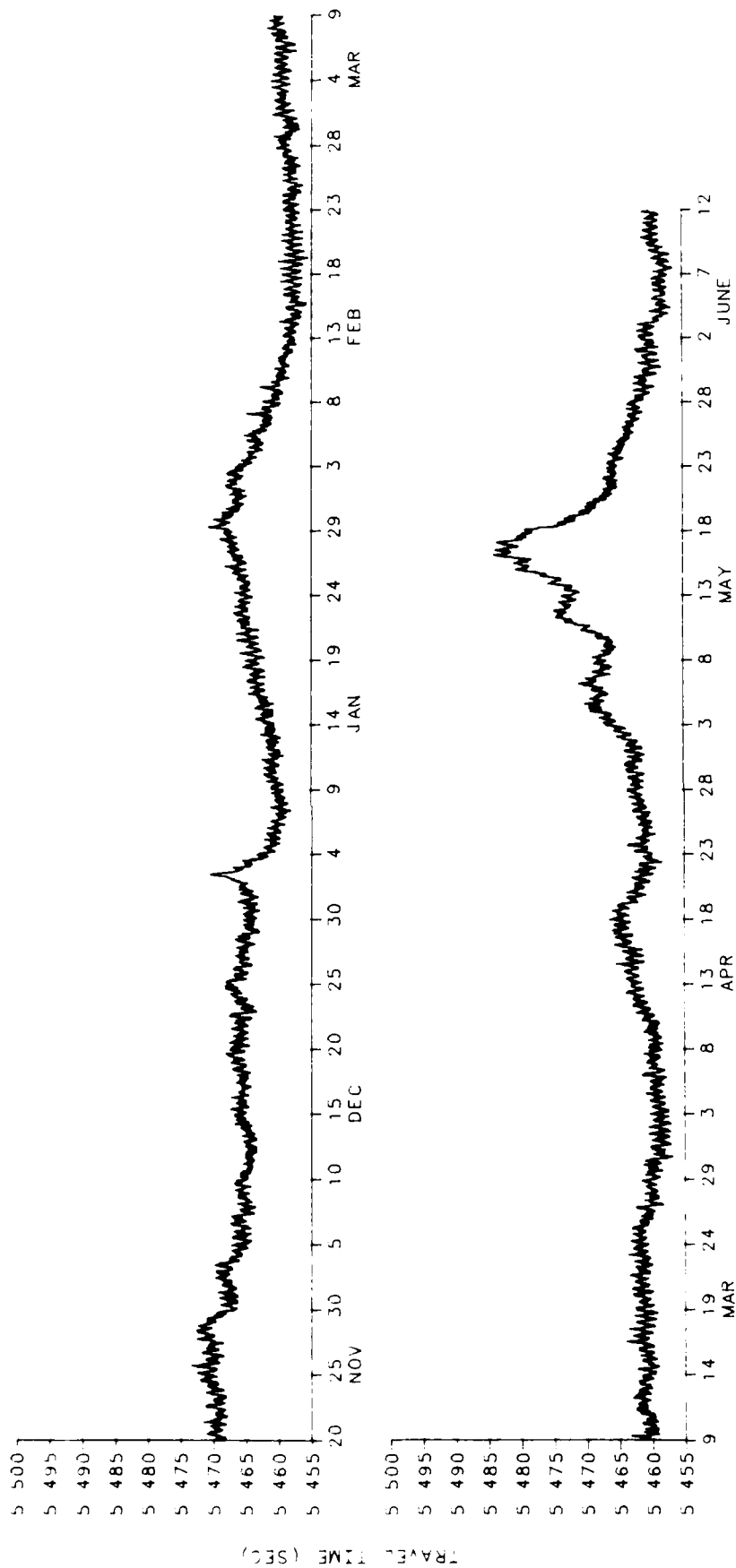


Figure 3.15 (continued)

IES84E3 1983-1984

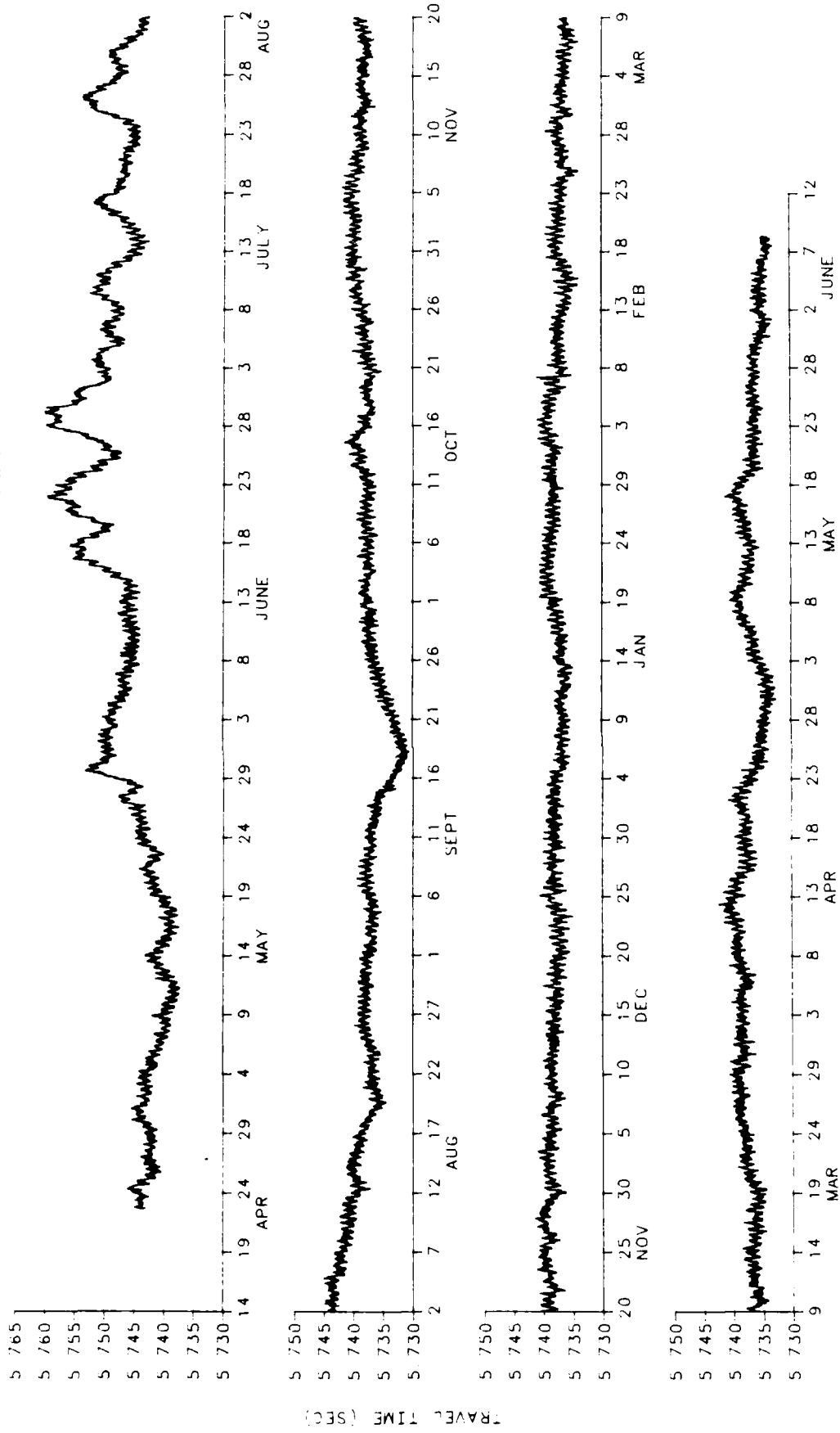


Figure 3.16

IES84F1 1983-1984

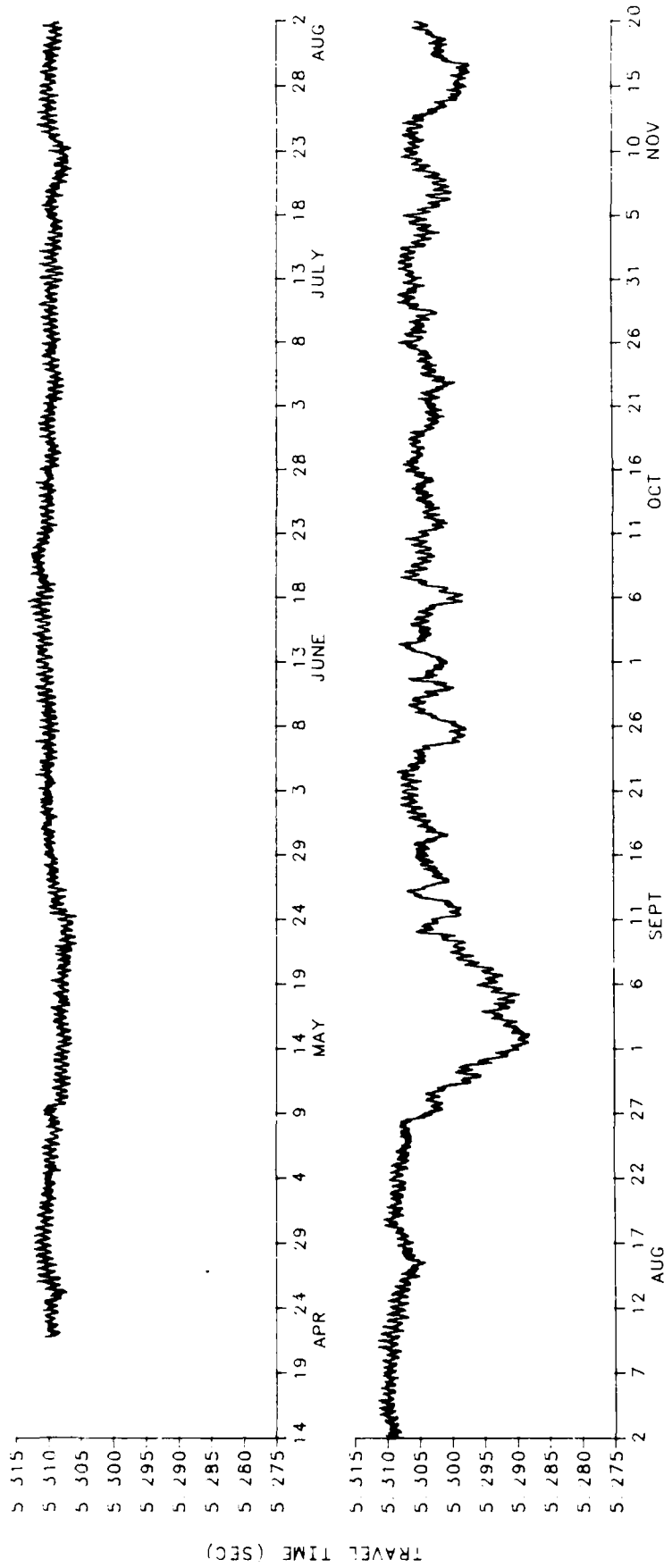


Figure 3.17

IES84F1 1983-1984

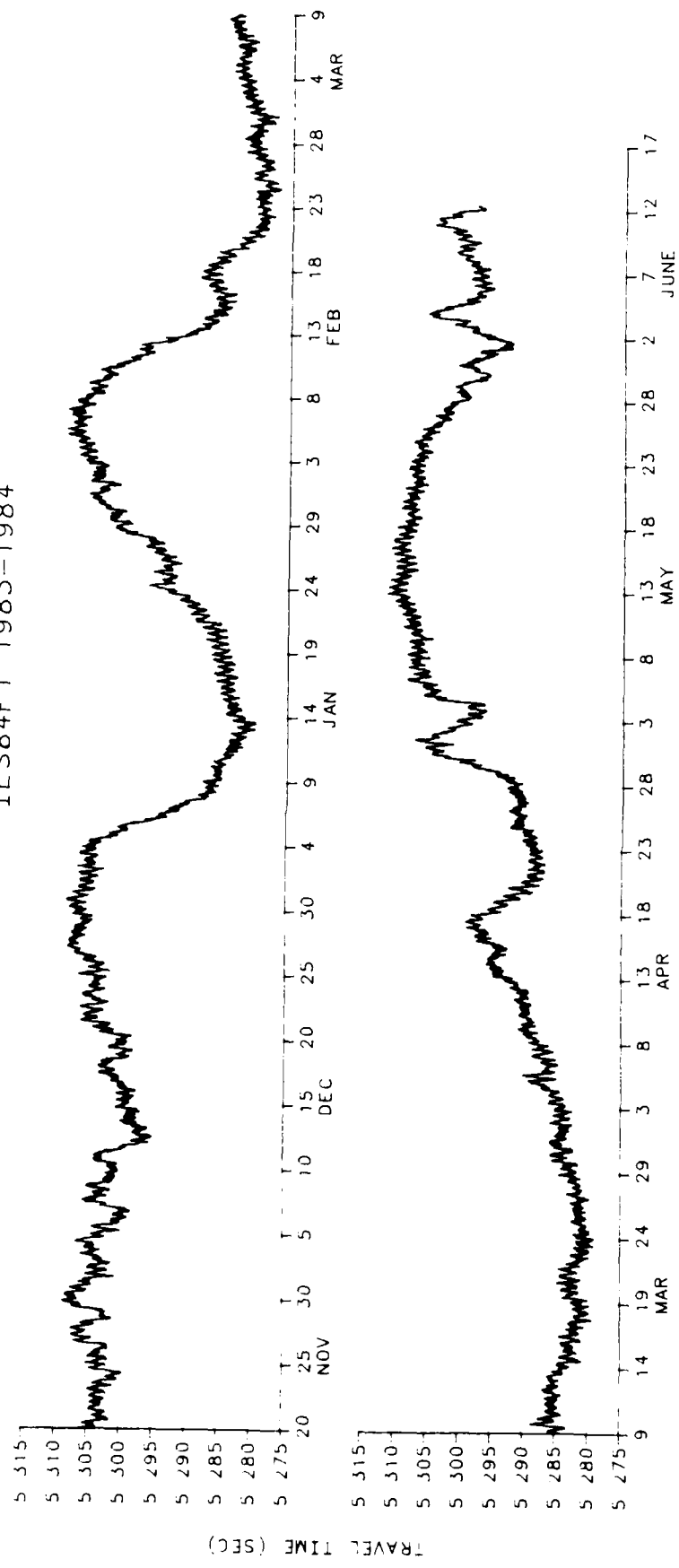


Figure 3.17 (continued)

IES84F2 1983-1984

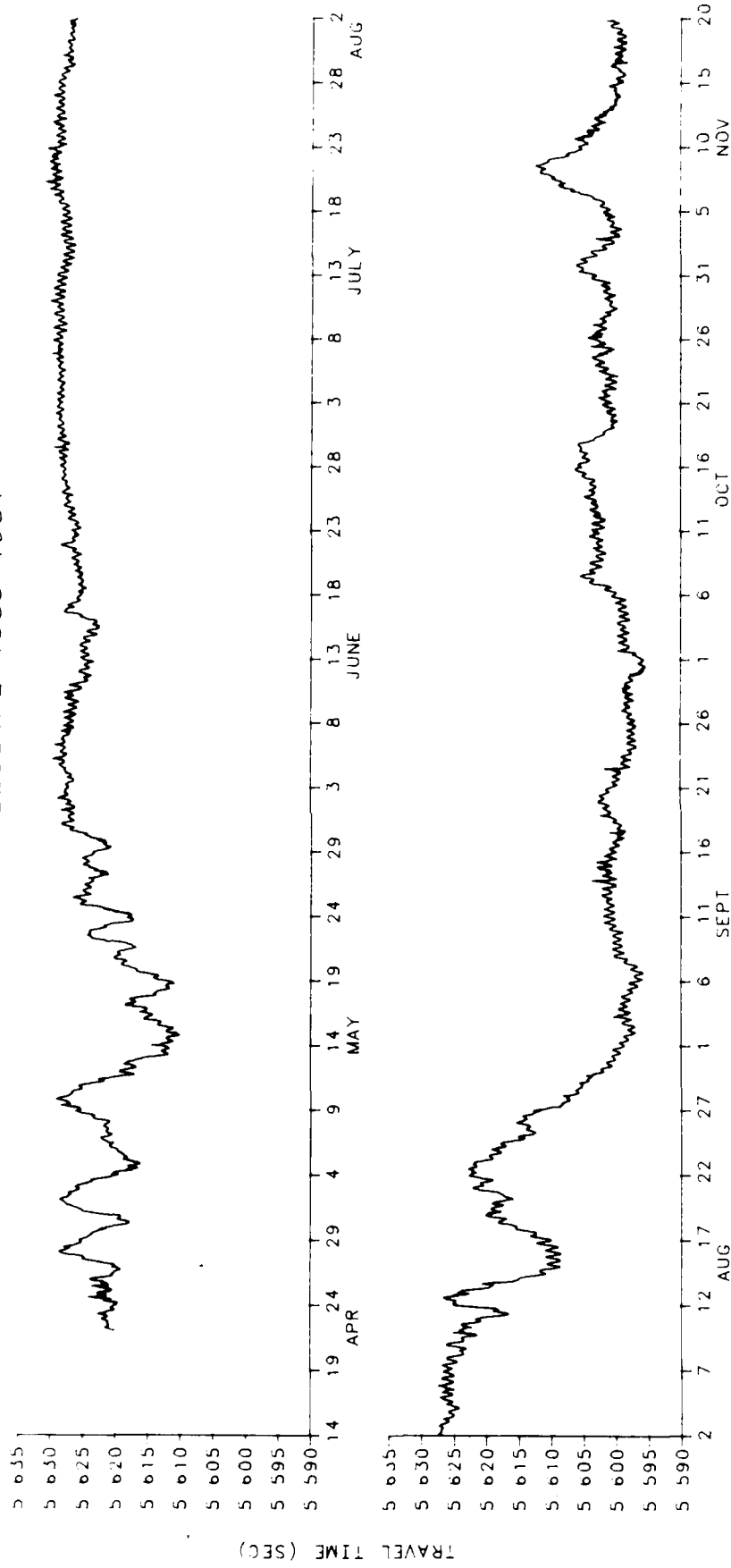


Figure 3.18

IES84F2 1983-1984

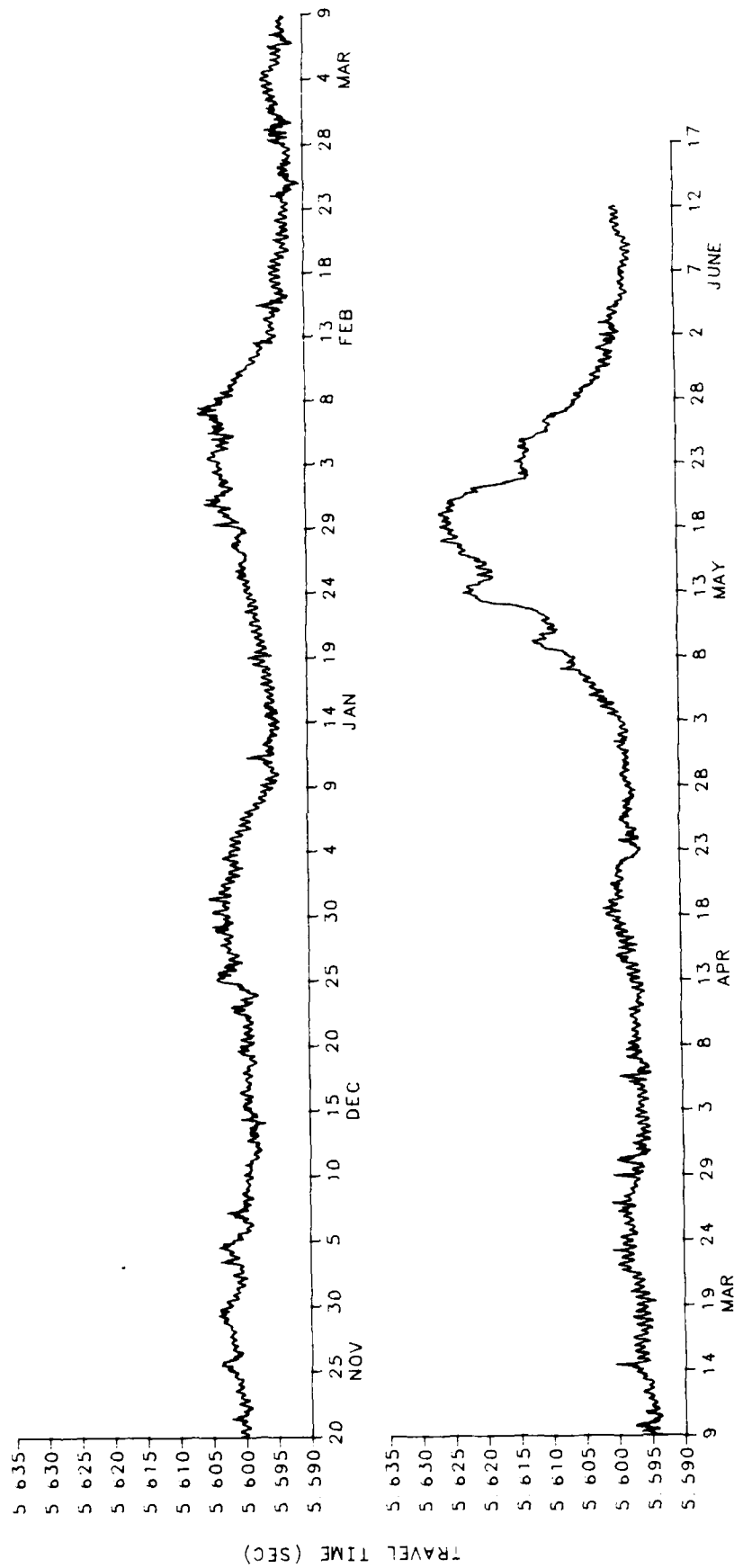


Figure 3.18 (continued)

IES84F3 1983-1984

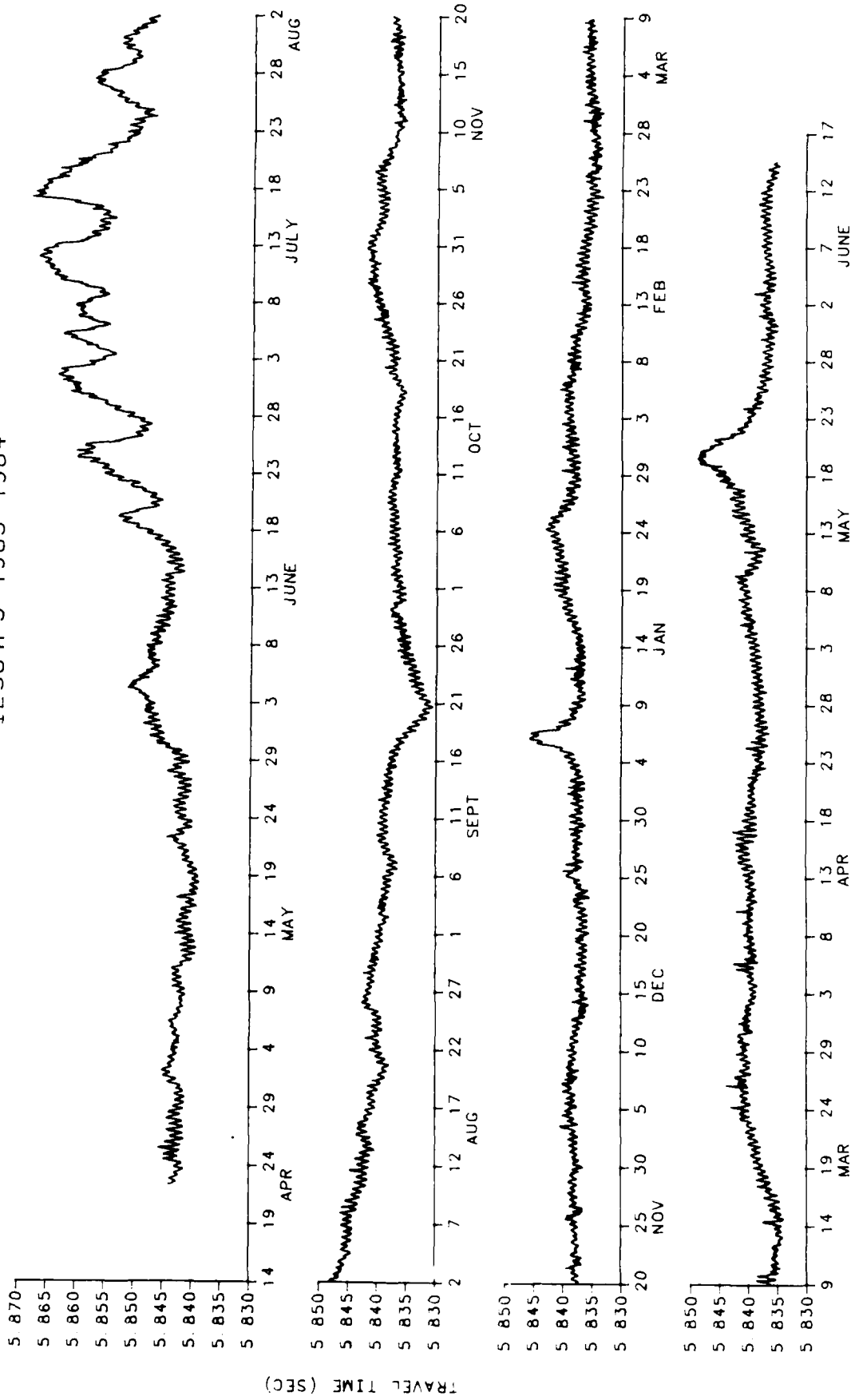


Figure 3.19

IES84G1 1983-1984

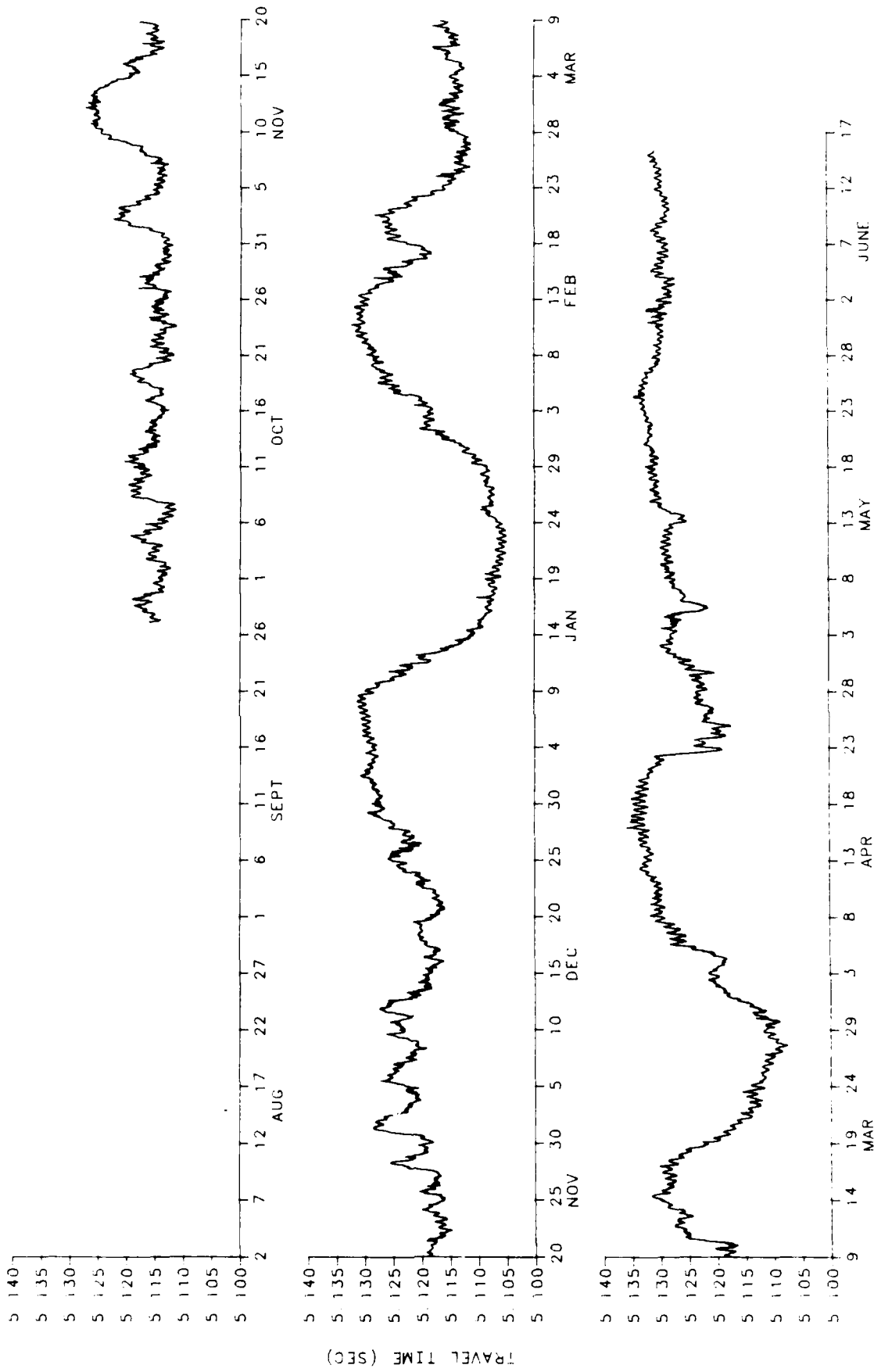


Figure 3.20

IES84G2 1983-1984

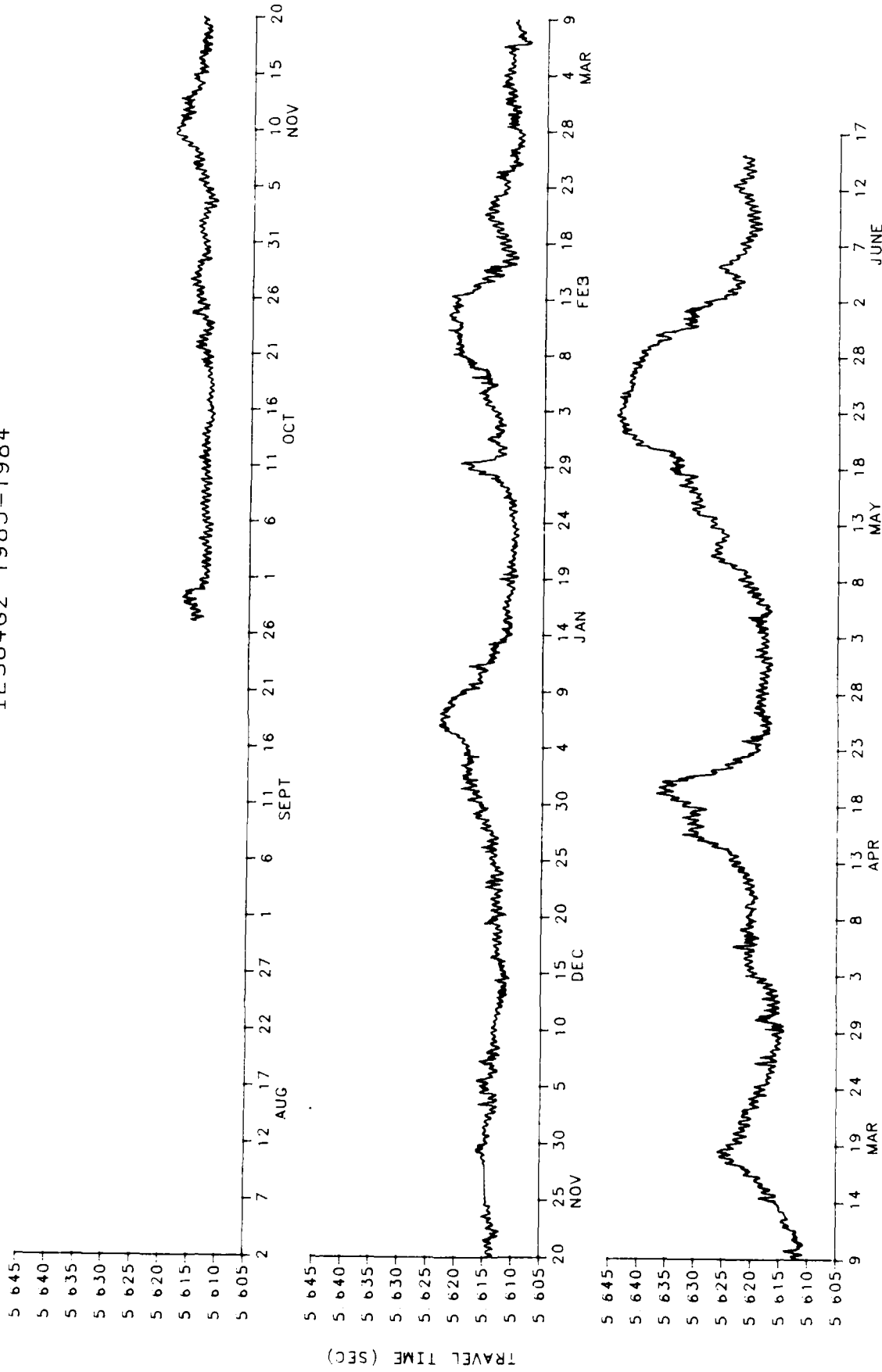


Figure 5.21

IES84G3 1983-1984

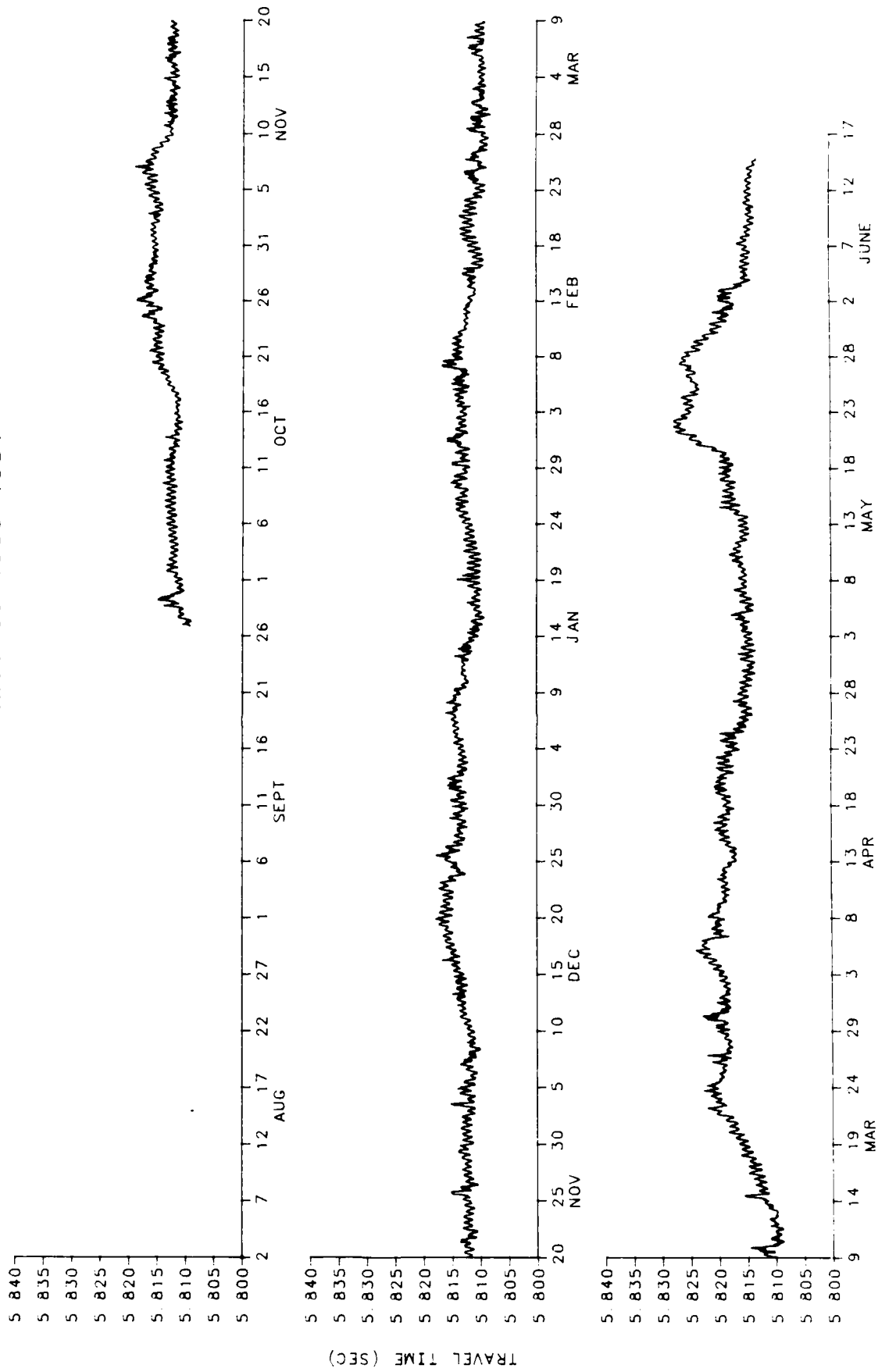


Figure 3.22

PIES84B2 1983

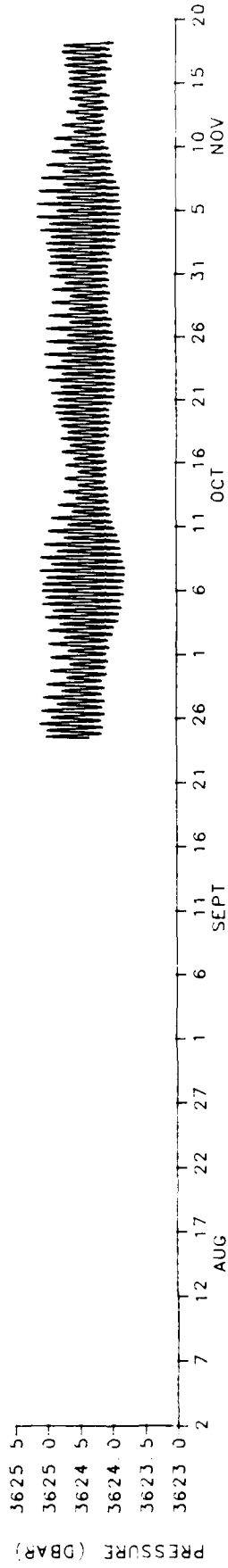


Figure 4.1

Figure 4.1-5. Full measured bottom pressure records at half-hourly intervals.

PIES85BCM2 1984-1985

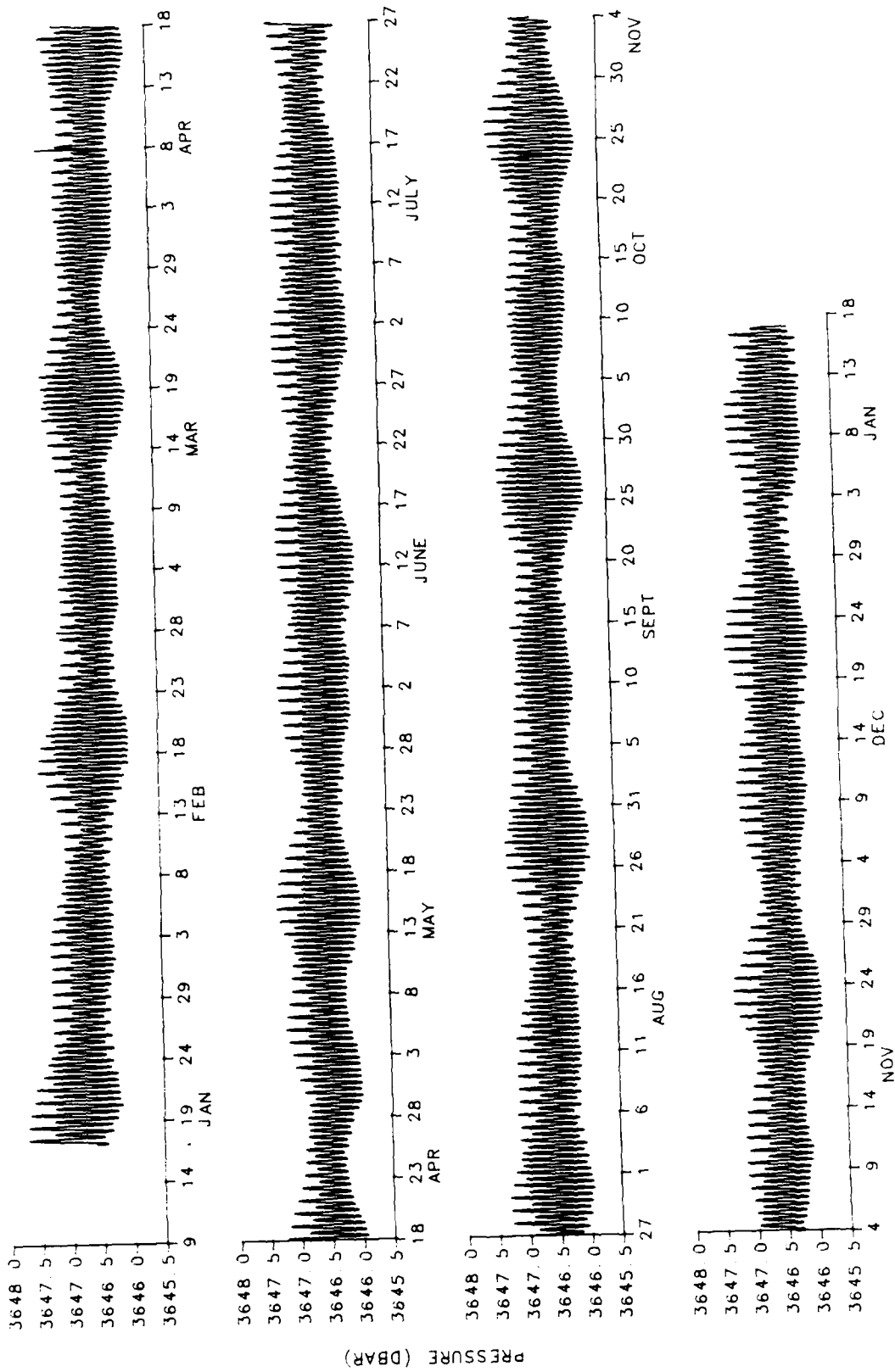


Figure 4.2

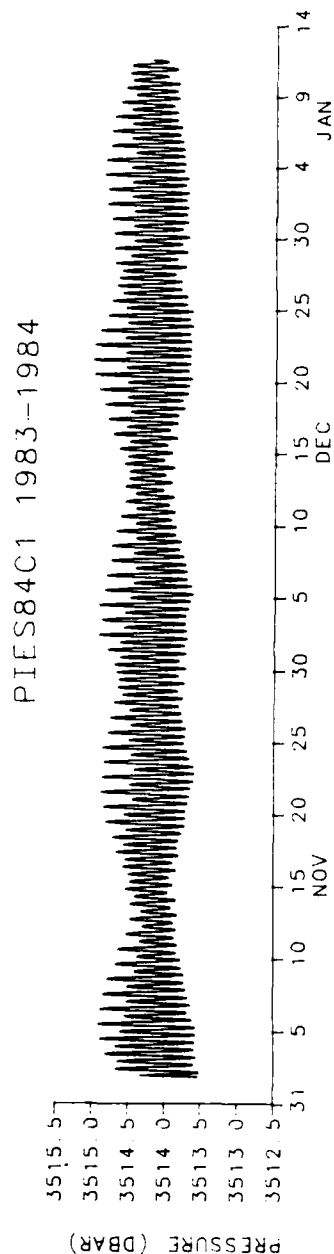


Figure 4.3

PIES84CCM2 1983-1984

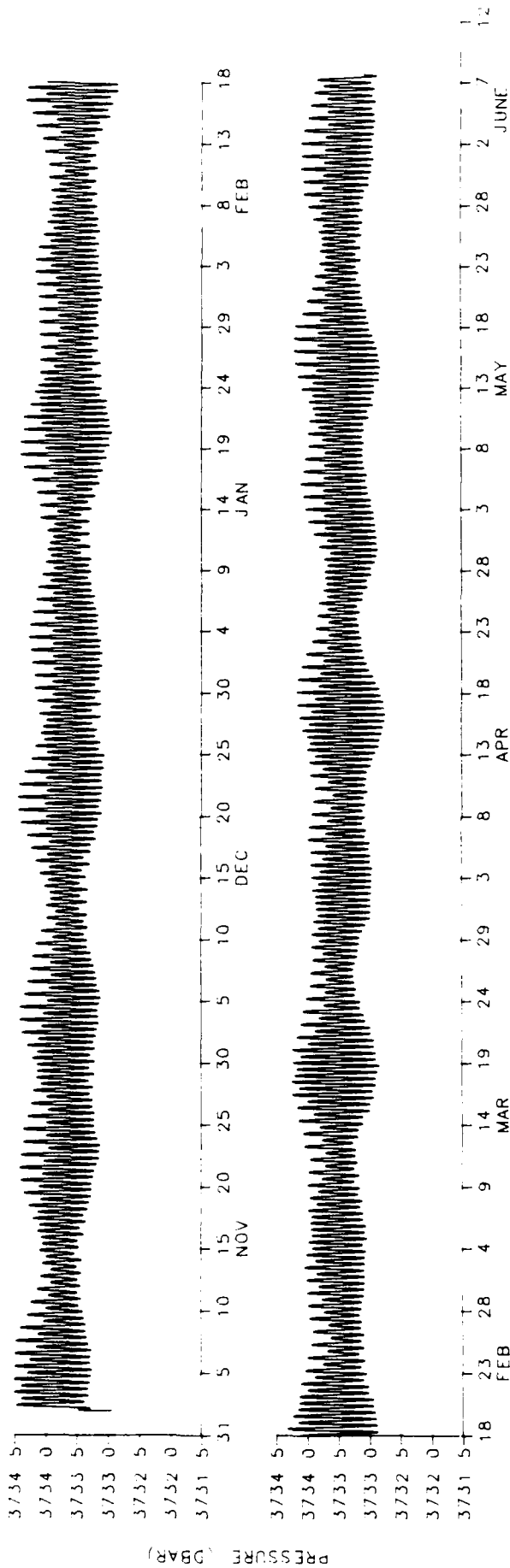


Figure 4.4

PIES84CCM3 1984

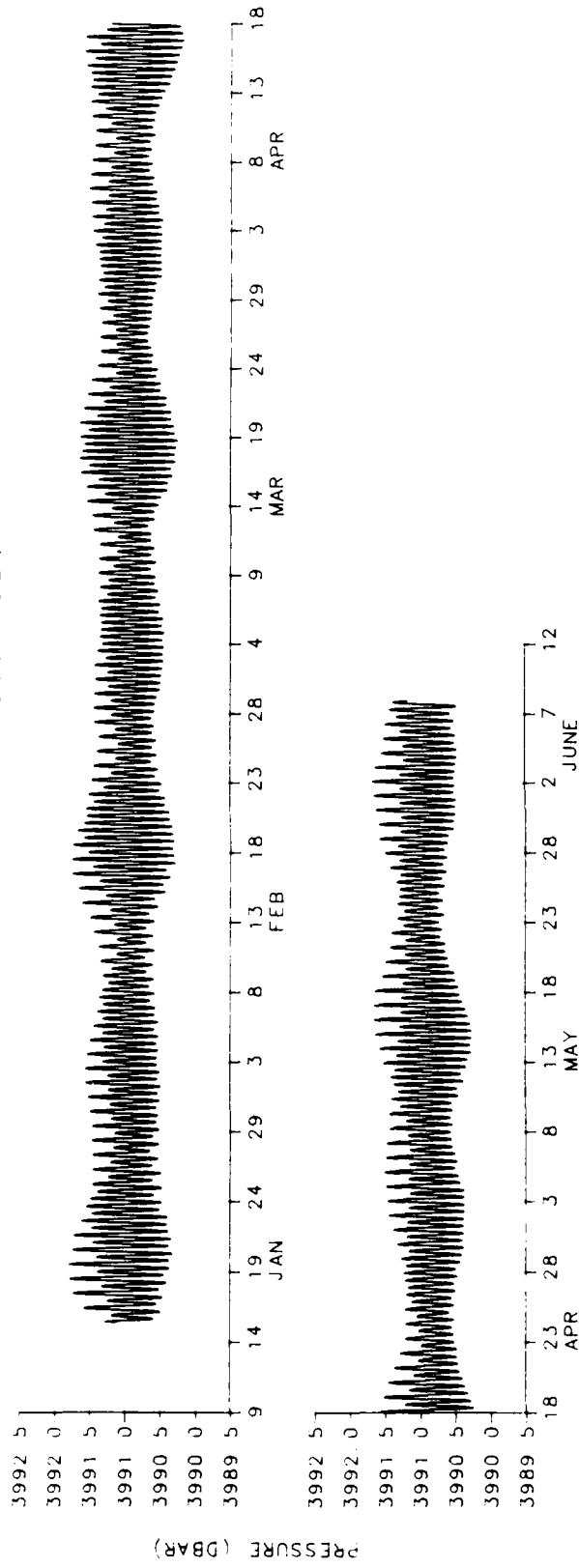


Figure 4.5

PIES84B2 1983

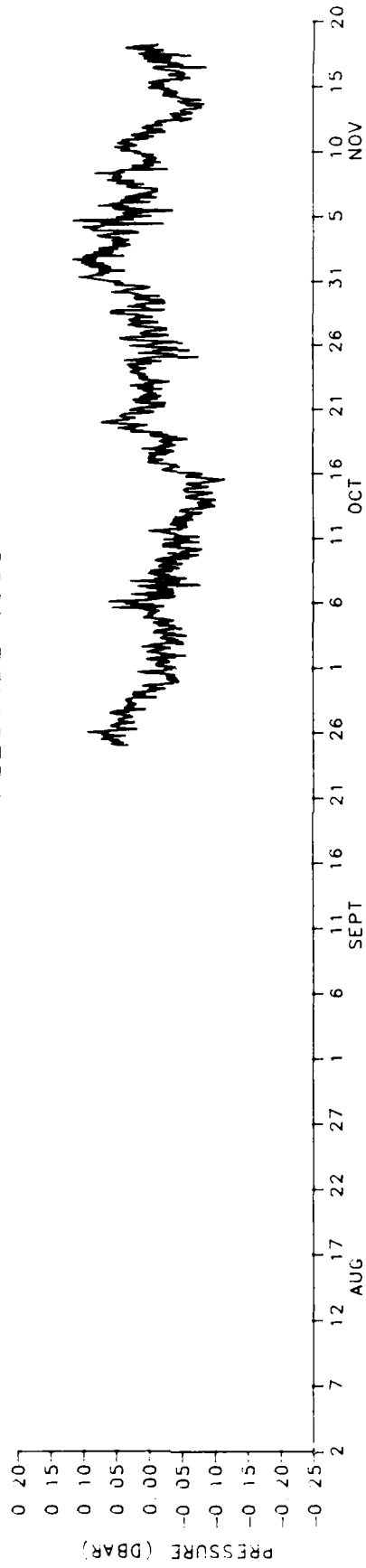
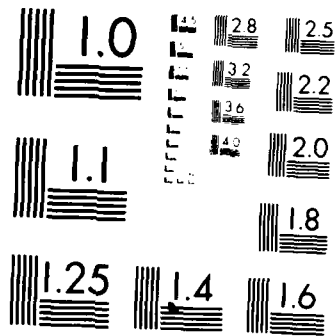


Figure 5.1

Figure 5.1-5. Residual bottom pressure records at half-hourly intervals. The tides, long-term drifts, and means, which have been removed, are given in Section 2.





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PIES85BCM2 1984-1985

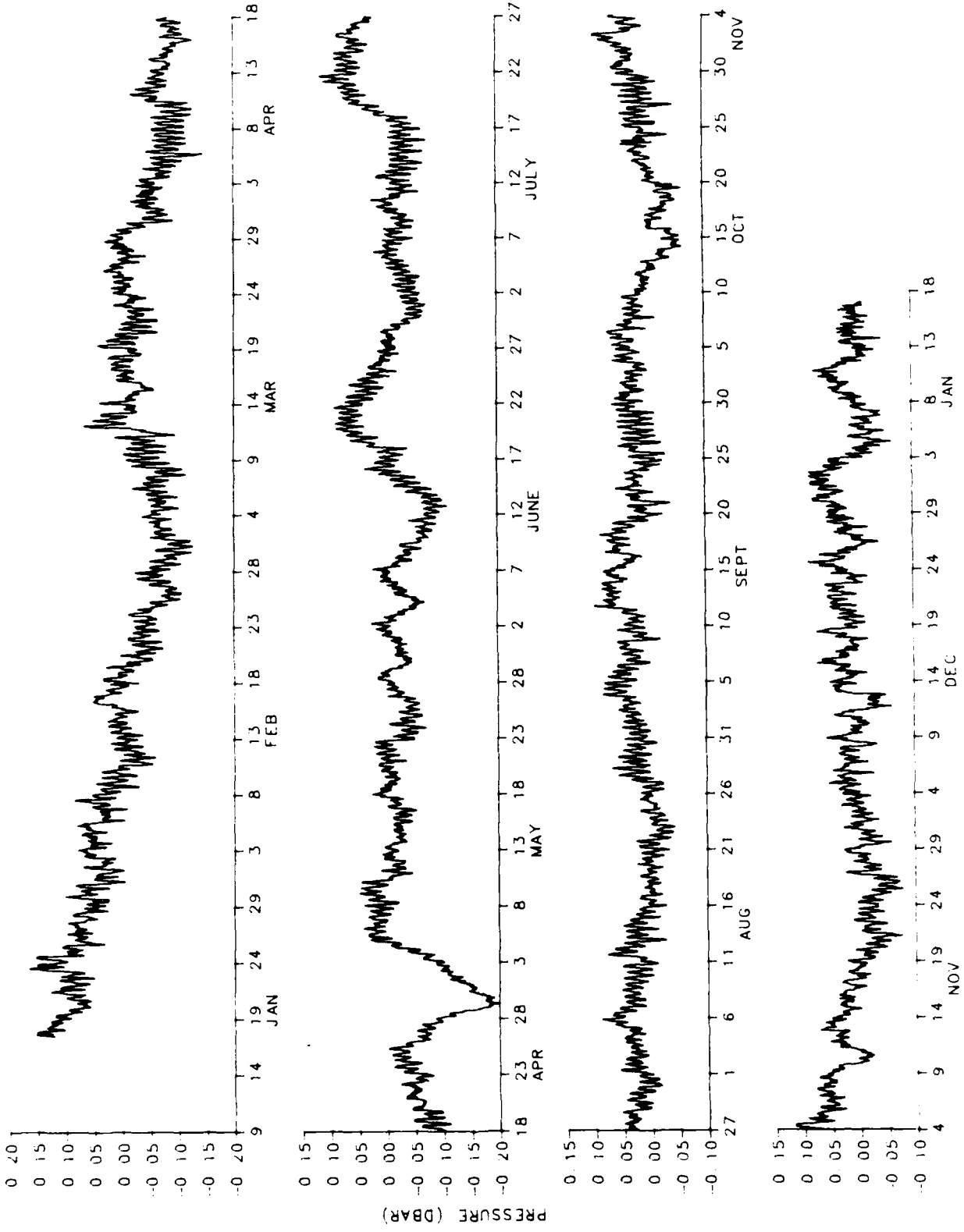


Figure 5.2

PIES84C1 1983-1984

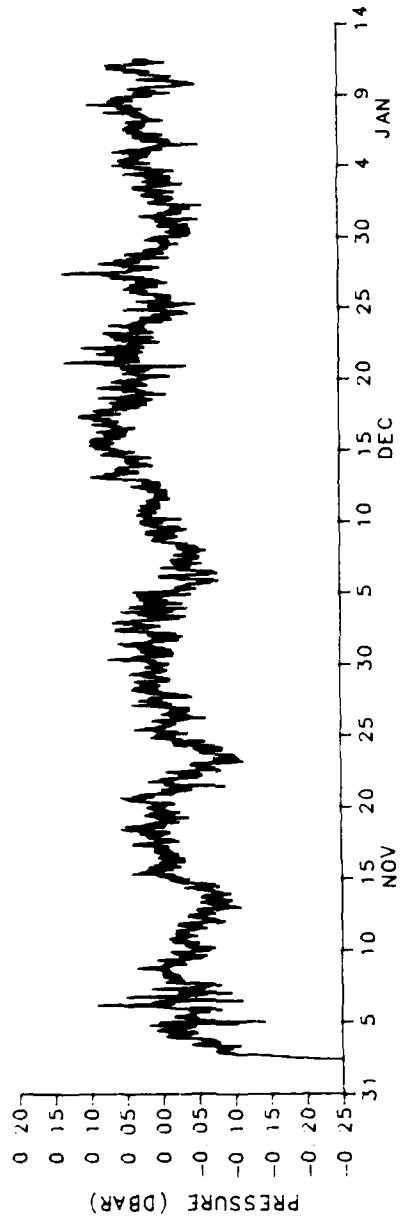


Figure 5.3

PIES84CCM2 1983--1984

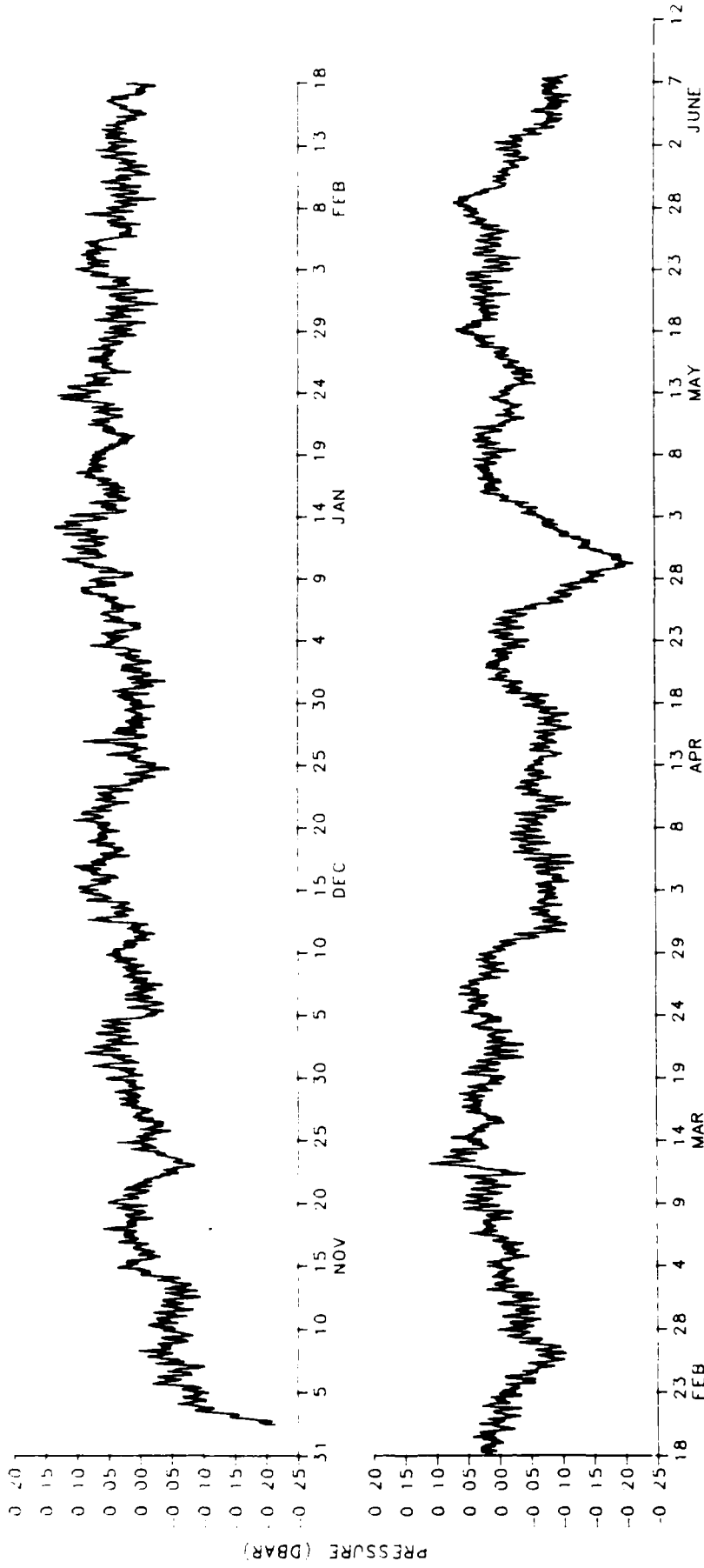


Figure 5.4

PIES84CCM3 1984

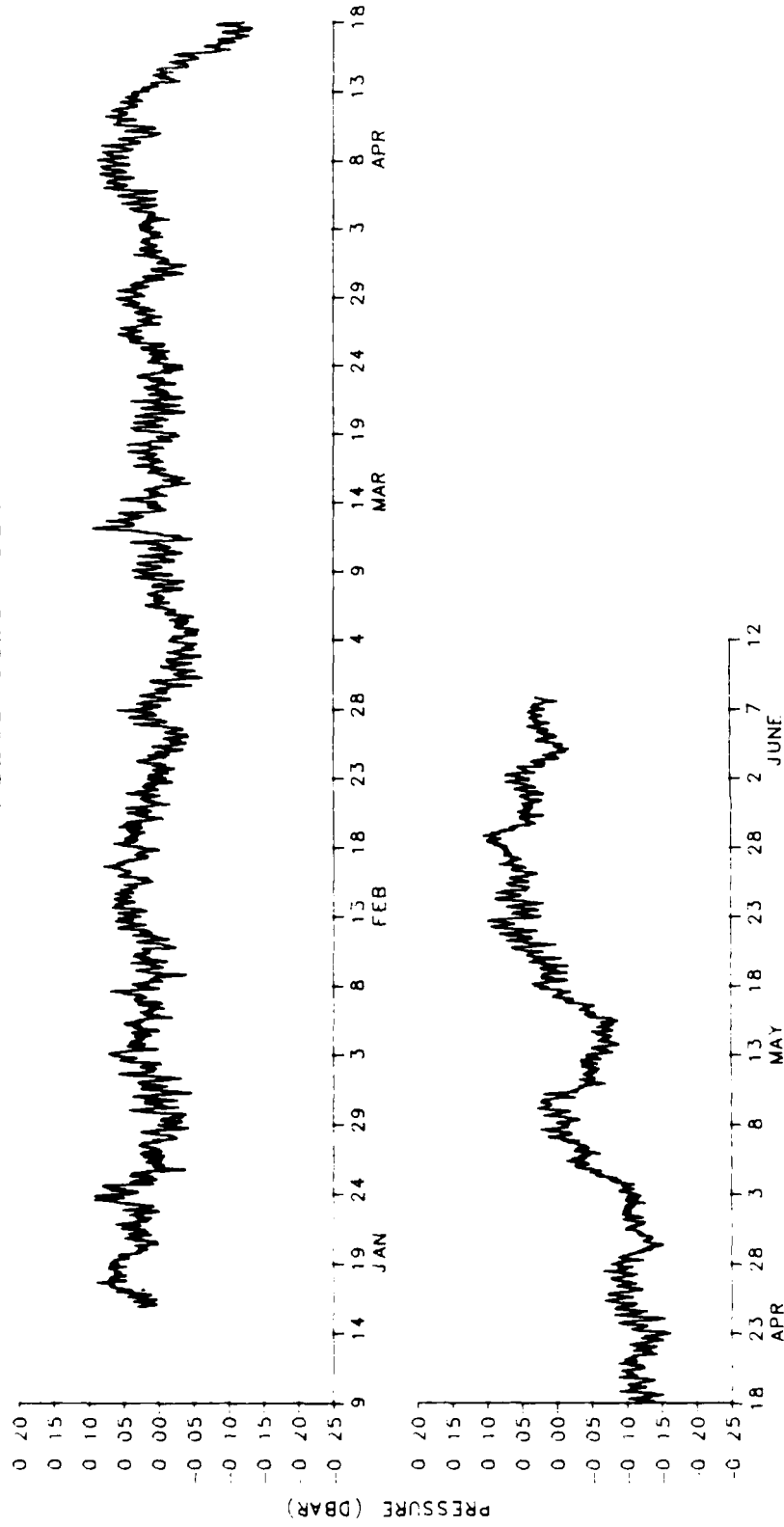


Figure 5.5

PIES84B2 1983

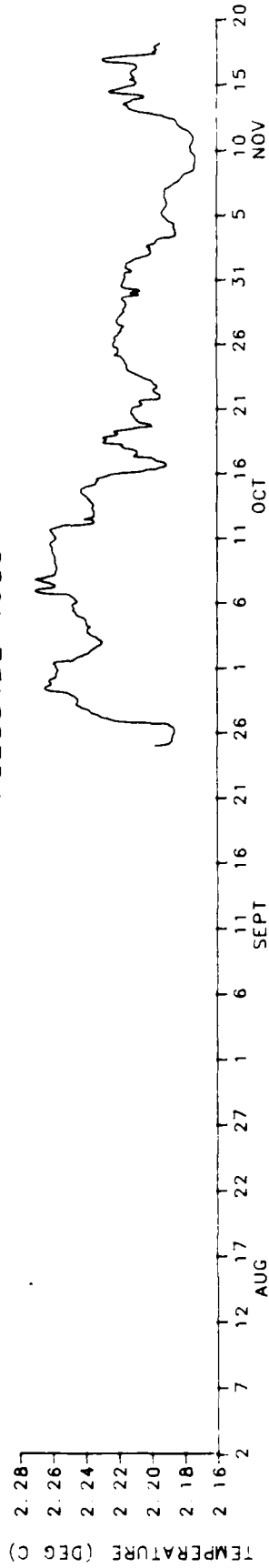


Figure 6.1

Figure 6.1-7 Full measured temperature records at half-hourly intervals.

PIES85BCM2 1984-1985

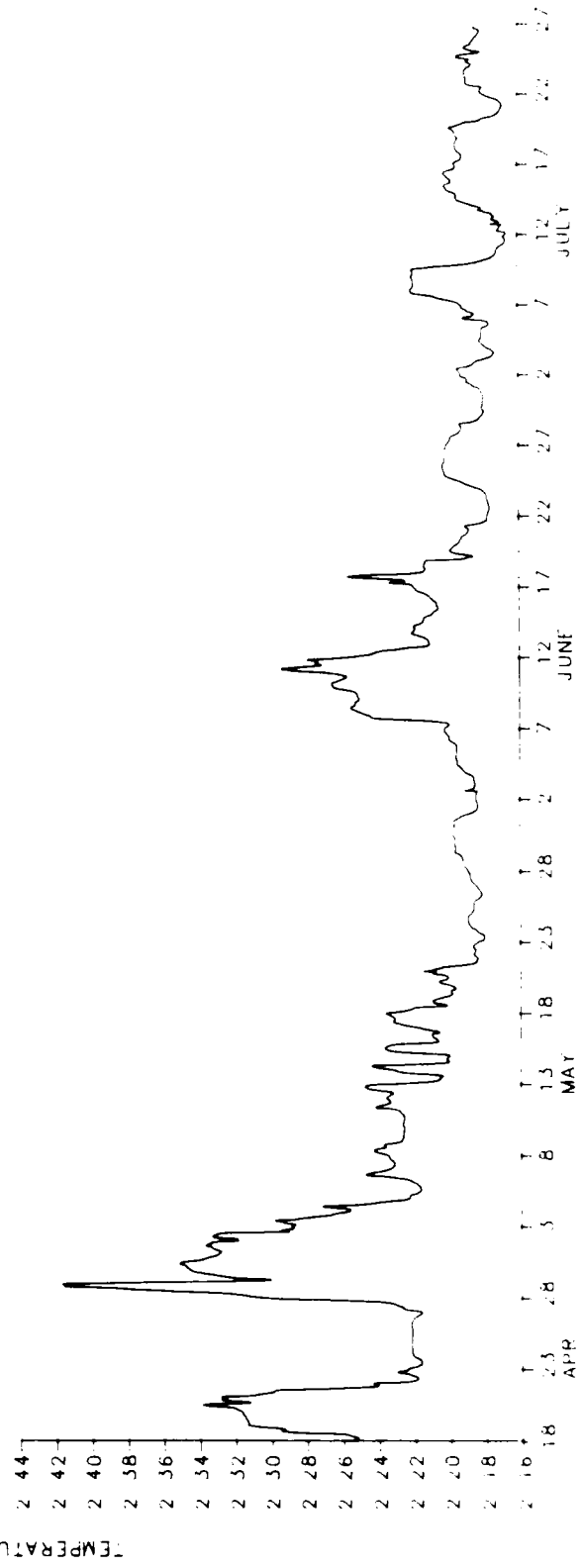
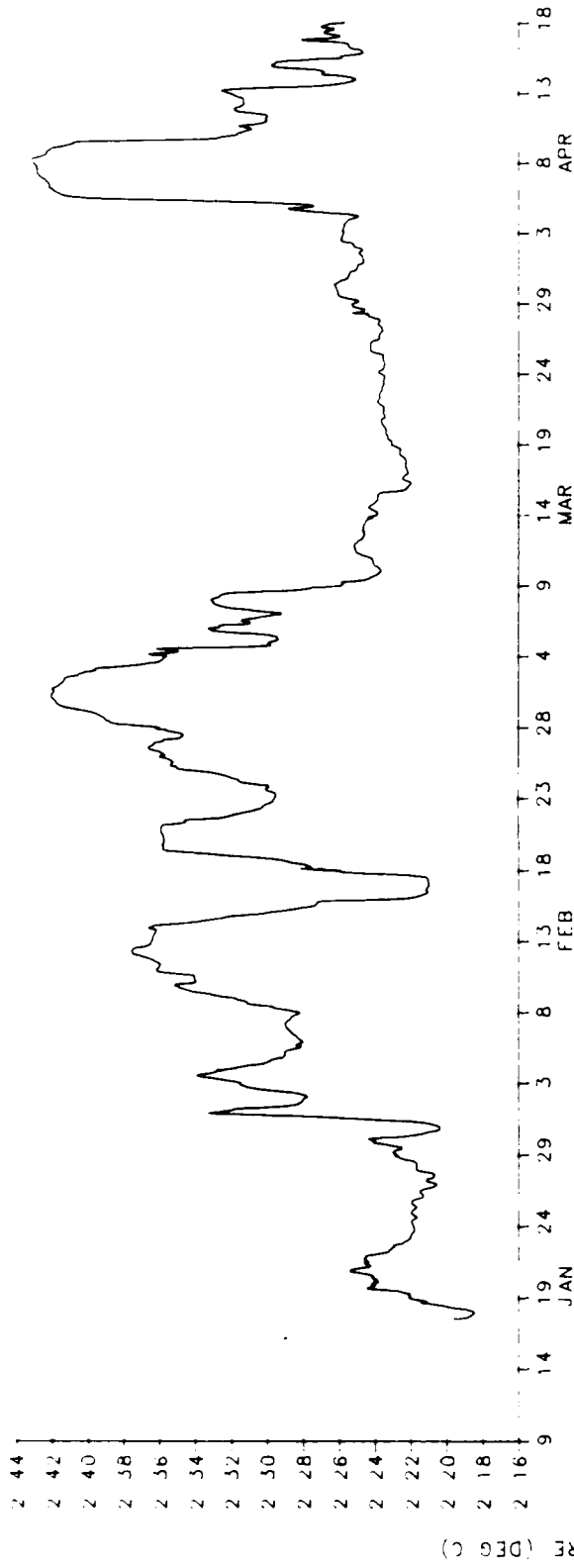


Figure 6.2

PIES85BCM2 1984-1985

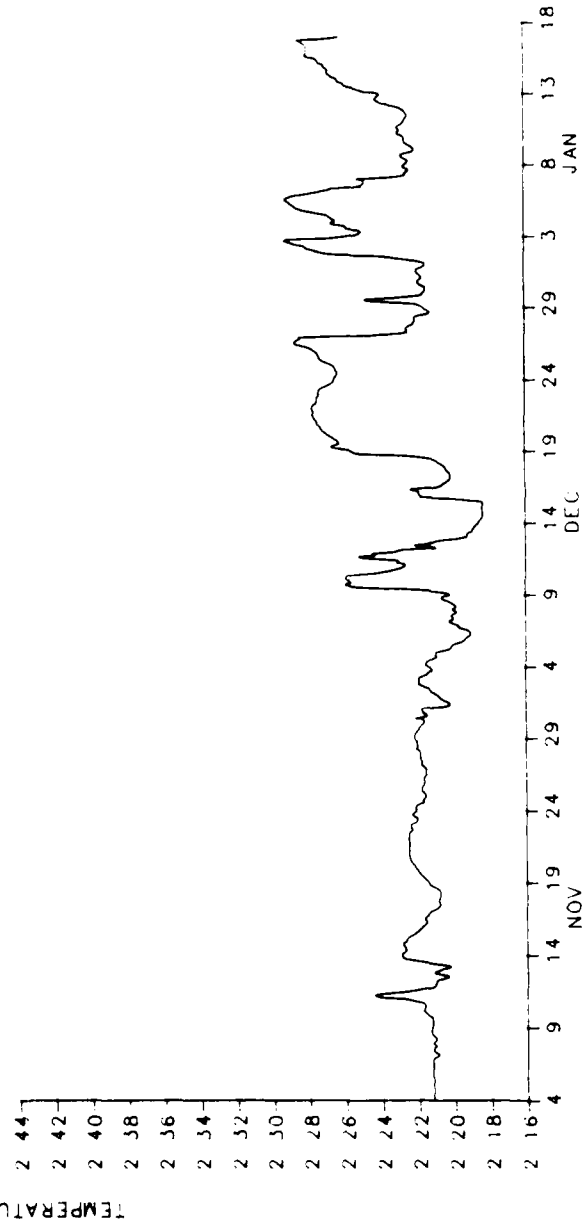
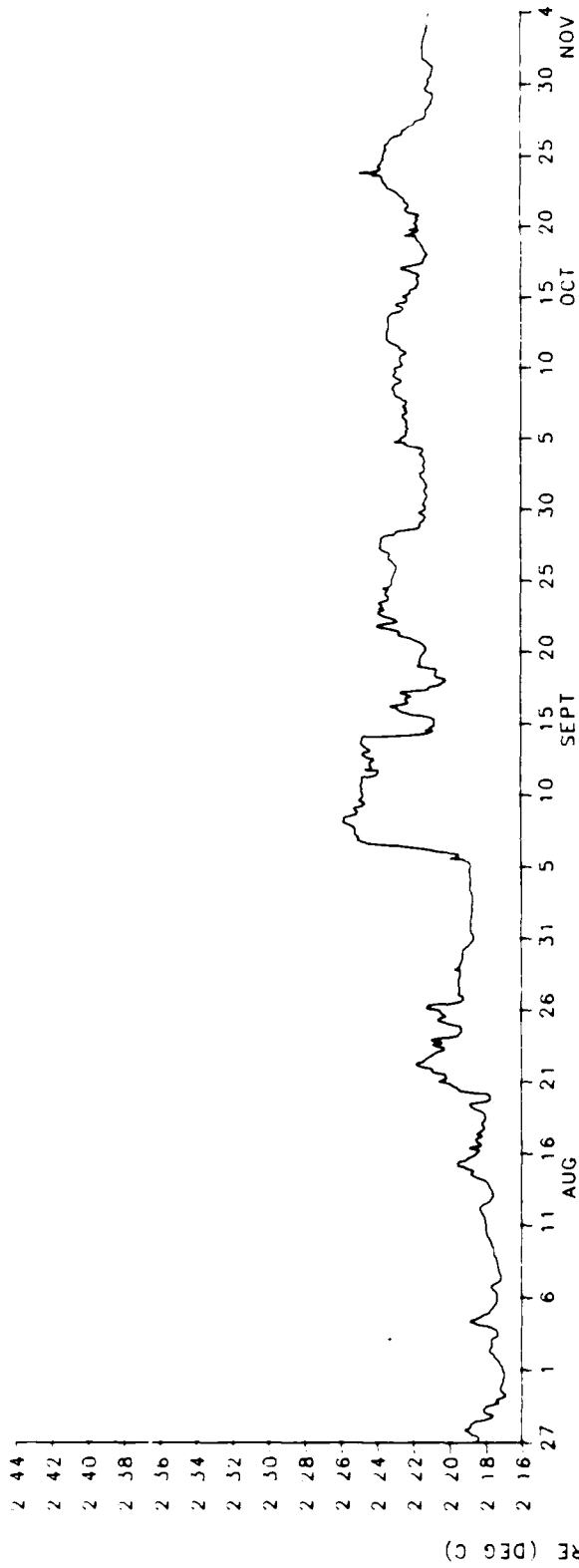


Figure 6.2 (continued)

PIES85BCM3 1984-1985

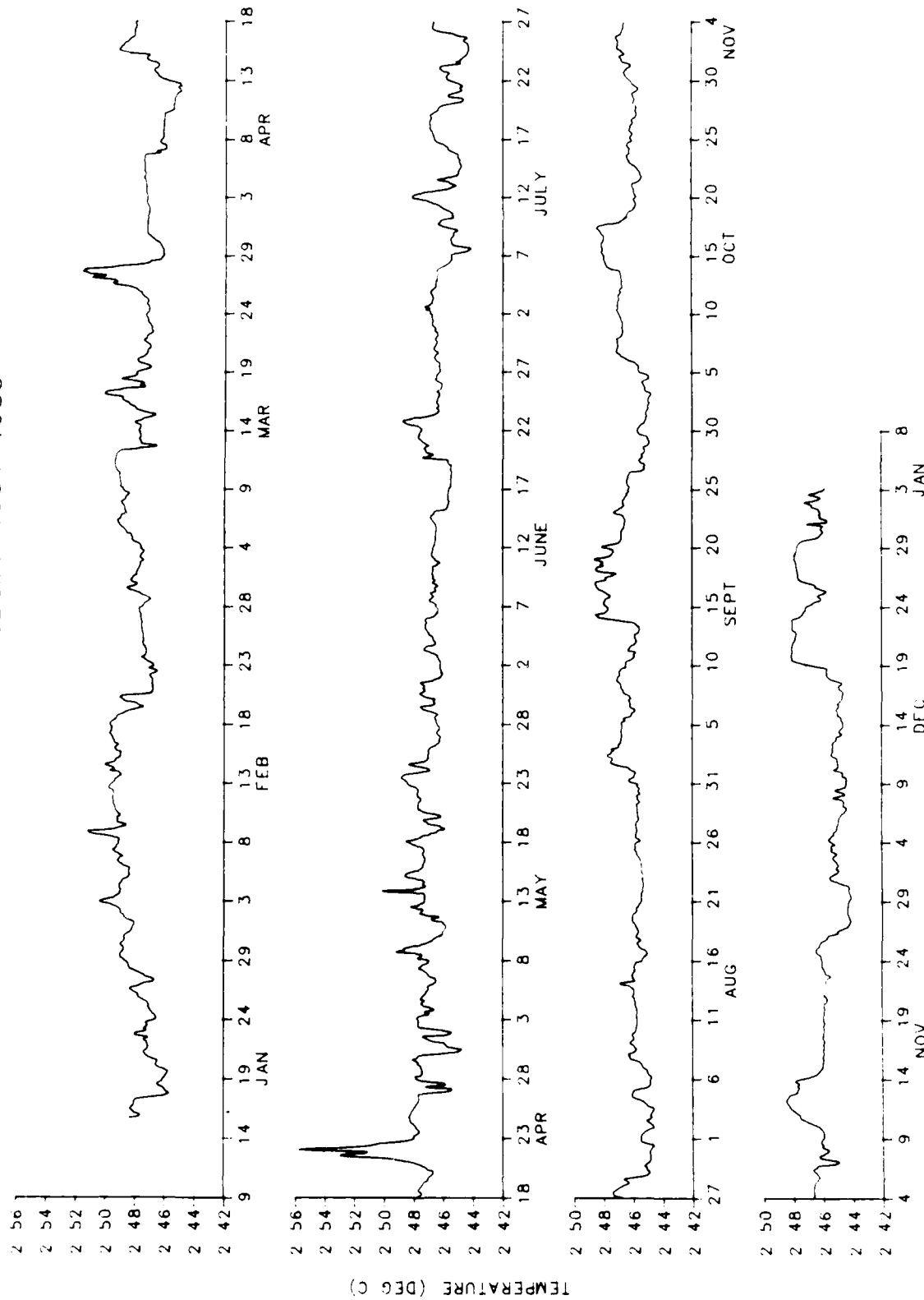


Figure 6.3

PIES84C1 1983-1984

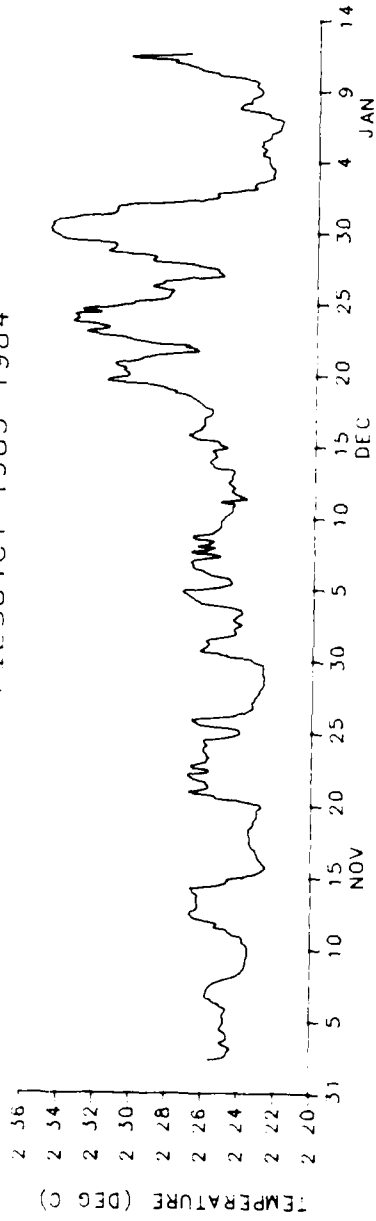


Figure 6.4

PIES85CCM1 1984-1985

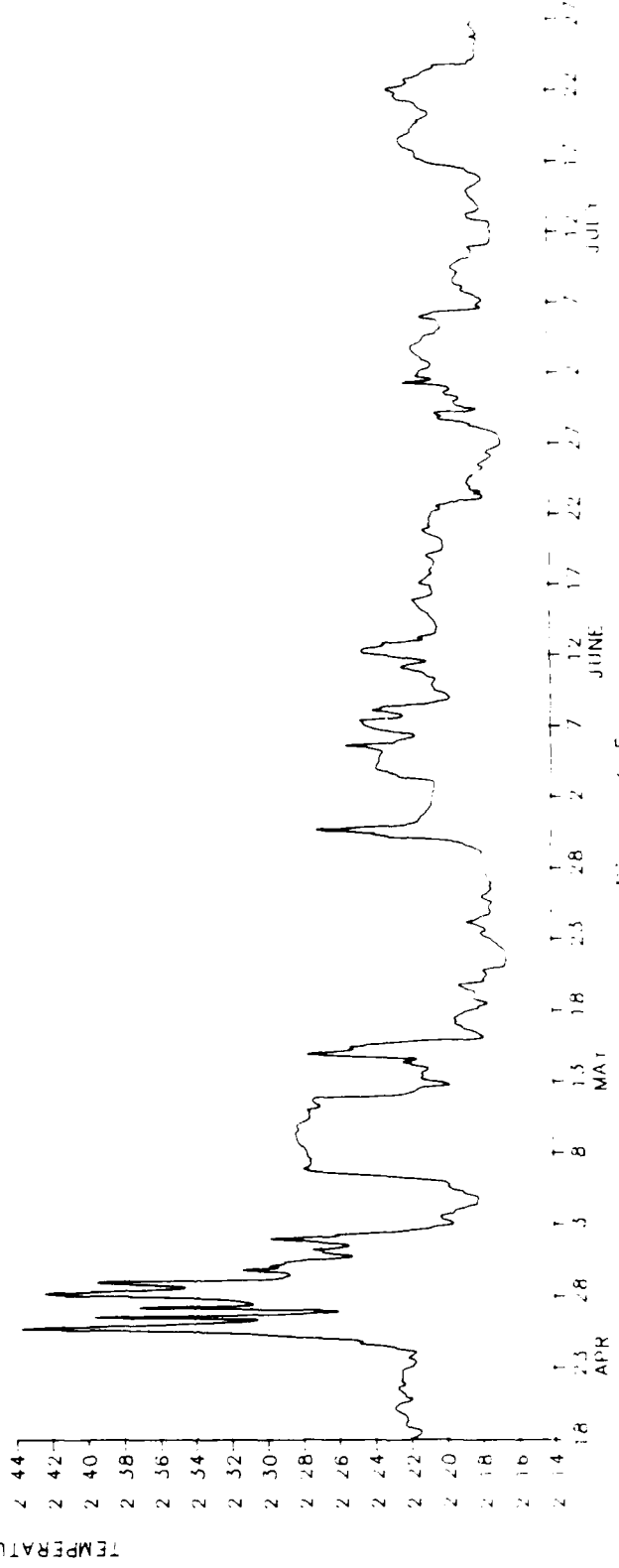
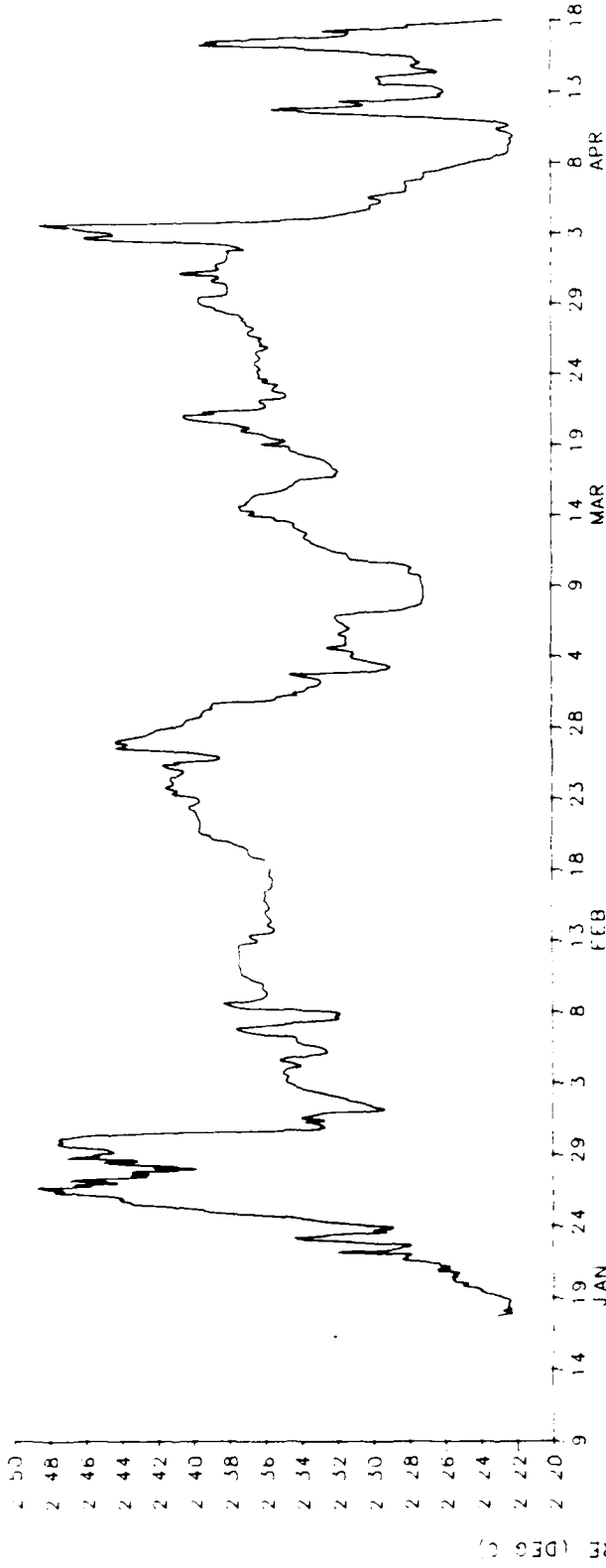


Figure 6.5

PIFS85CCM1 1984-1985

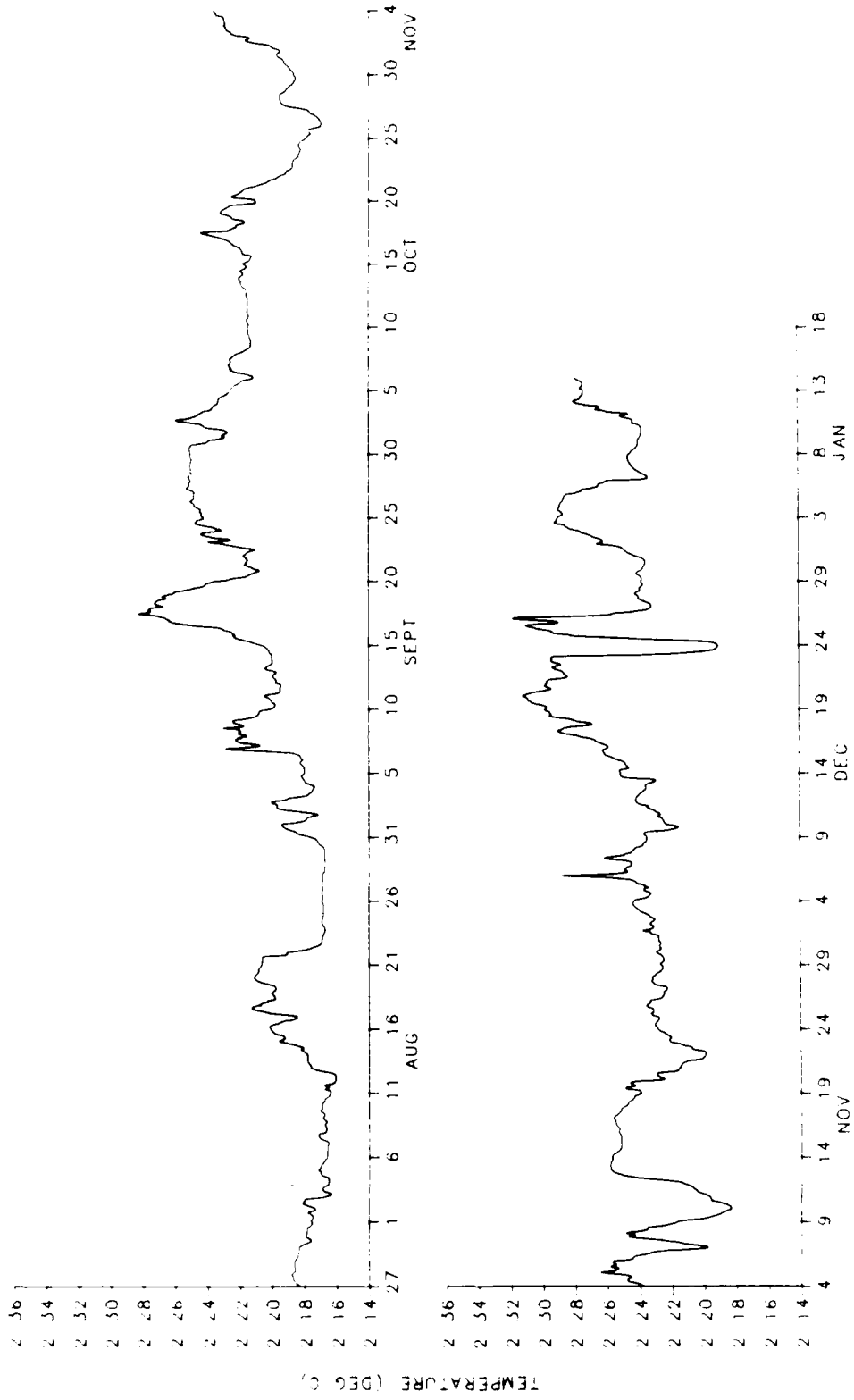


Figure 6.5 (continued)

FILE 18400.MZ 1985 1984

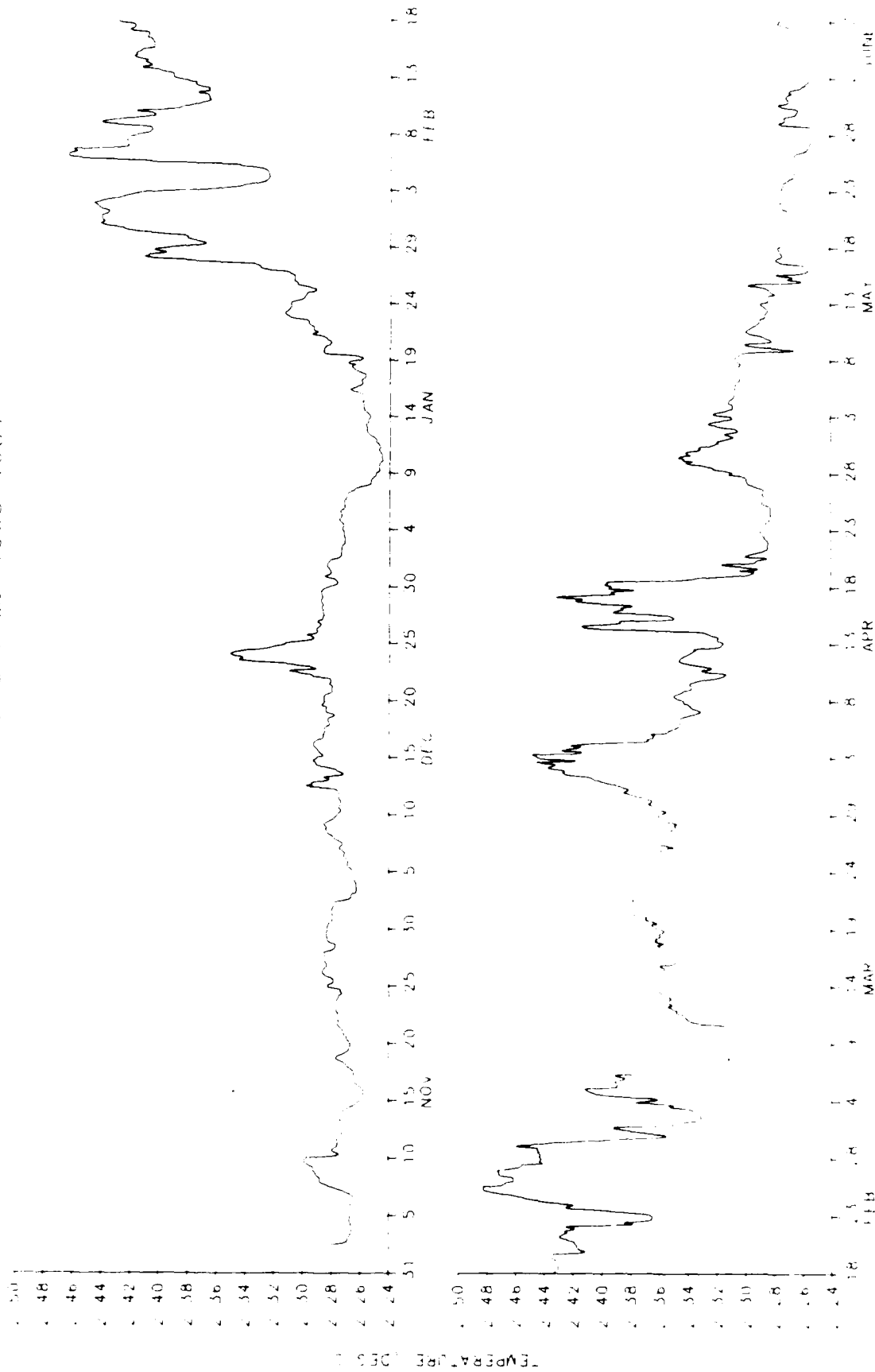


Figure 6.6

PIES84CCM3 1984

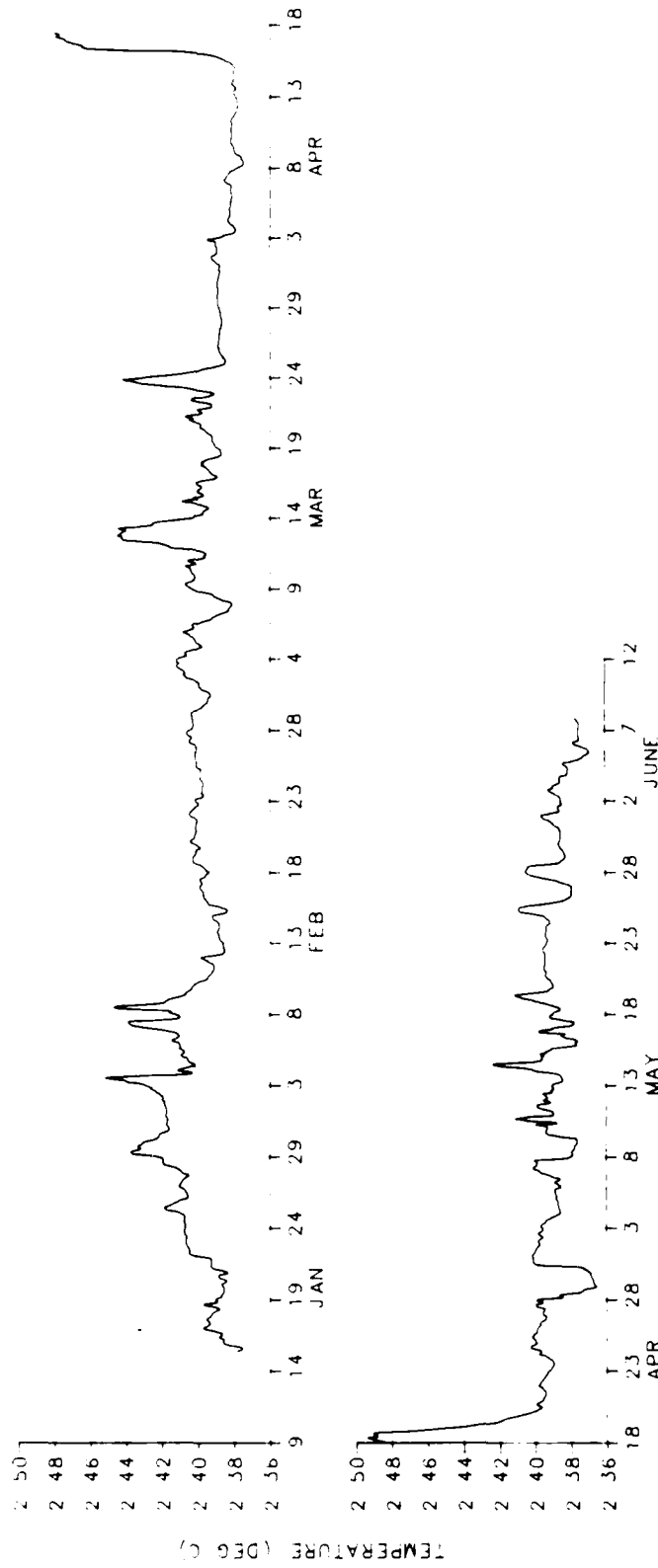


Figure 6.7

## SECTION 4

## 40 HRLP Data For Each Cross-Stream Section

The 40 HRLP thermocline depth ( $Z_{1,2}$ ), bottom pressure, and temperature records are presented for each instrument. These are grouped by cross-stream line, with the northernmost IES on each line plotted at the top. Each record is labelled with the instrument name in the upper left corner.

The 40 HRLP  $Z_{1,2}$  records for each cross-stream section are presented first. These are followed by the 40 HRLP residual pressure records and the 40 HRLP temperature data for the instruments which had those additional sensors.

The time scale is the same for all plots, with each increment corresponding to 10 days. The axis begins on 0000 GMT of the first date labelled.

Vertical scale for each variable is consistent between instruments. Each increment corresponds to 100 m for the  $Z_{1,2}$  records, 0.05 dbar for the bottom pressure measurements, and 0.04°C for the temperatures.

The sampling interval is 6 hours for all variables. The length and the start and end times of the data records are tabulated in Section 2.

LINE B 1983-1984

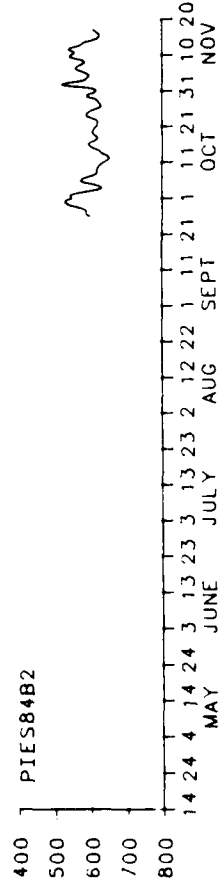
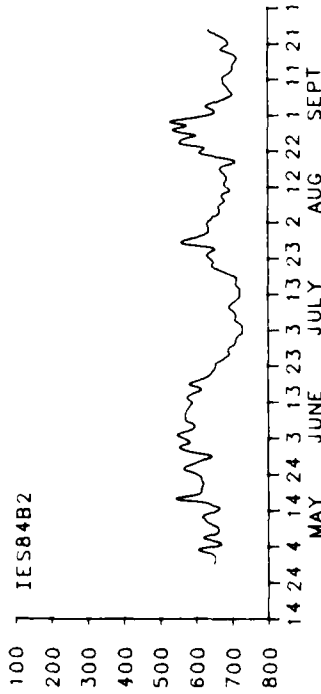
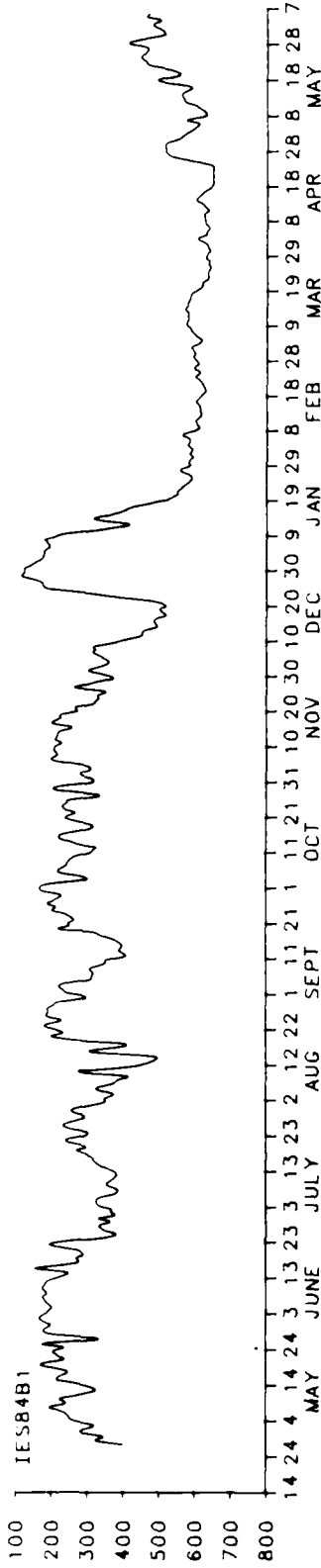


Figure 7.1

Figure 7.1-6 40 HRLP thermocline depth data along lines B to G.

LINE B 1983-1984

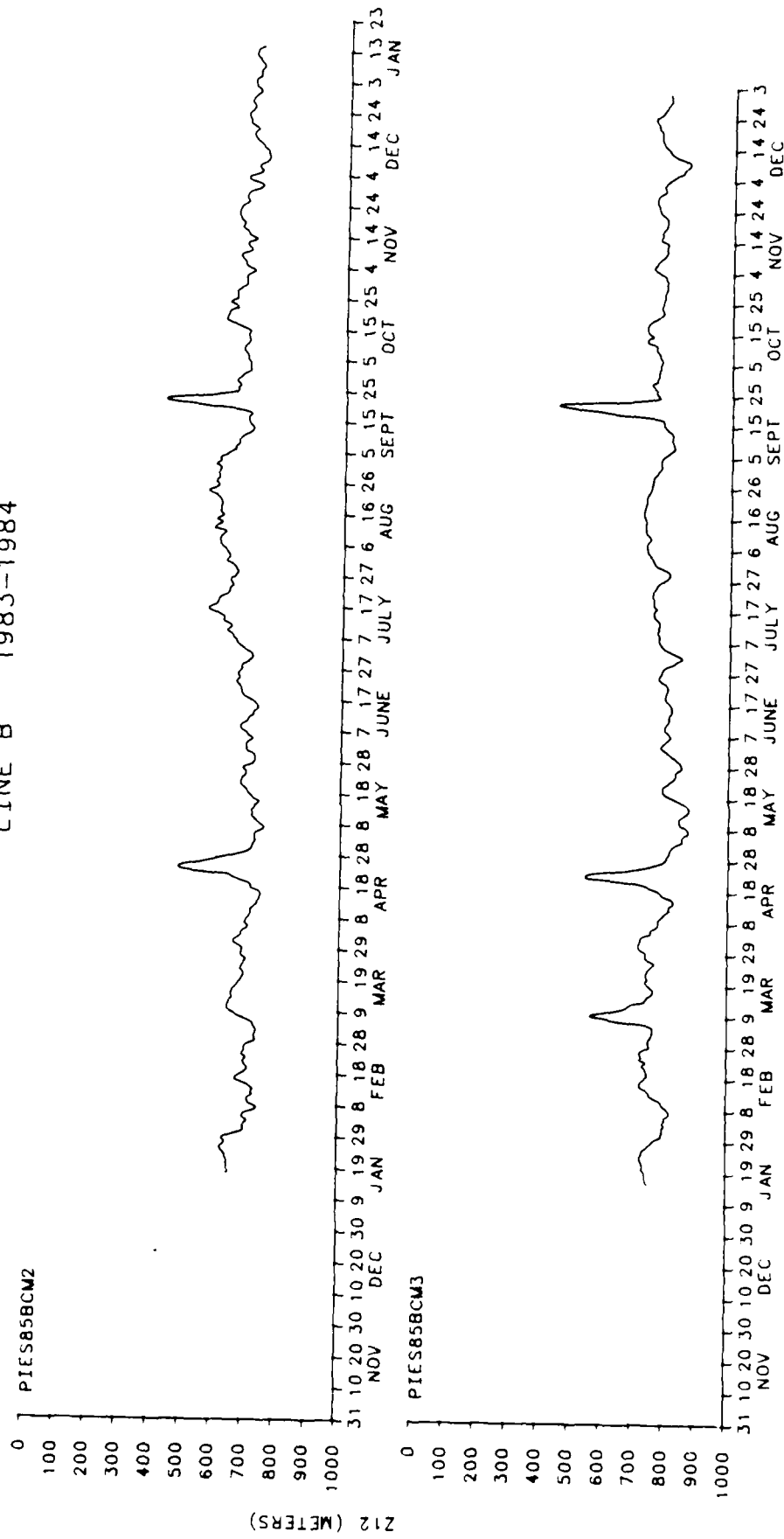


Figure 7.1 (continued)

LINE C 1983--1984

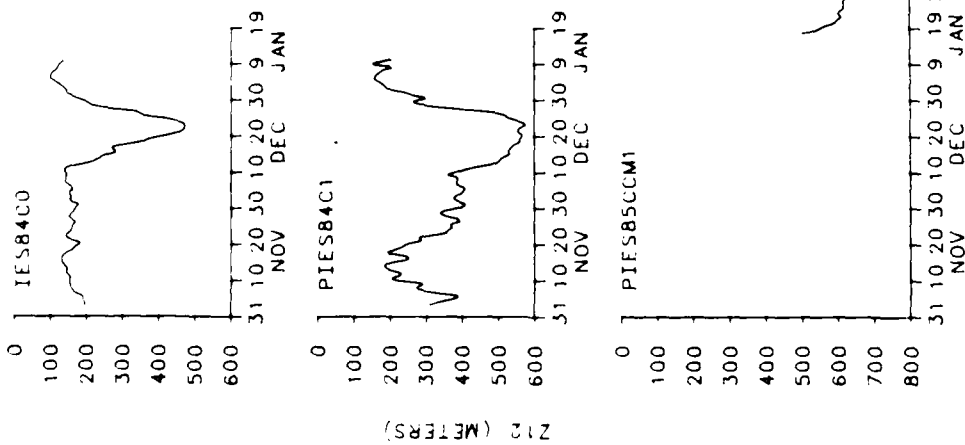


Figure 7.2

LINE C 1983-1984

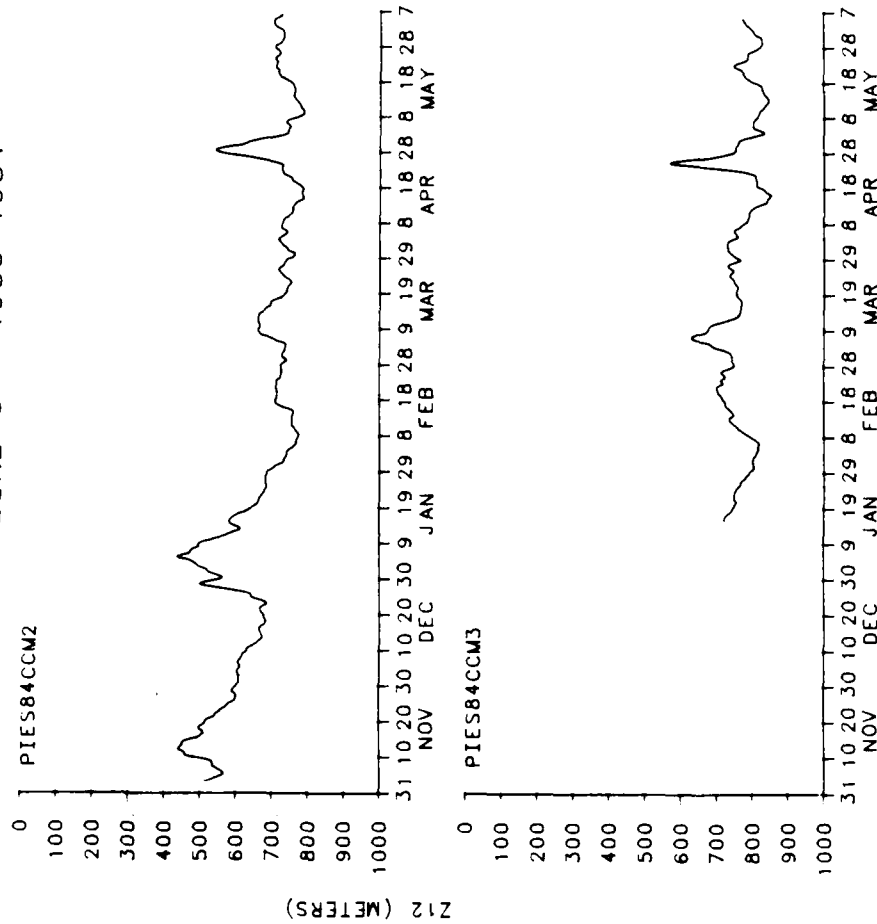


Figure 7.2 (continued)

LINE D 1983-1984

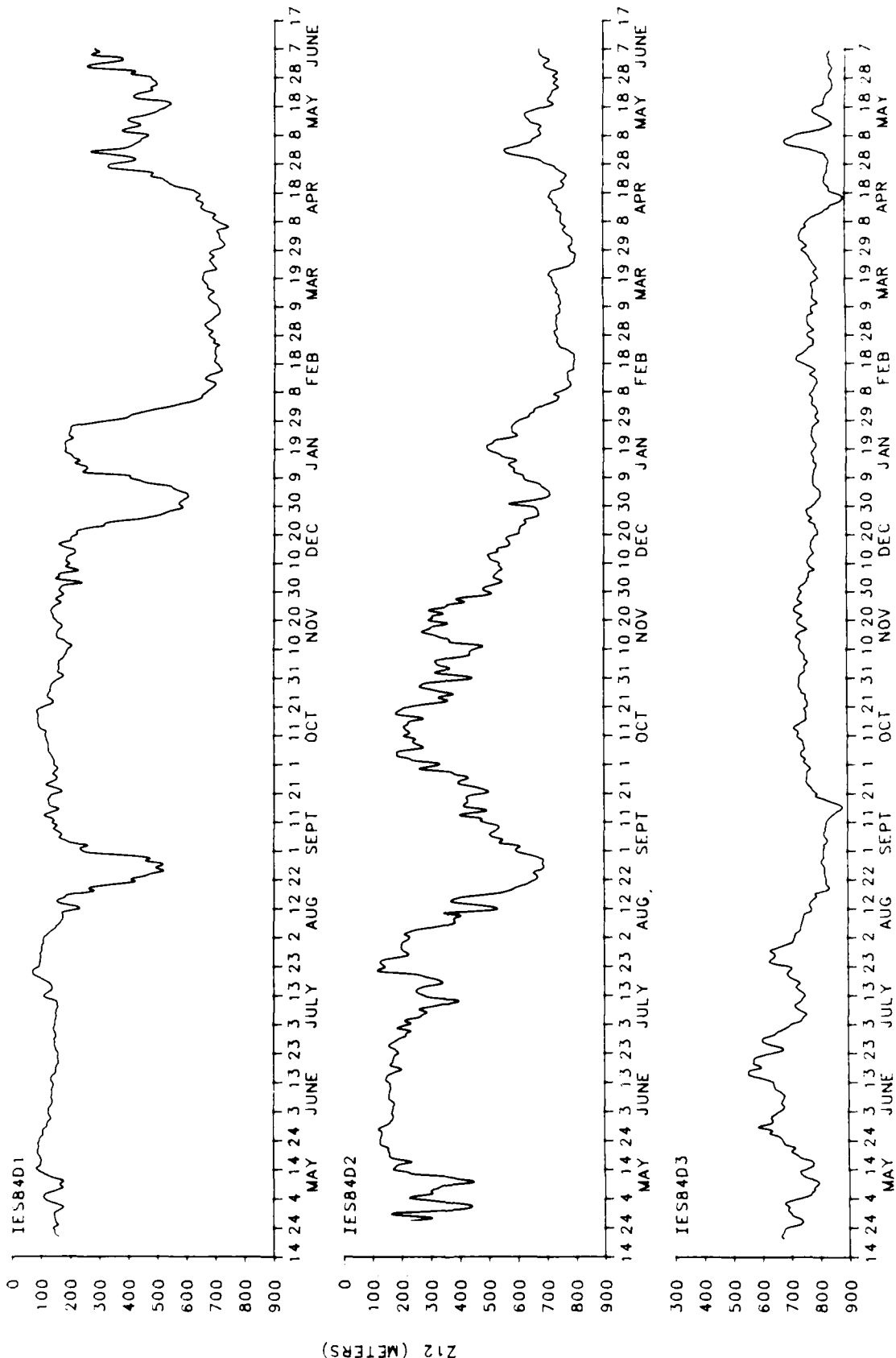


Figure 7.3



LINE F 1983-1984

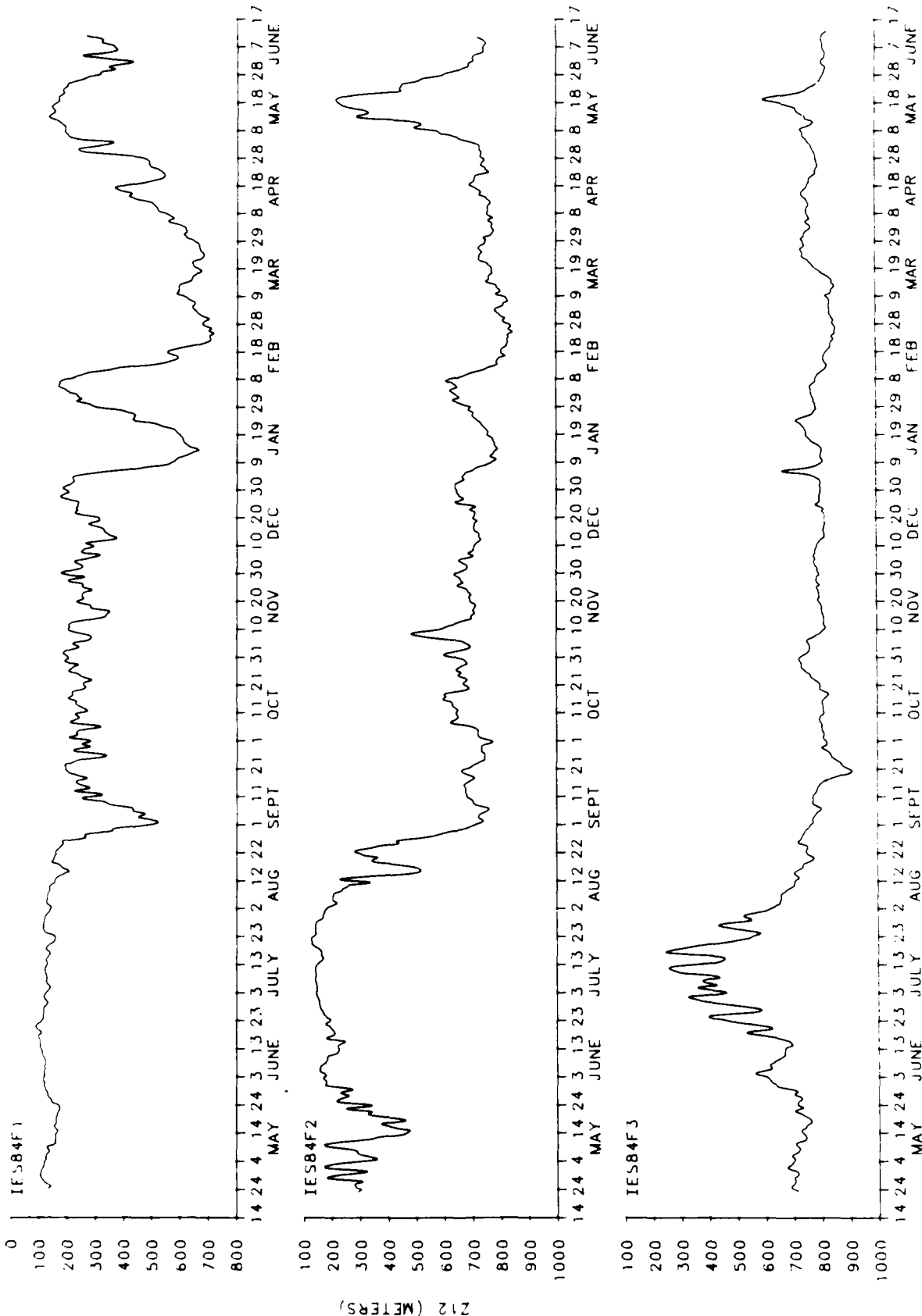


Figure 7.5



LINE B 1983-1985

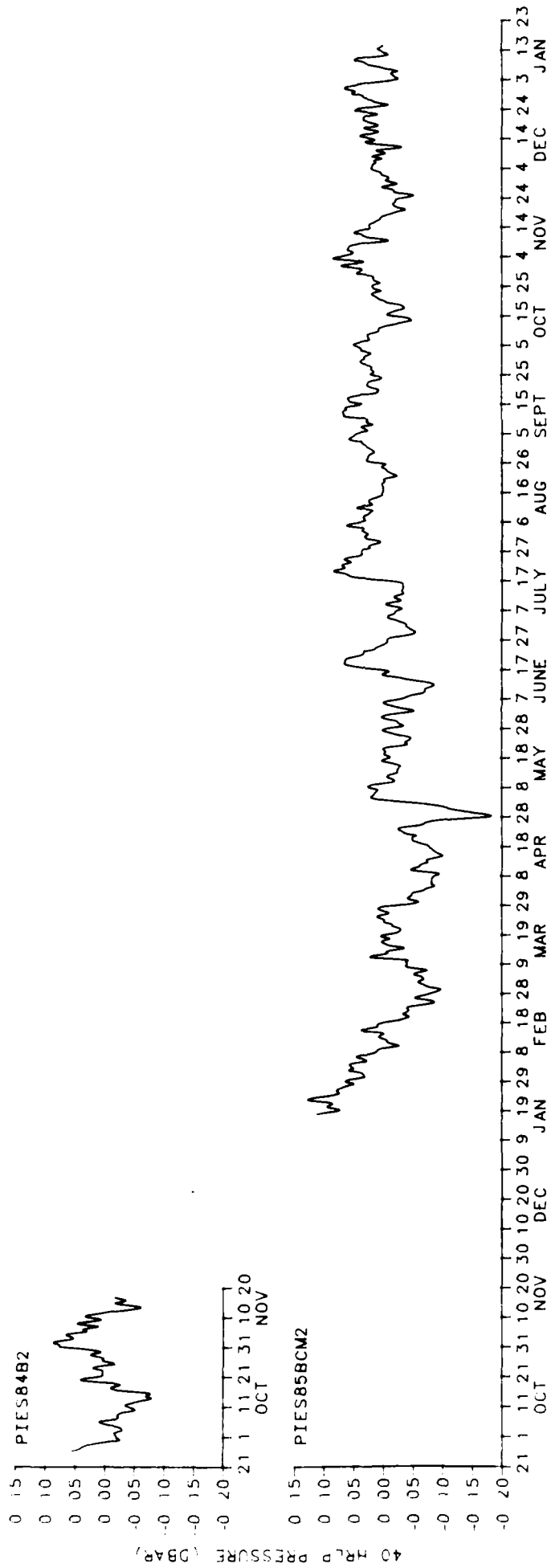


Figure 8.1

Figure 8.1-2 40 HRIP bottom pressure data for Lines B and C.

LINE C 1983-1984

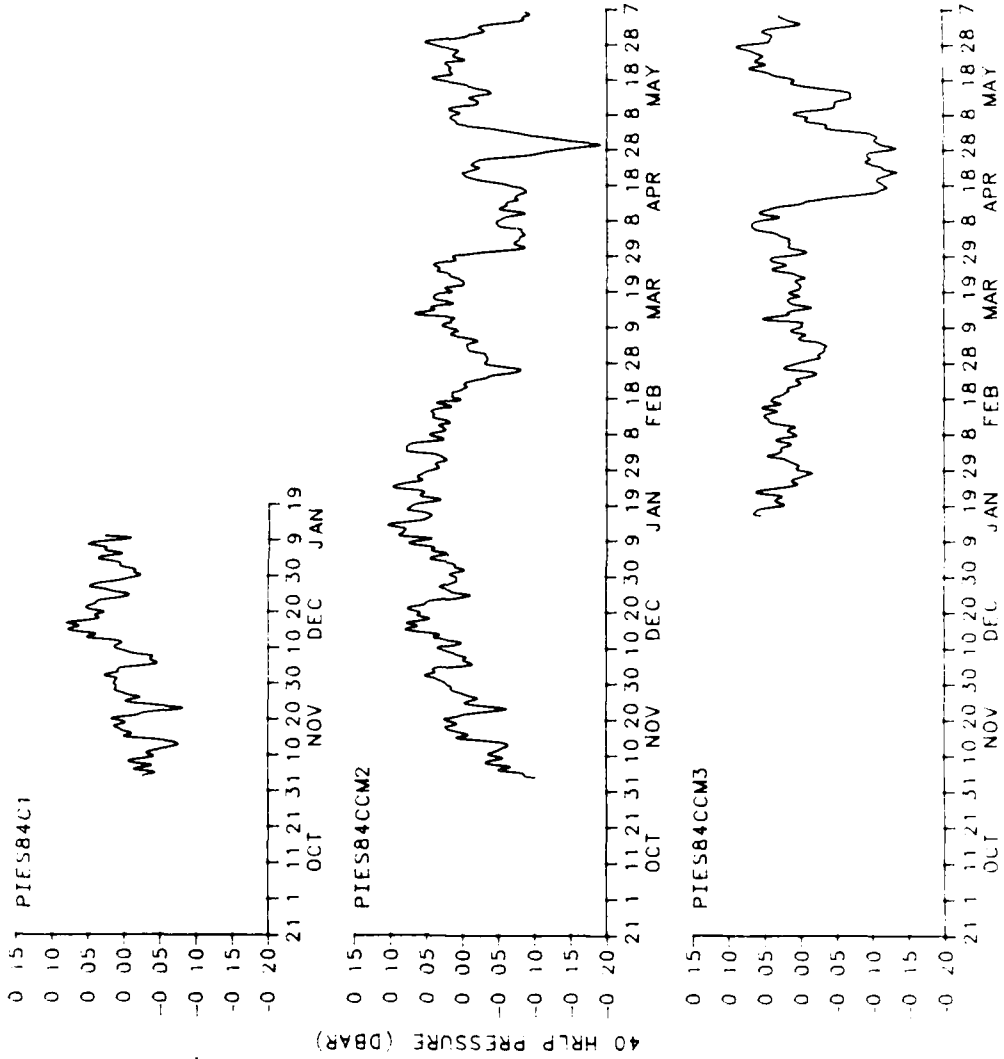


Figure 8.2

LINE B 1983-1985

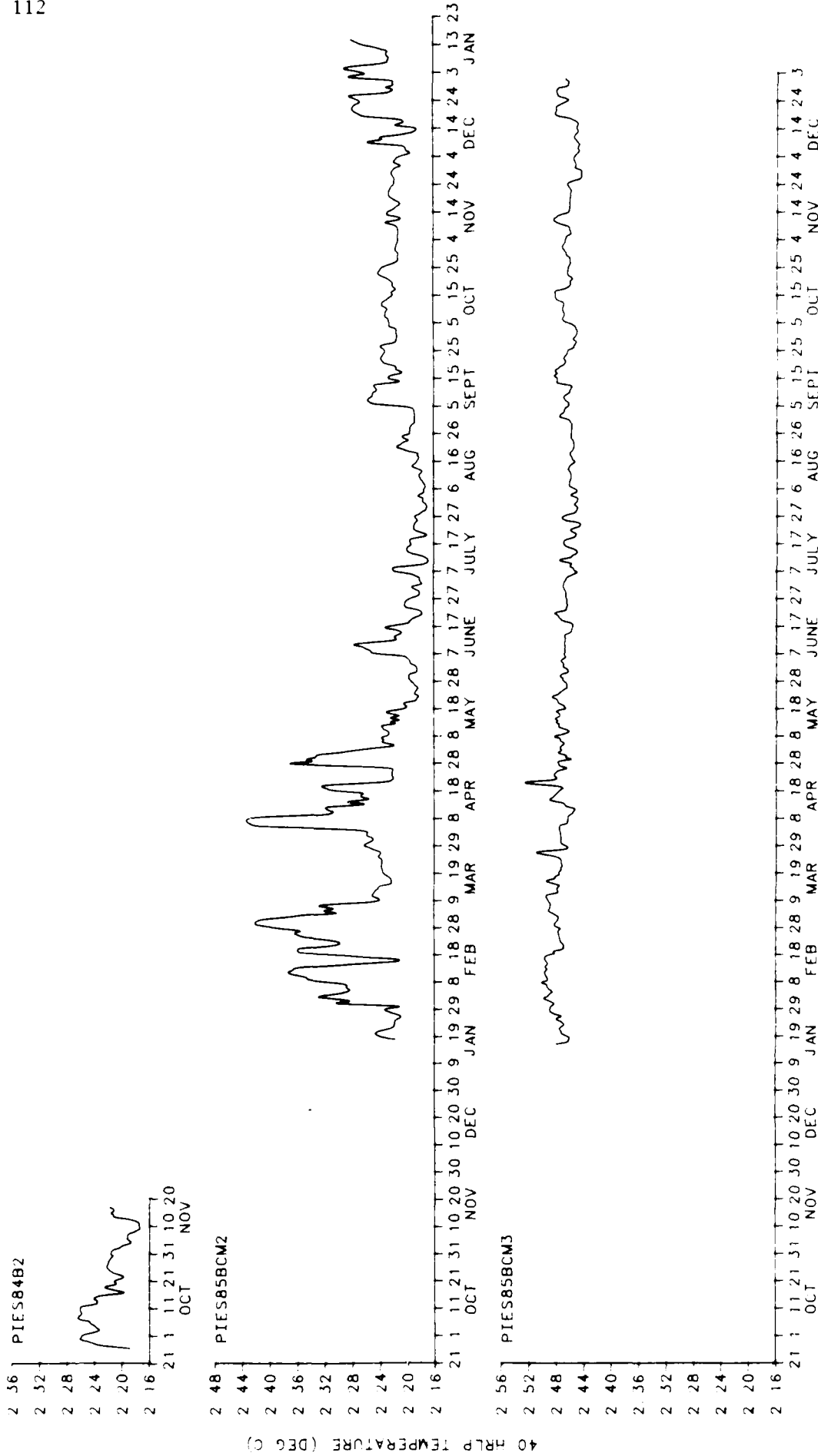


Figure 9.1

Figure 9.1-2 40 HRLP temperature data for lines B and C.

LINE C 1983-1985

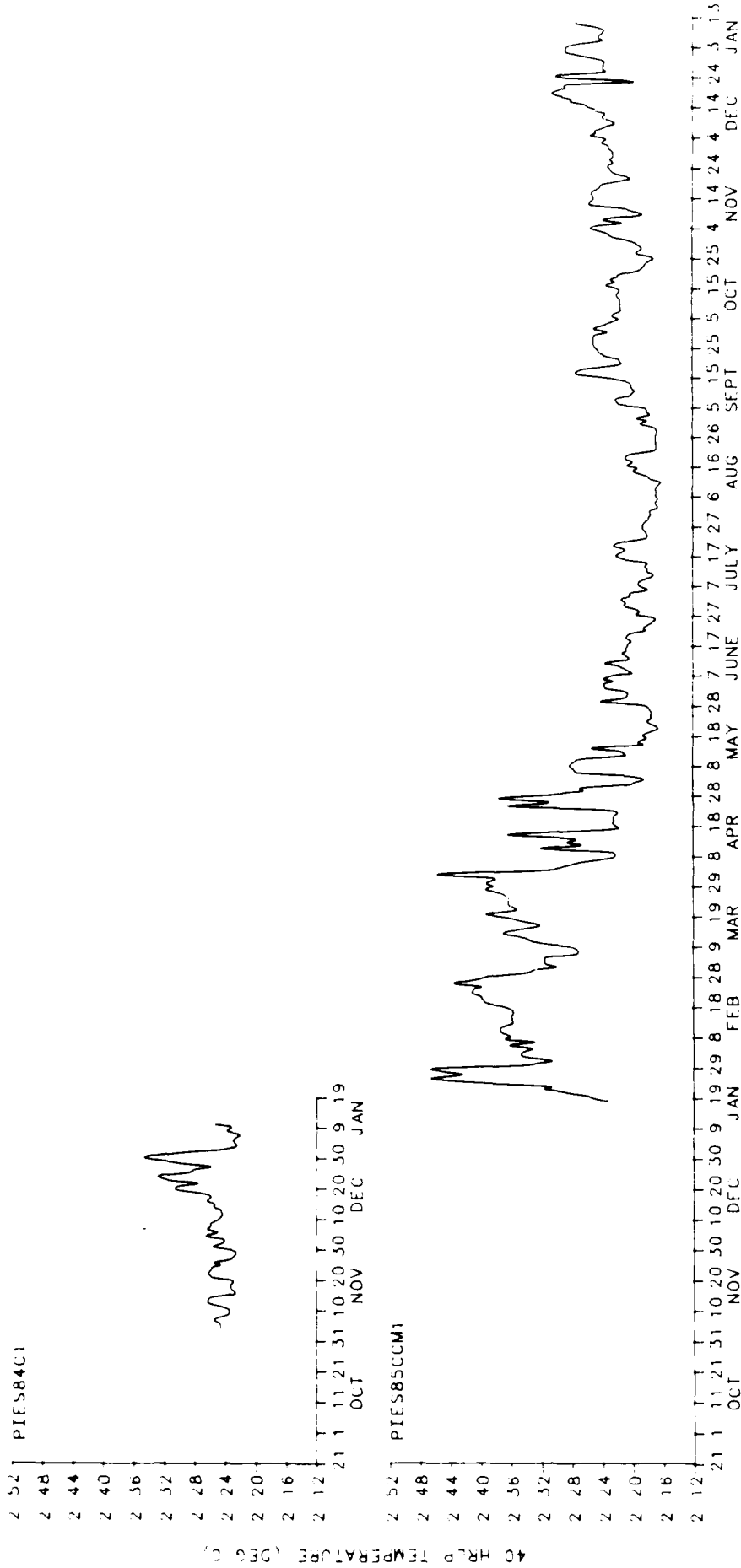


Figure 9.2

LINE C 1983-1984

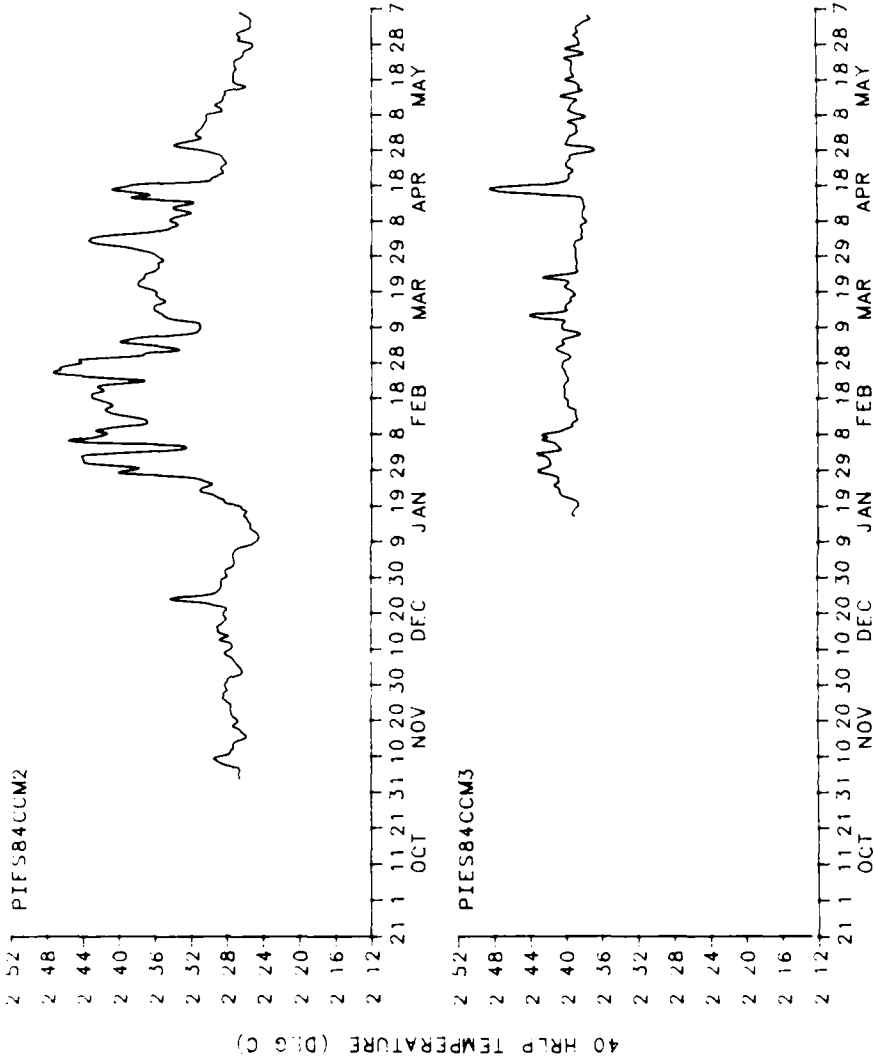


Figure 9.2 (continued)

## SECTION 5

## Thermocline Depth Maps

Contour plots of the mean and standard deviation fields, the error fields, the thermocline depth ( $Z_{1,2}$ ) fields, and the perturbation fields are presented.

Three different sizes of regions are mapped, depending on the number and location of the instrumented sites. These are: a) From April to September 1983, the region is 200 km cross-stream by 400 km downstream. b) From September 1983 to January 1984, it is 200 km by 460 km. c) From January to June 1984, it is 240 km by 460 km. The inset in Figure 10 shows the relationship of these regions to each other; the upper left-hand corner of all three regions corresponds to the same location. In Figures 10-12, each of the contoured frames corresponds to either the full boxed region in Figure 1 or a portion of it. The boxed region is oriented  $064^\circ T$ , and north is indicated by the arrow in Figure 10. The horizontal scales in Figure 10 apply to the frames in Figures 11 and 12.

Each frame consists of a grid of points at 20 km spacing. The actual IES sites are indicated by the + marks and the positions are listed in Table 1. From January to June 1984,  $Z_{1,2}$  data was available from two additional IESs, IES85C4 and IES85C5. These data have been included in the mapped fields. Additionally, during June 1984, most of the IESs documented in this report were recovered and redeployed at the same locations. Thus for 9-16 June 1984, the most accurate  $Z_{1,2}$  maps

were obtained by combining the data records from both deployment periods. The positions of the instruments and their data records from the June 1984 to May 1985 deployment are presented in Tracey et al. (1985).

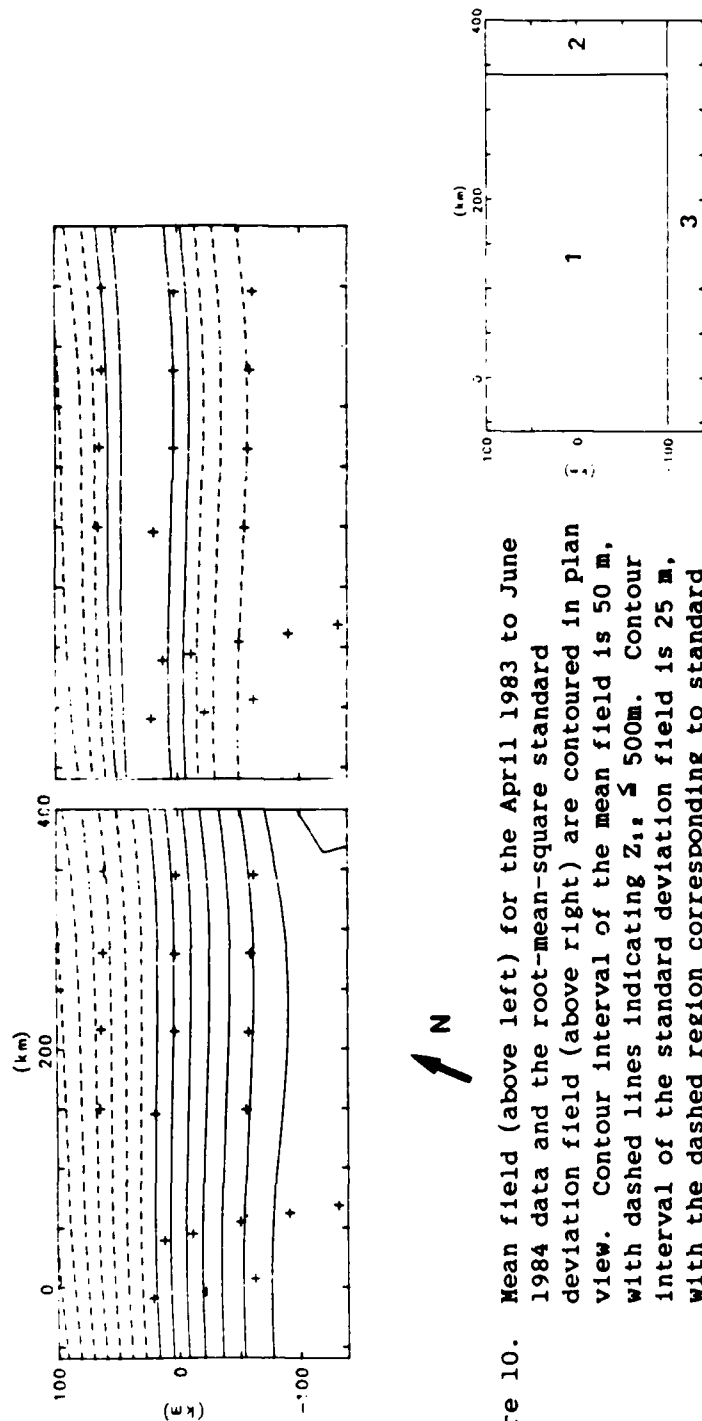


Figure 10. Mean field (above left) for the April 1983 to June 1984 data and the root-mean-square standard deviation field (above right) are contoured in plan view. Contour interval of the mean field is 50 m, with dashed lines indicating  $Z_1 \leq 500$  m. Contour interval of the standard deviation field is 25 m, with the dashed region corresponding to standard deviation  $\leq 150$  m rms. North is indicated by the arrow. The inset (right) shows the three regions which are mapped in Figures 11 and 12: a) Area 1 corresponds to the region mapped from 28 April to 26 September 1983 (200 x 400 km). b) The combined areas 1 and 2 were mapped from 27 September 1983 to 12 January 1984 (200 x 460 km). c) The full region, areas 1, 2, and 3, was mapped from 13 January to 16 June 1984 (240 x 460 km).

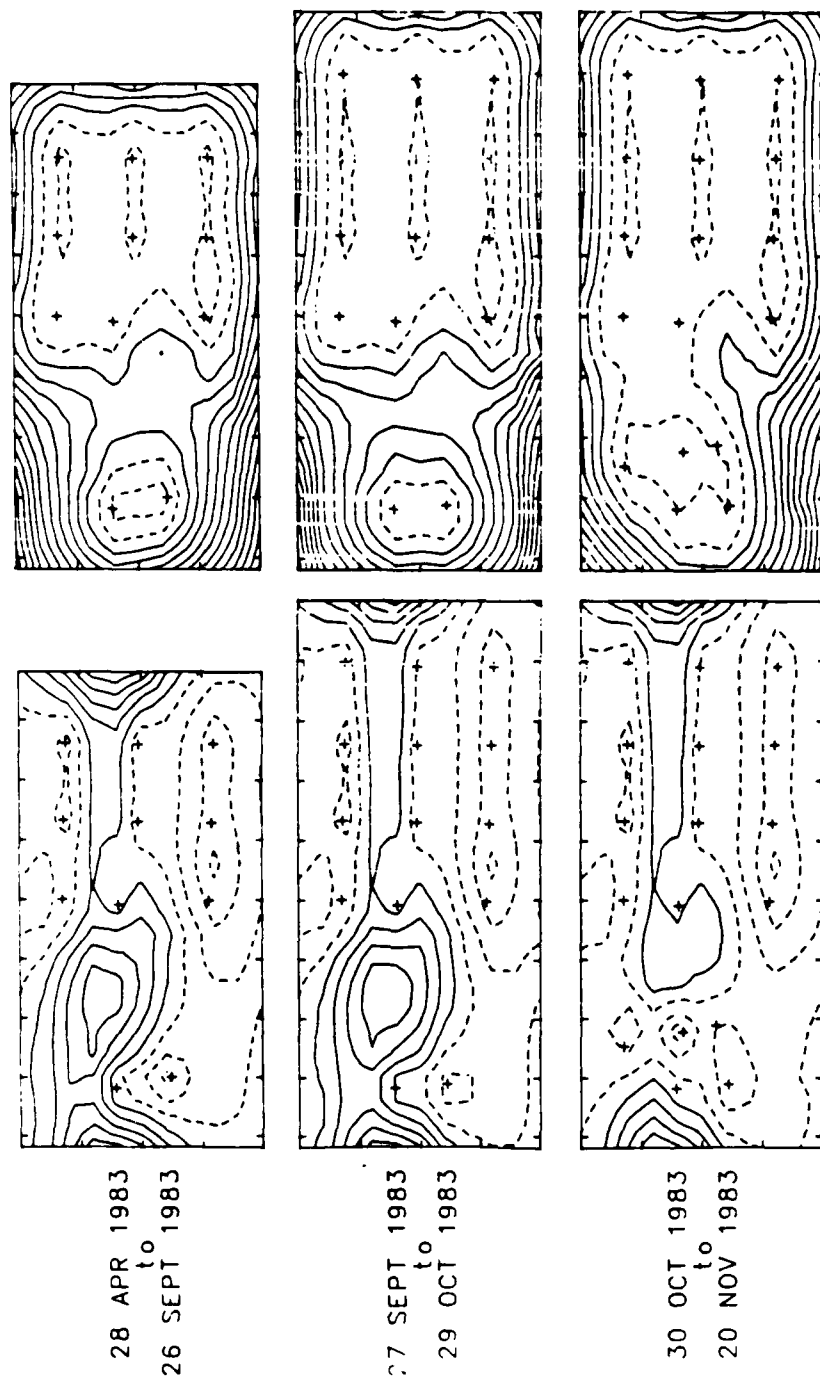
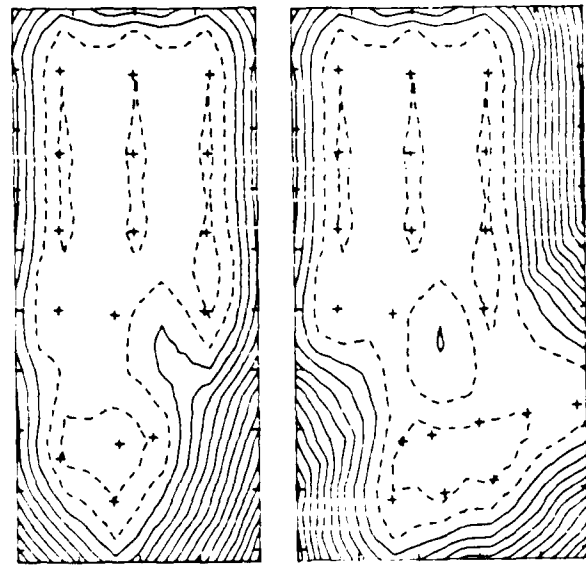
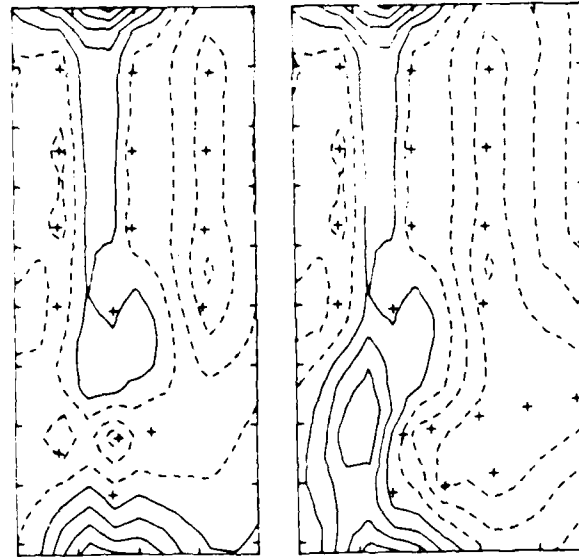


Figure 11. The error (percent standard deviation) fields, shown at right, are contoured at 5% intervals, with the dashed region corresponding to < 15% error. The error-bar fields (left) have a contour interval of 10 m and the dashed region corresponds to errors < 50 m. The five sets of error maps apply to the  $Z_1$  and perturbation fields in Figure 12 for the dates shown. The horizontal scales are the same as those labelled in Figure 10, with the upper-left-hand corner of all frames corresponding to the same location.



21 NOV 1983.  
to  
12 JAN 1984

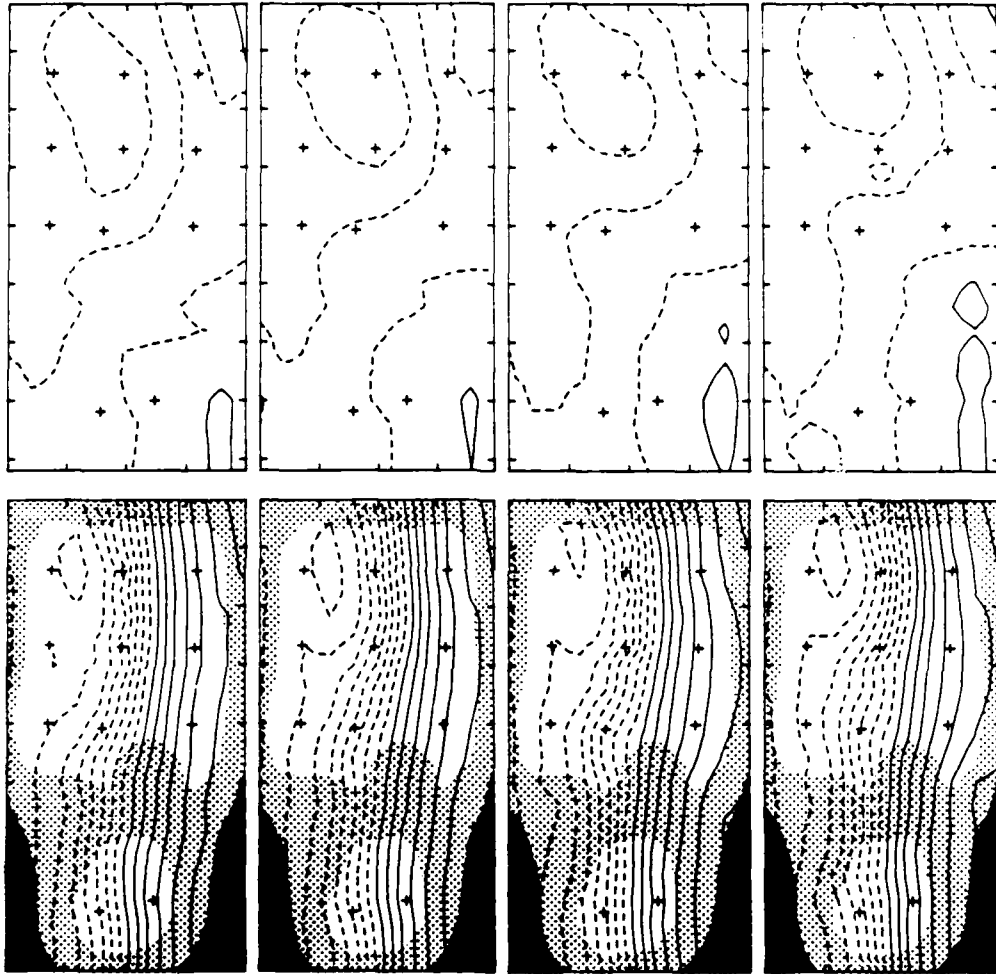


13 JAN 1984  
to  
16 JUNE 1984

Figure 11 (continued)



Figure 12. The 12°C isotherm depth,  $Z_{12}$ , field (left) and the perturbation field (right) are shown at daily intervals from 28 April 1983 to 16 June 1984. The maps are shown for 1200 GMT on the date indicated at the left. Contour interval of the perturbation field is 0.5 with the dashed region corresponding to negative values. The  $Z_{12}$  field is contoured at 50 m intervals and depths shallower than 500 m are dashed. The lighter shaded area corresponds to regions of  $\geq 15\%$  estimated error and the darker shading to errors of  $\geq 35\%$  from the error maps shown in Figure 11.

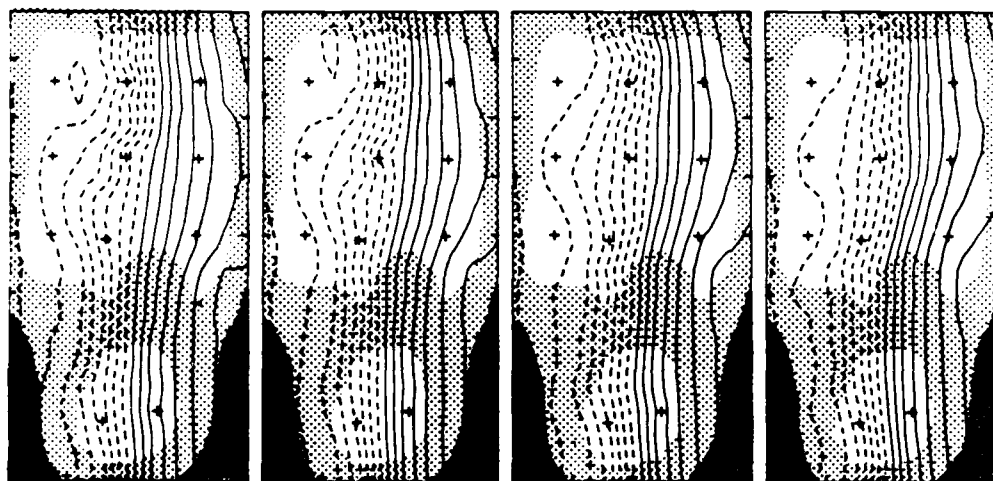
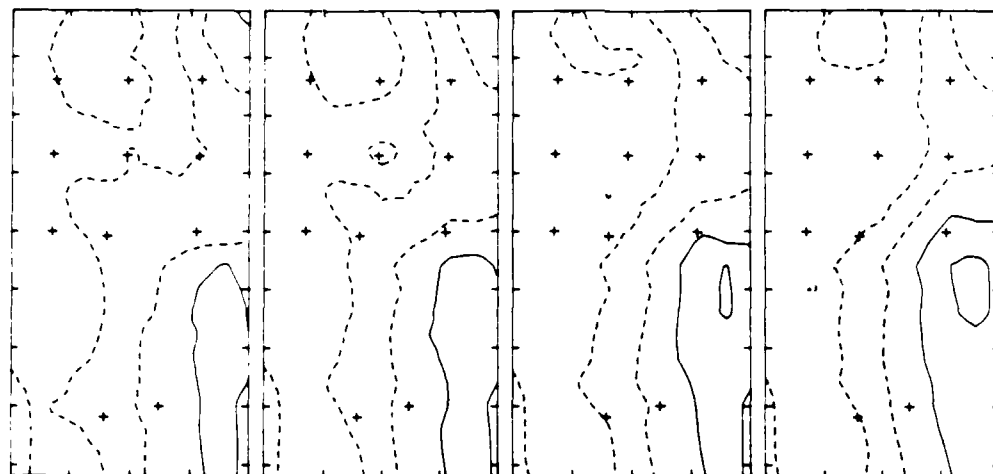


28 APR  
1983

29 APR  
1983

30 APR  
1983

1 MAY  
1983

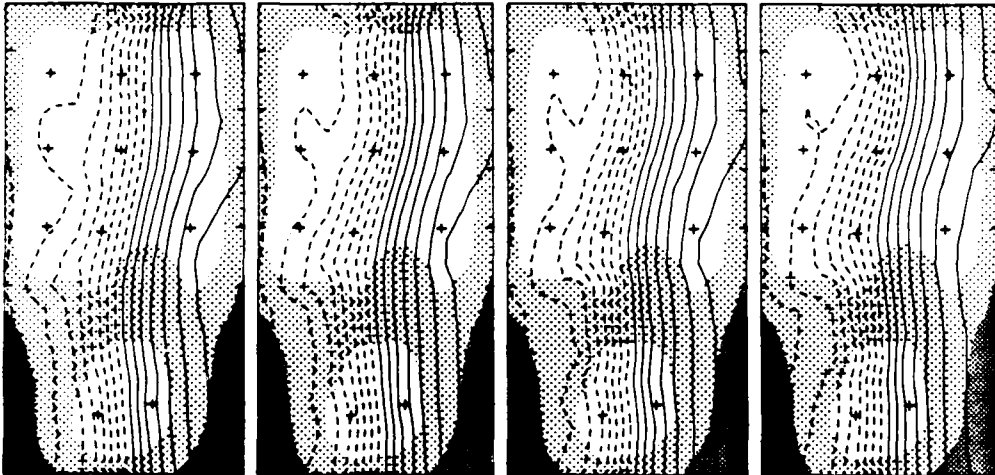
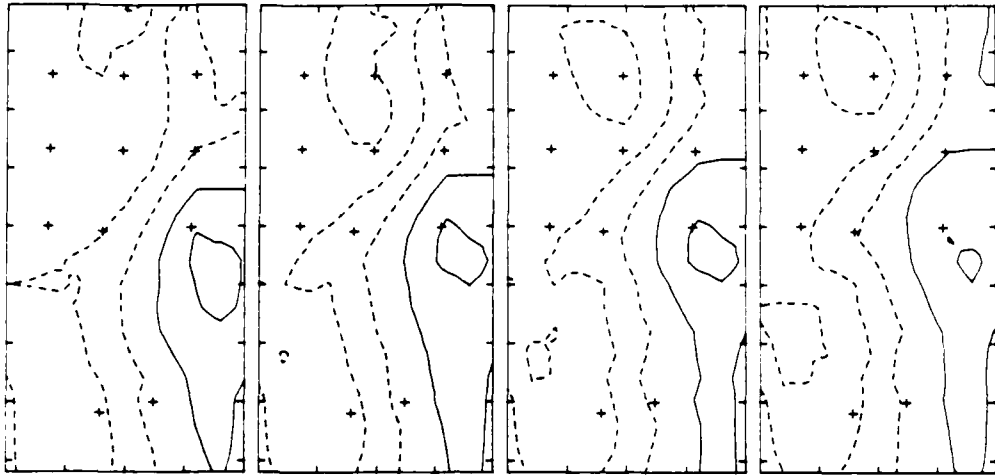


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4 MAY  
1983

5 MAY  
1983

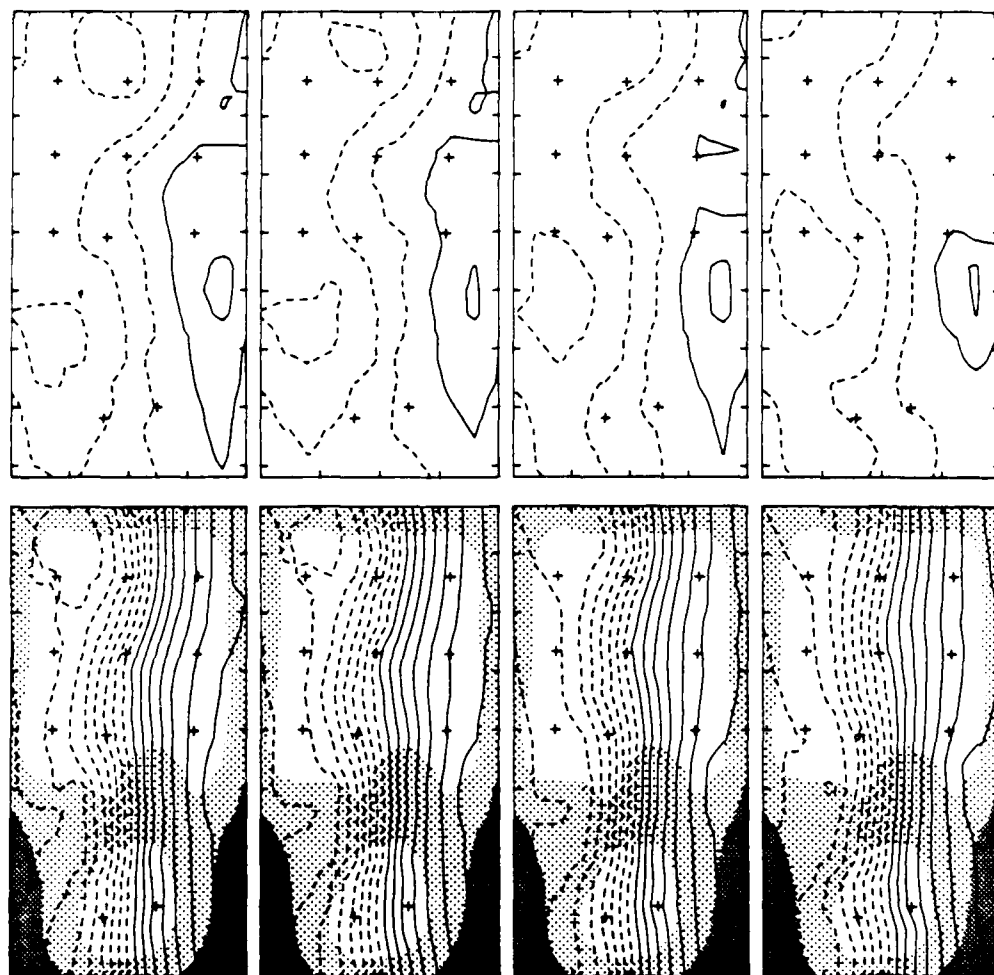


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7 MAY  
1983

8 MAY  
1983

9 MAY  
1983

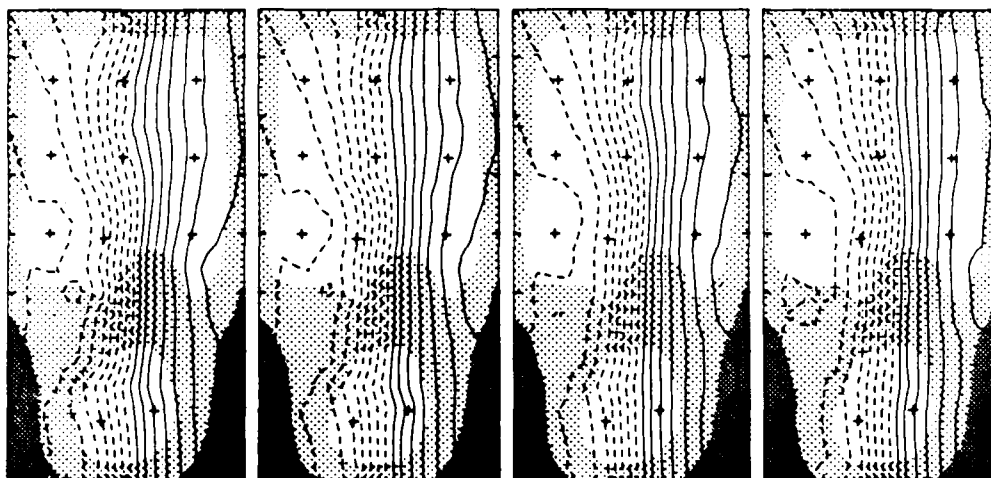
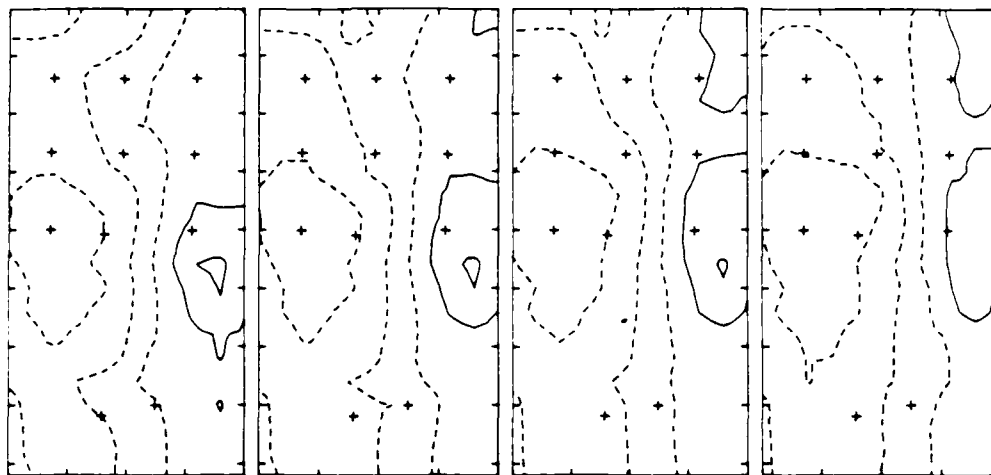


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11 MAY  
1983

12 MAY  
1983

13 MAY  
1983

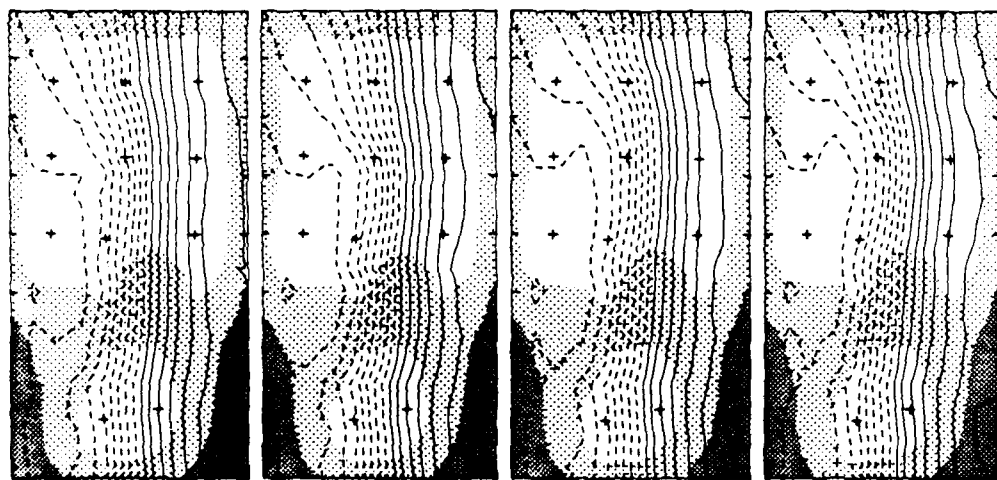
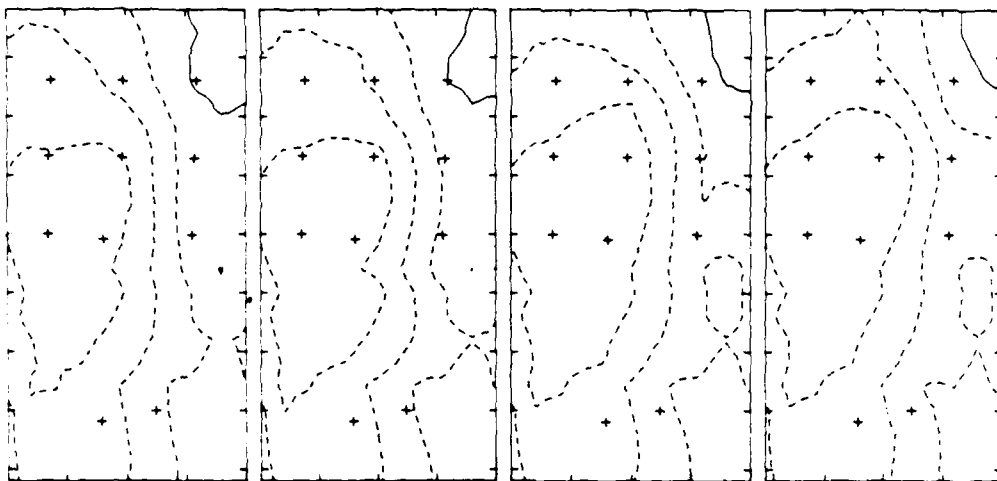


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1983

16 MAY  
1983

17 MAY  
1983

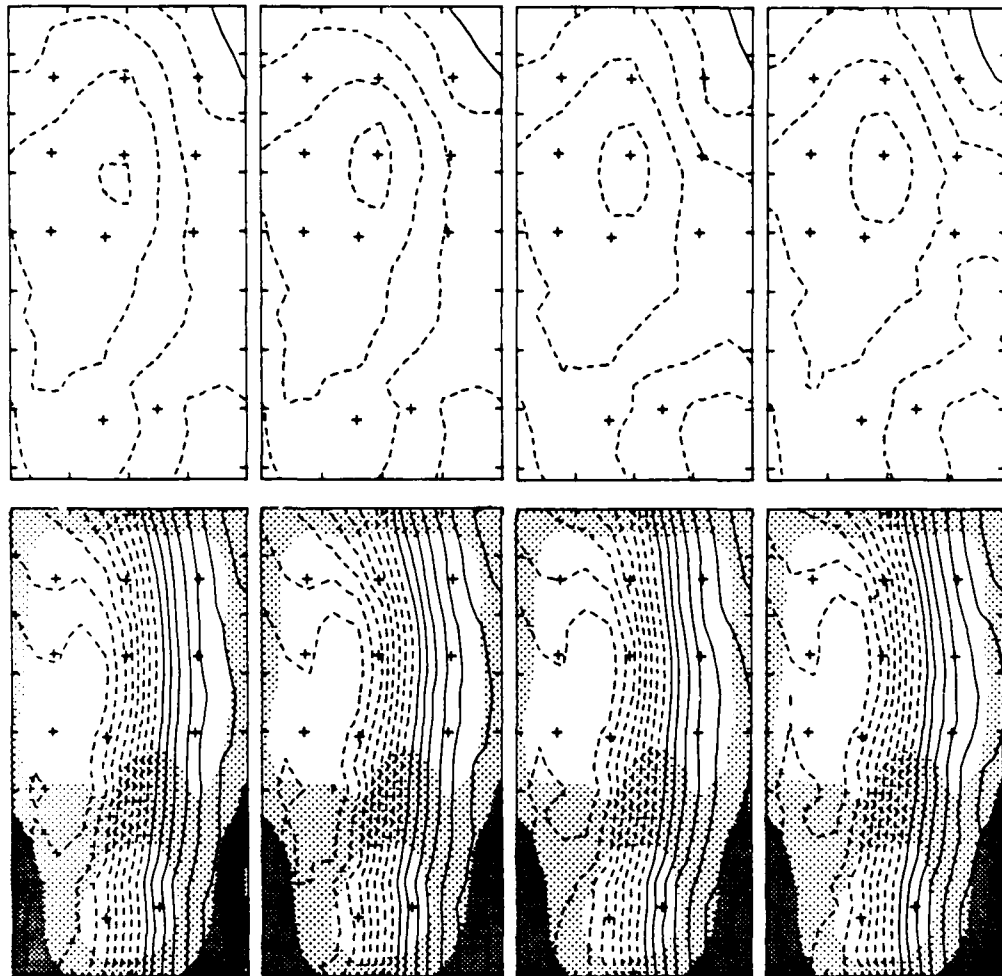


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21 MAY  
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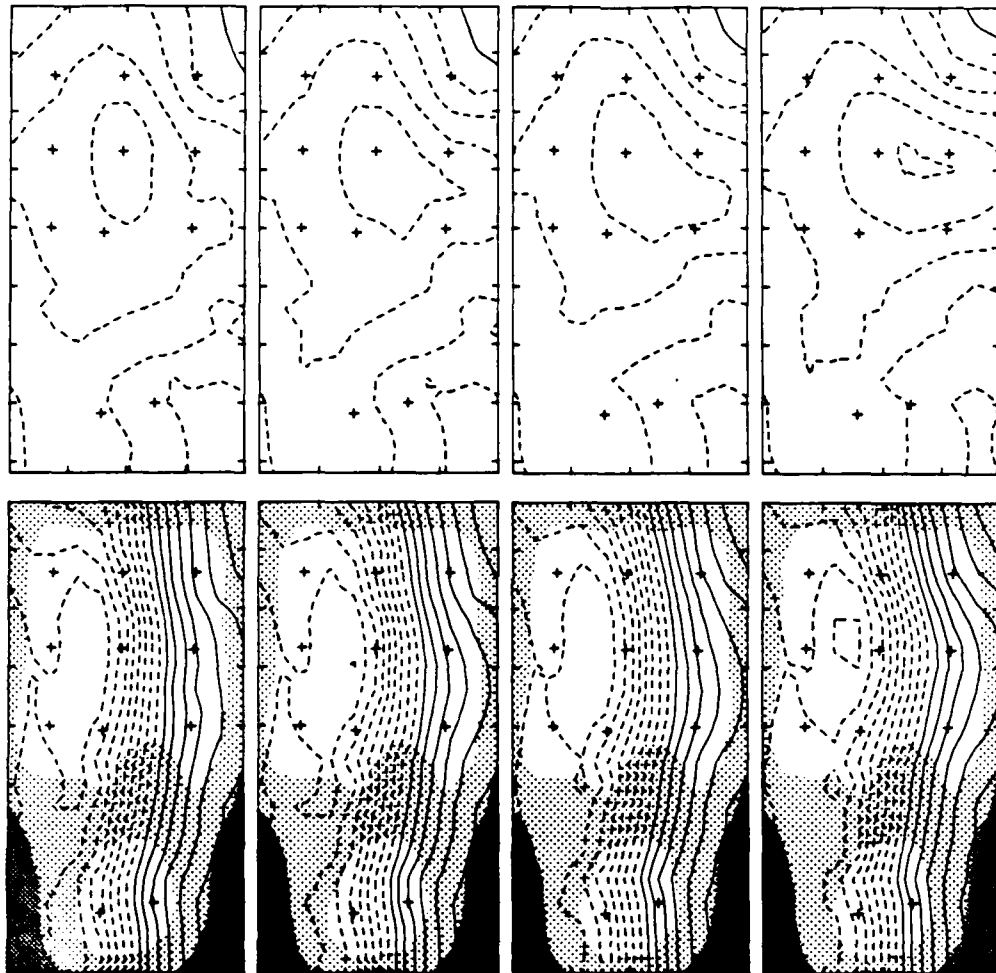


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25 MAY  
1983

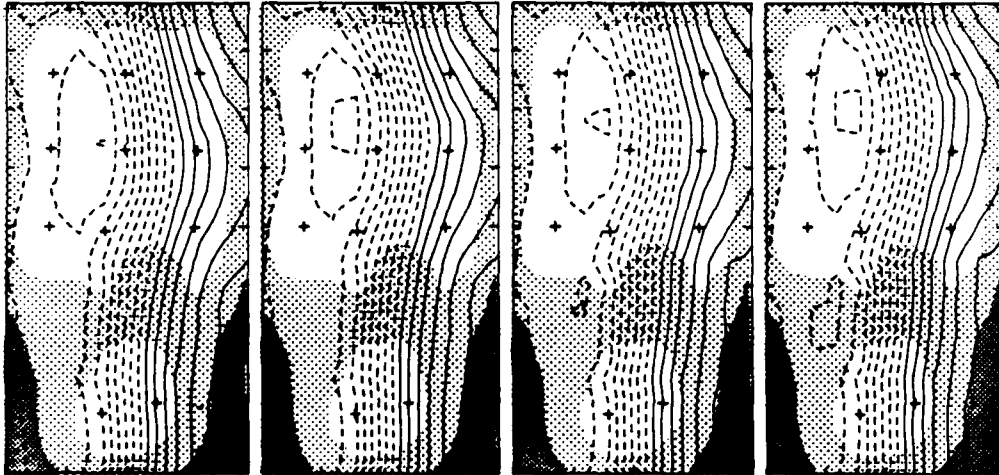
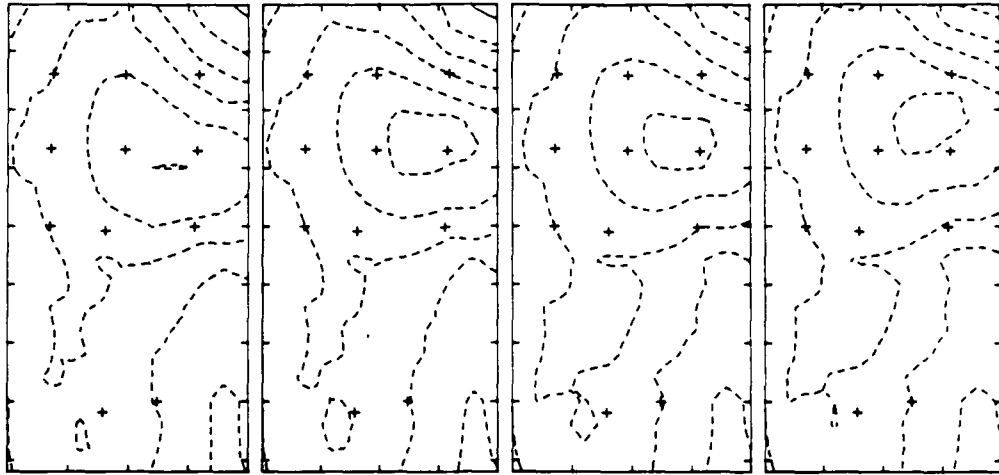


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27 MAY  
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29 MAY  
1983

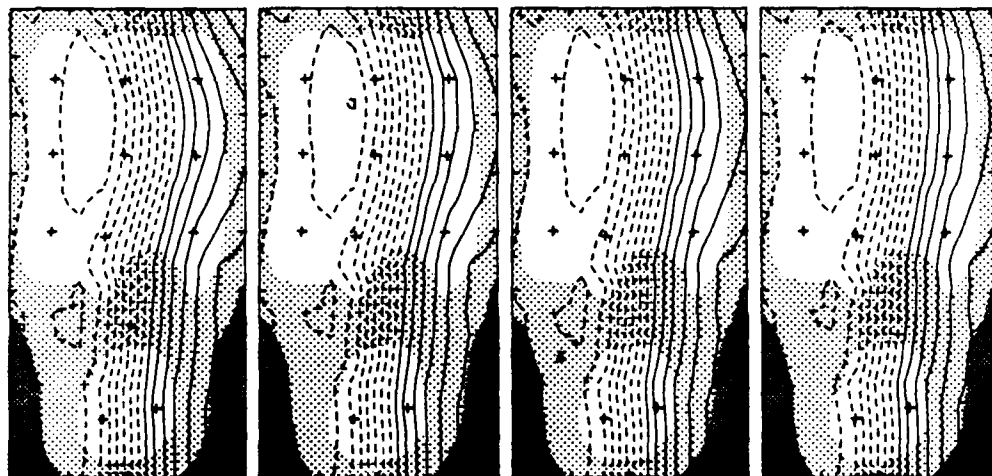
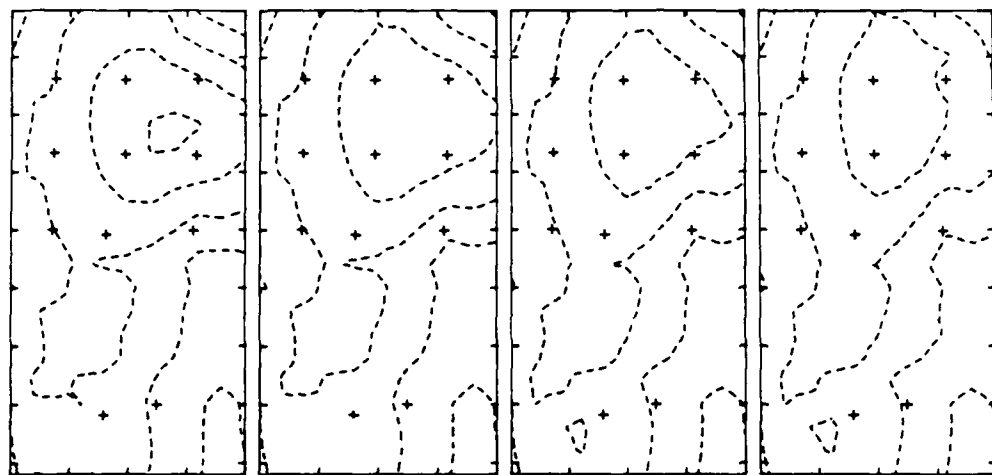


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31 MAY  
1983

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2 JUNE  
1983

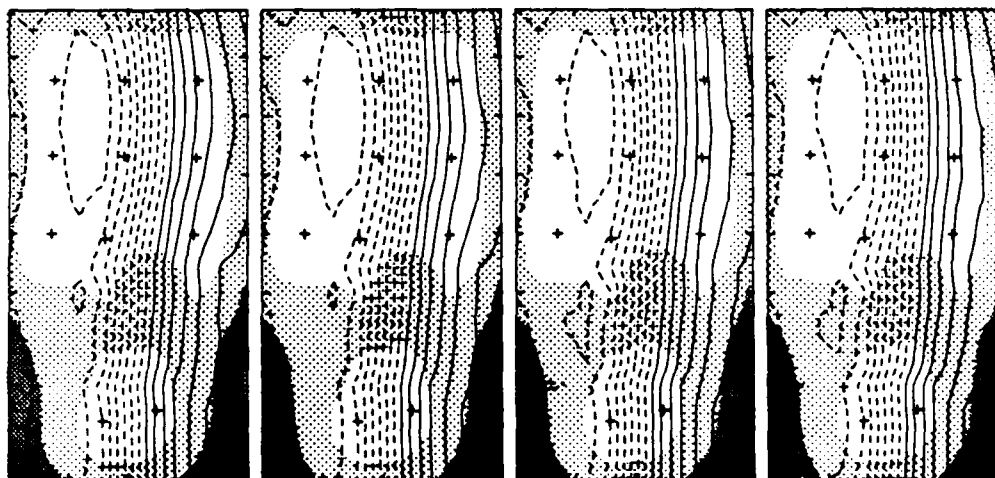
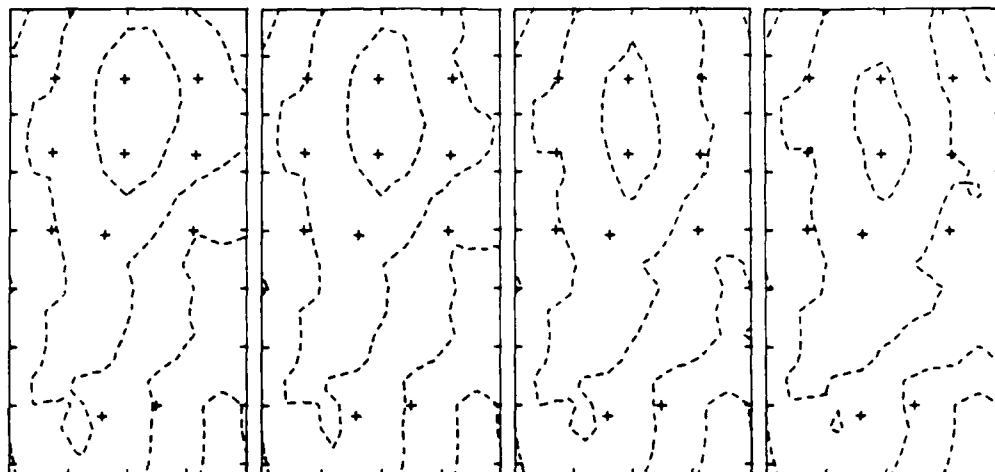


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6 JUNE  
1983

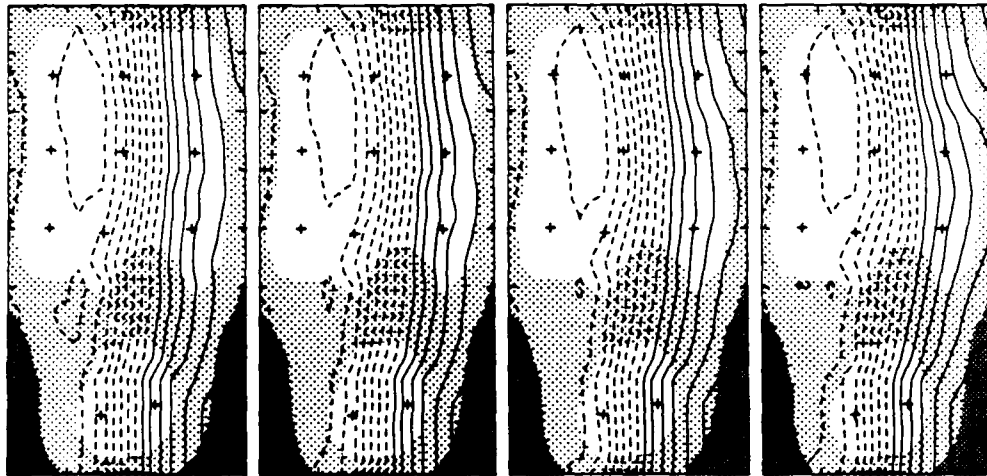
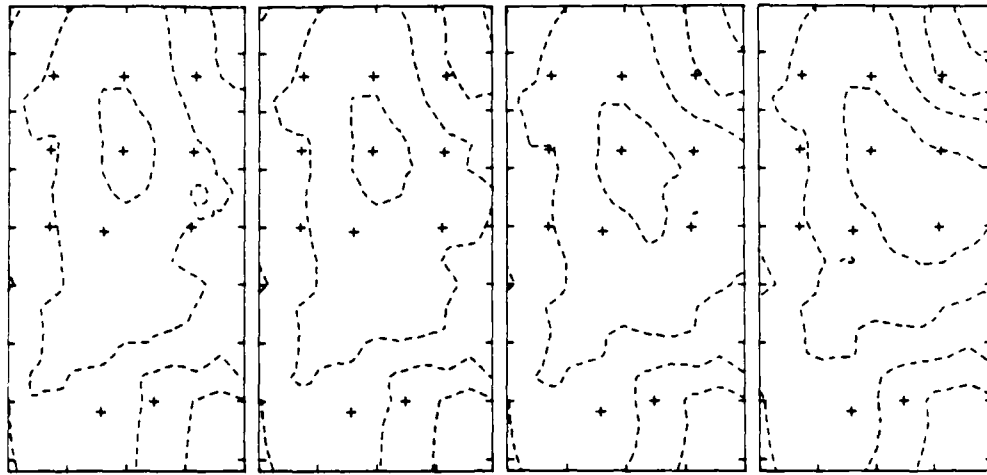


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10 JUNE  
1983

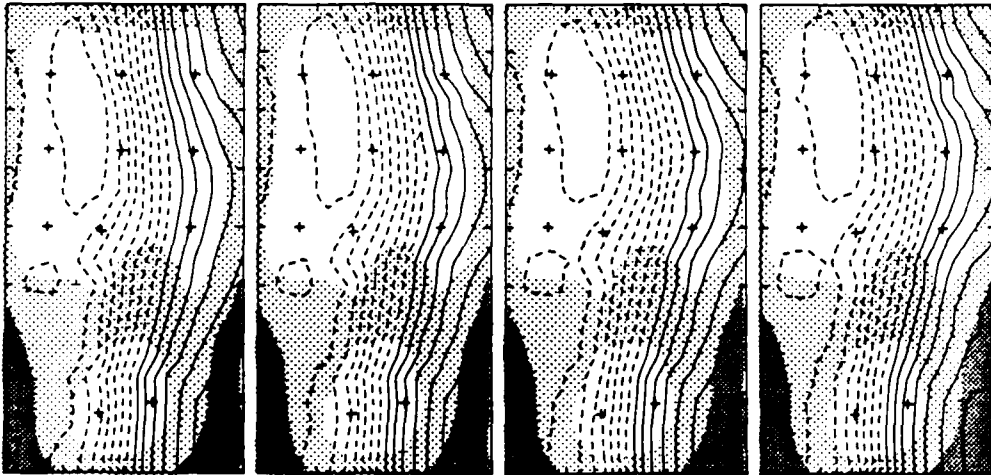
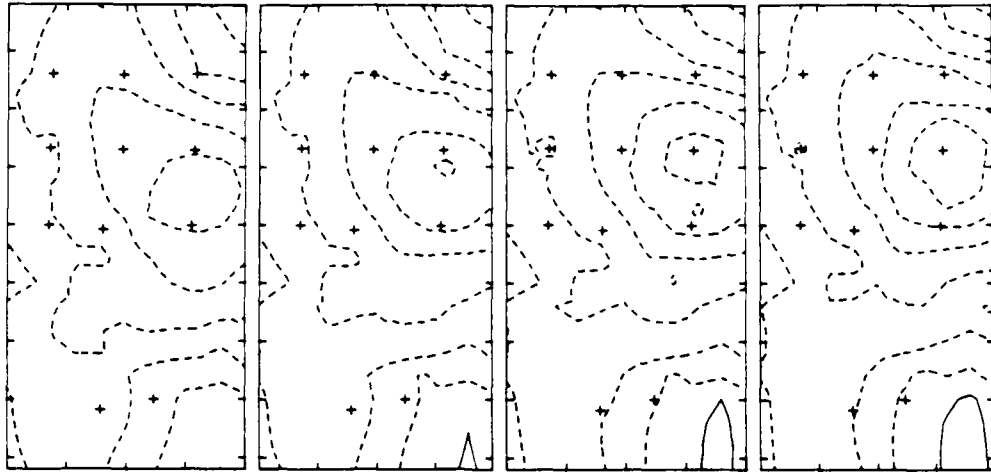


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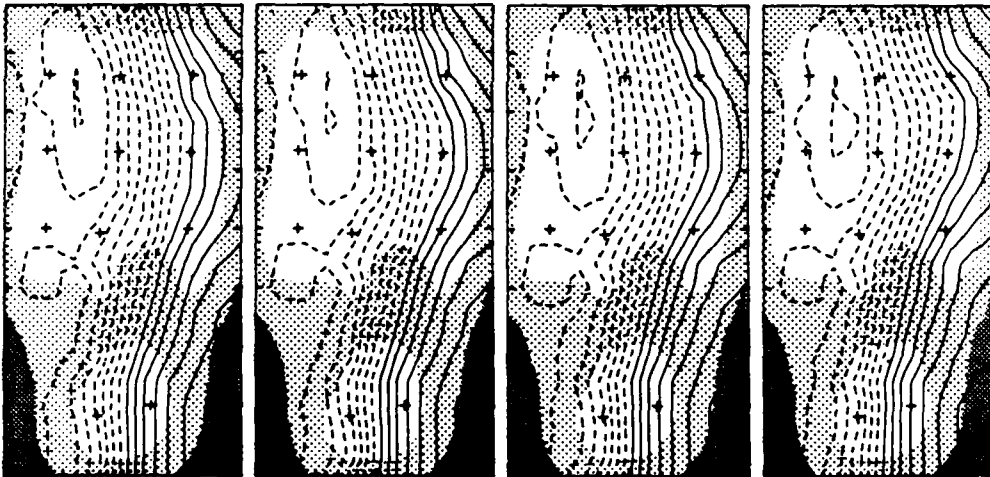
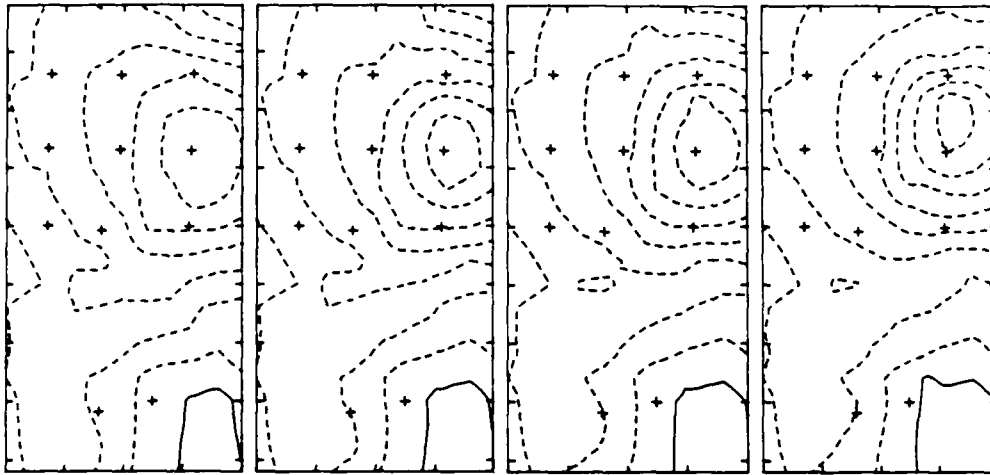


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18 JUNE  
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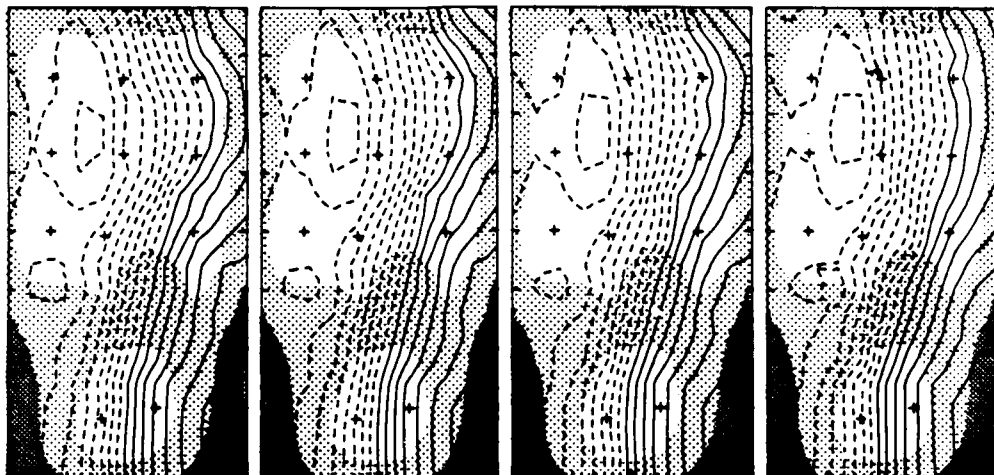
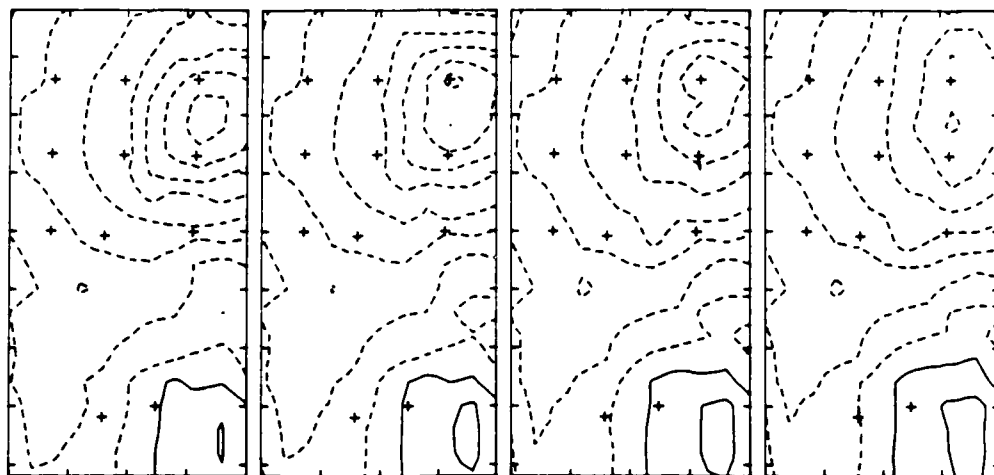


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1983

22 JUNE  
1983

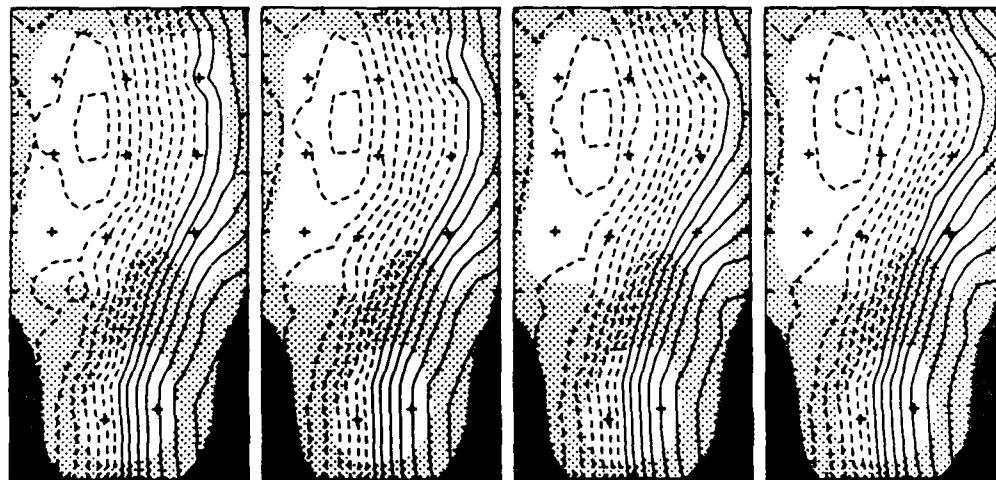
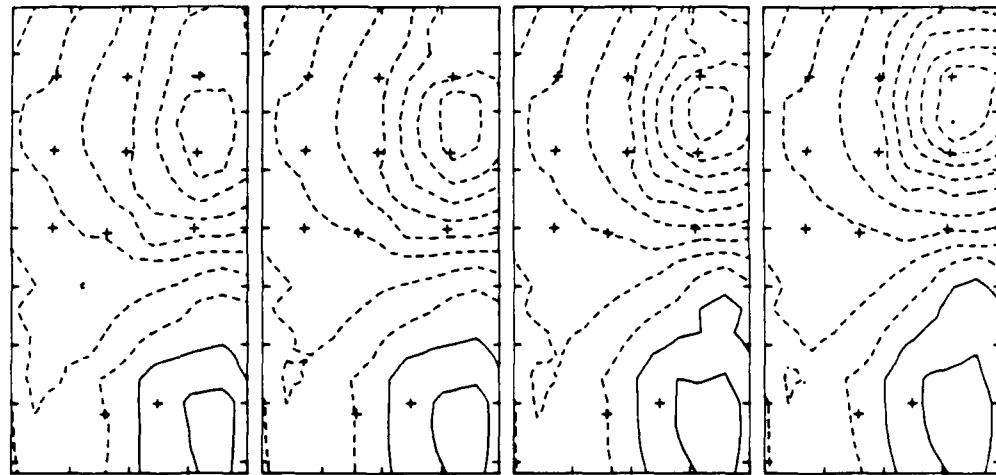


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26 JUNE  
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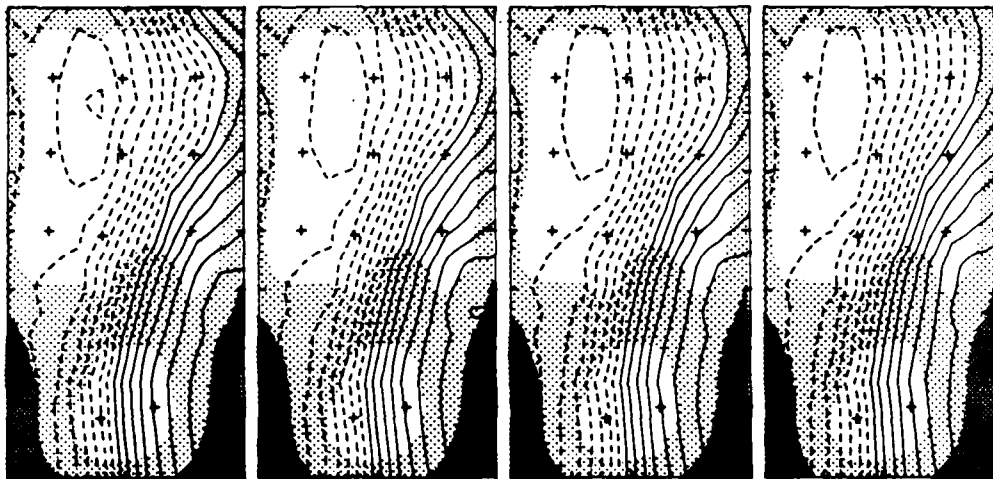
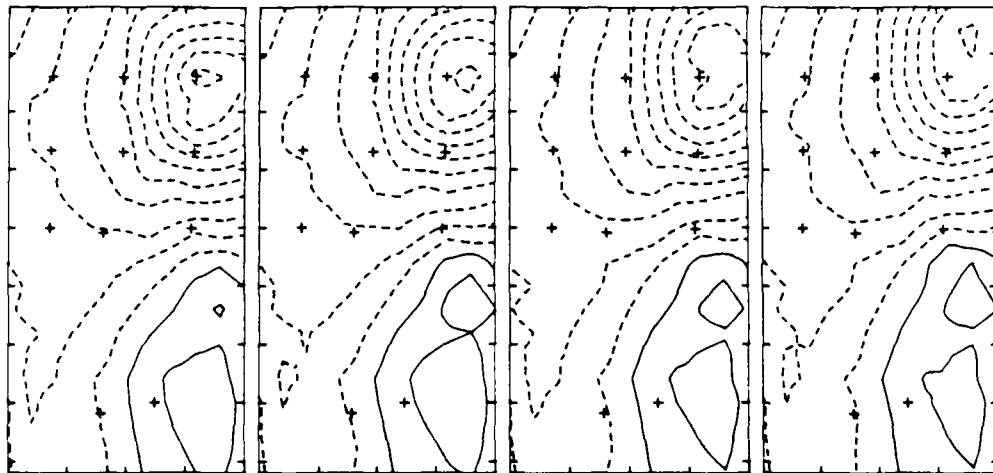


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30 JUNE  
1983

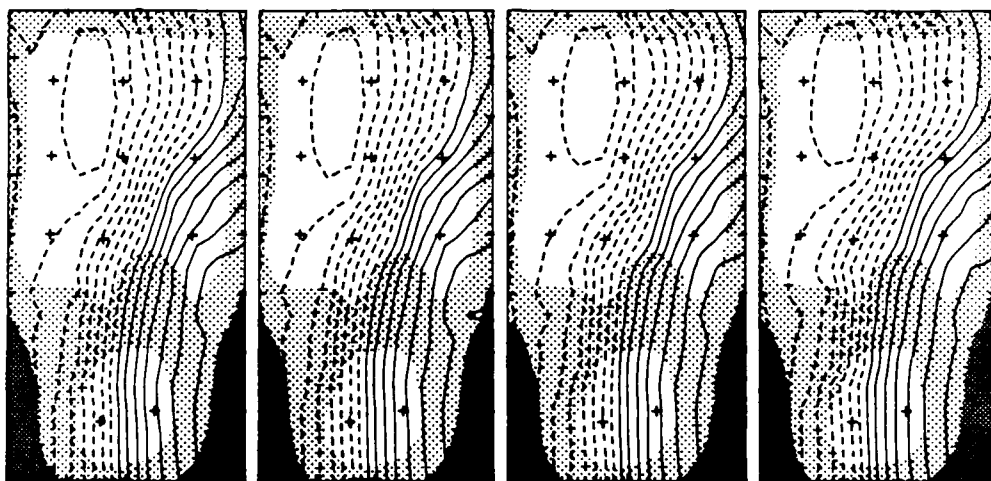
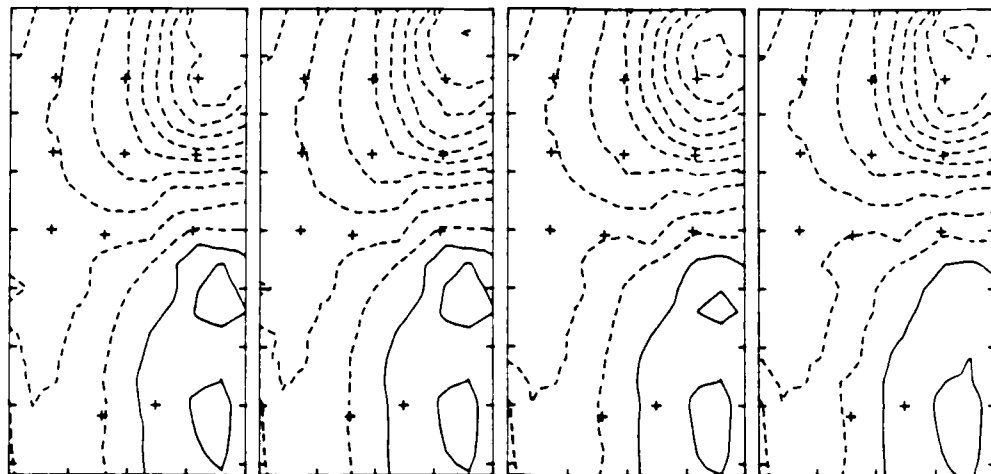


1 JULY  
1983

2 JULY  
1983

3 JULY  
1983

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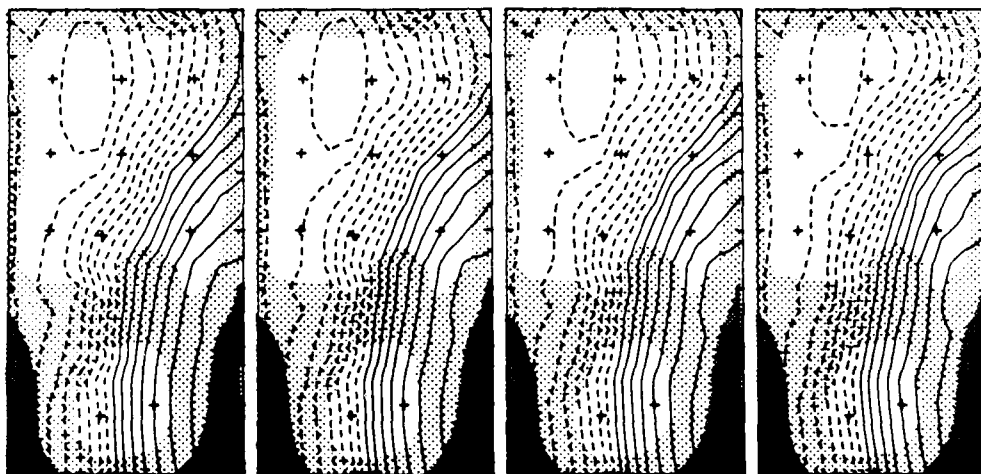
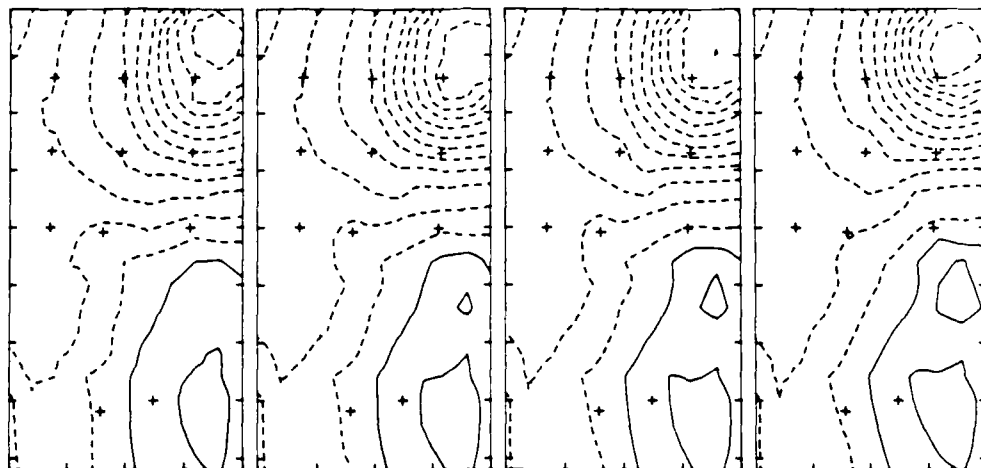


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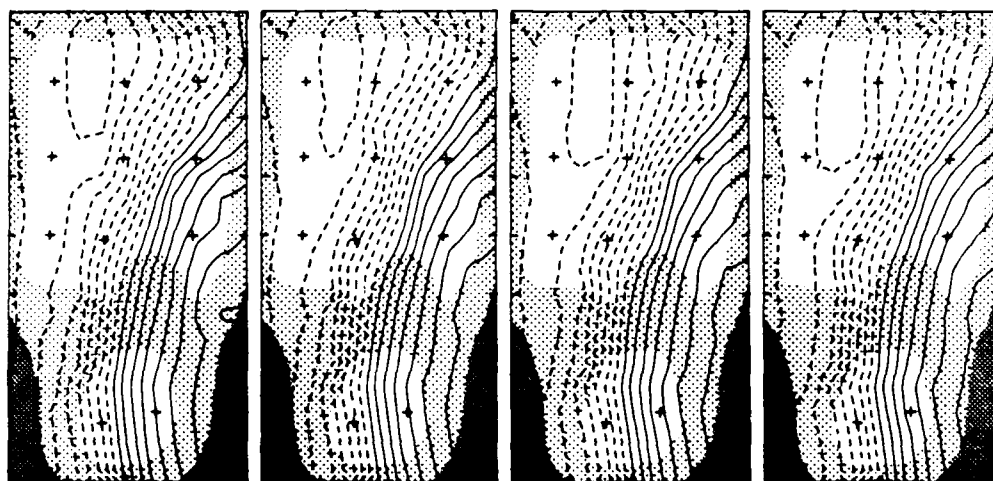
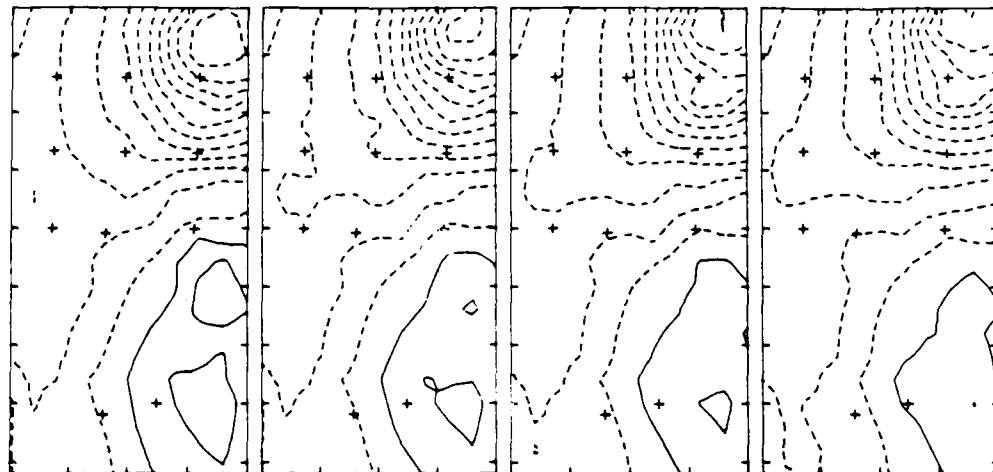


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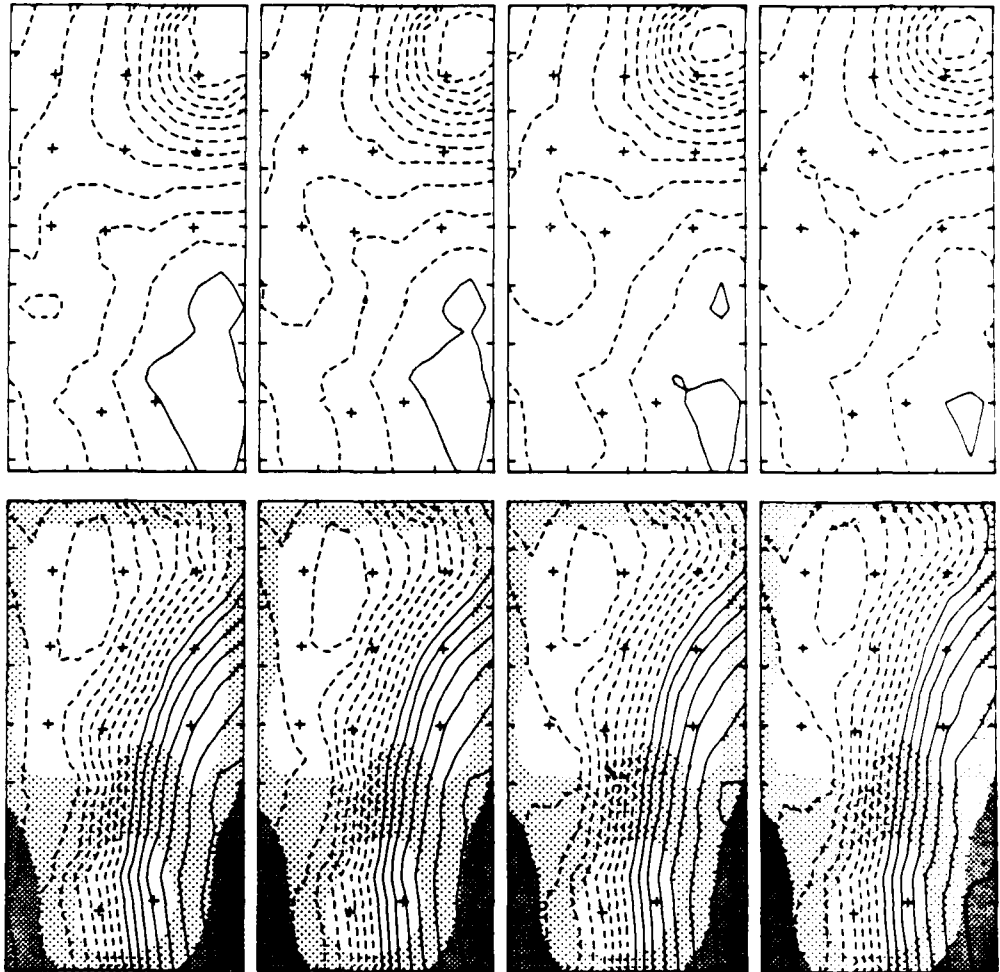


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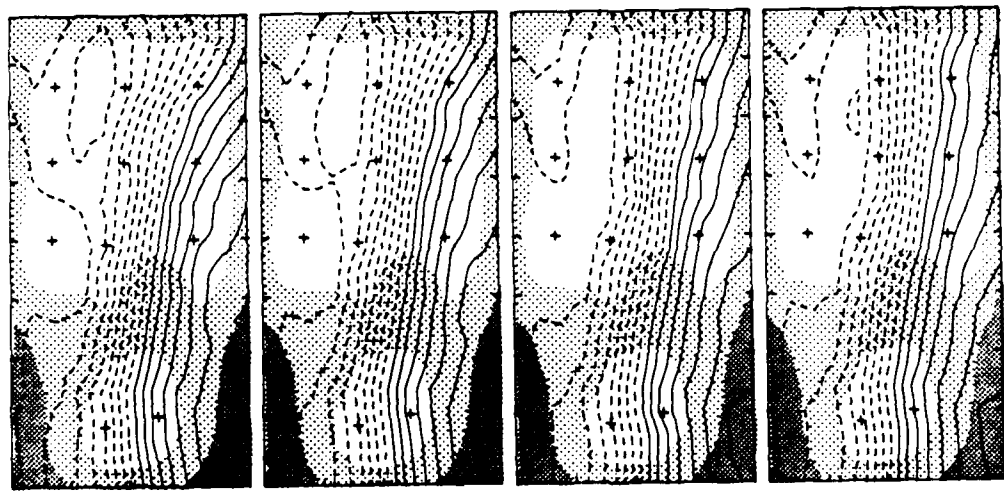
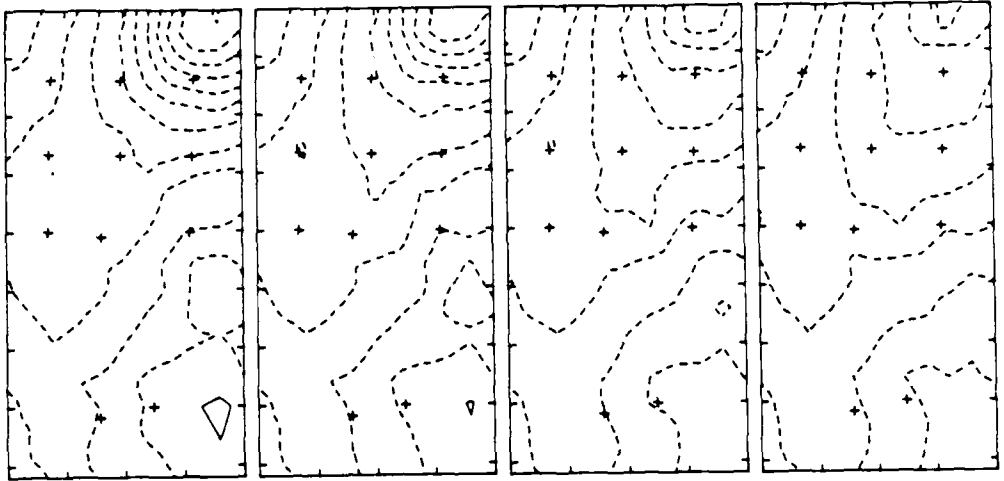


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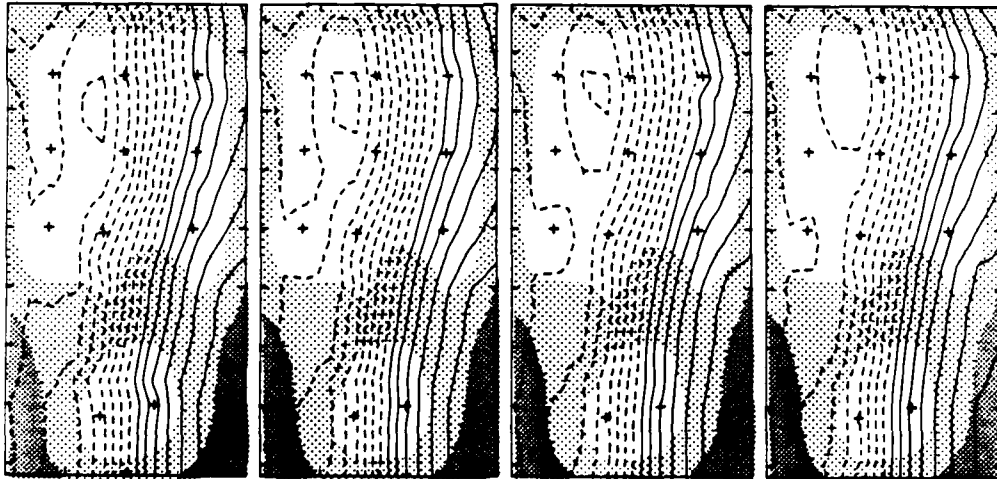
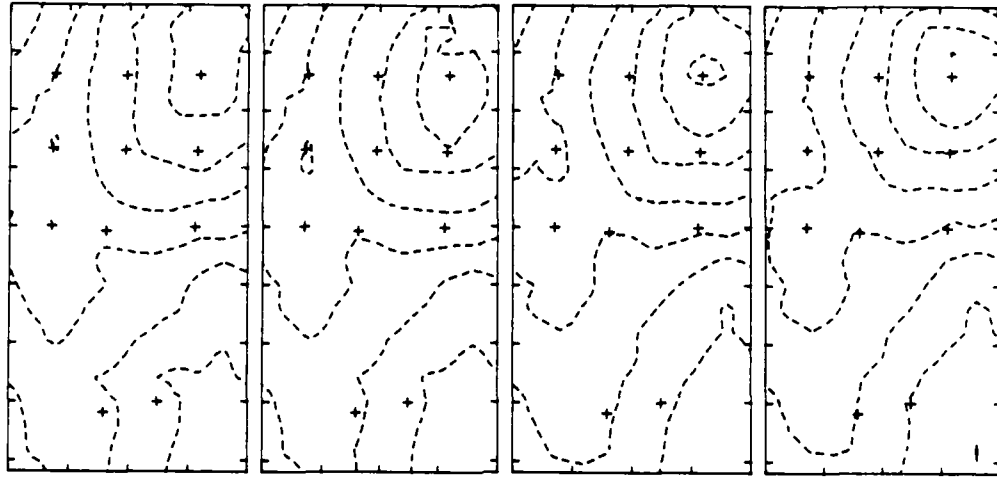


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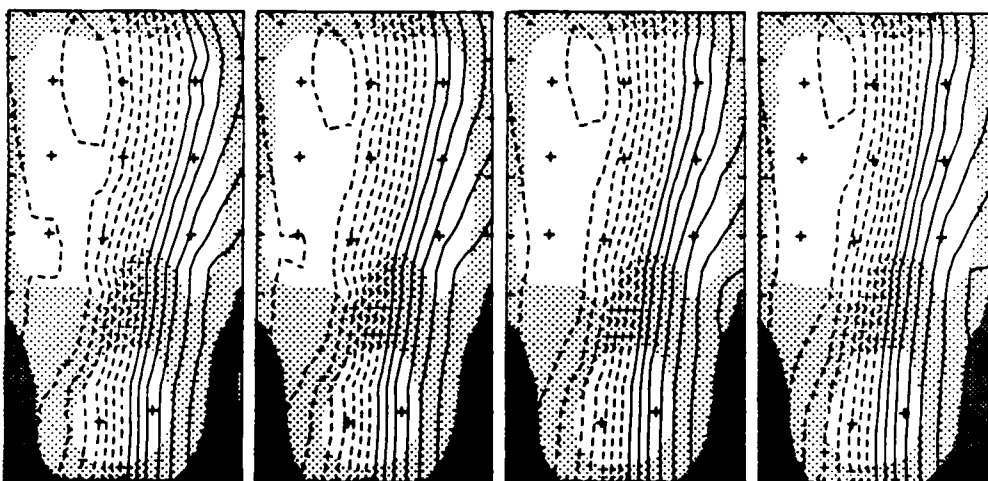
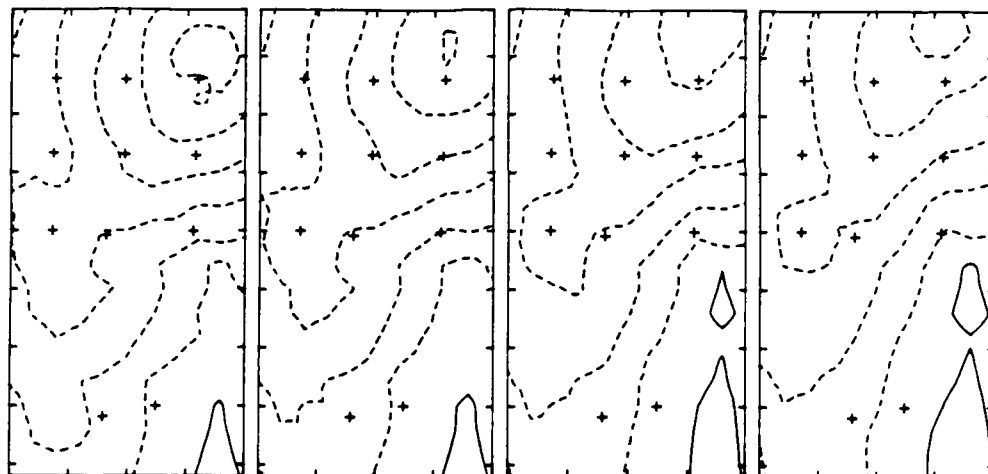


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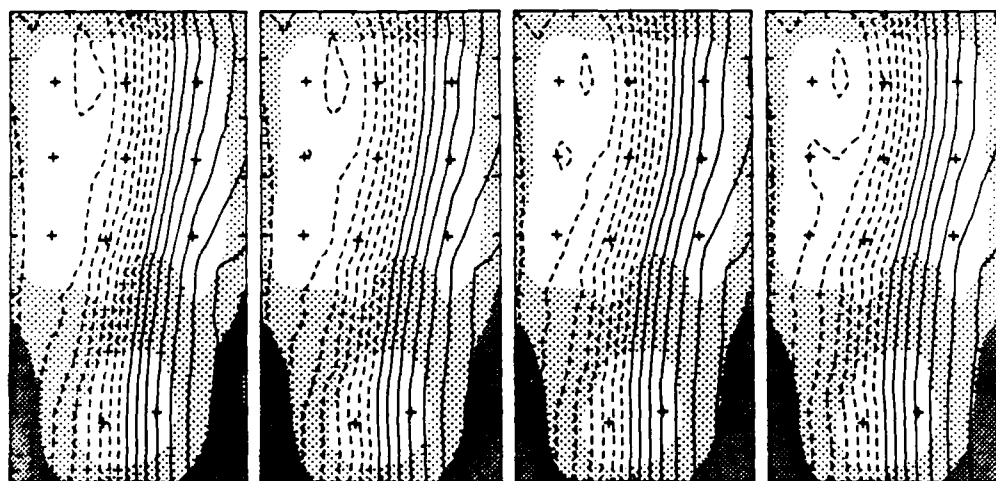
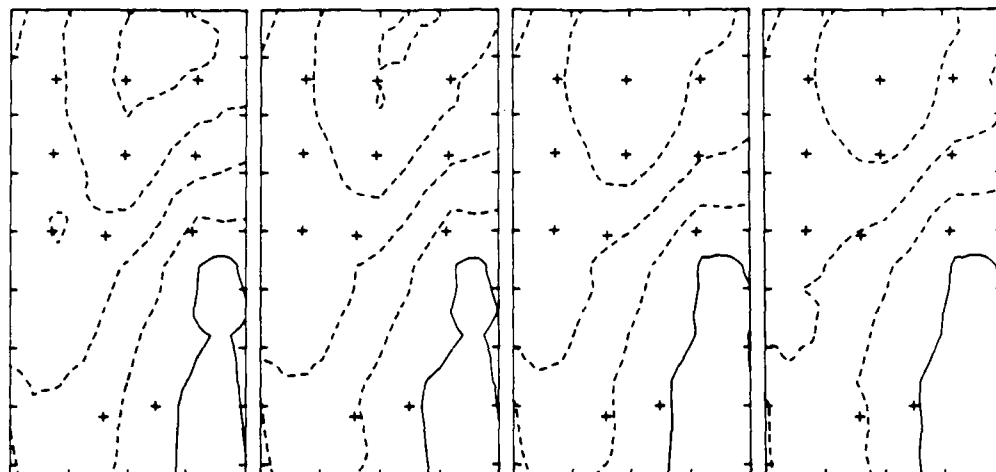


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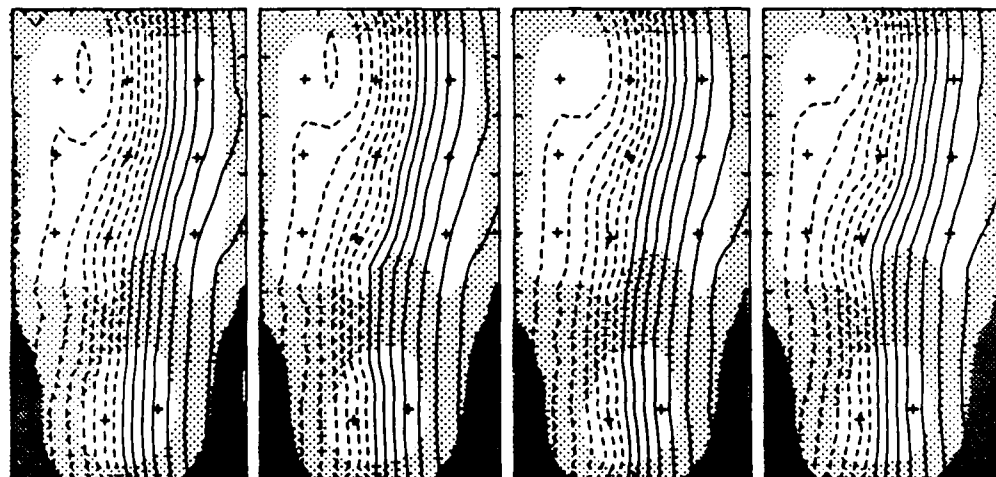
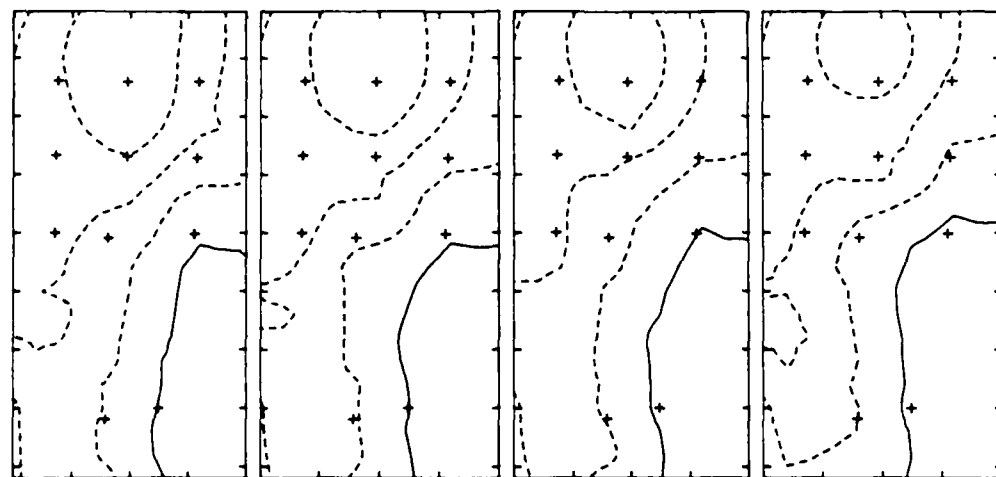


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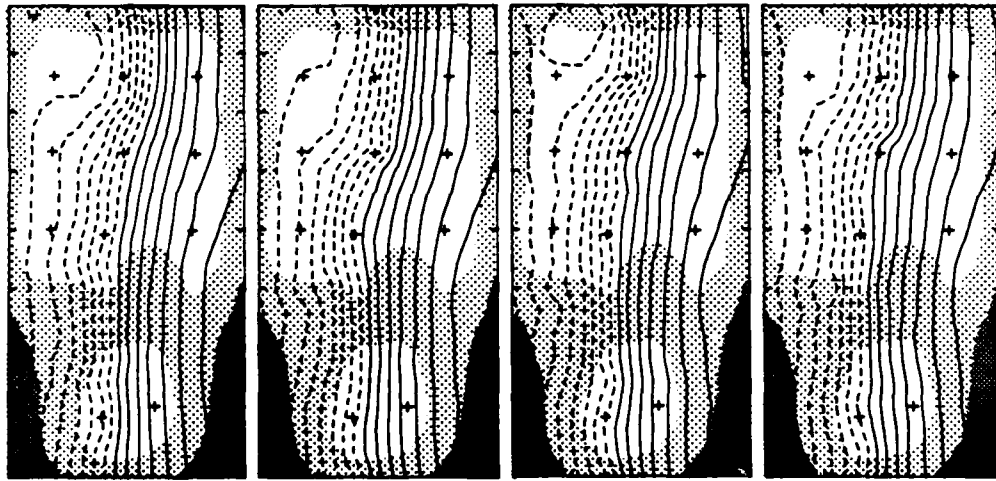
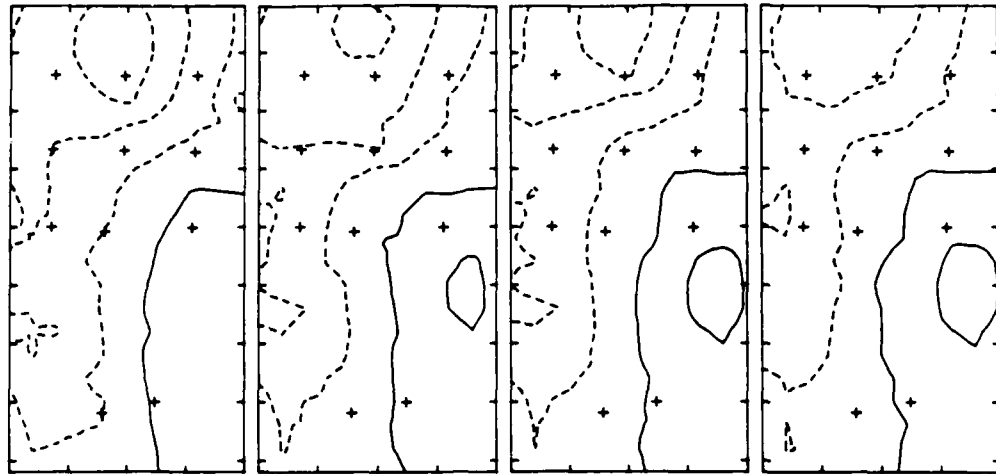


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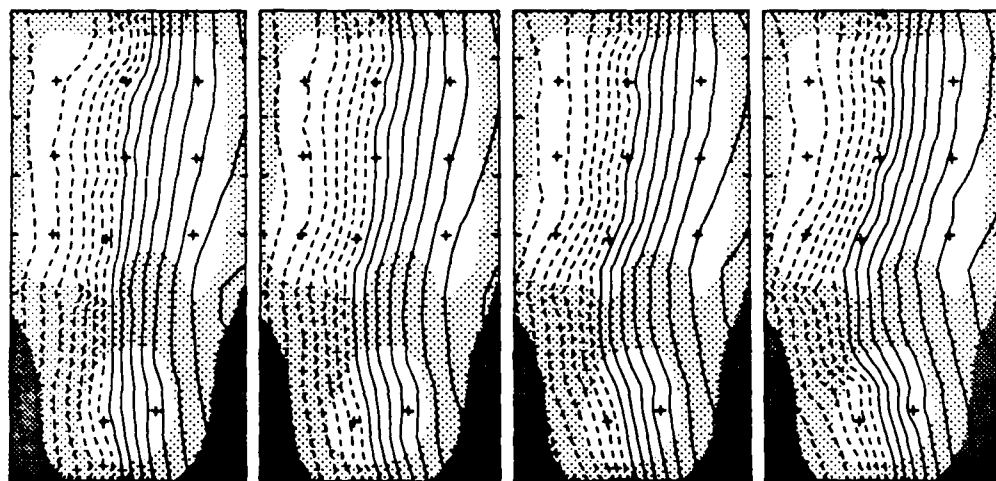
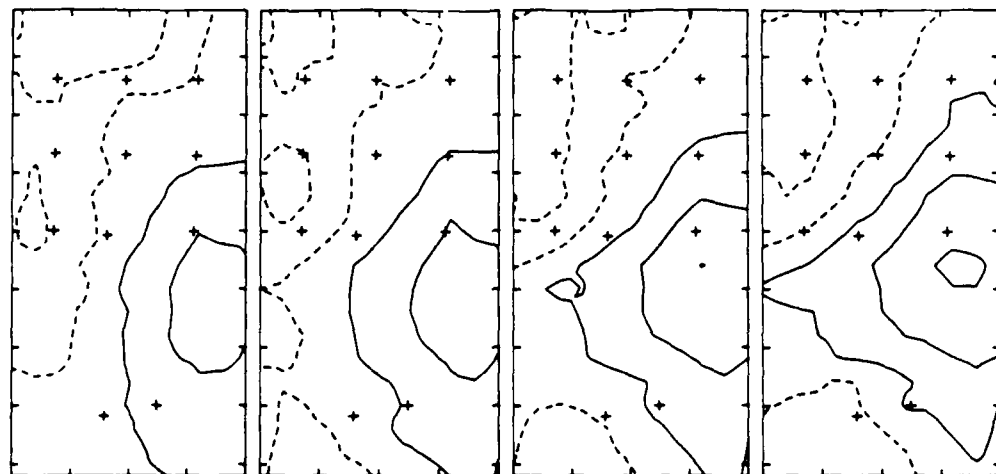


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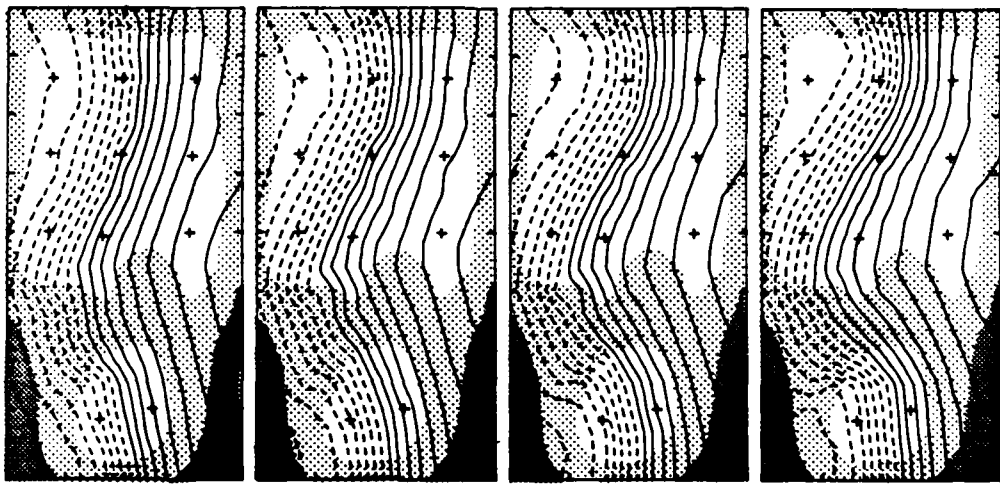
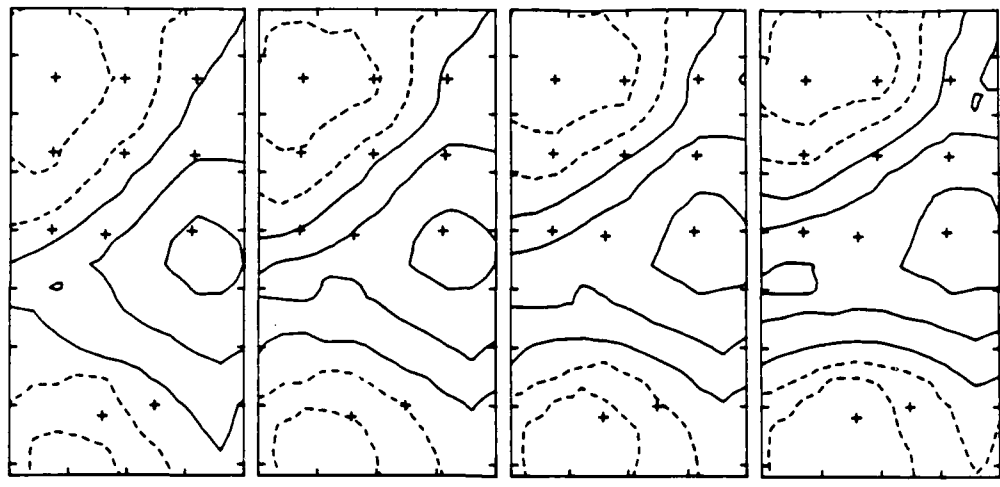


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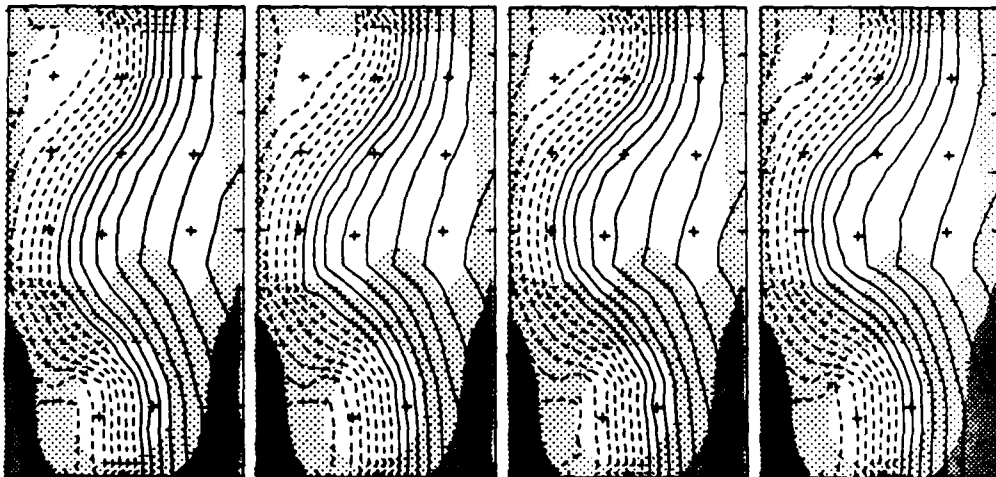
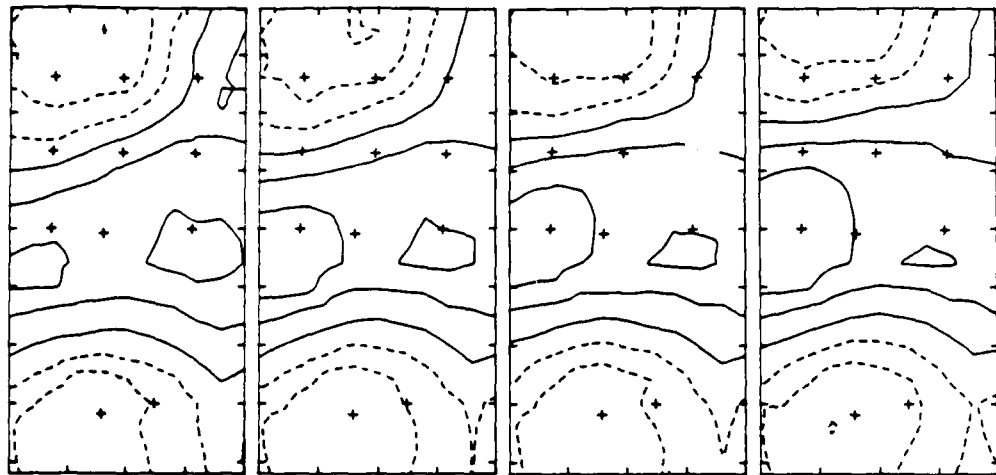


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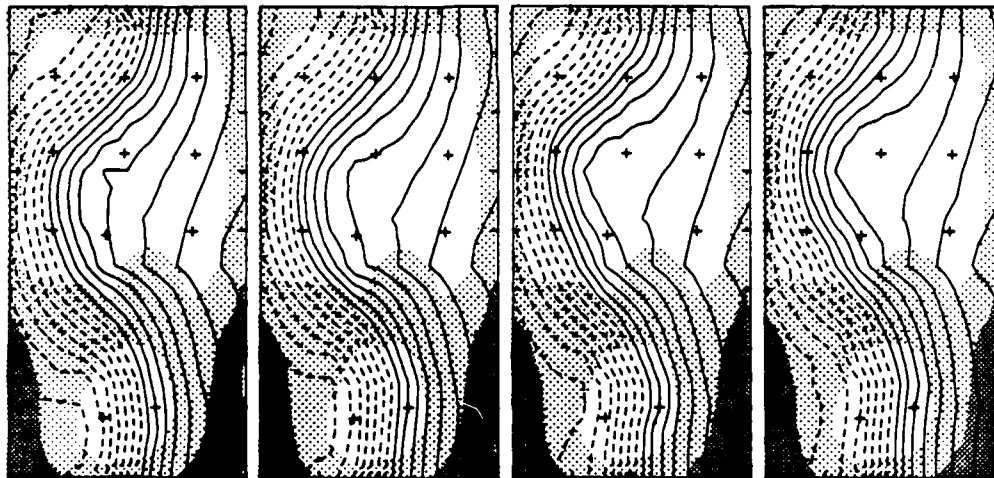
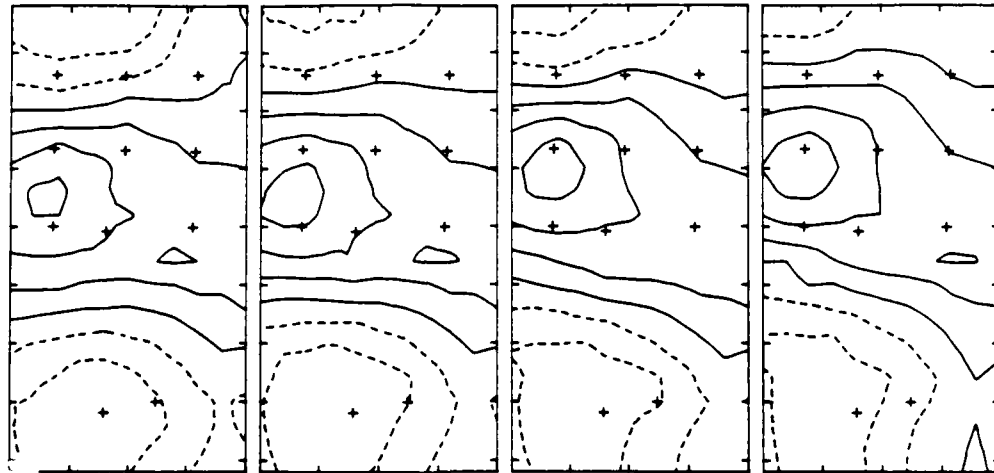


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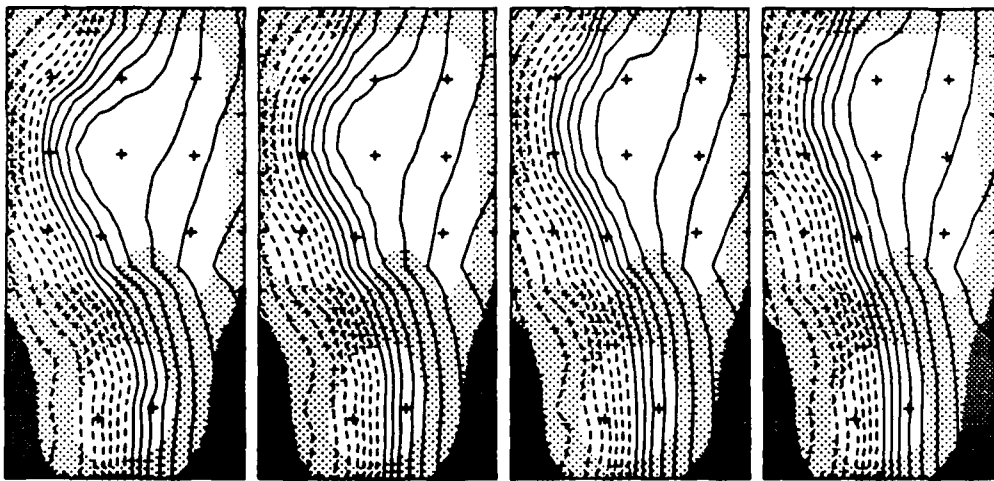
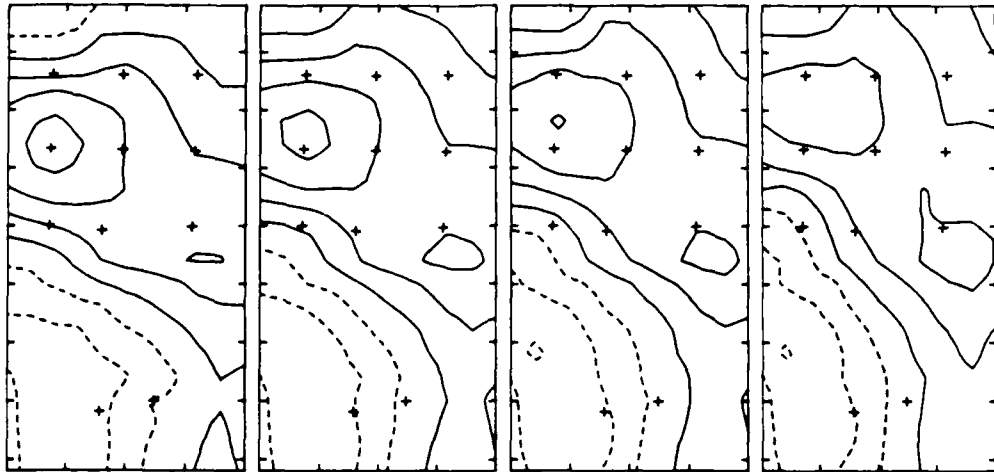


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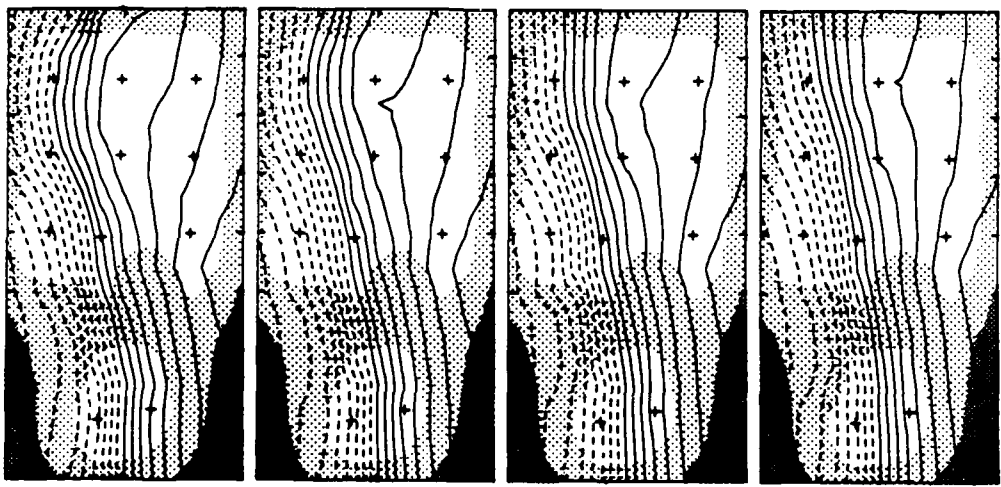
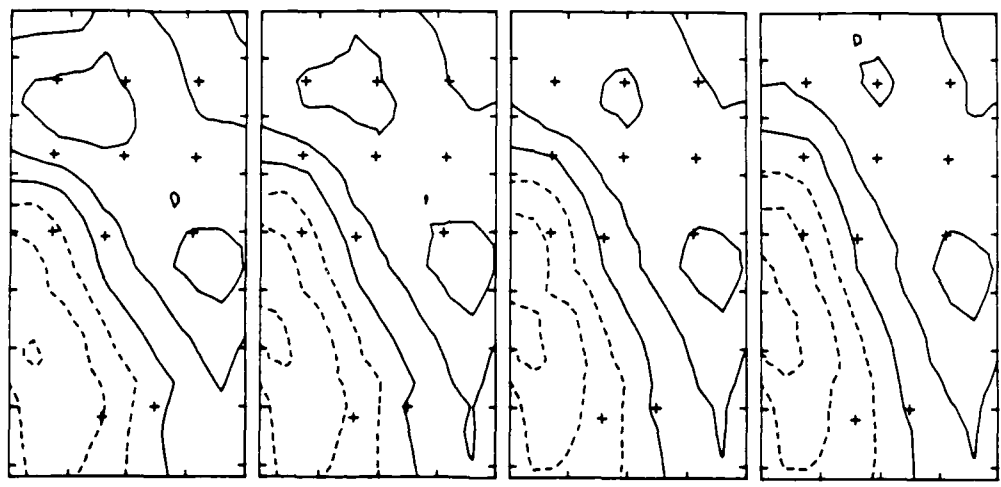


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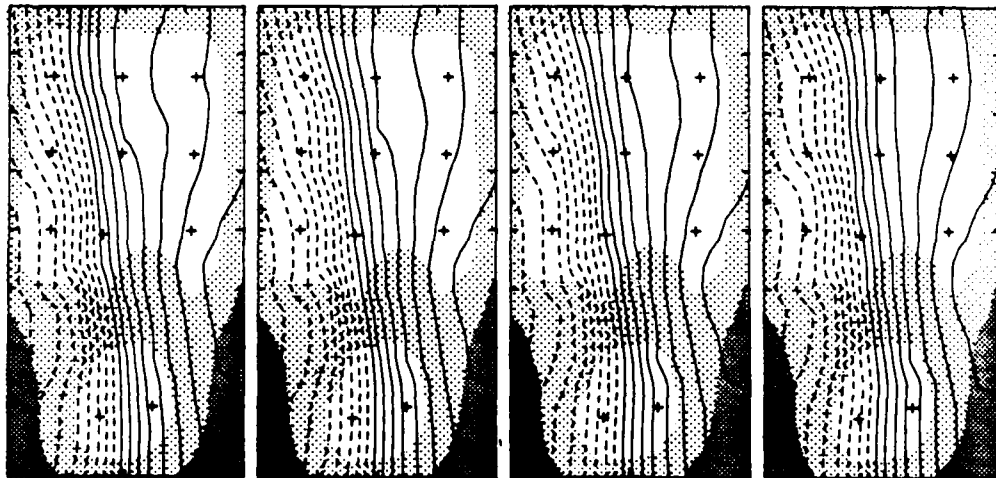
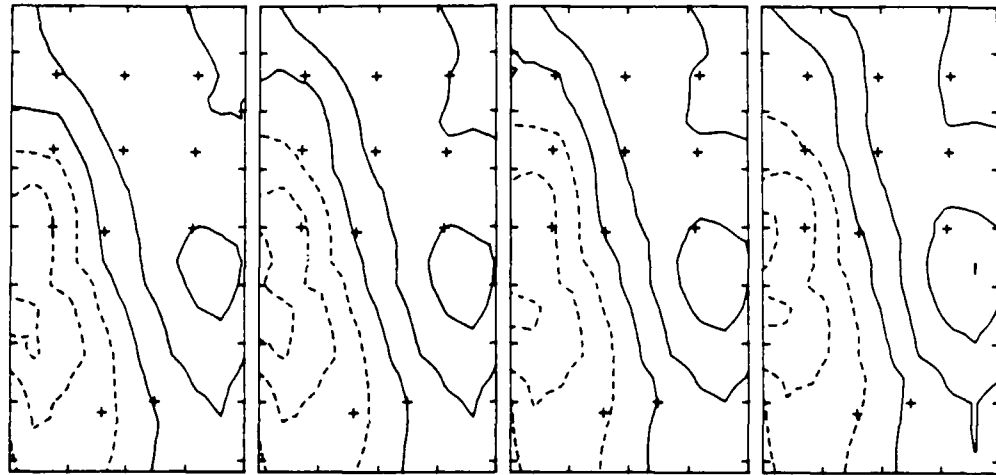


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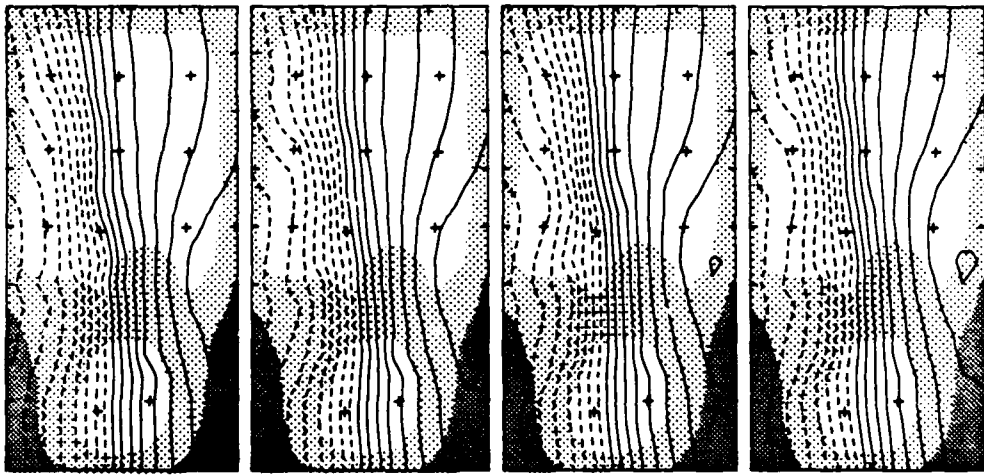
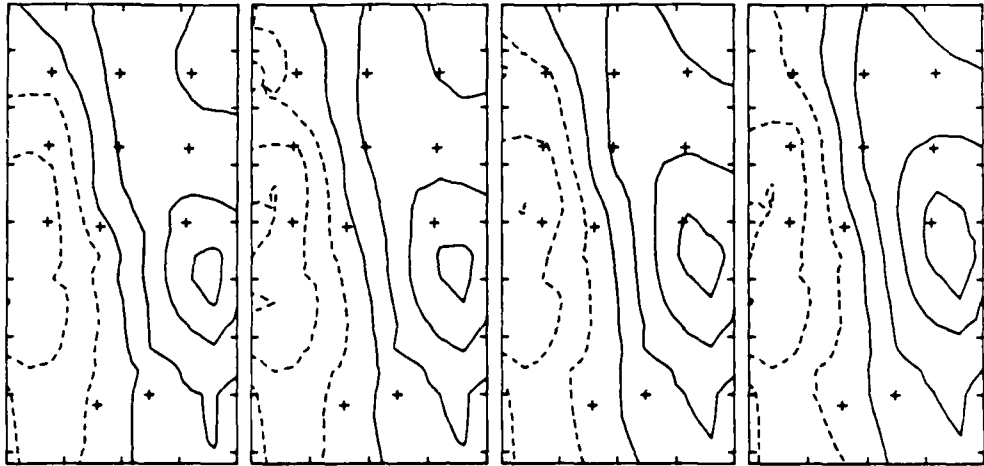


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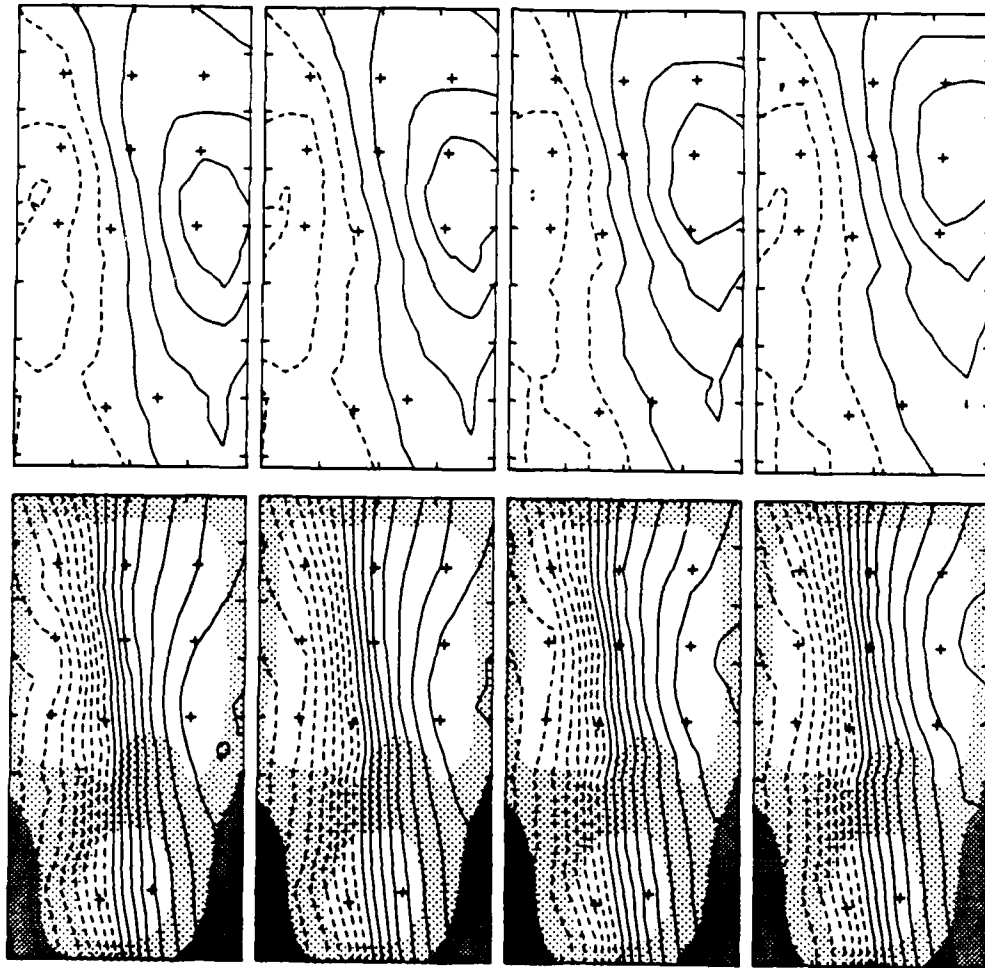


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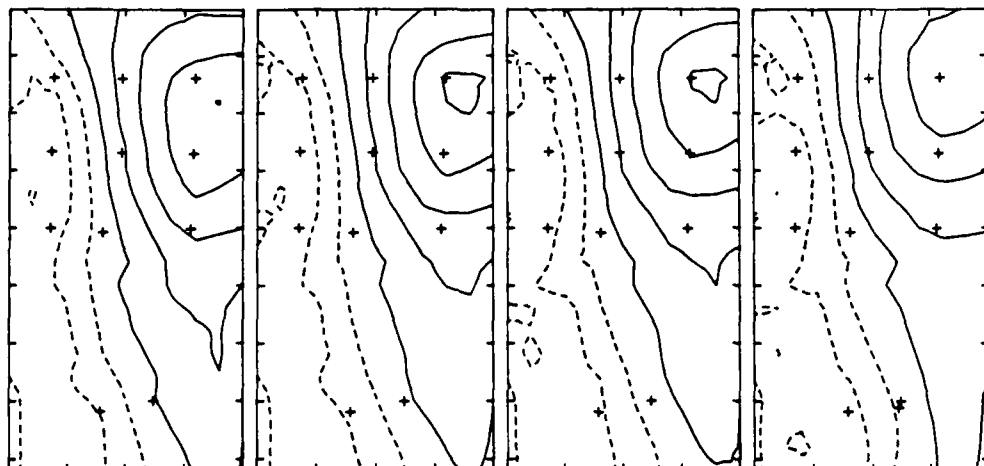


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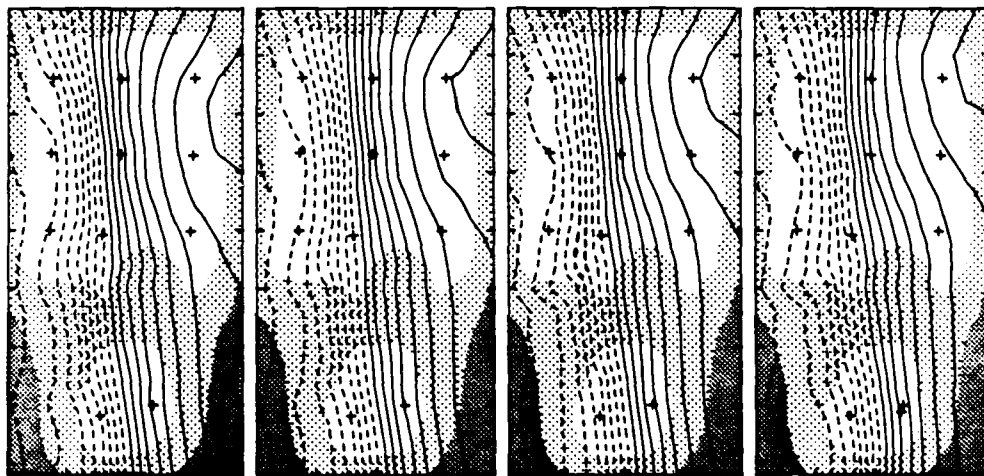


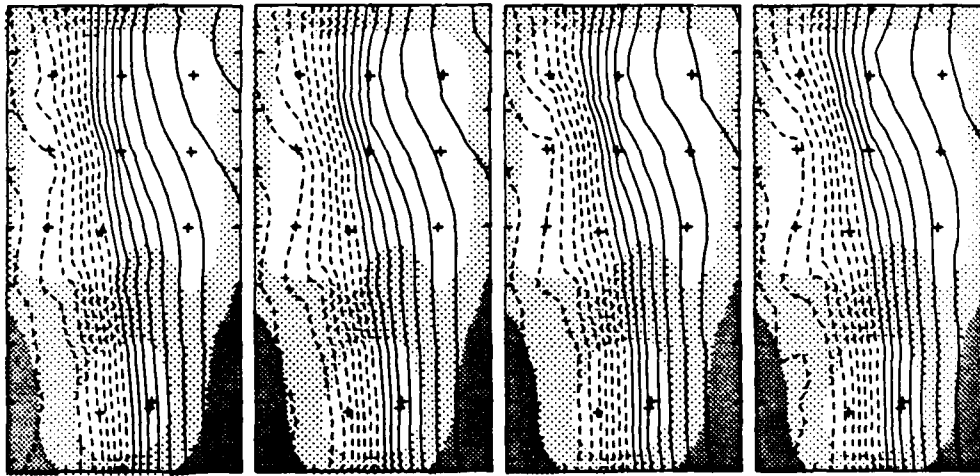
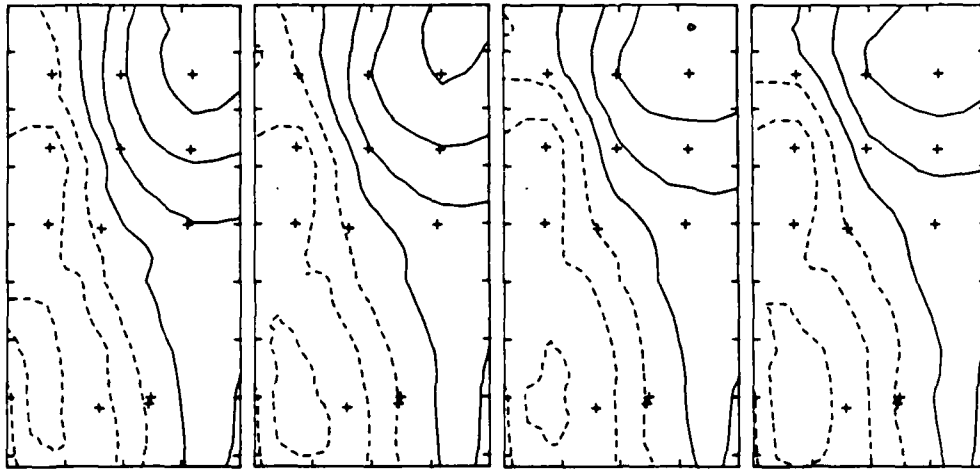
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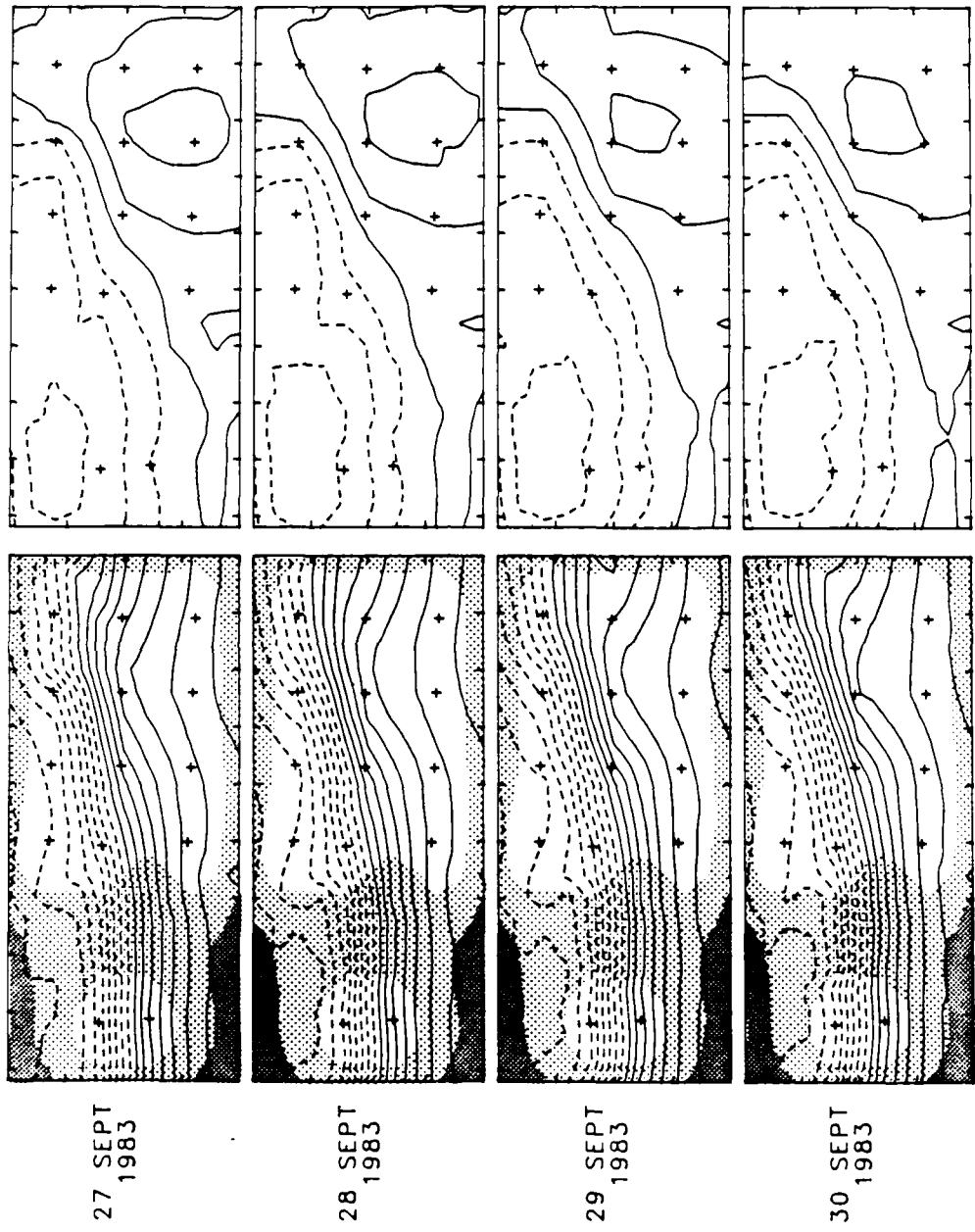


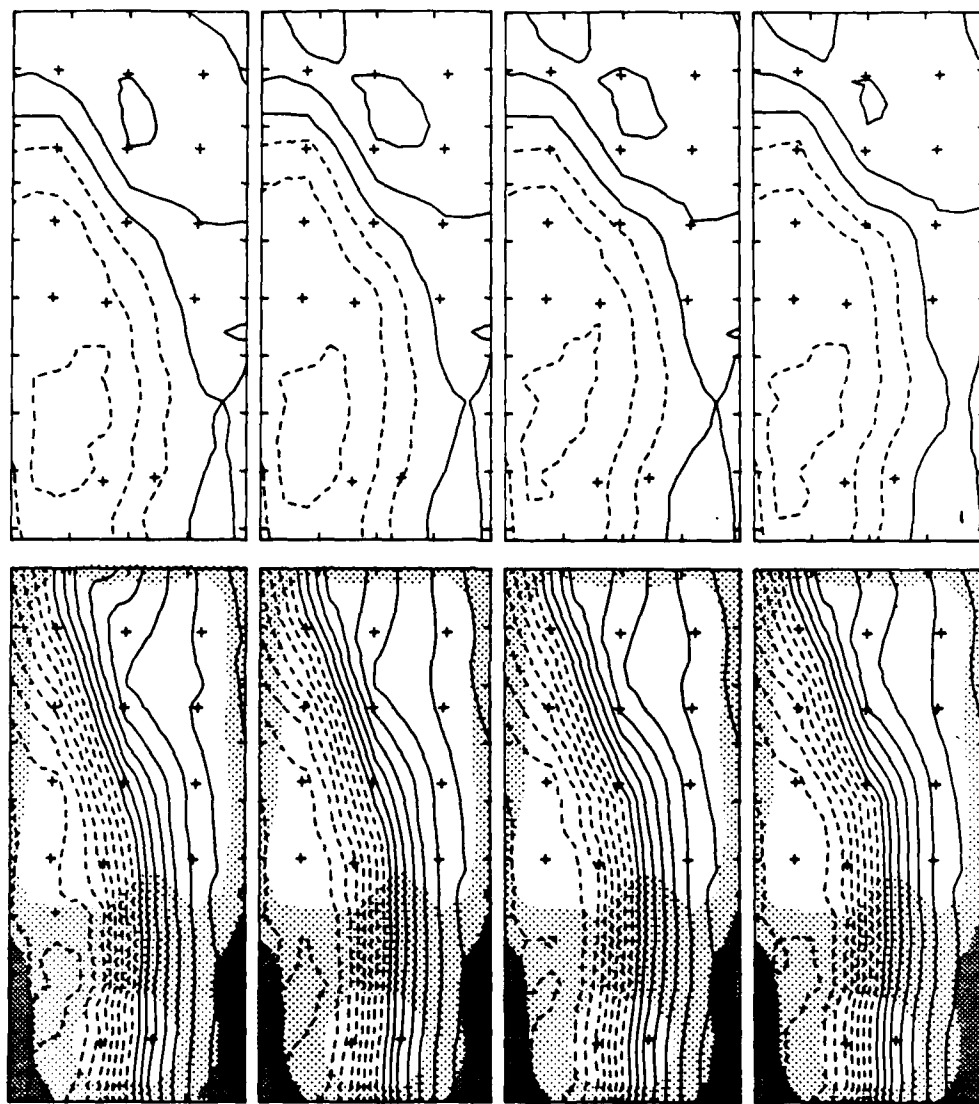
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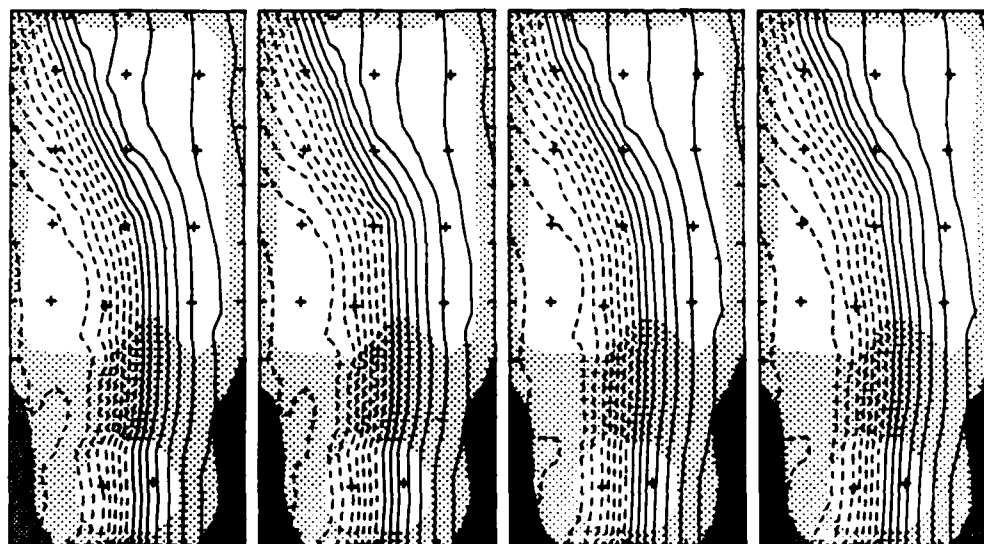
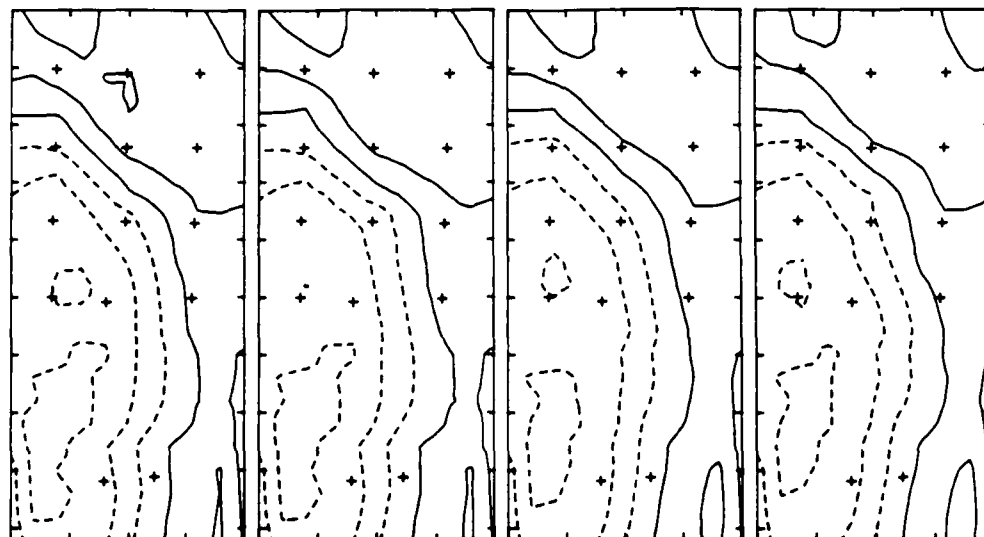


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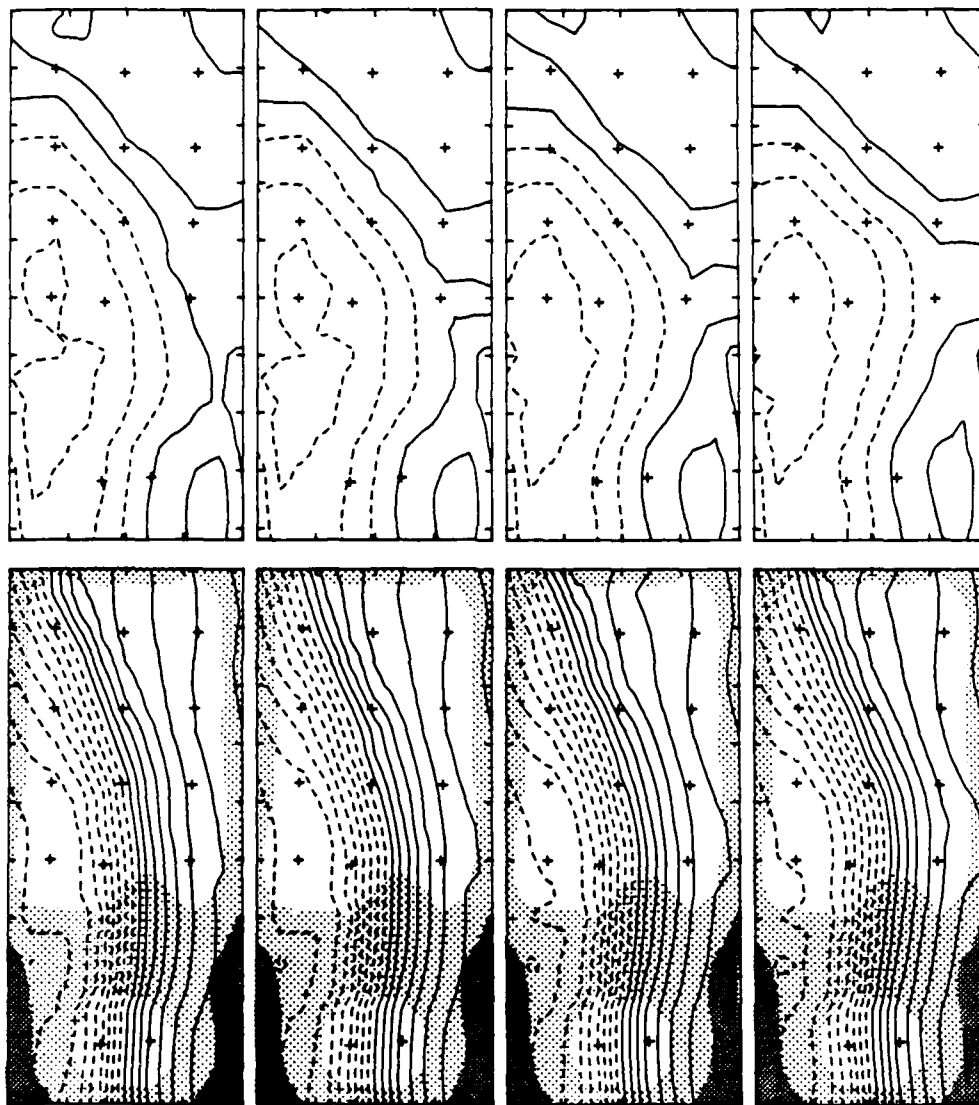


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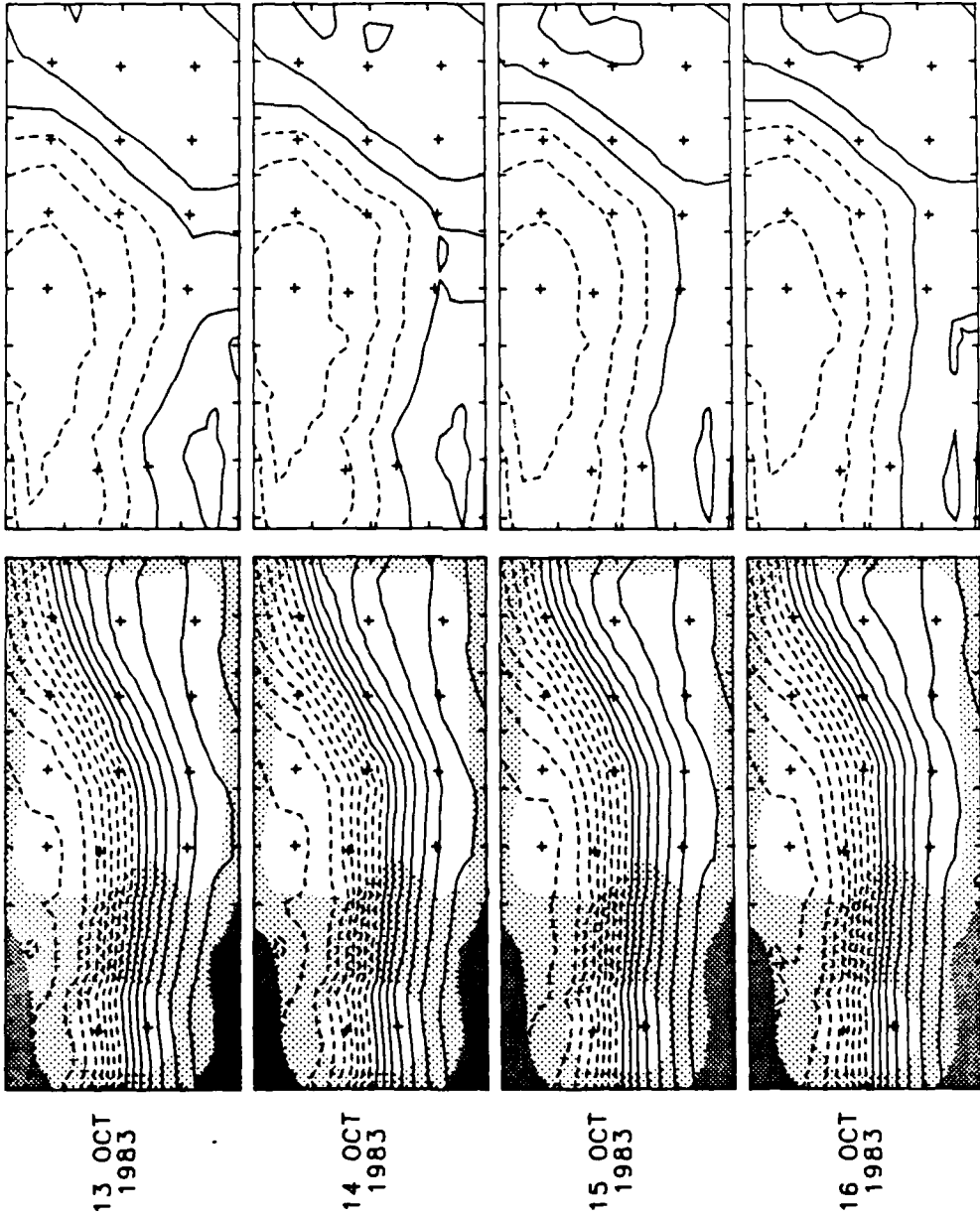


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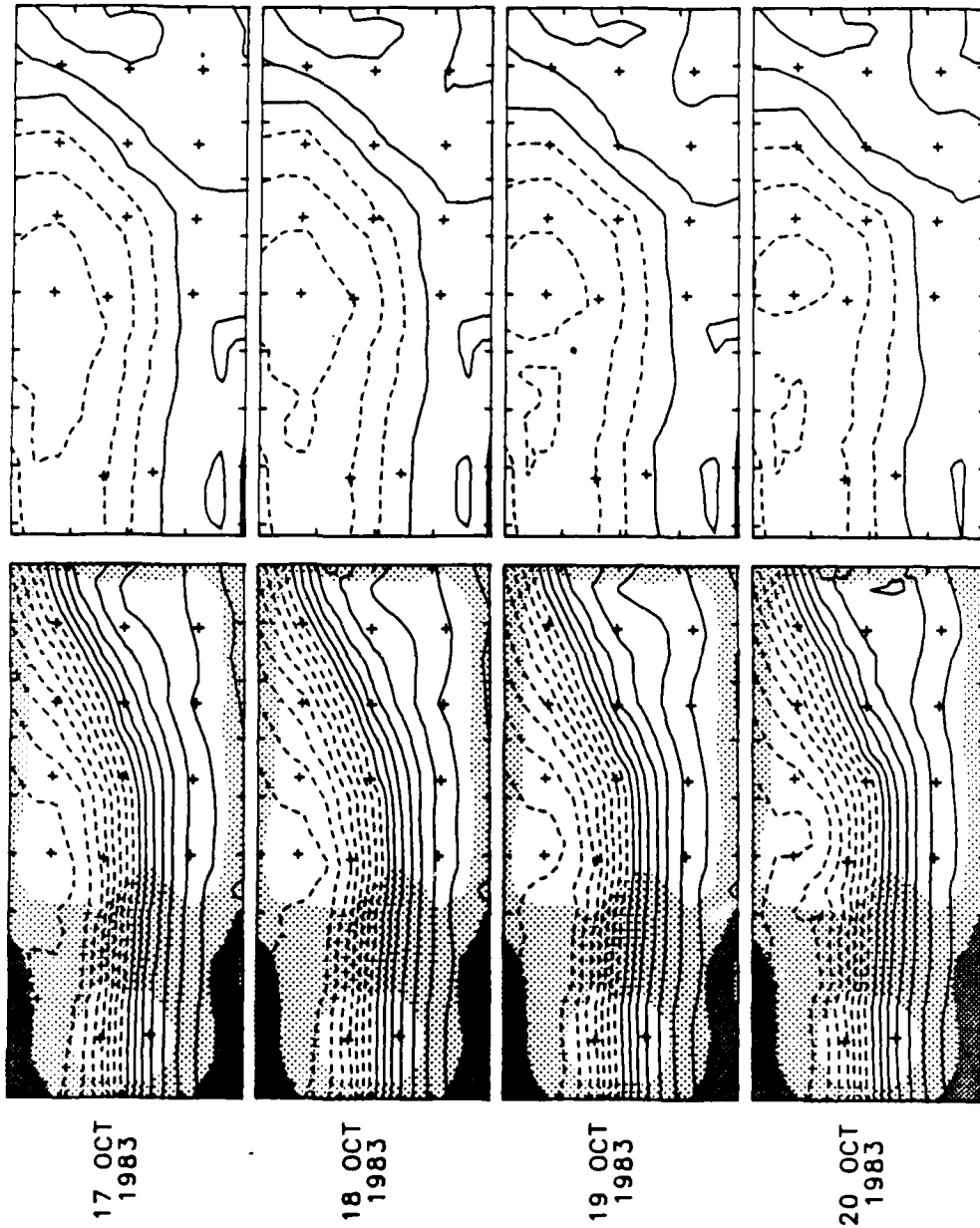


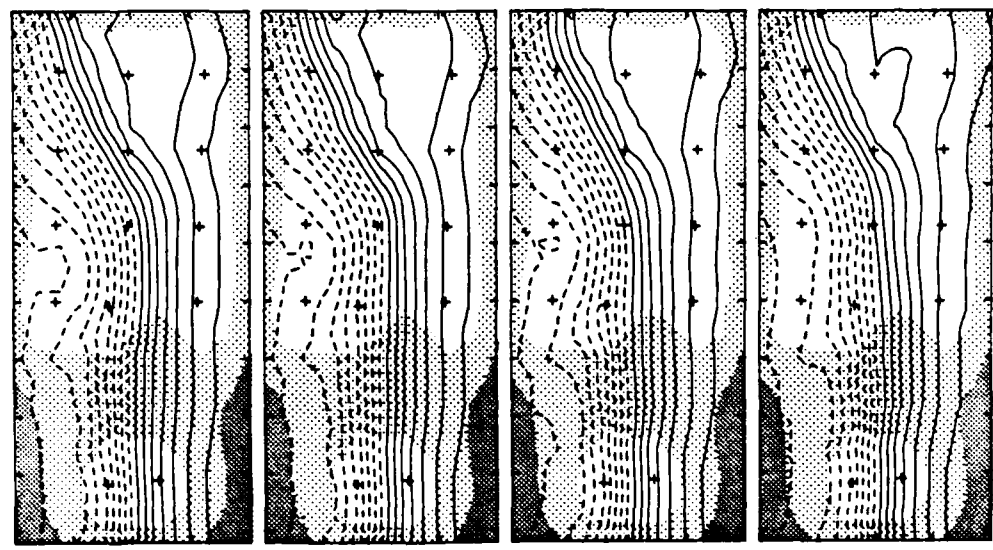
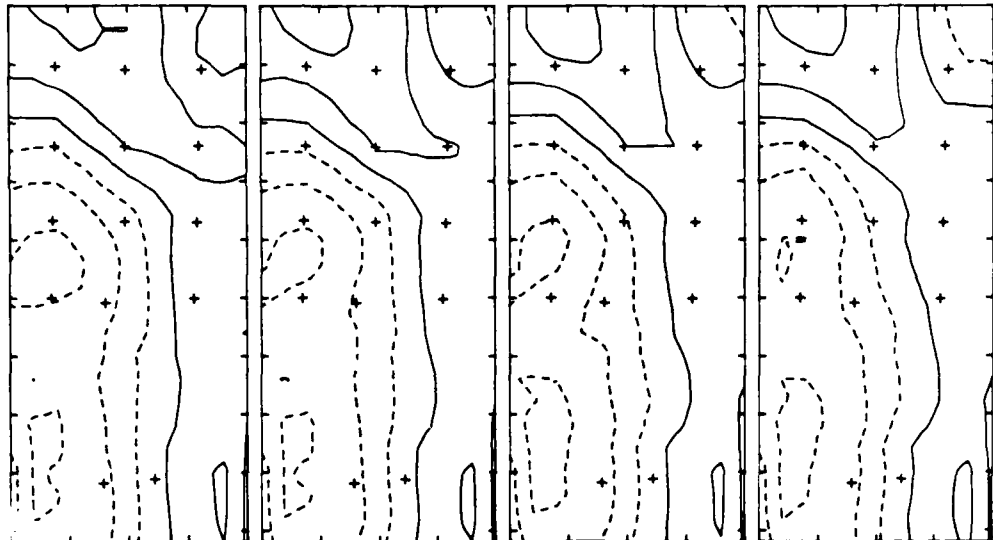
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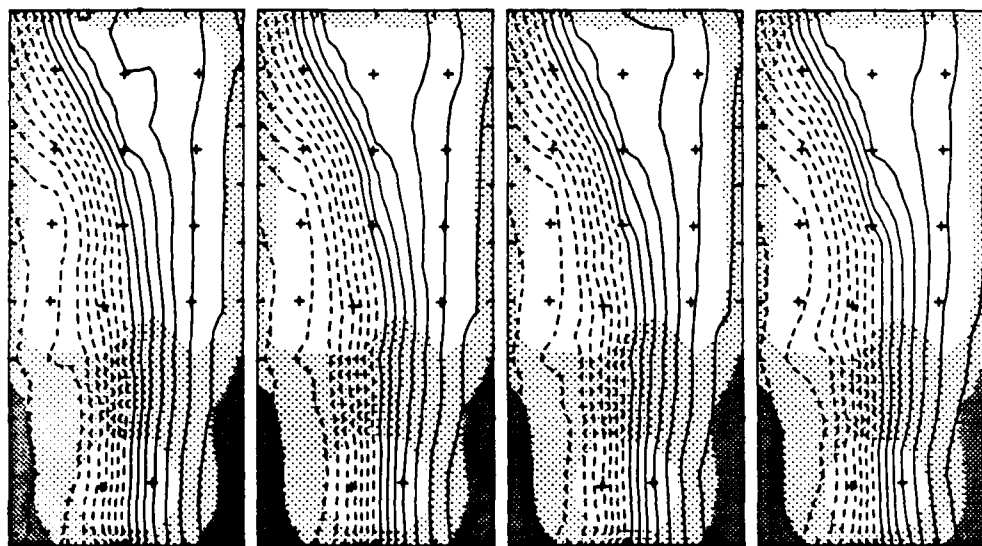
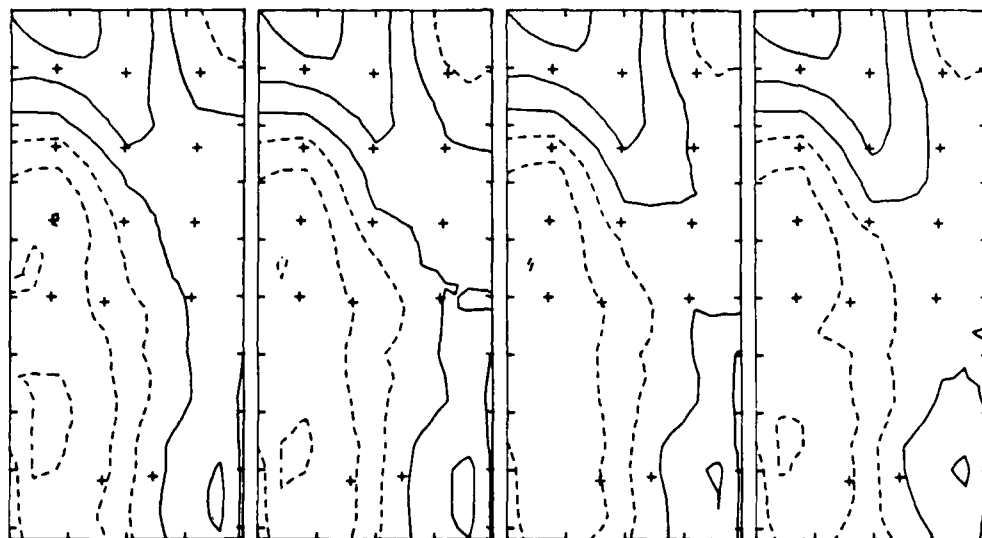


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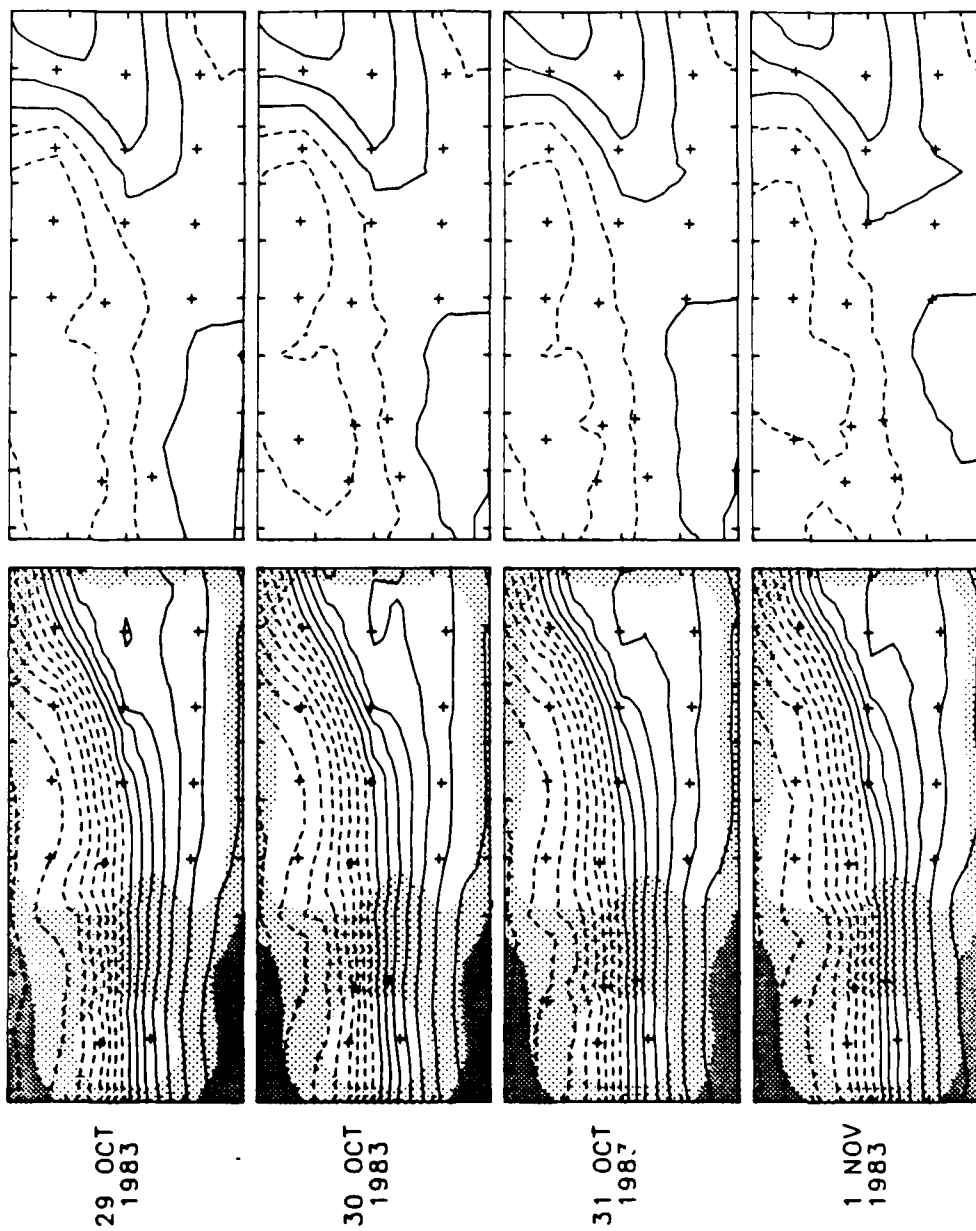


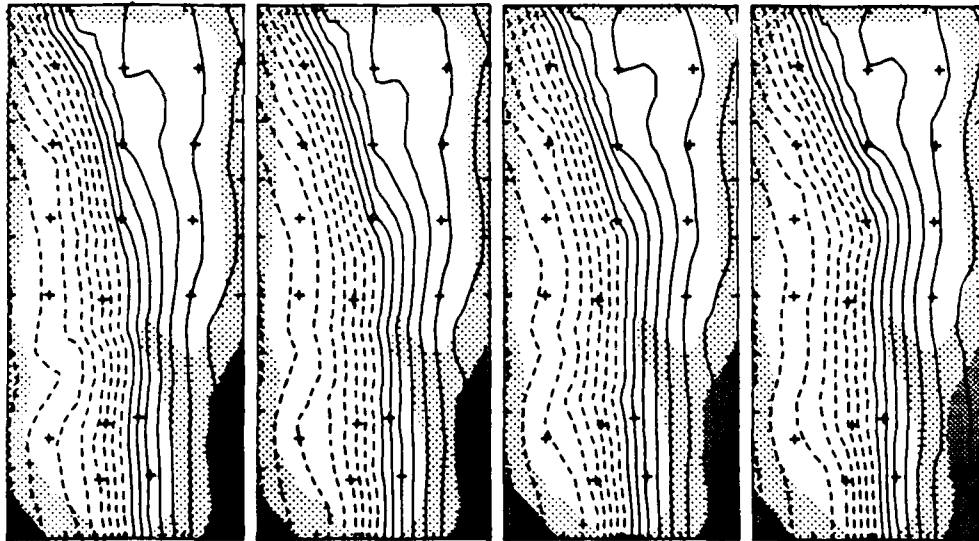
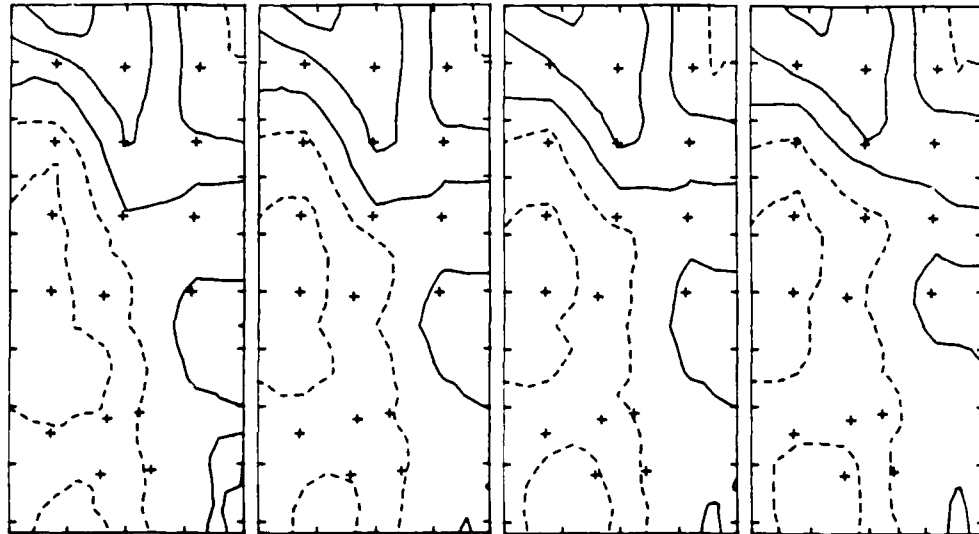
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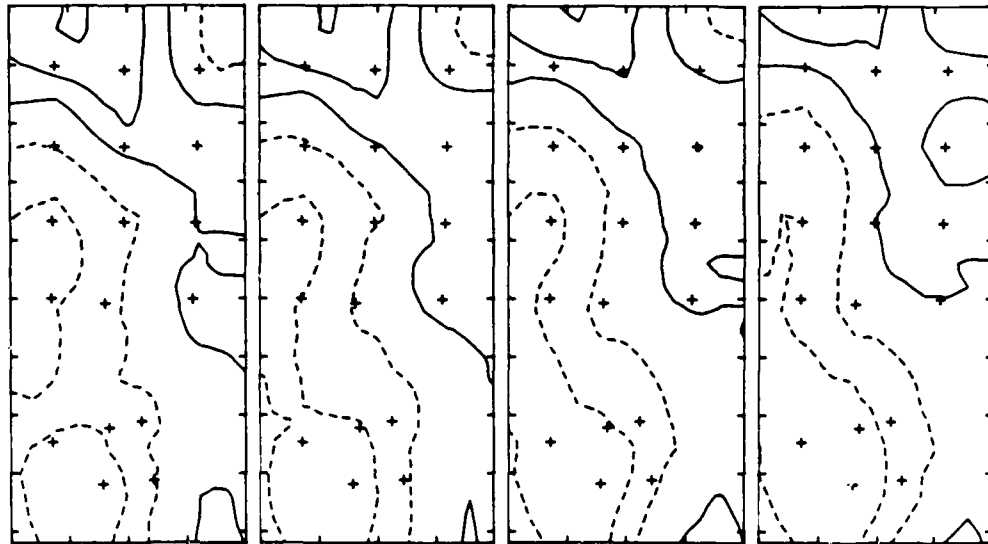


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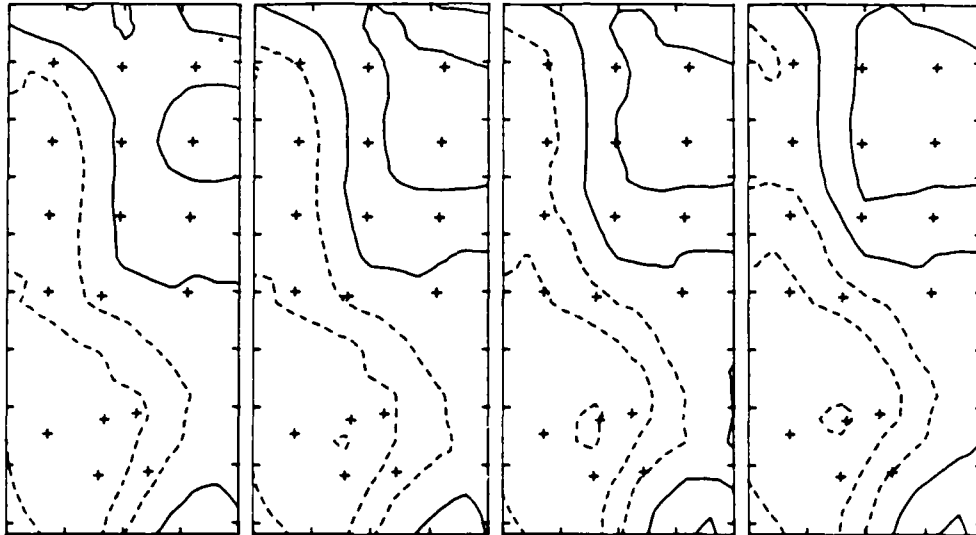


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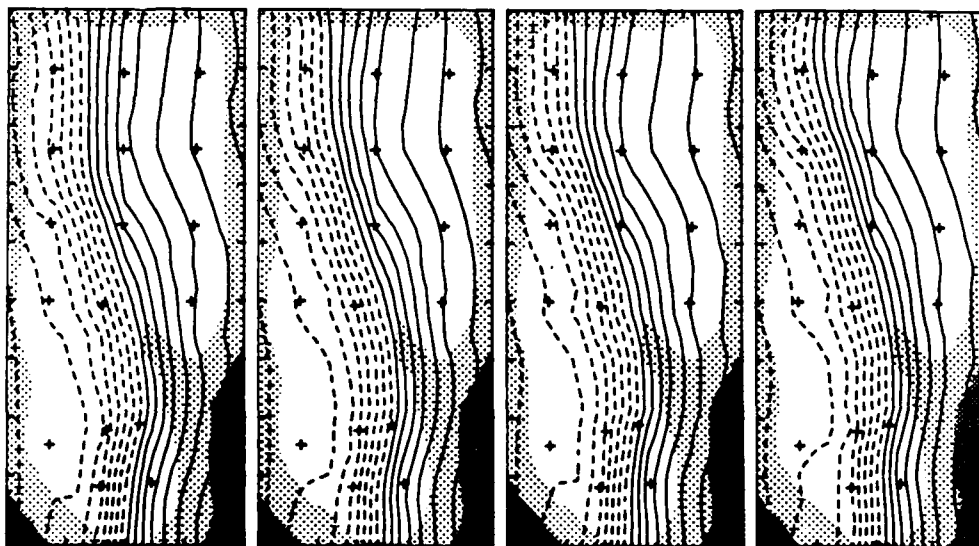
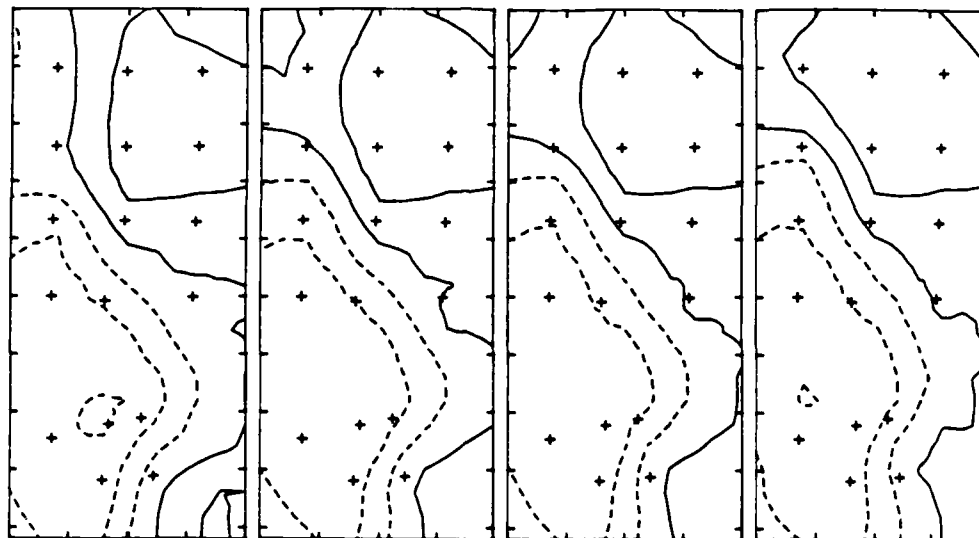


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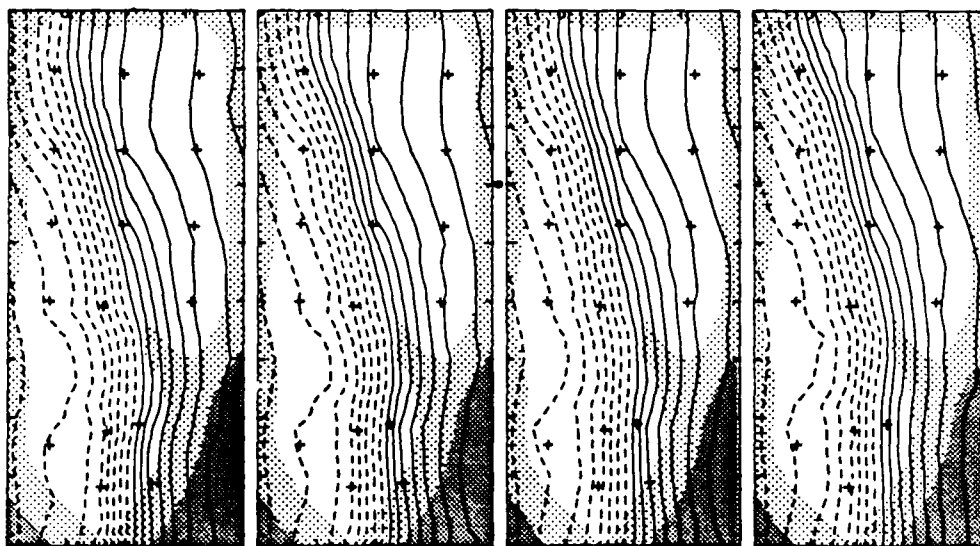
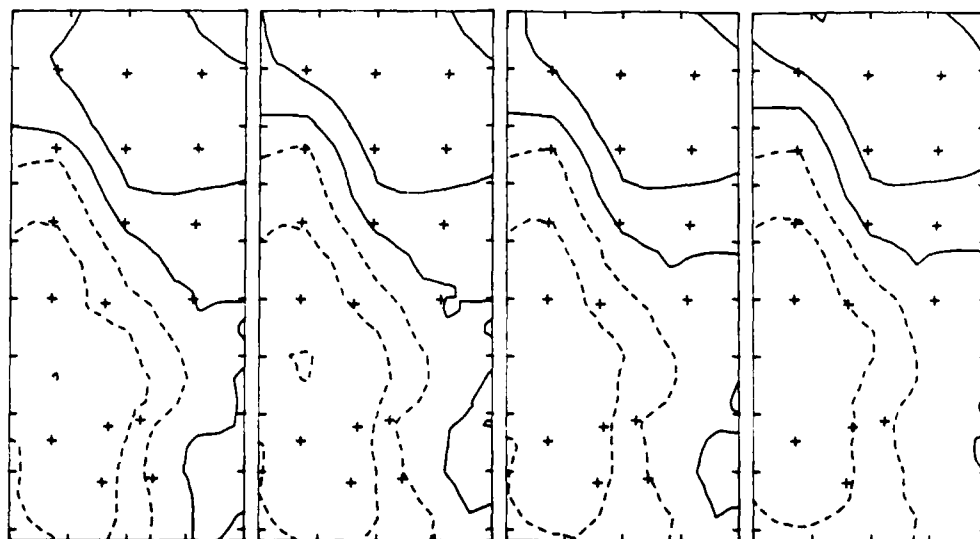


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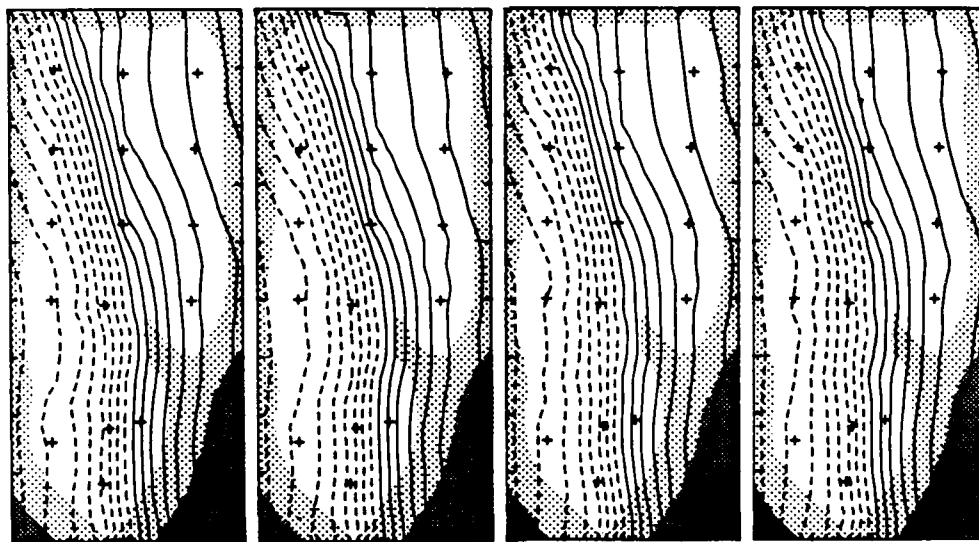
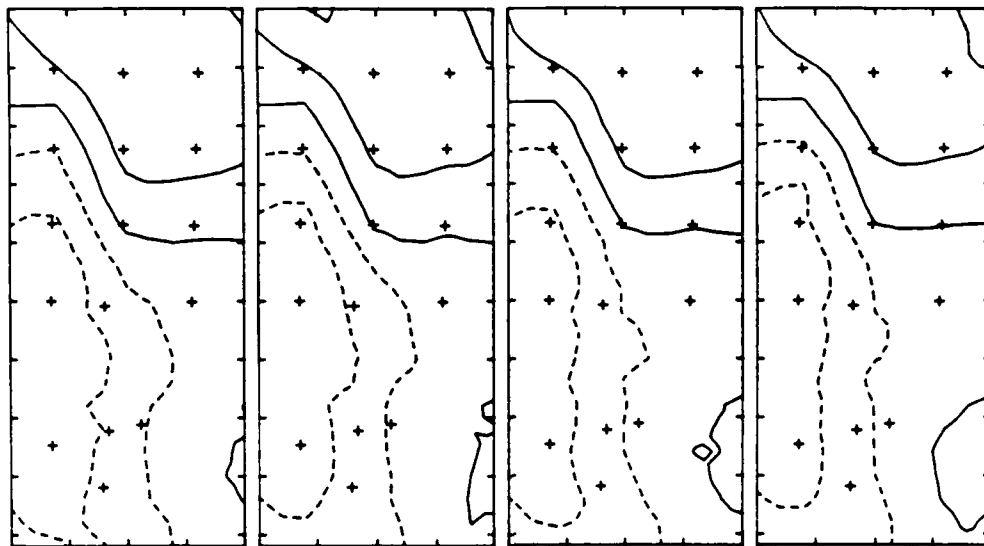


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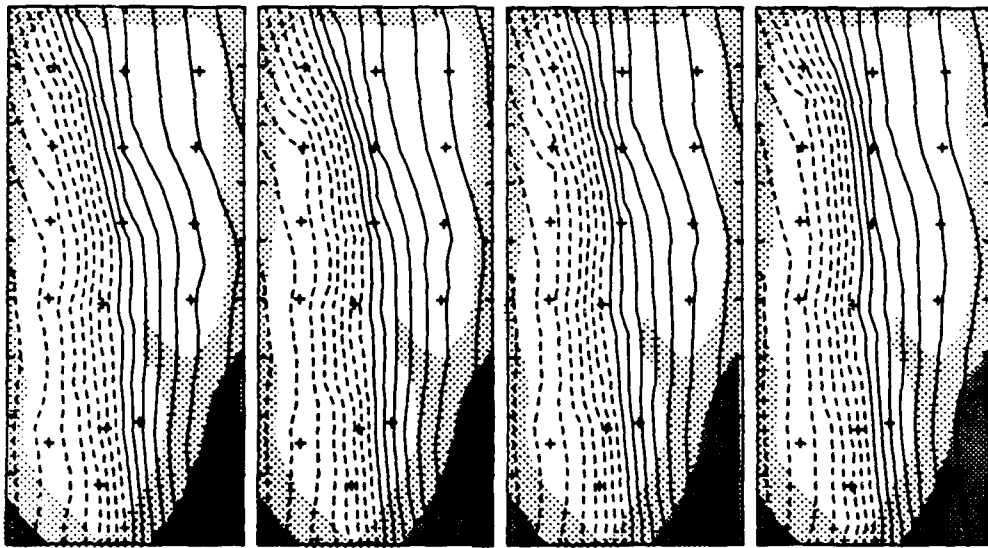
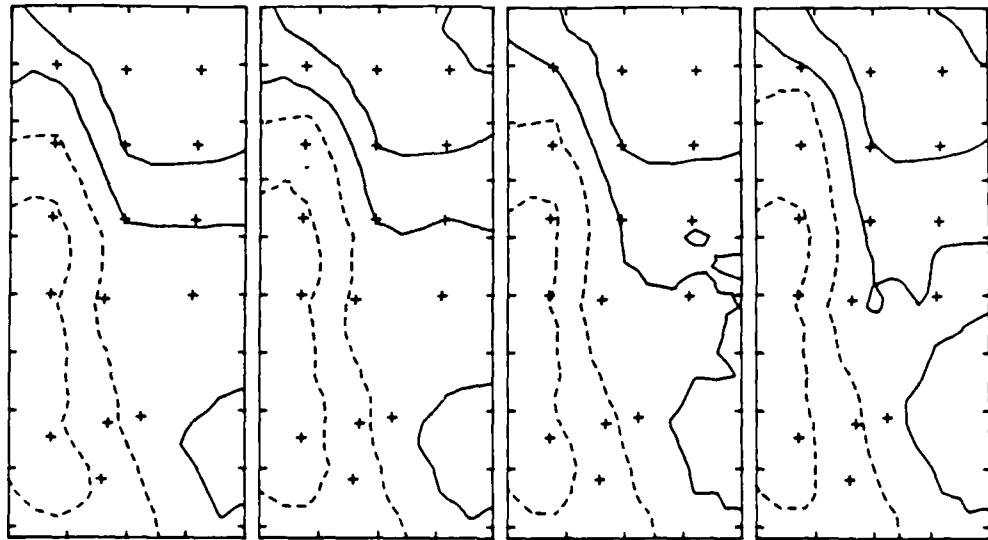


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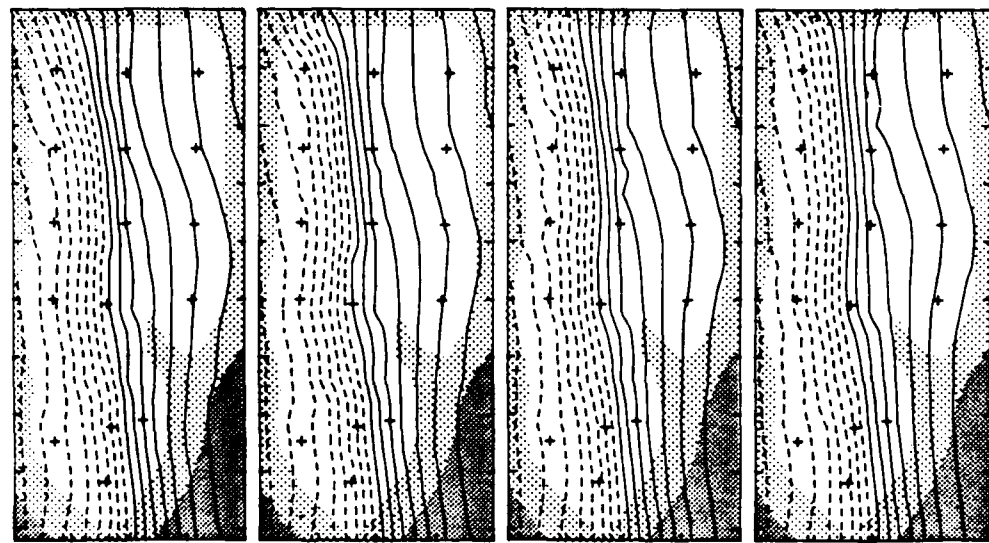
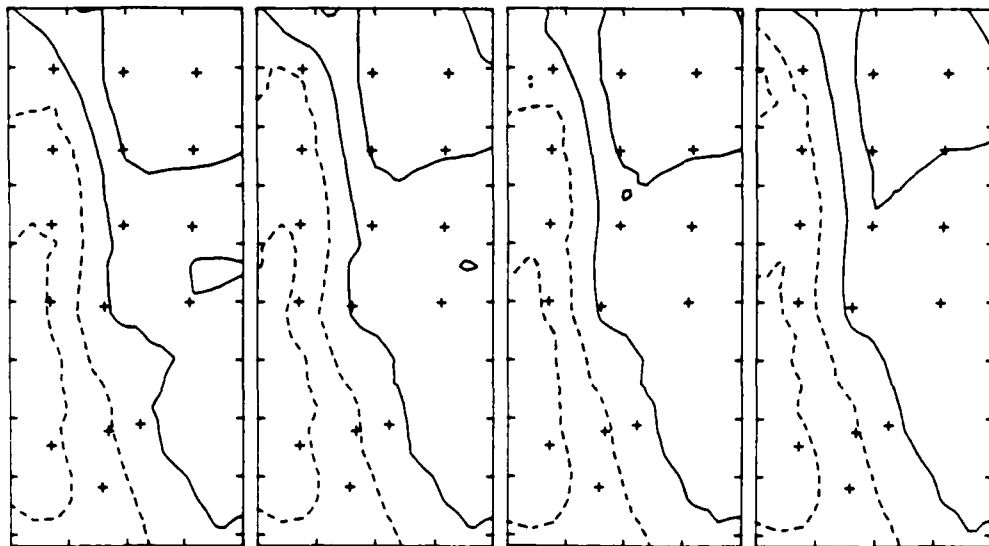


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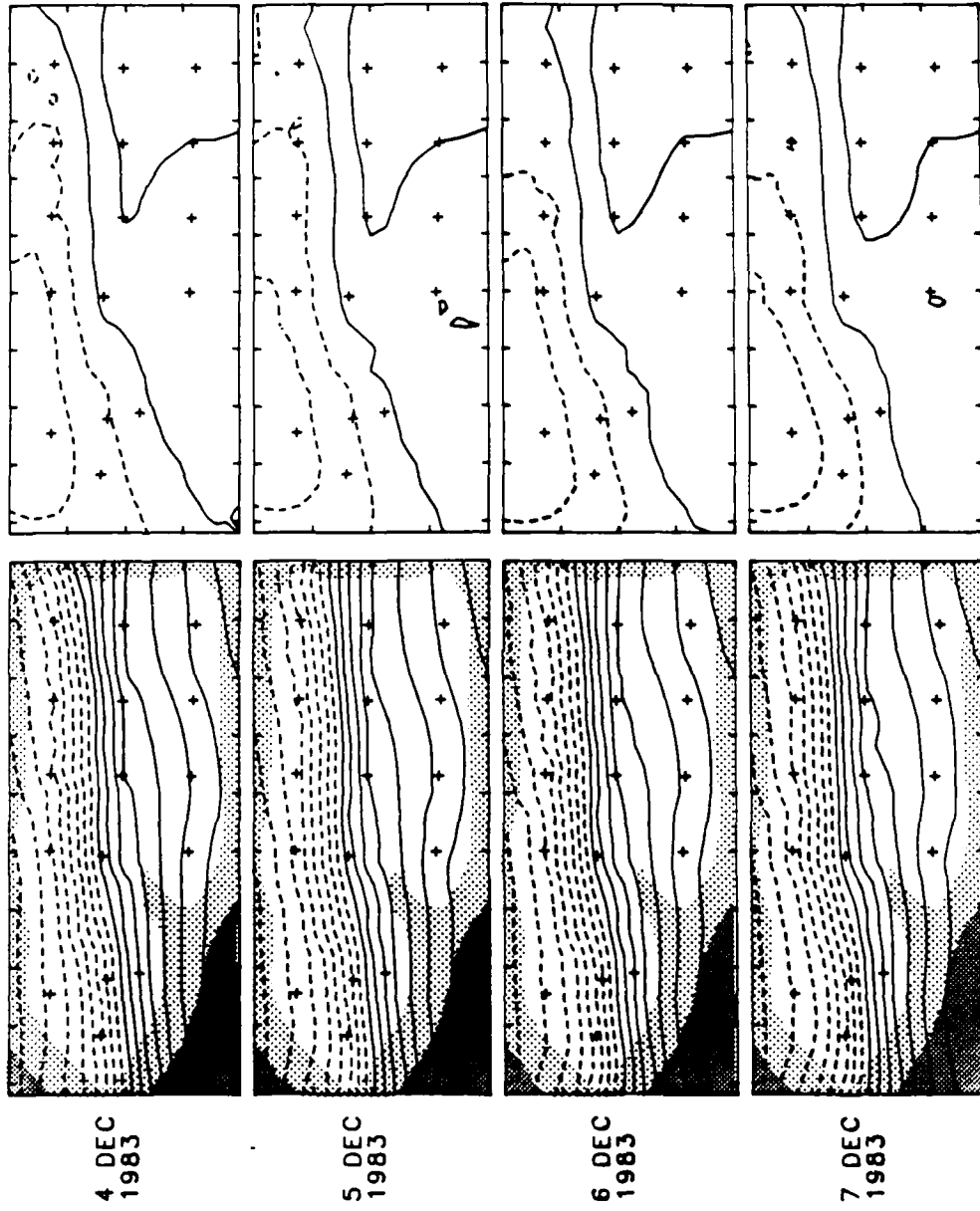


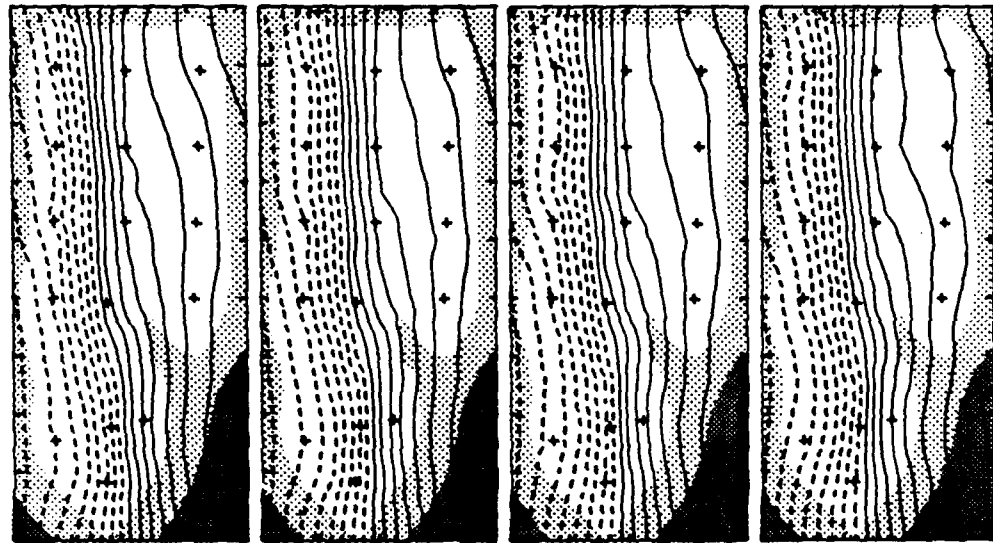
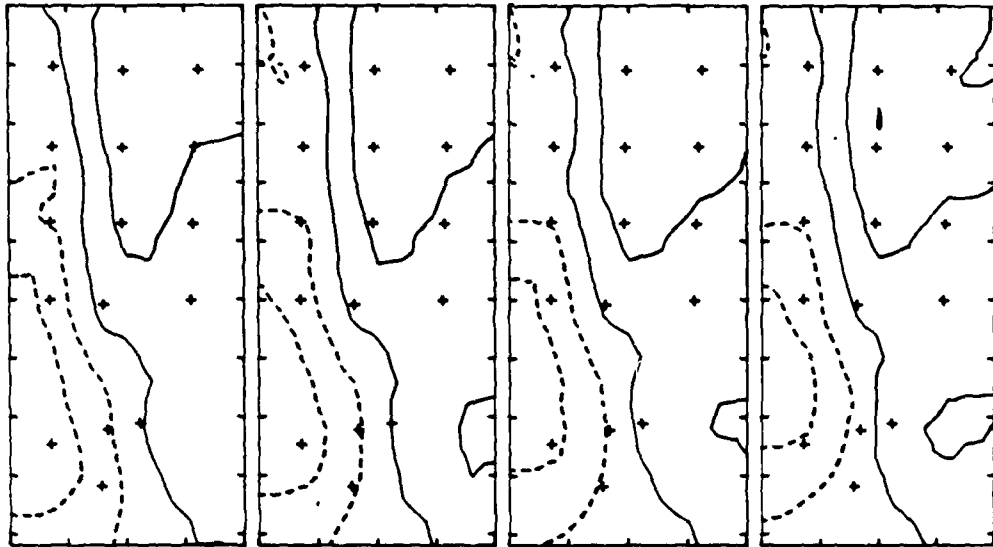
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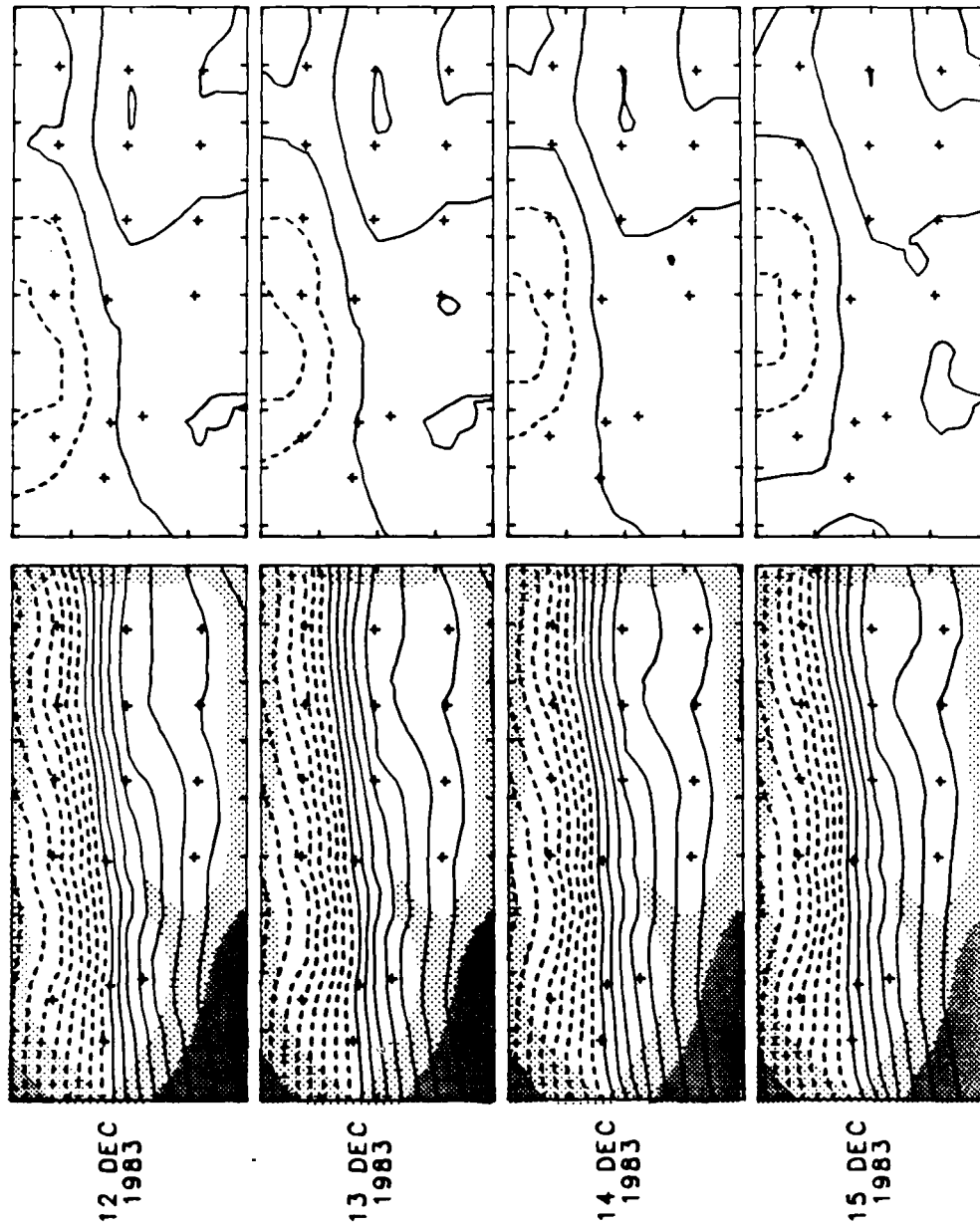


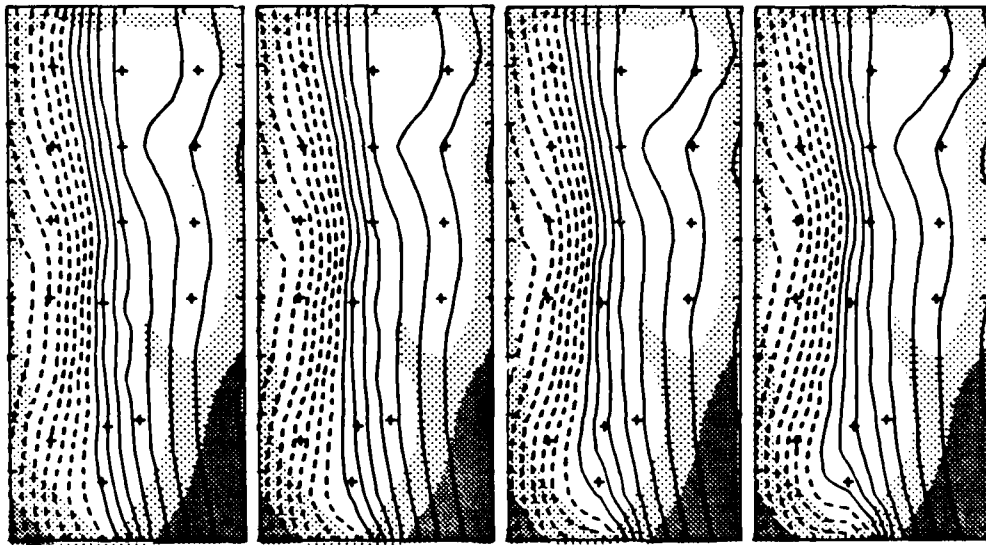
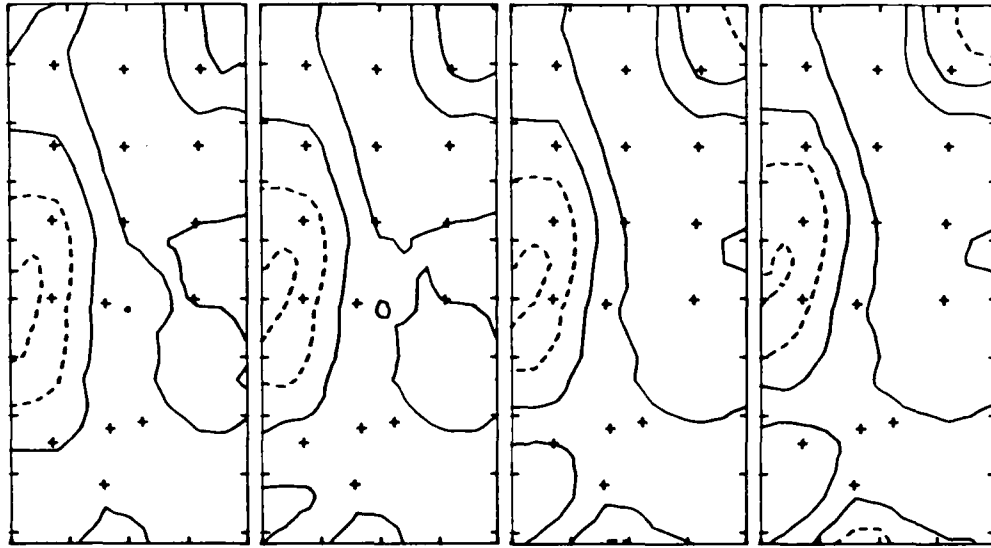
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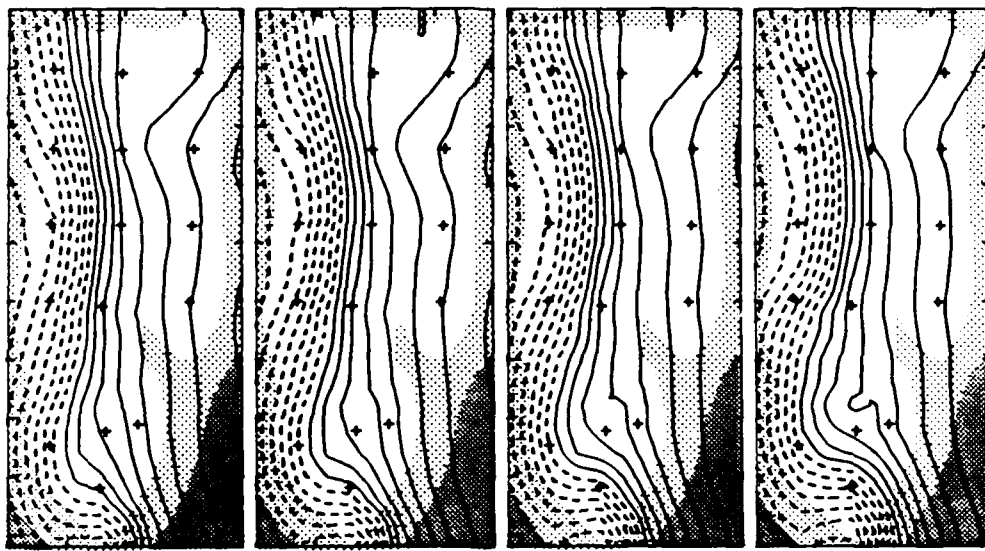
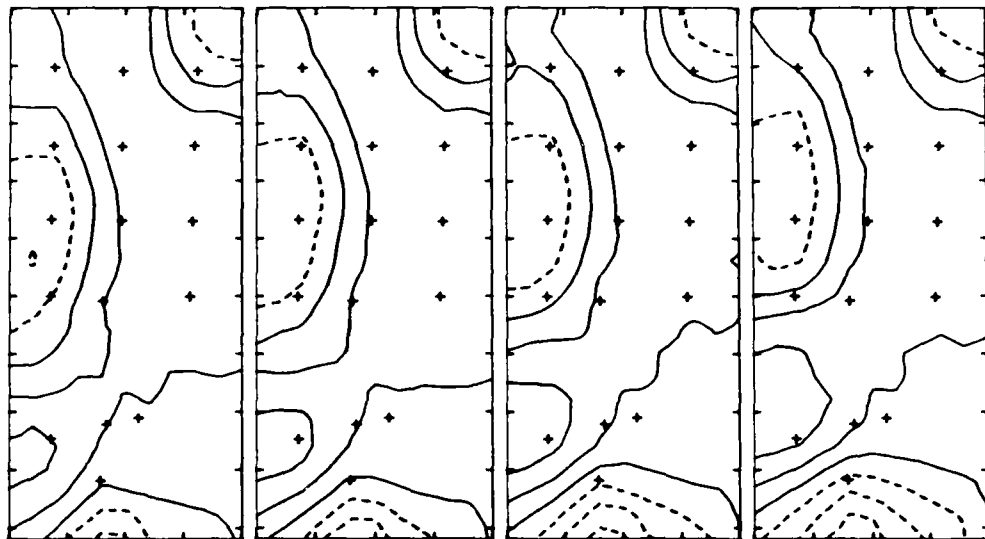


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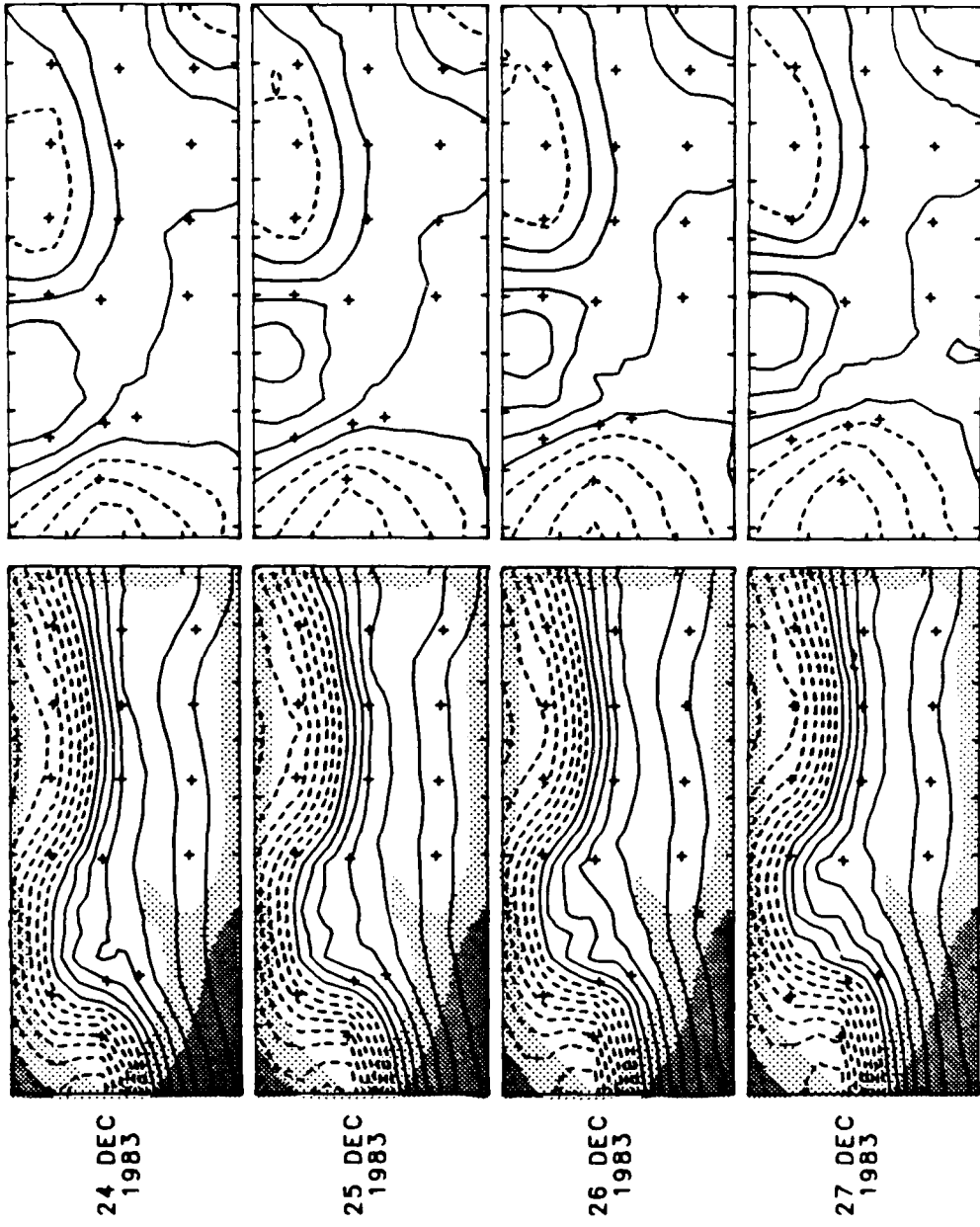


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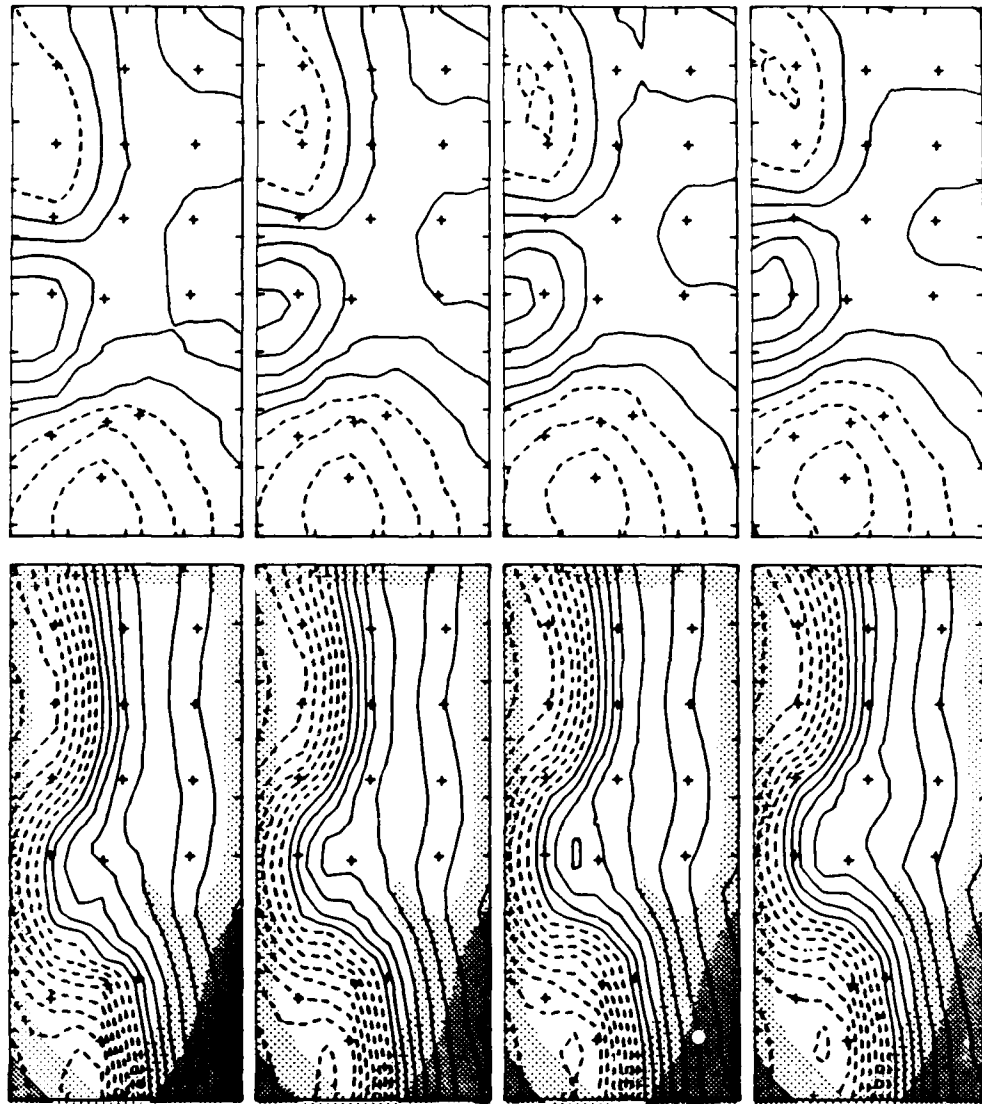


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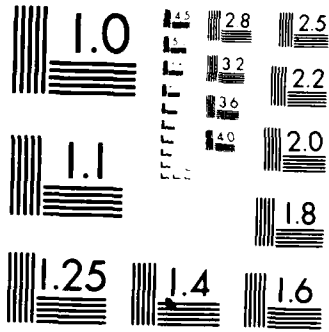
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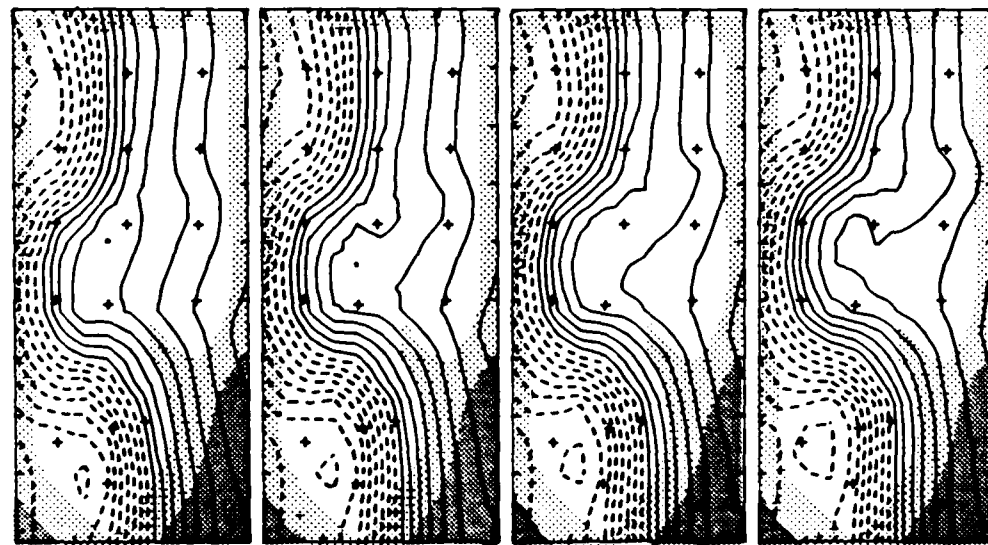
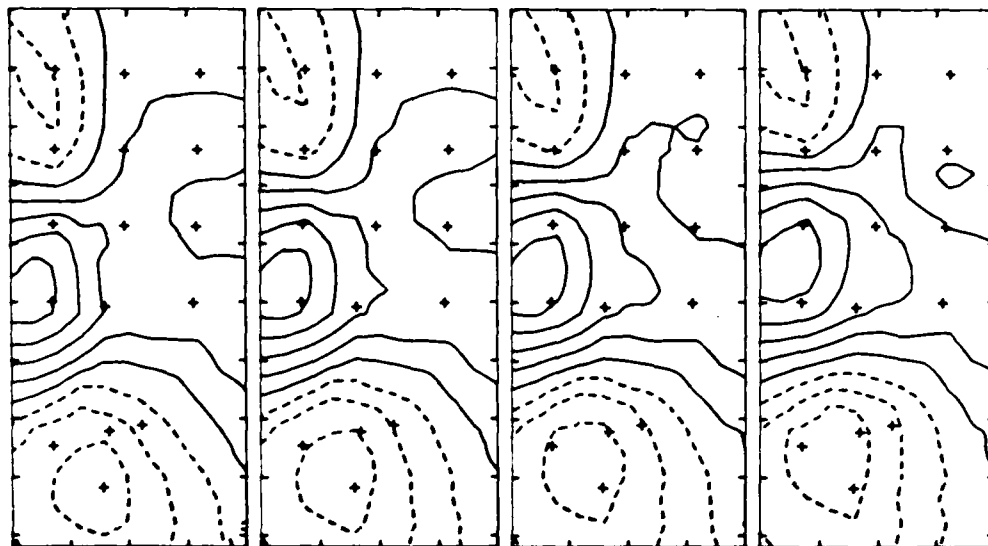
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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS-1963-A

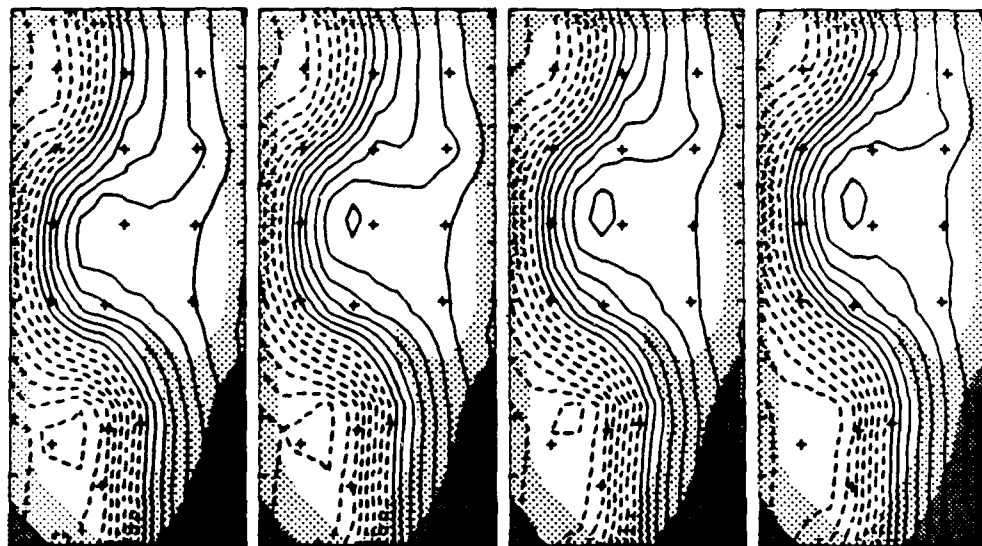
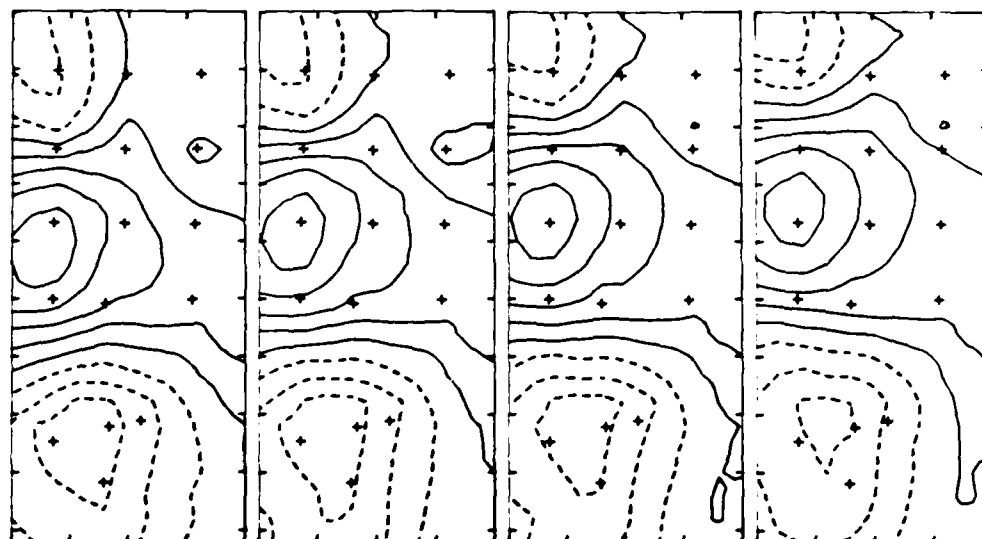


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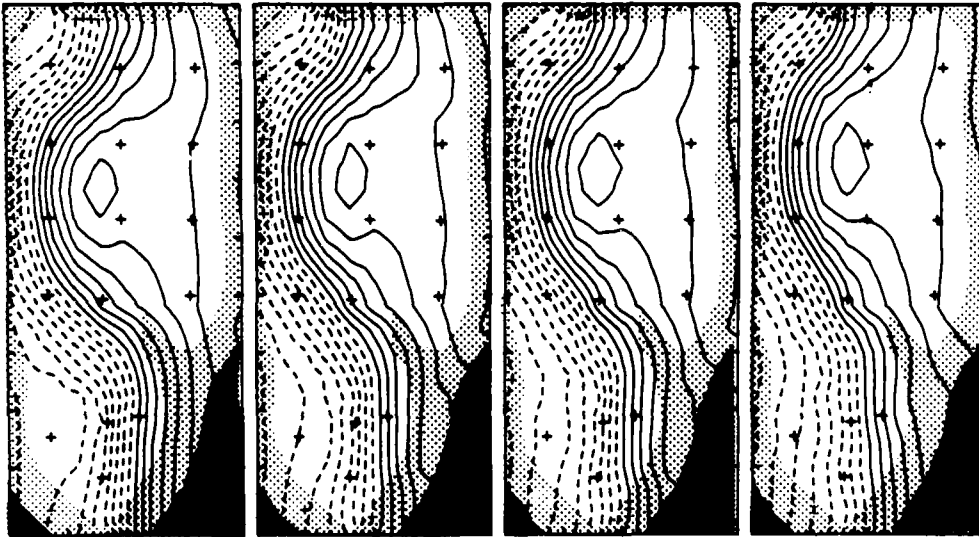
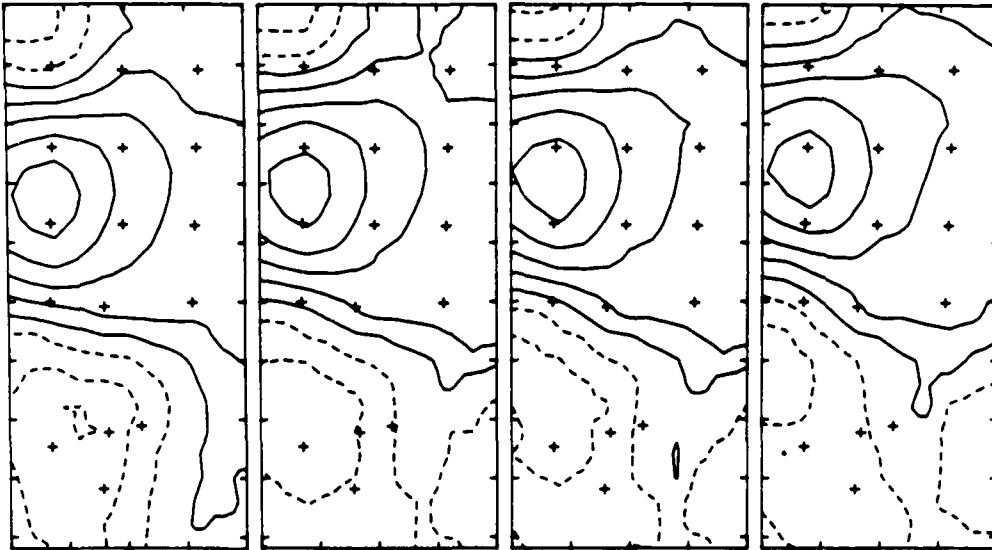


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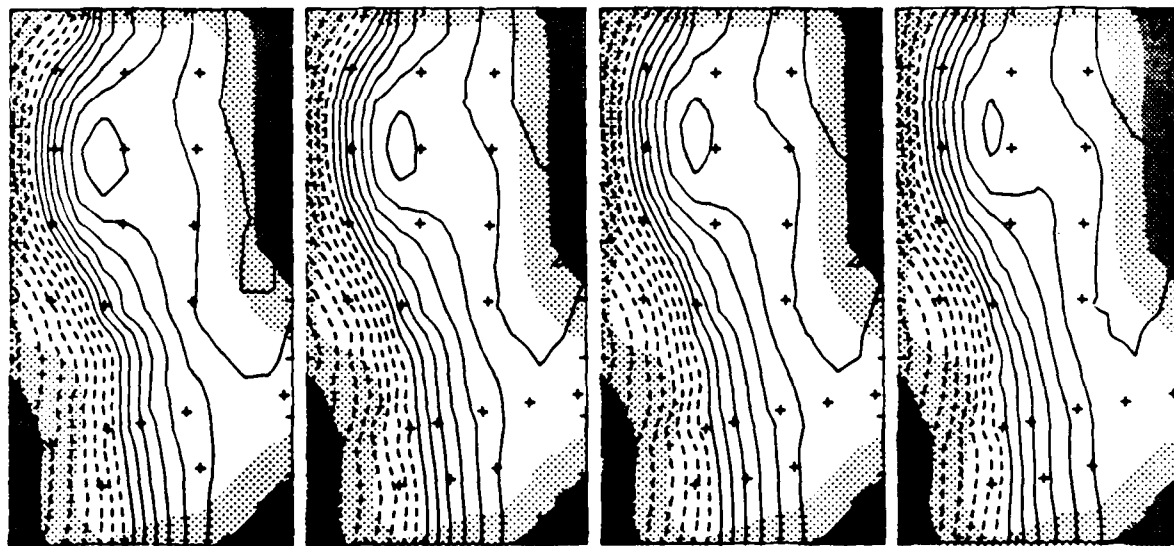
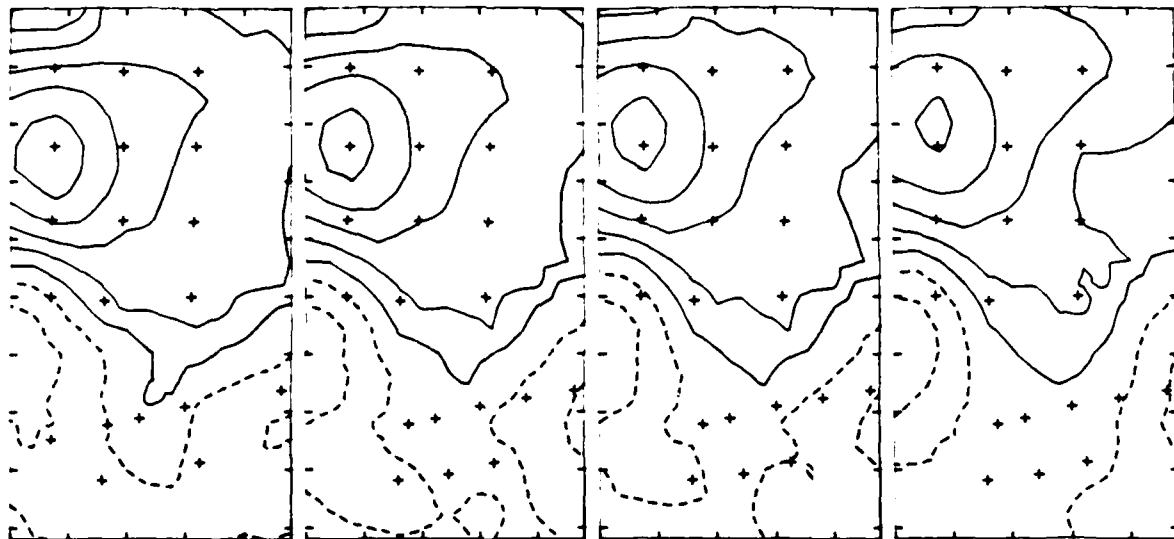


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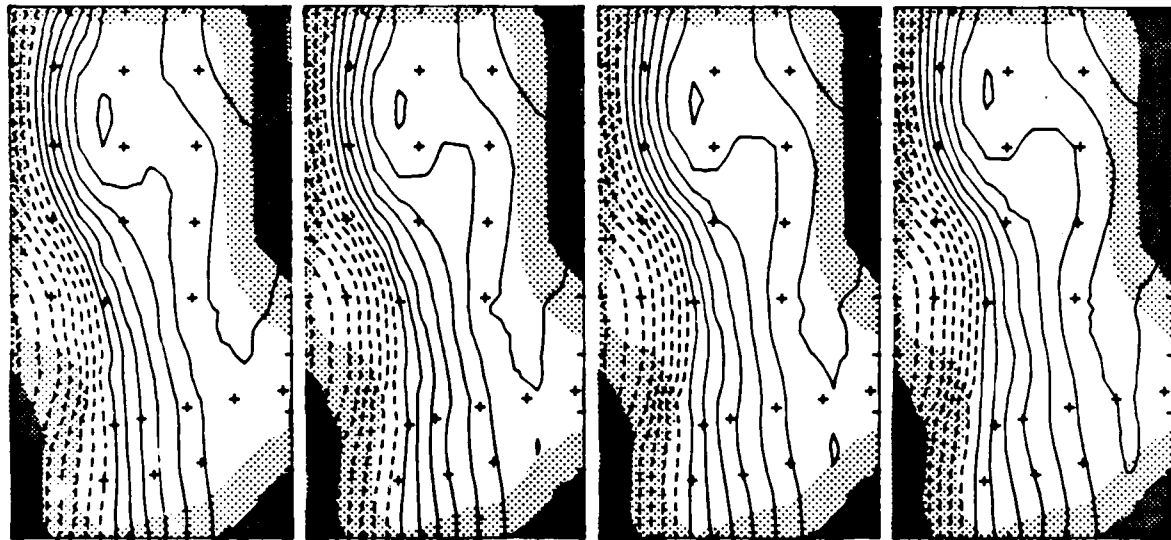
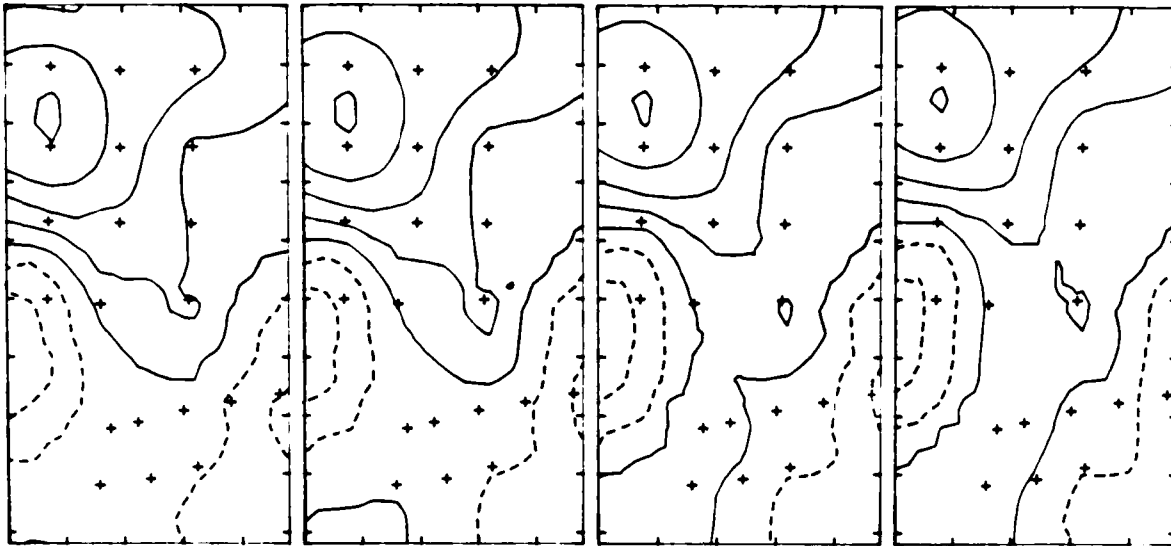


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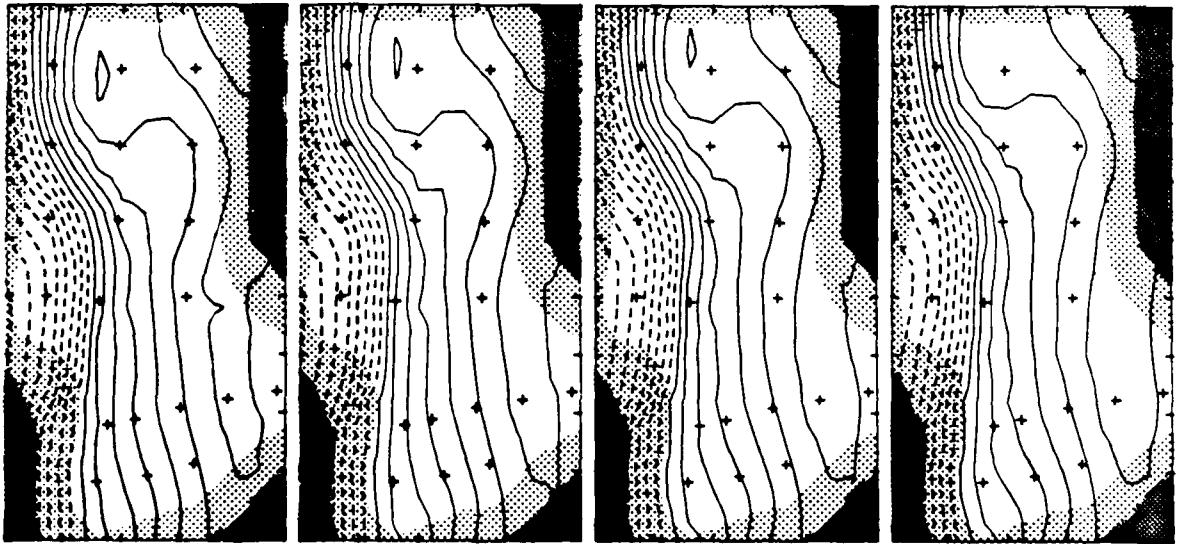
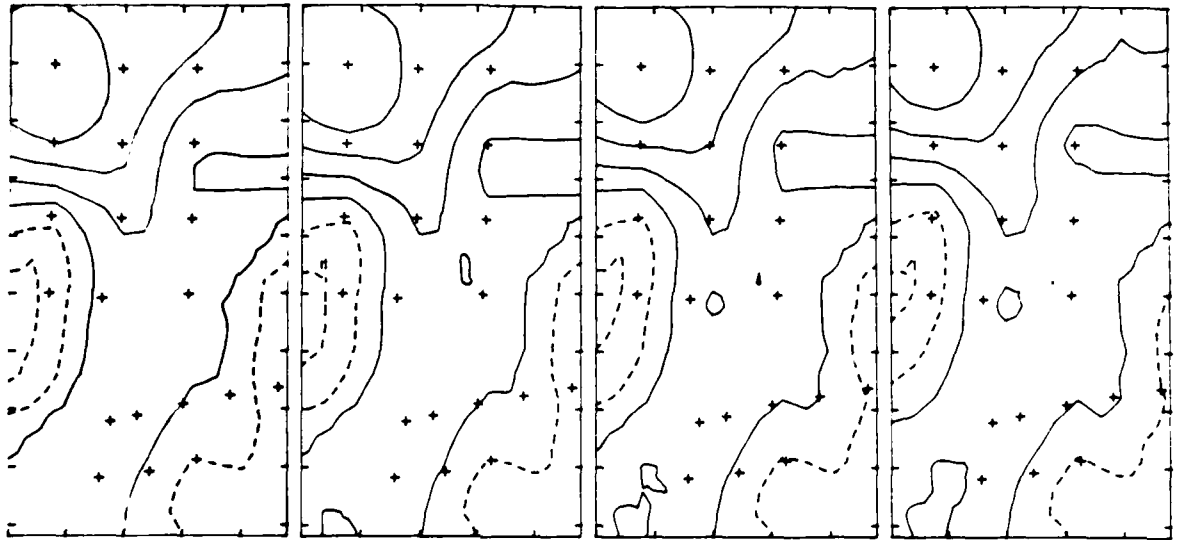


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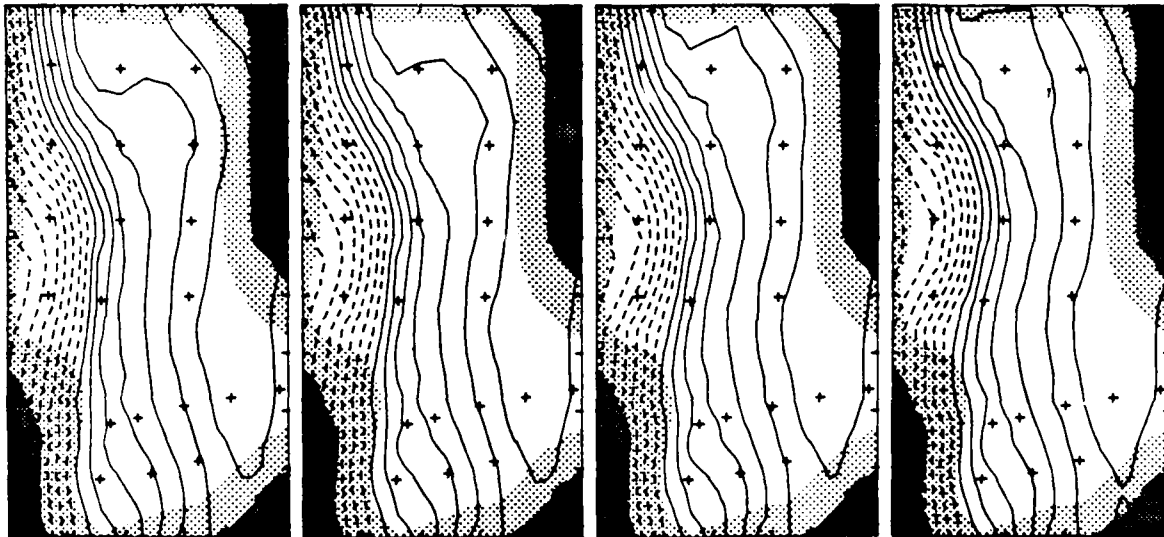
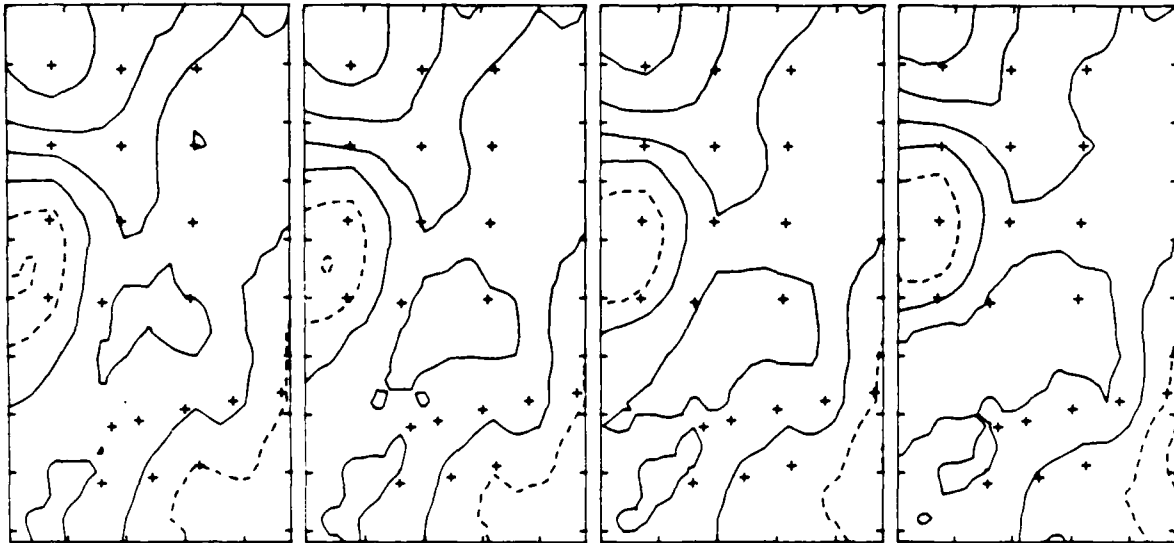


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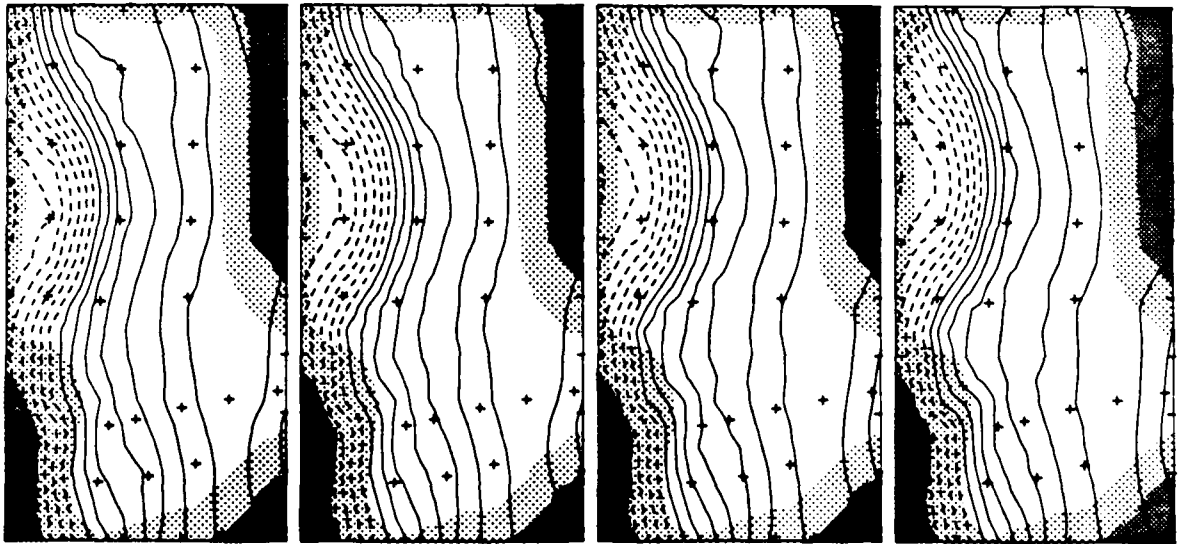
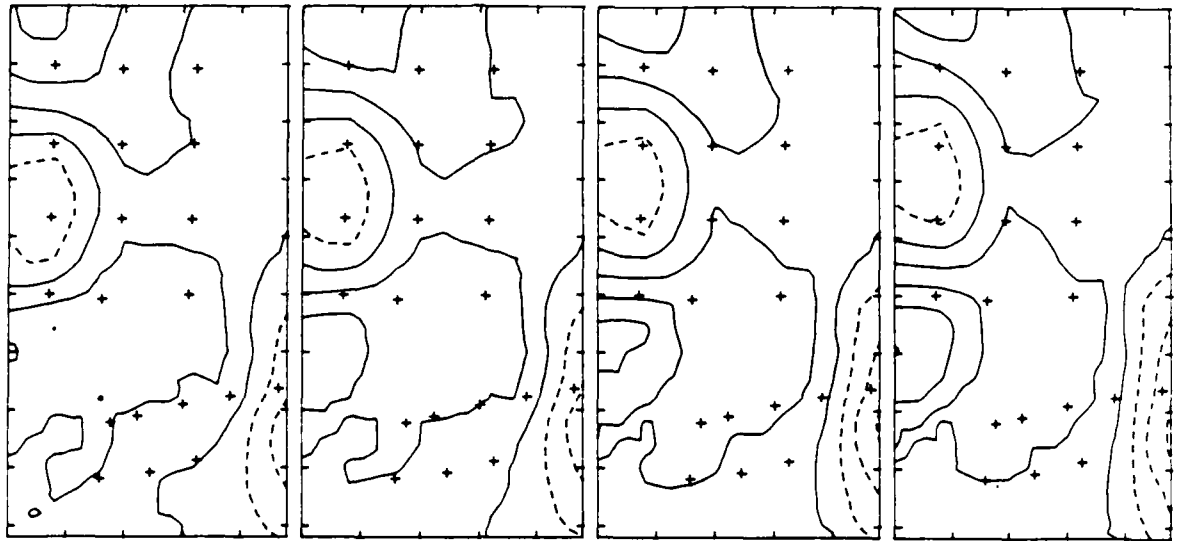


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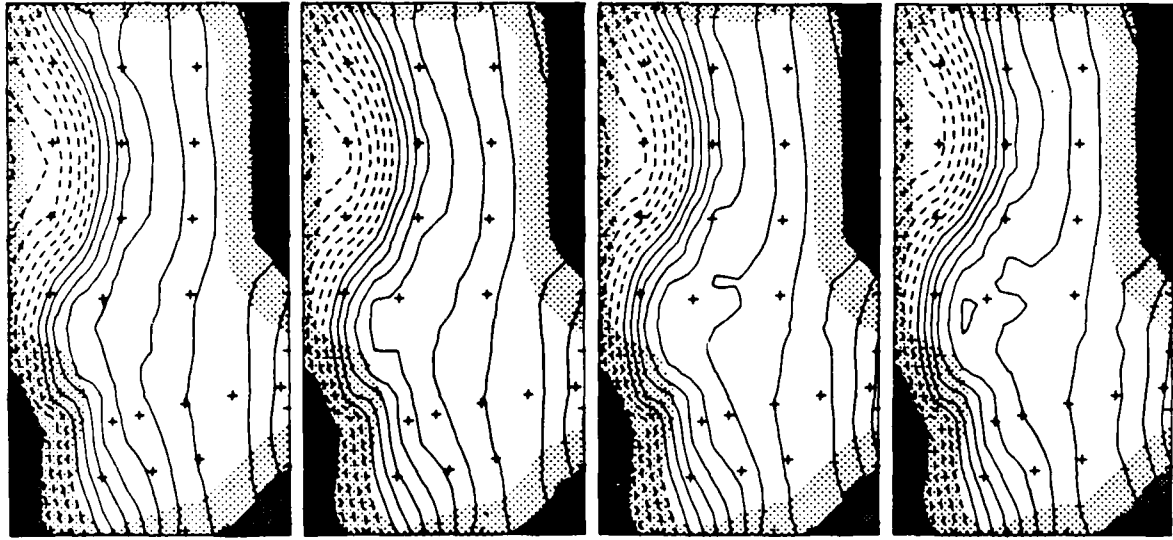
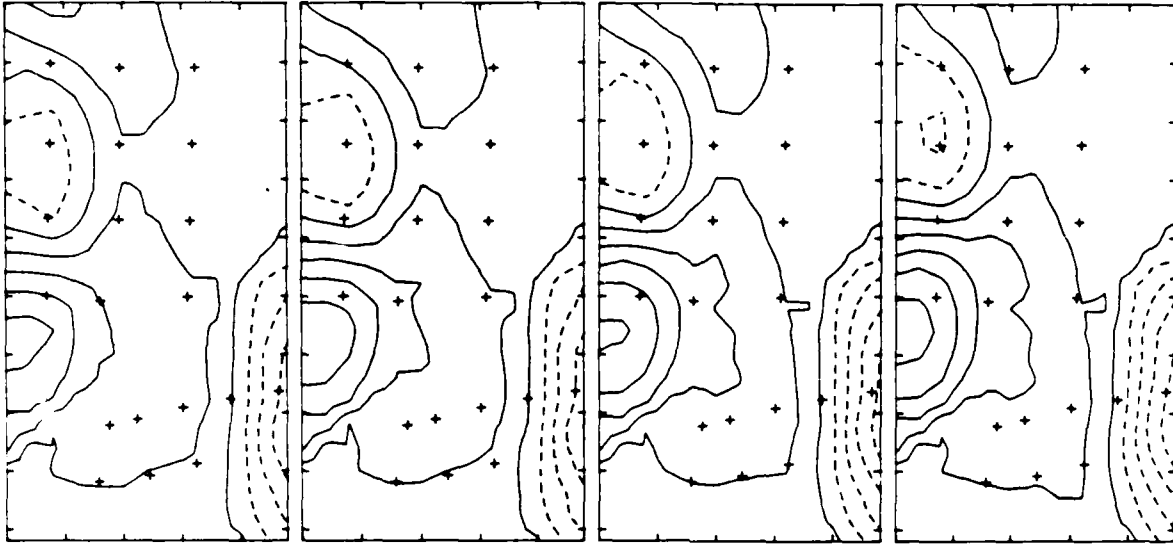


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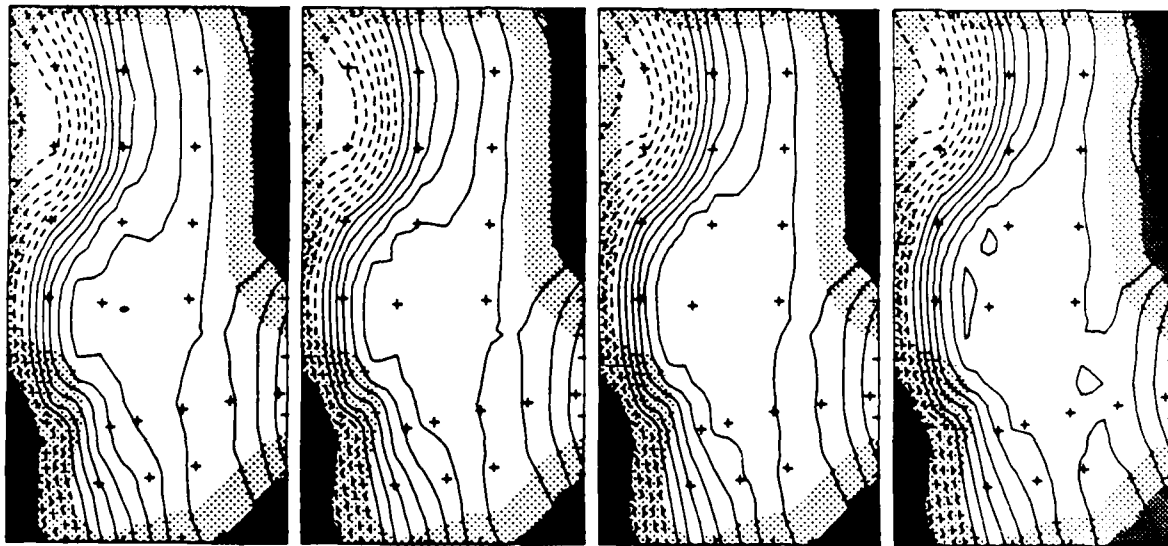
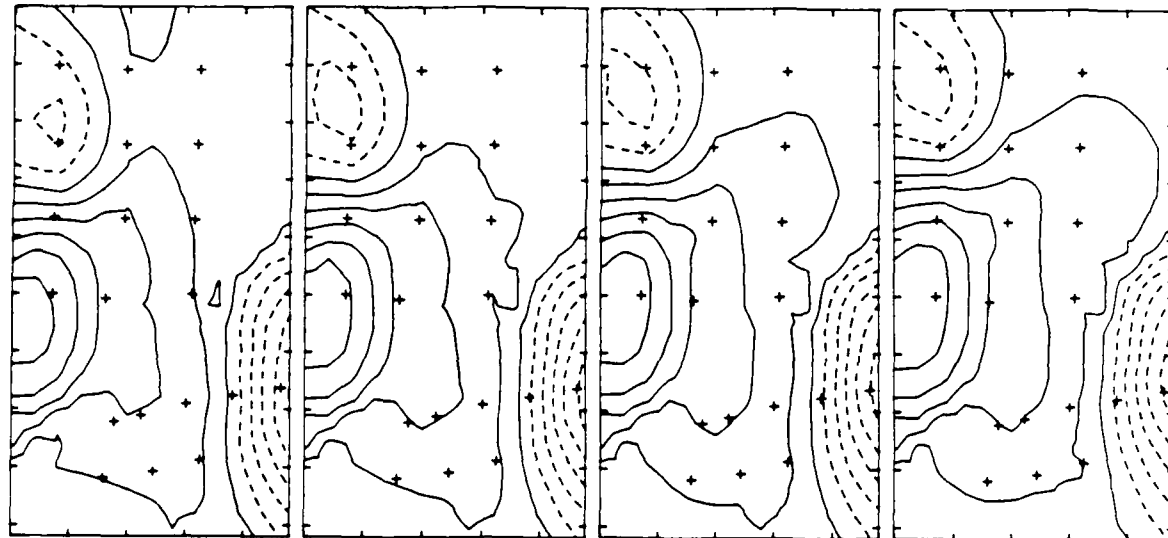


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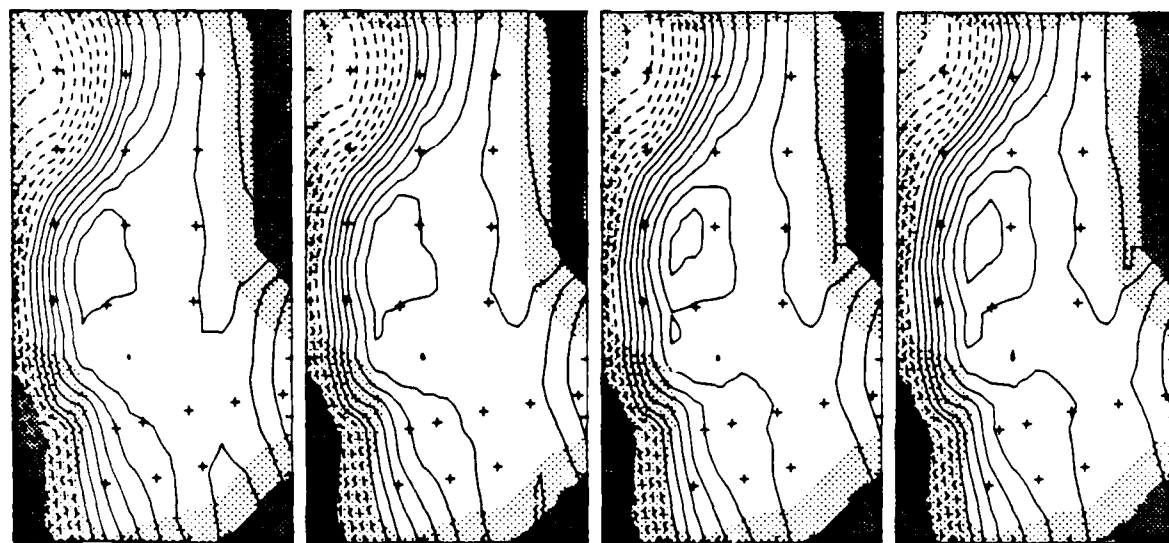


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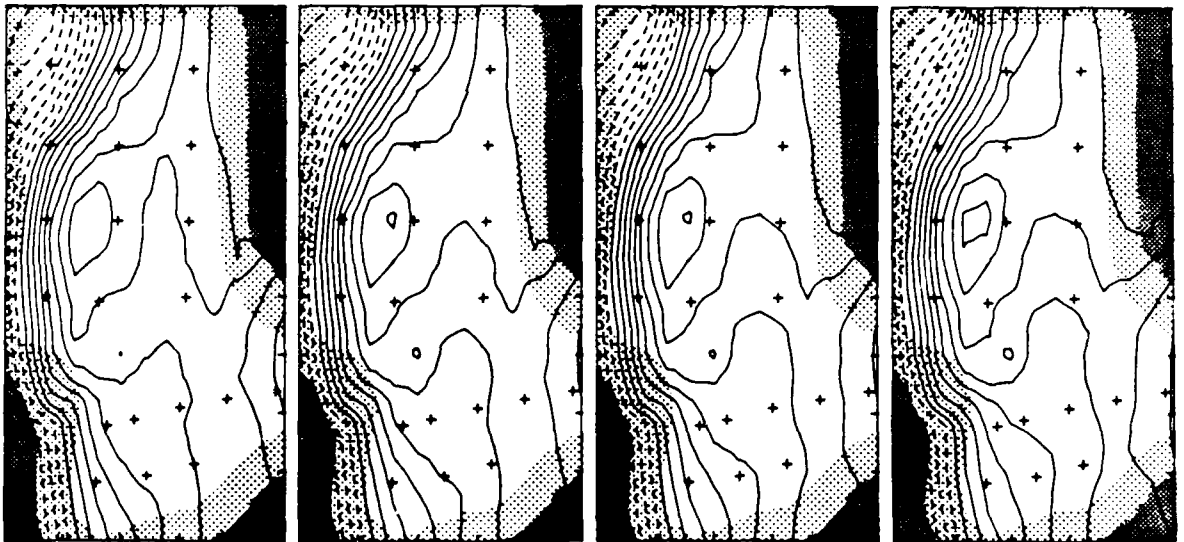
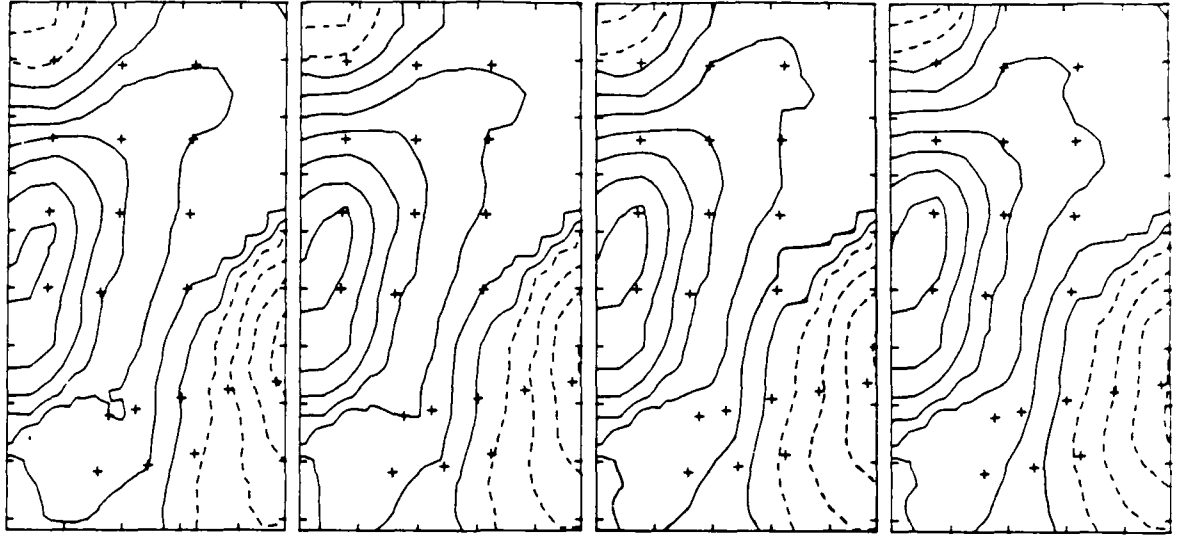


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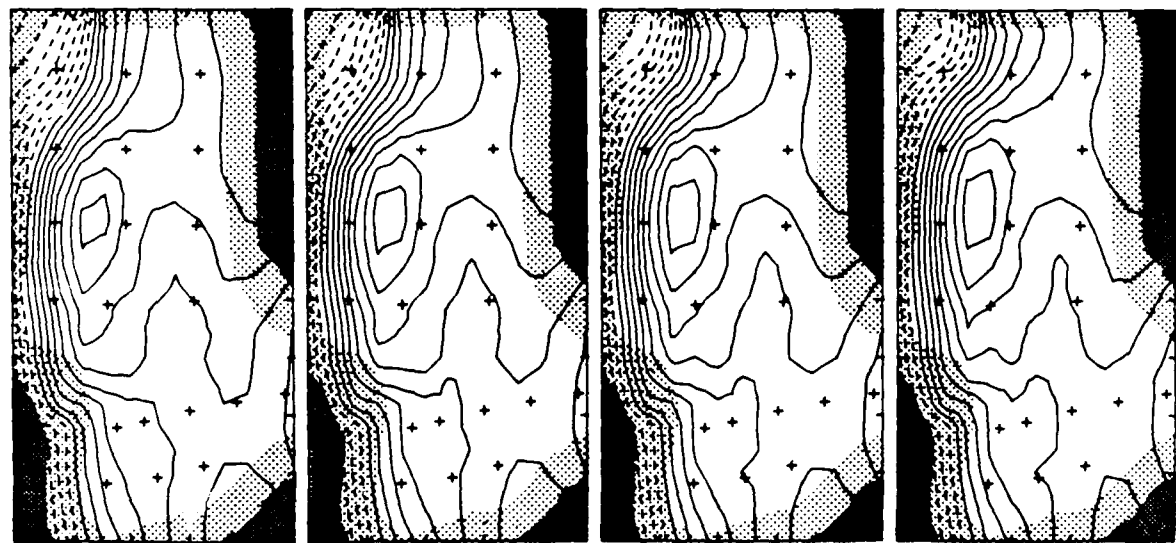
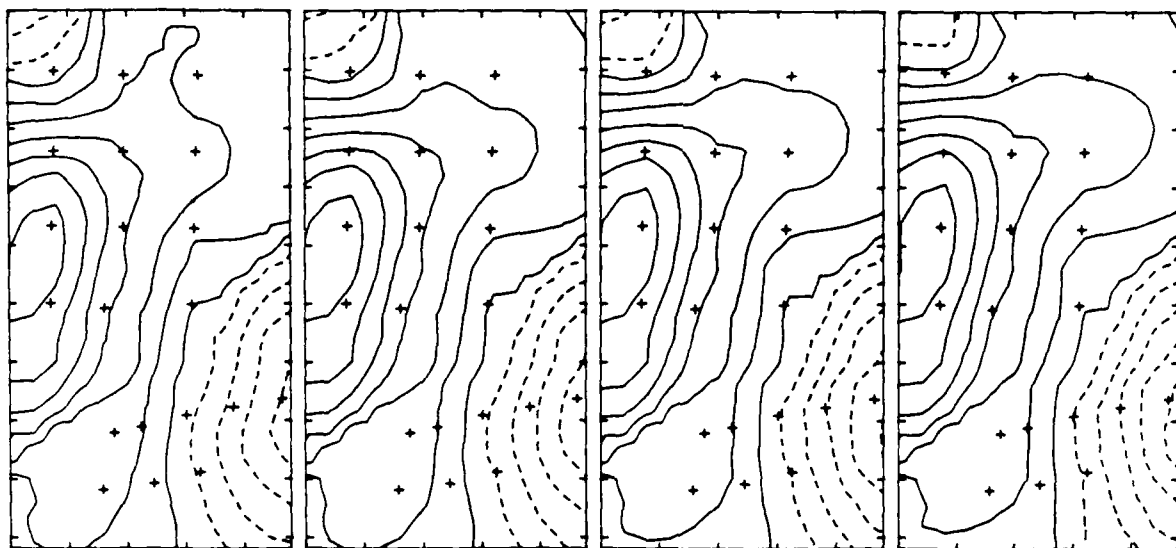


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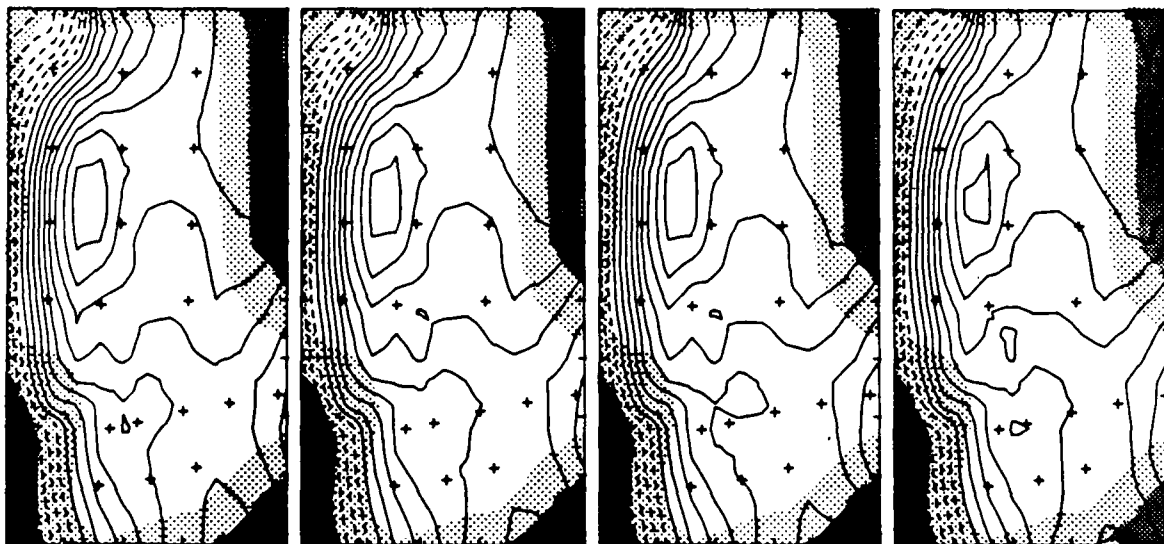
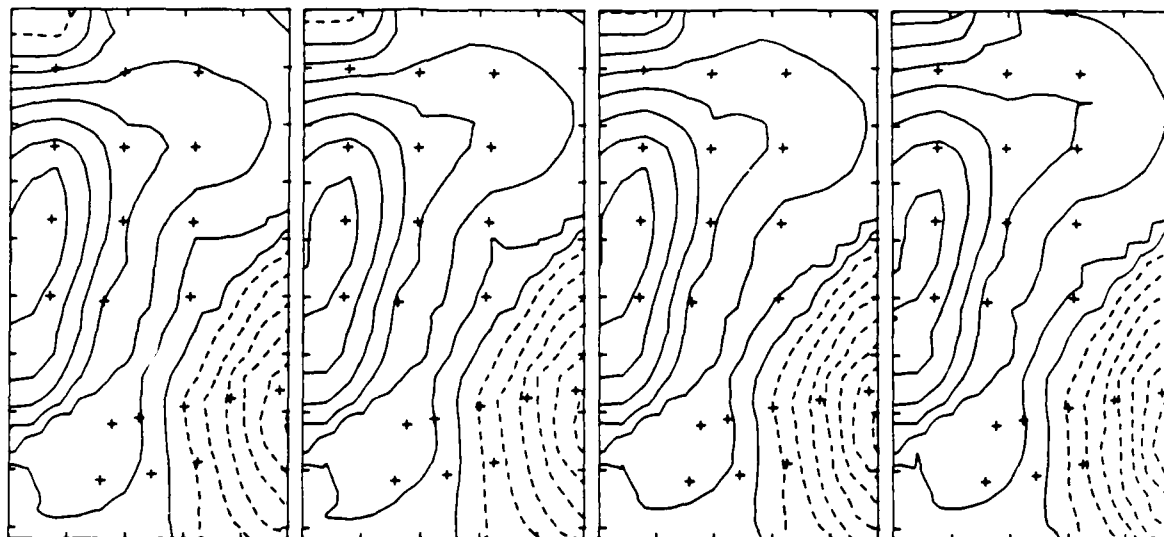


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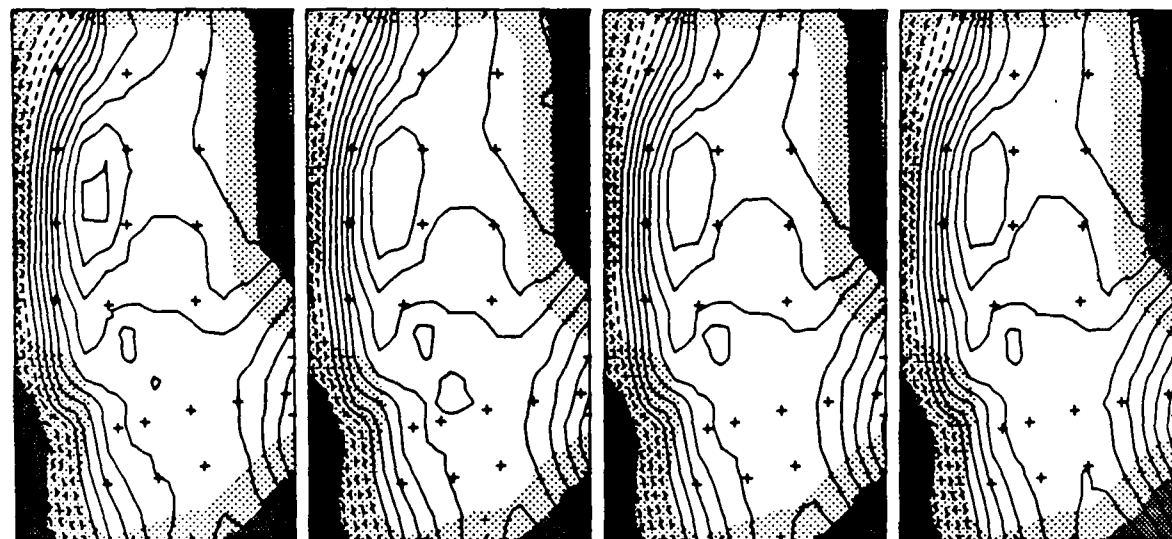
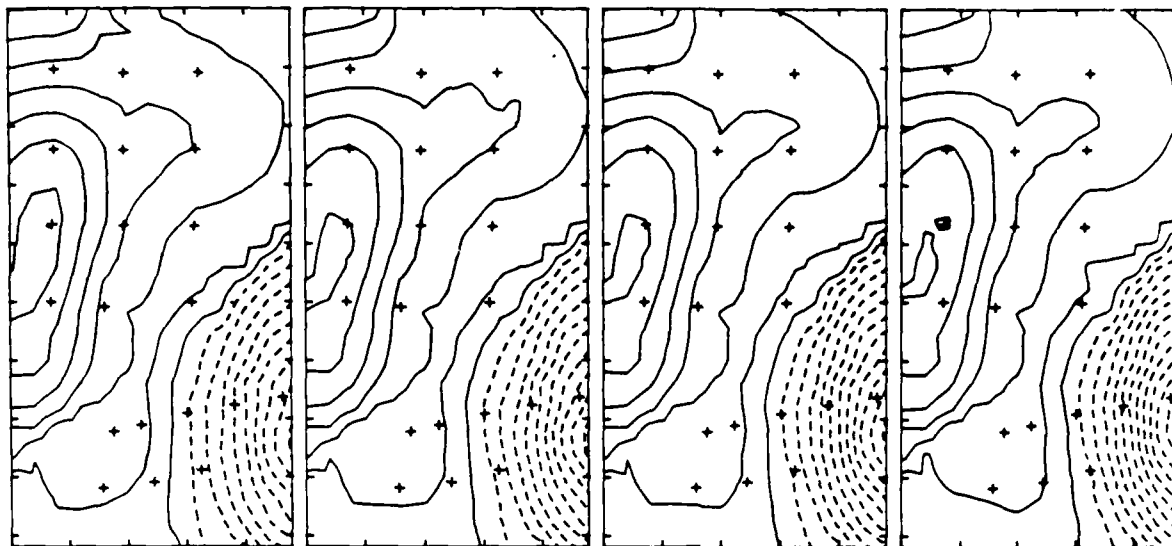


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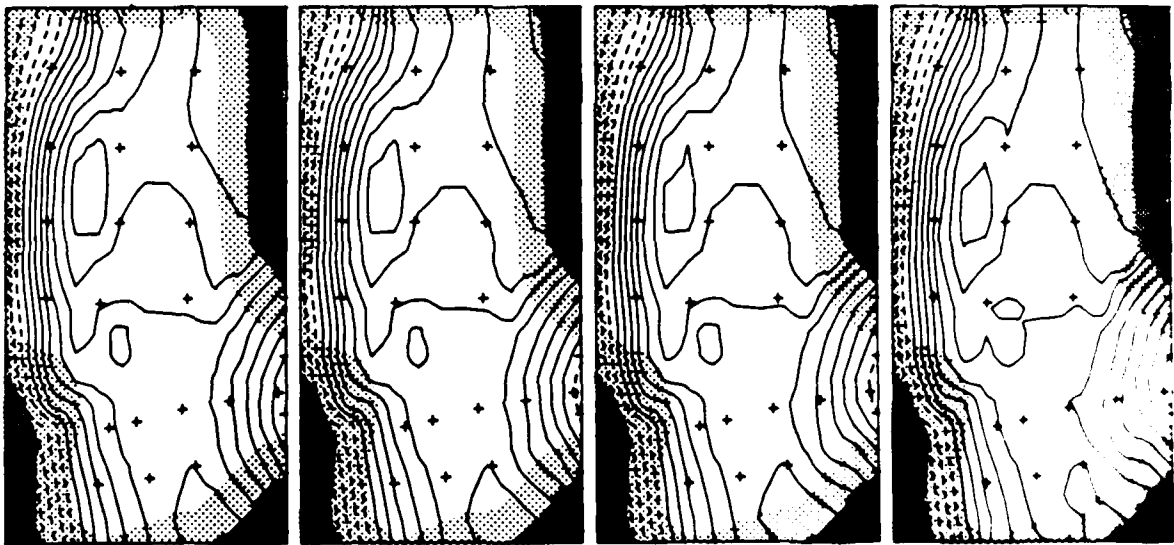
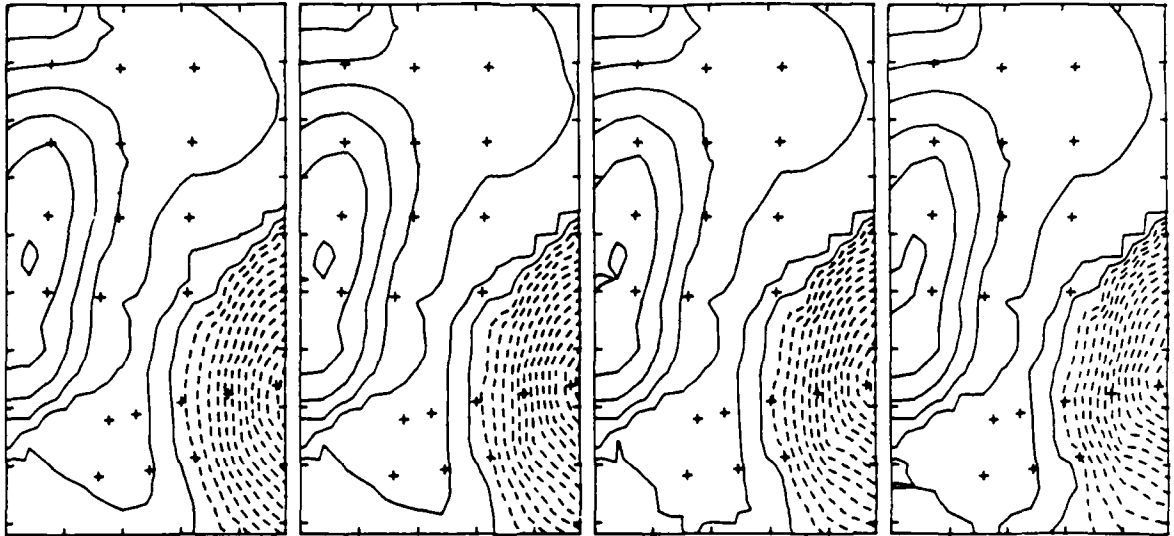


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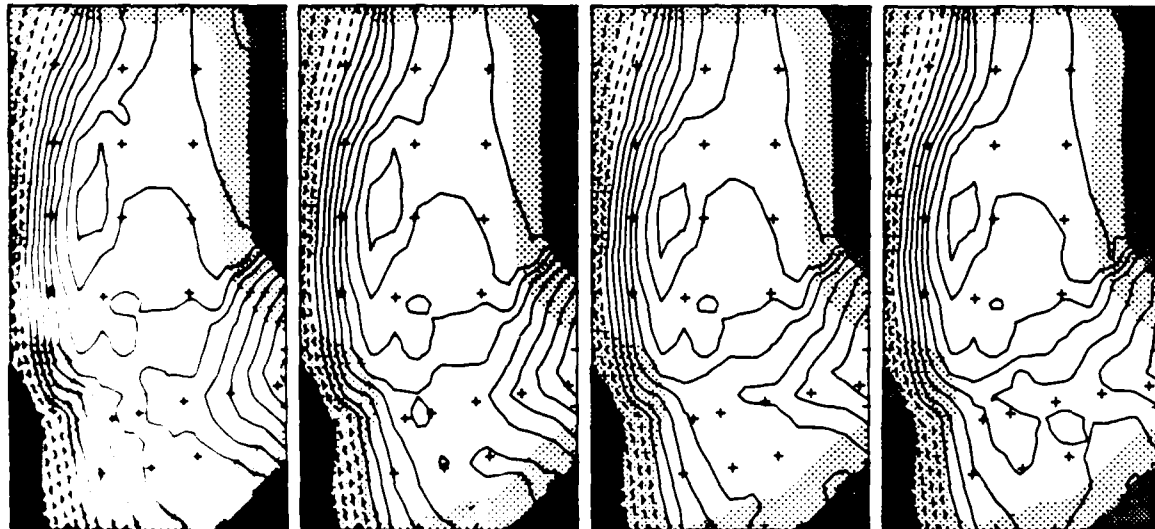
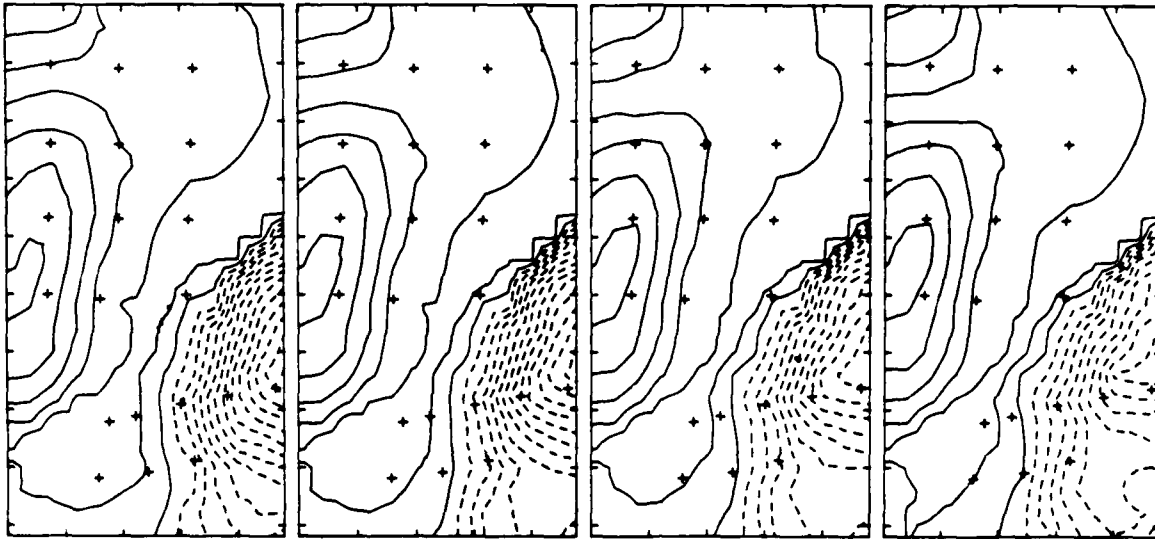


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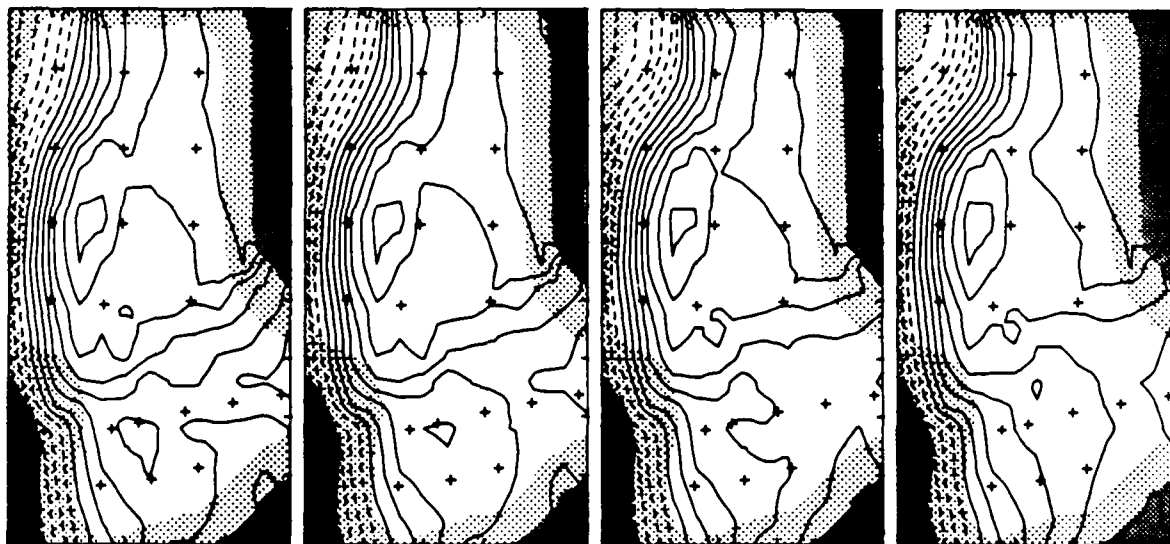
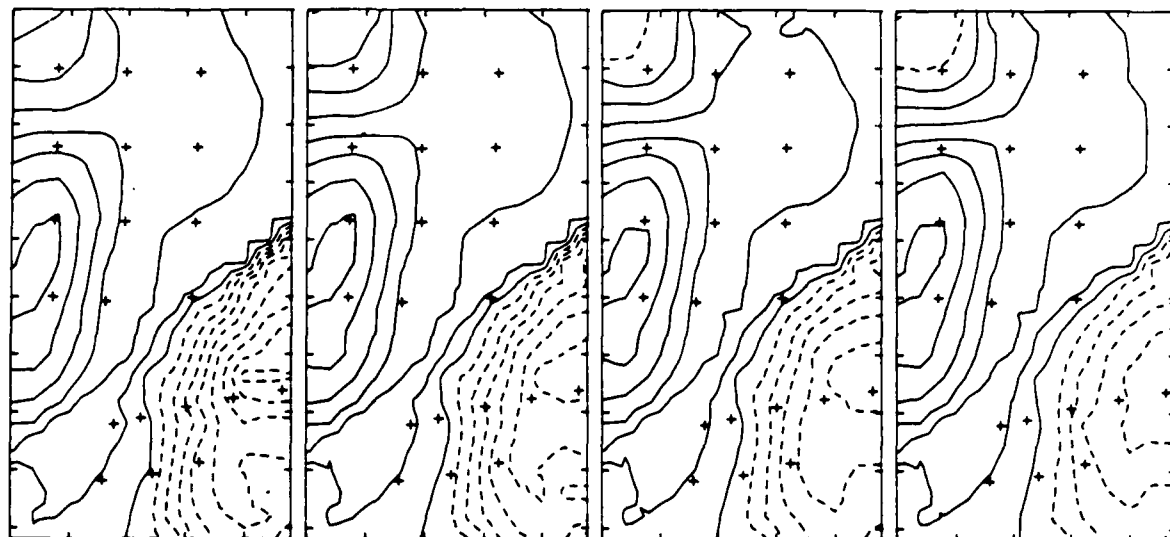


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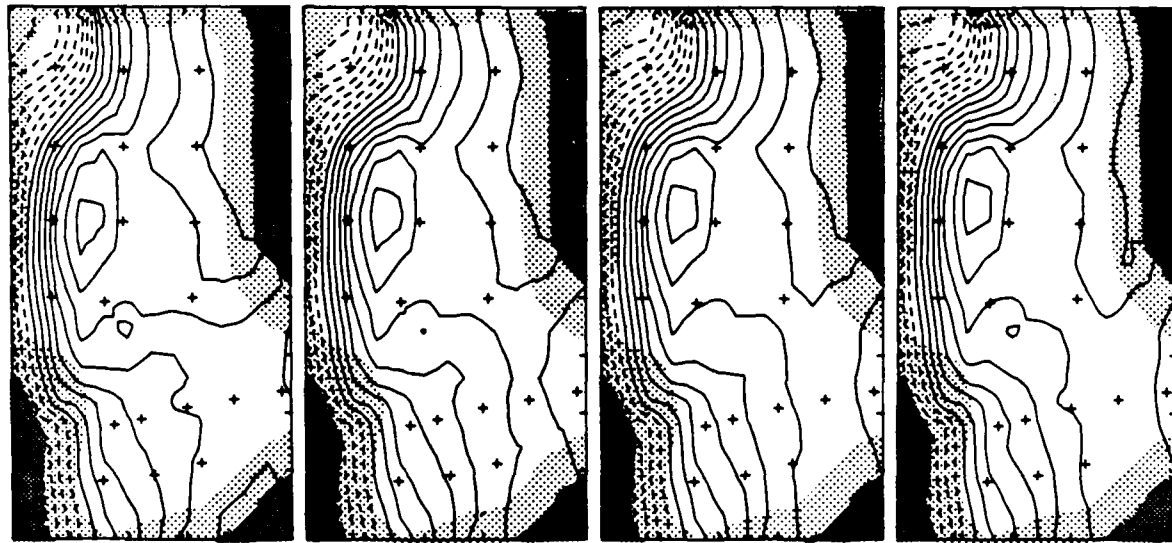
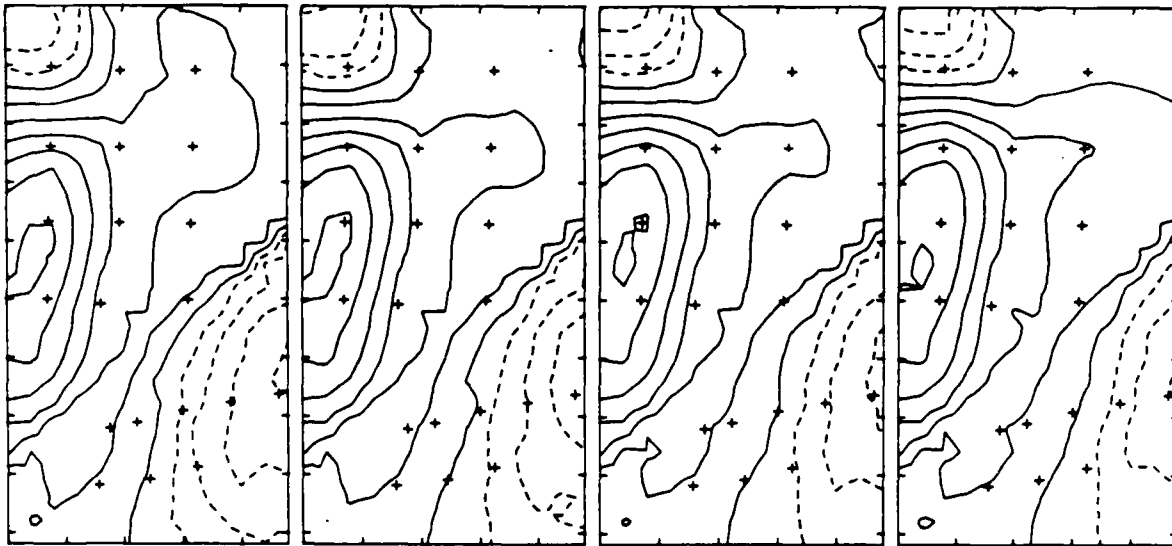


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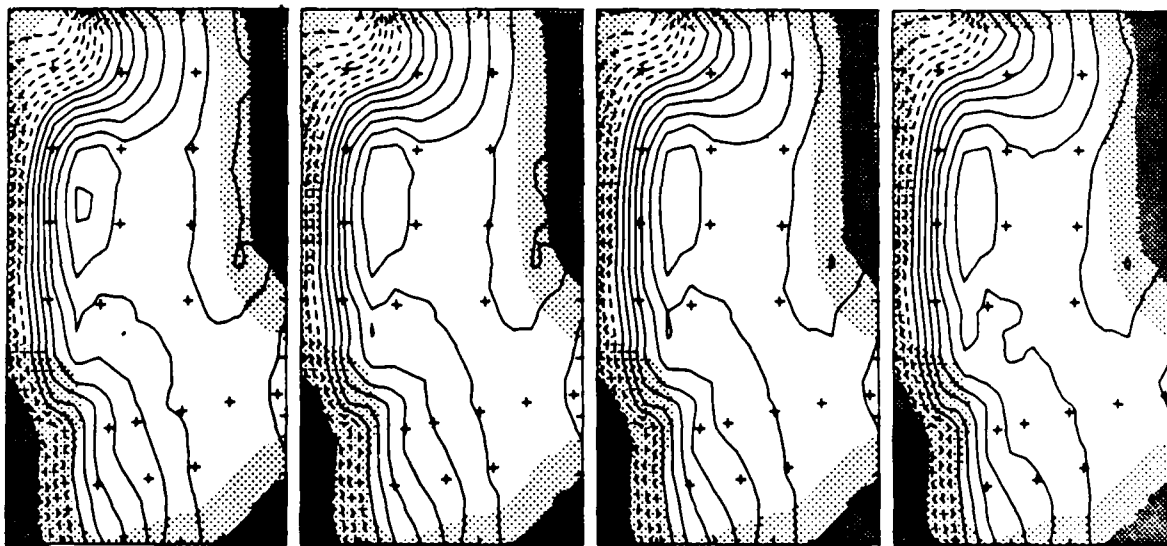
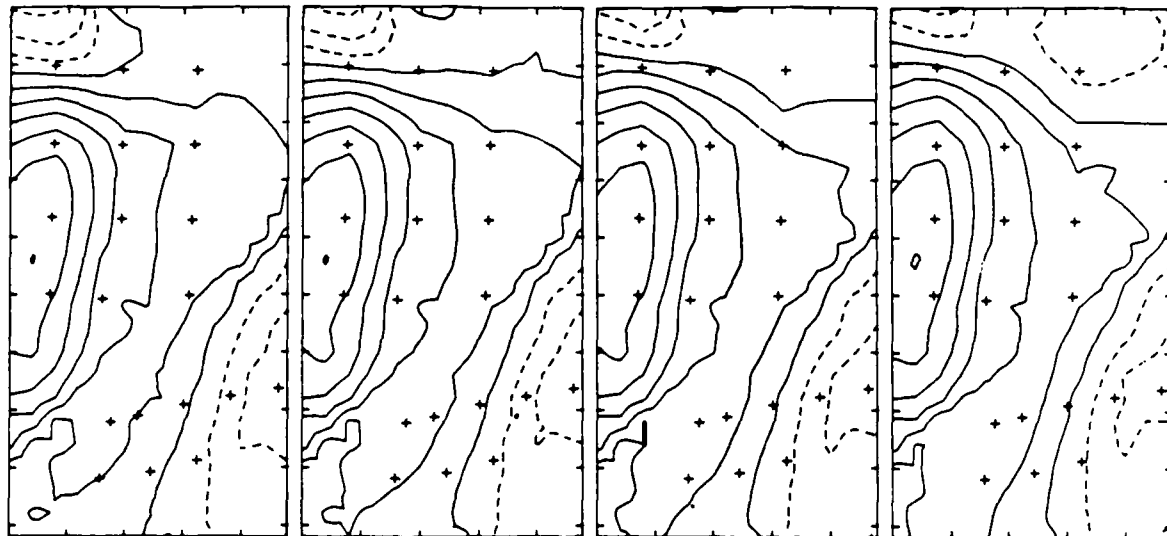


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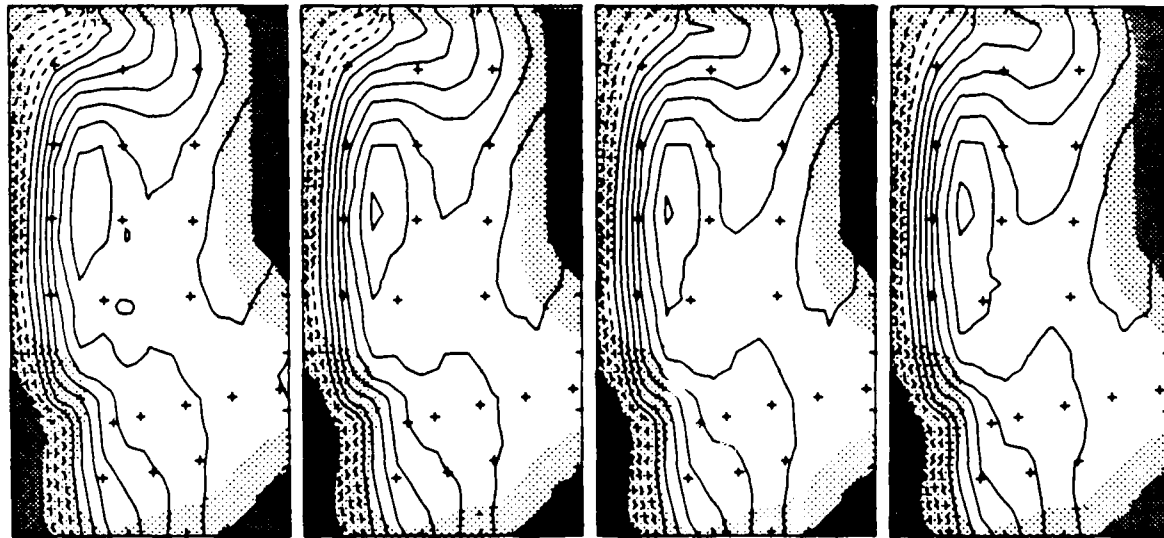
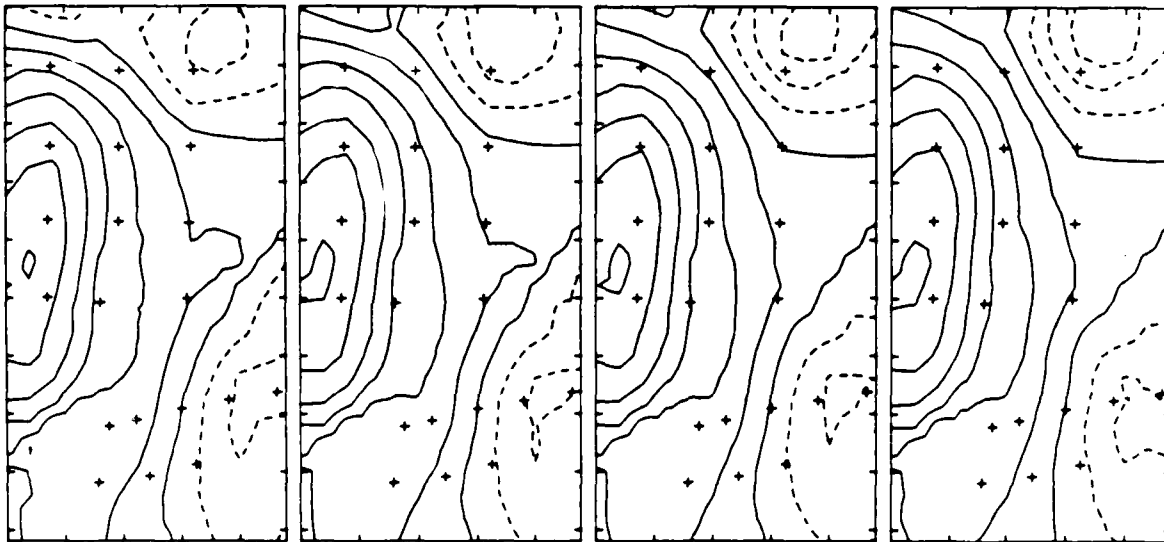


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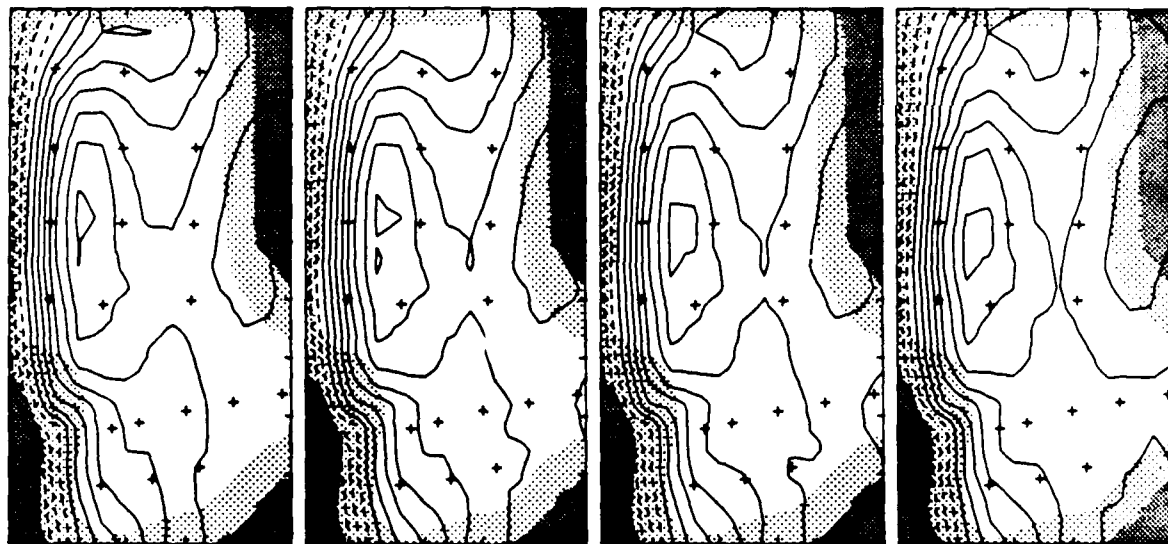
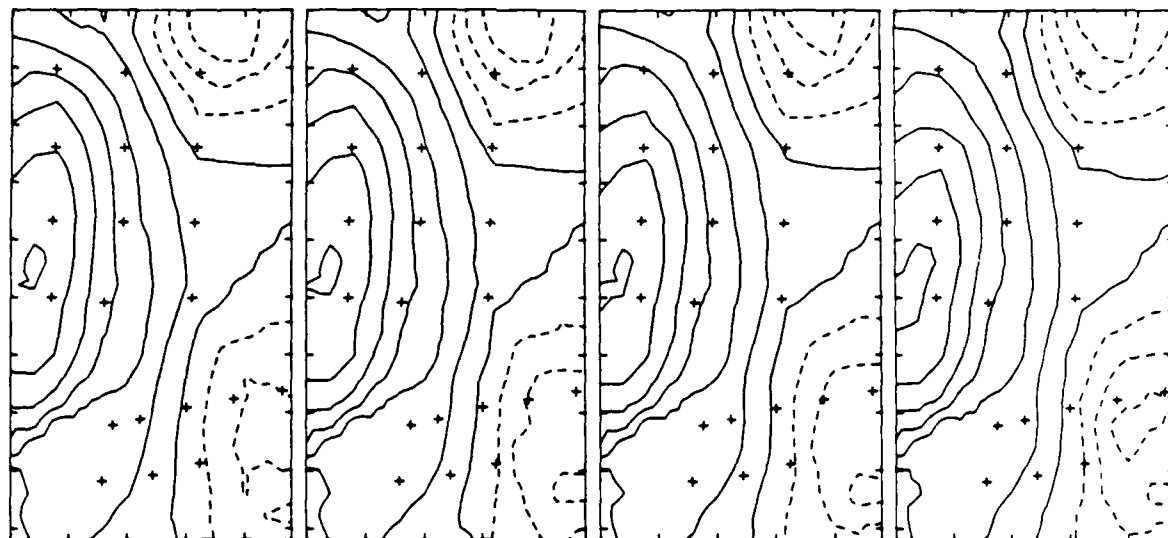


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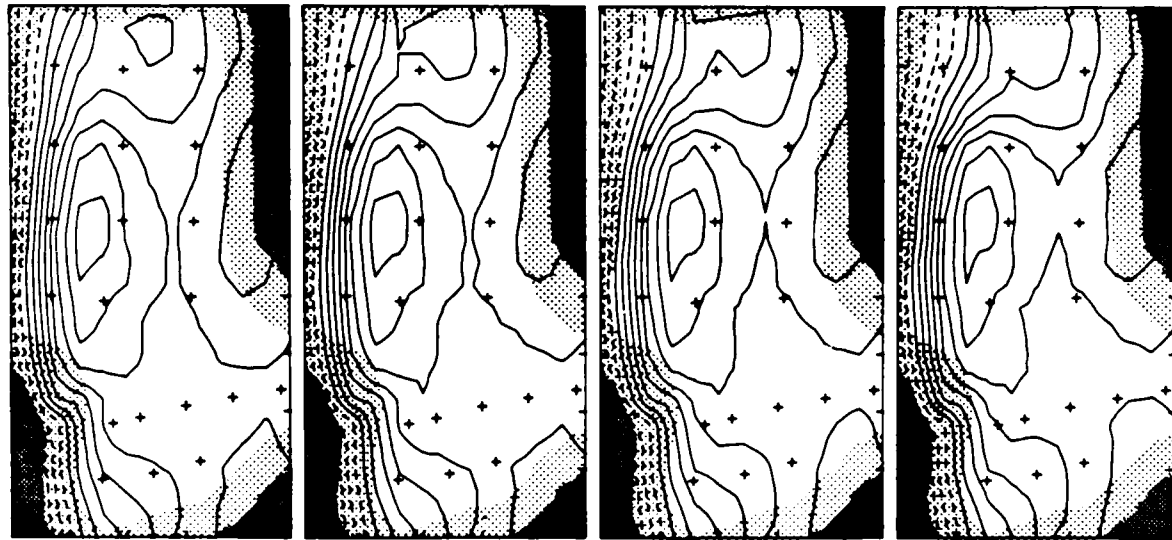
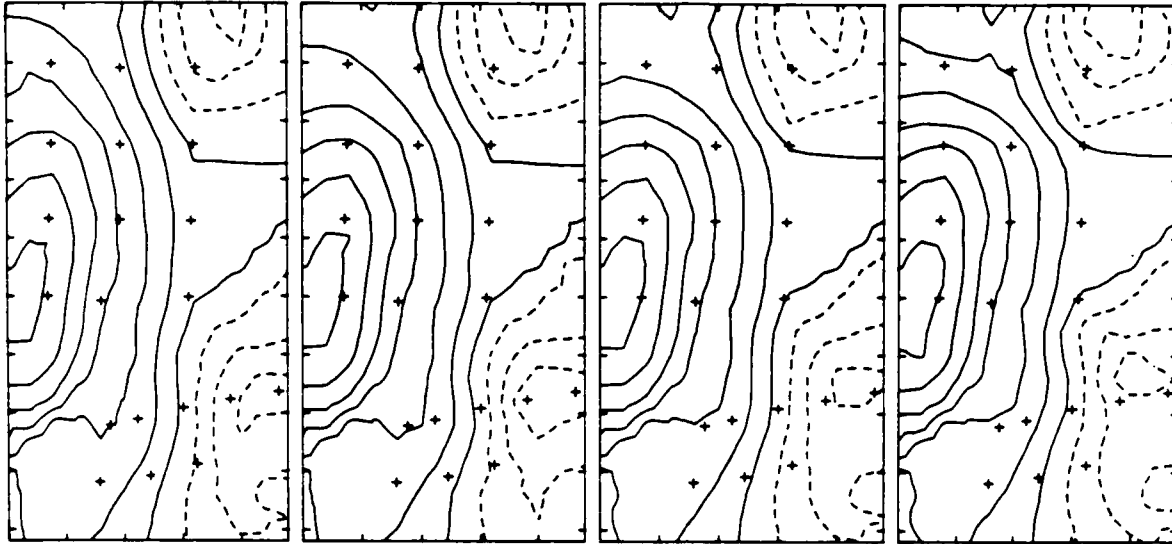


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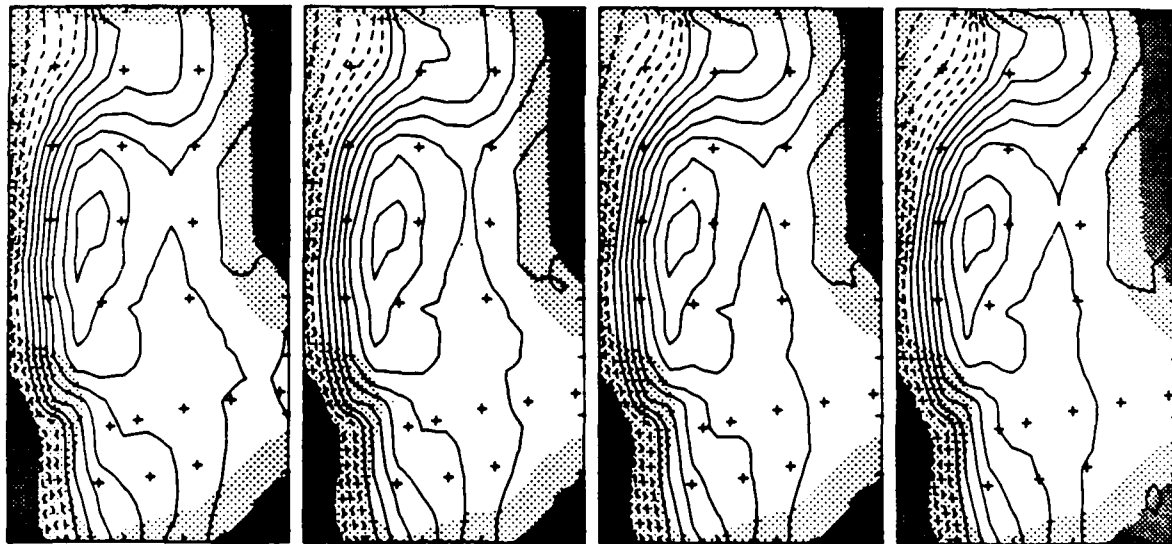
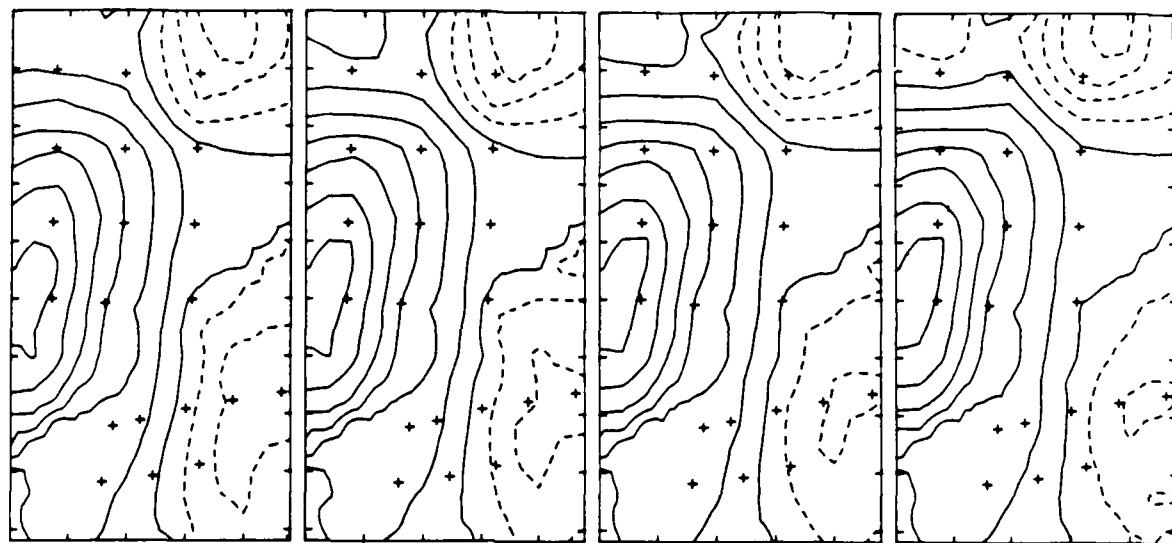


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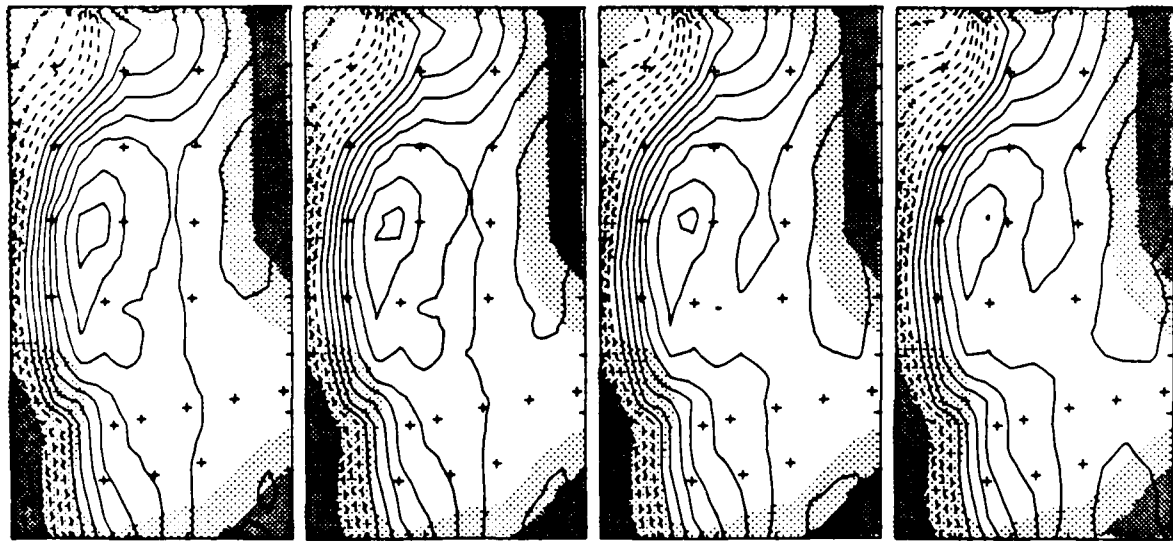
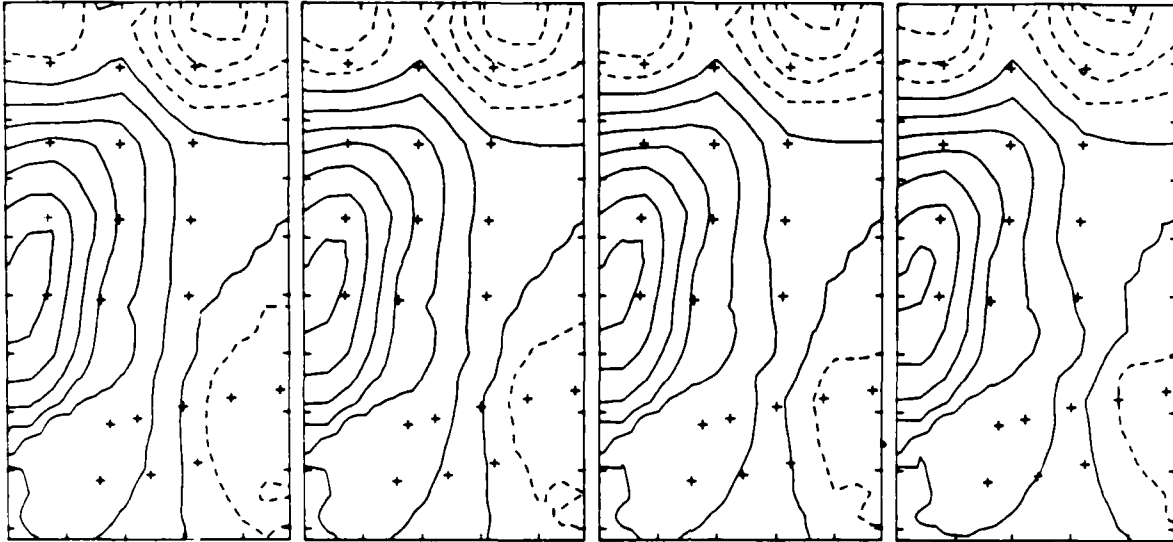


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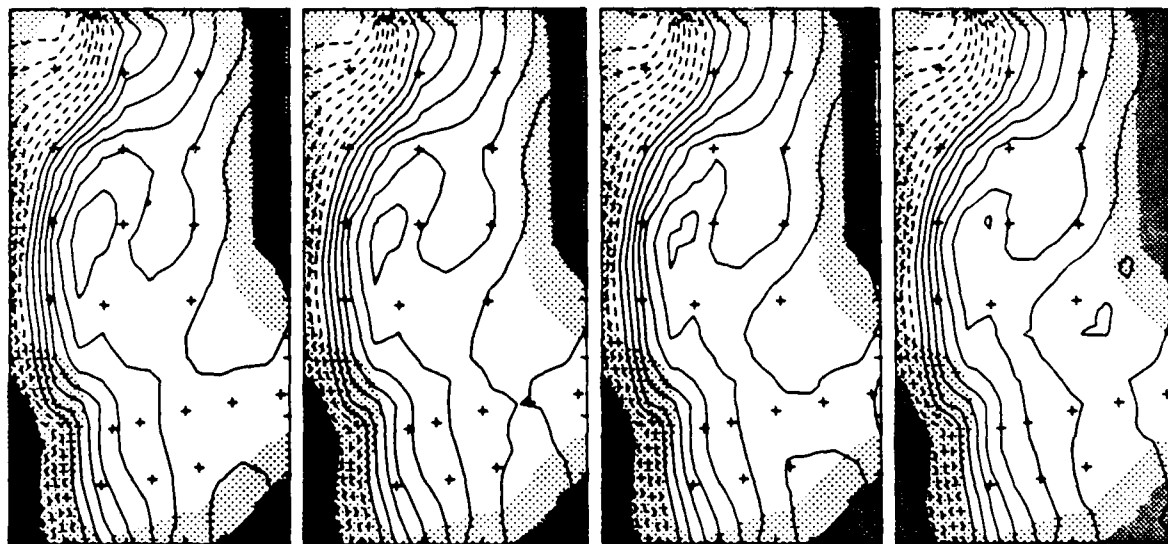
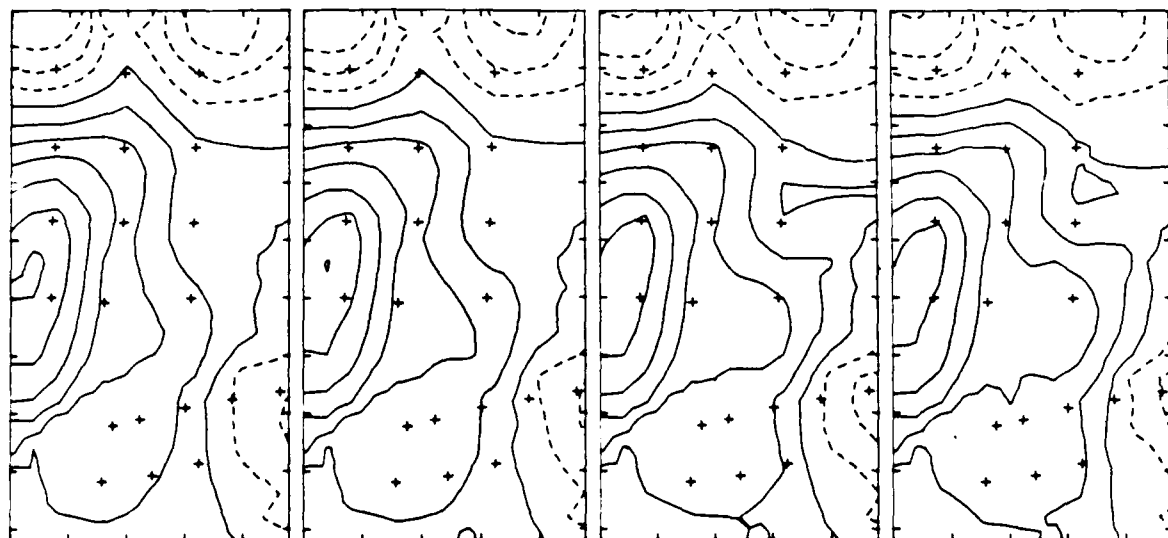


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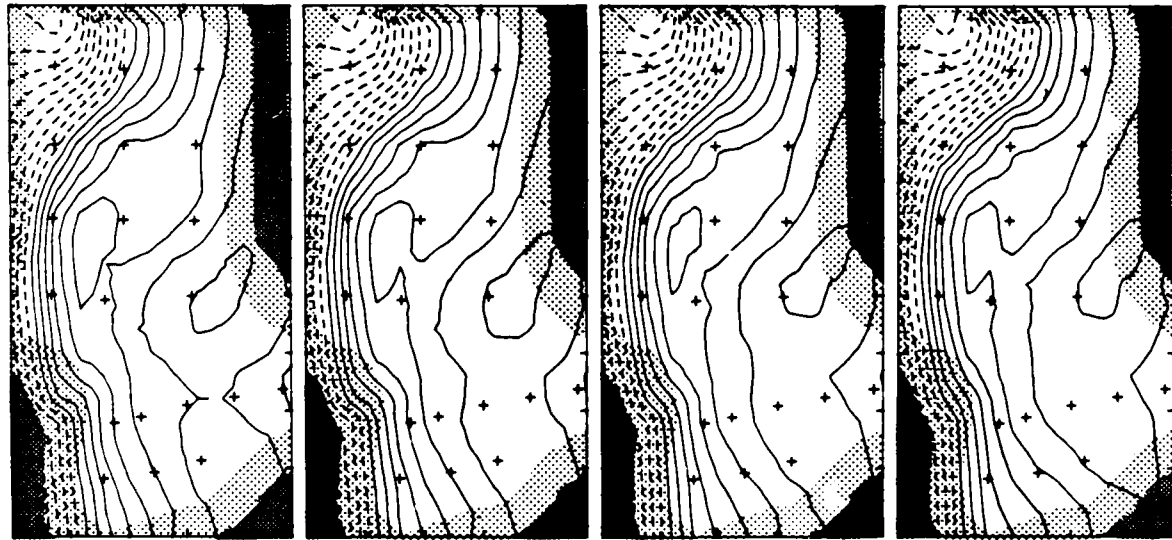
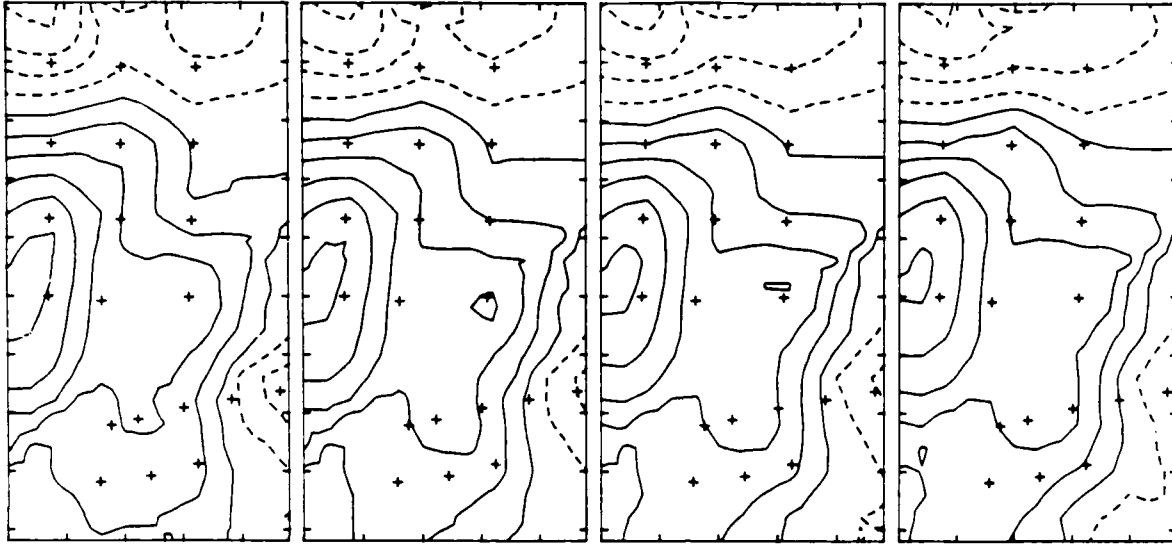


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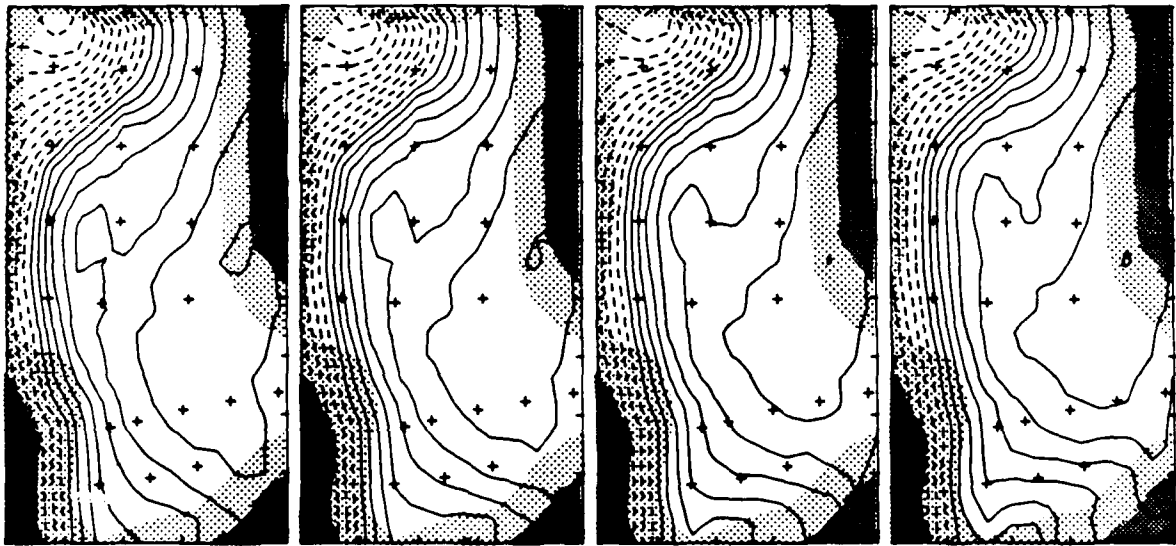
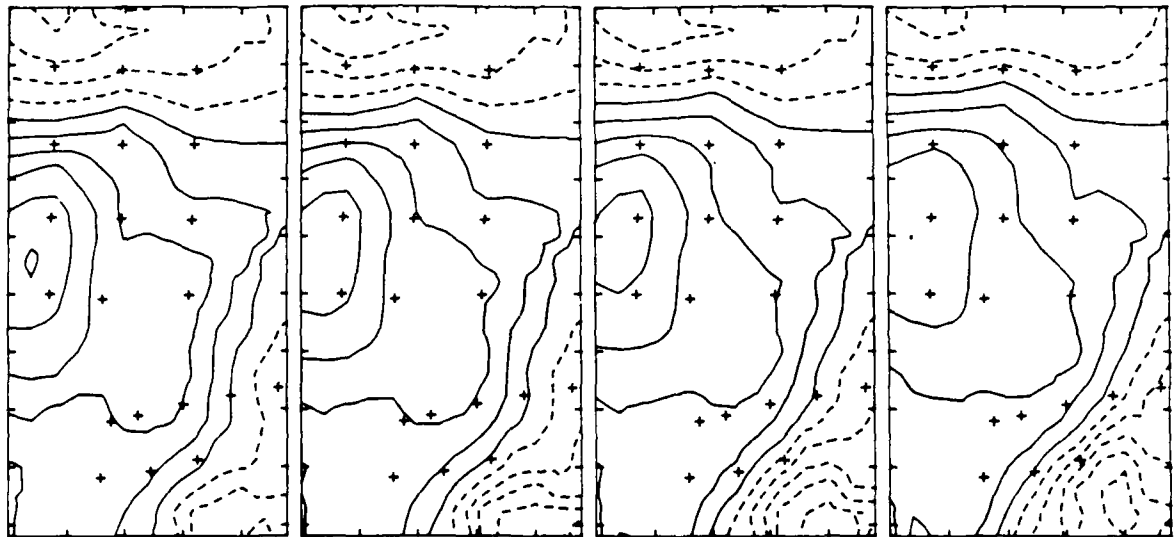


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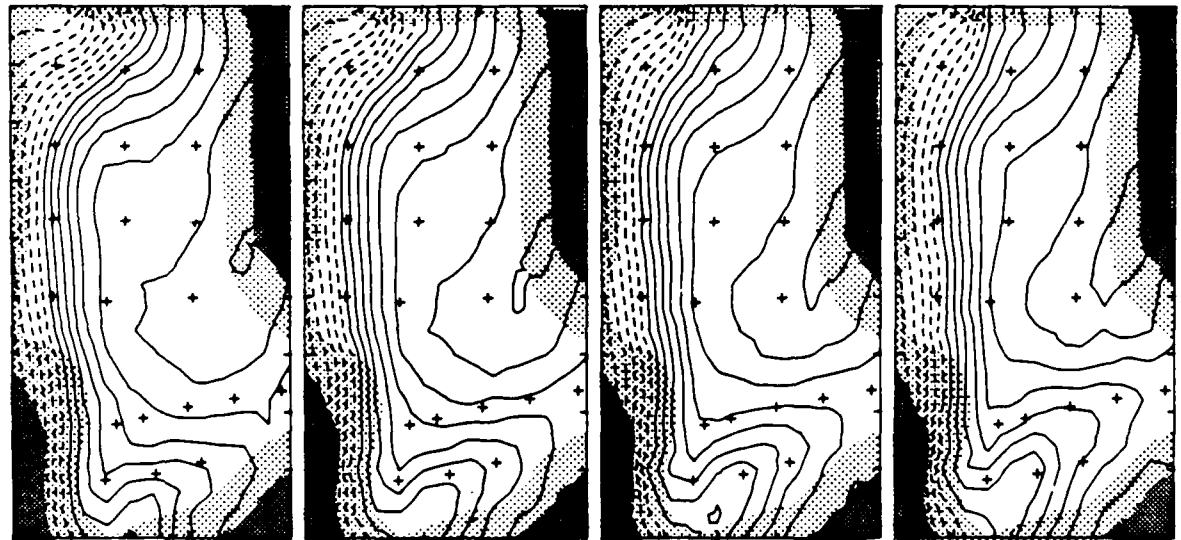
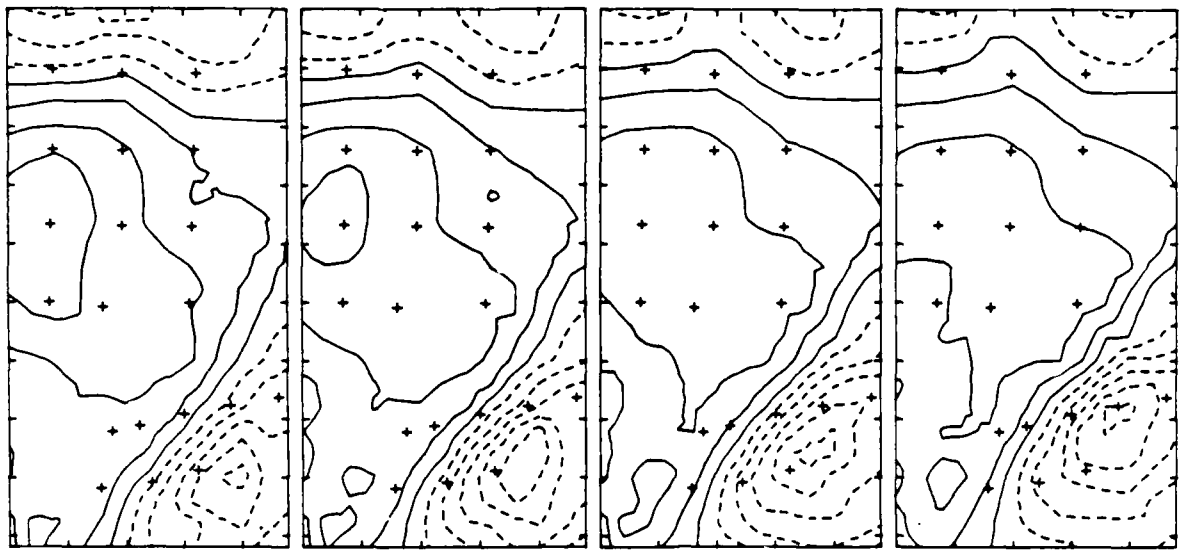


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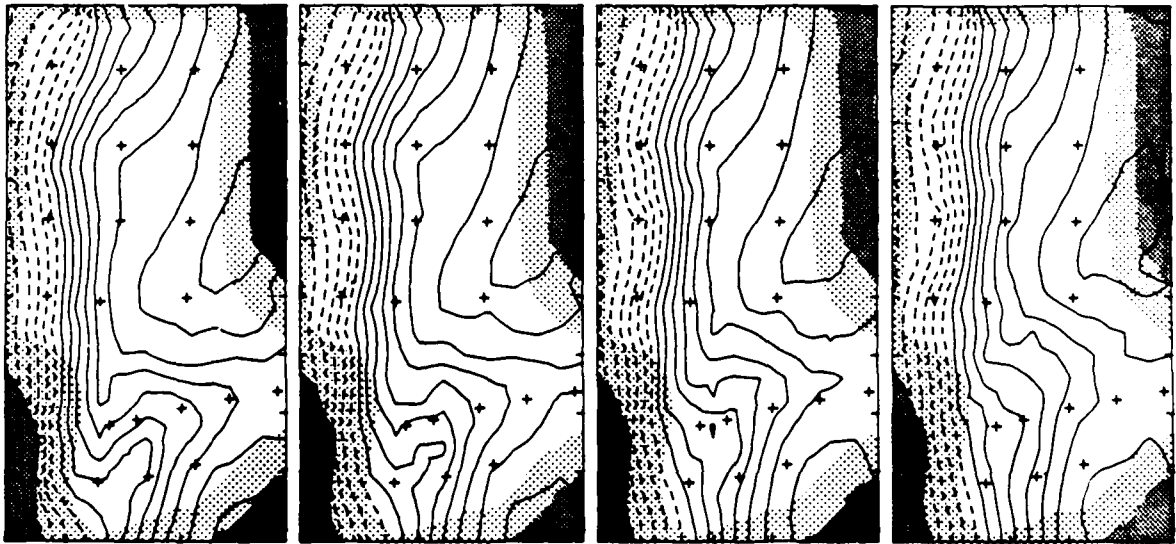
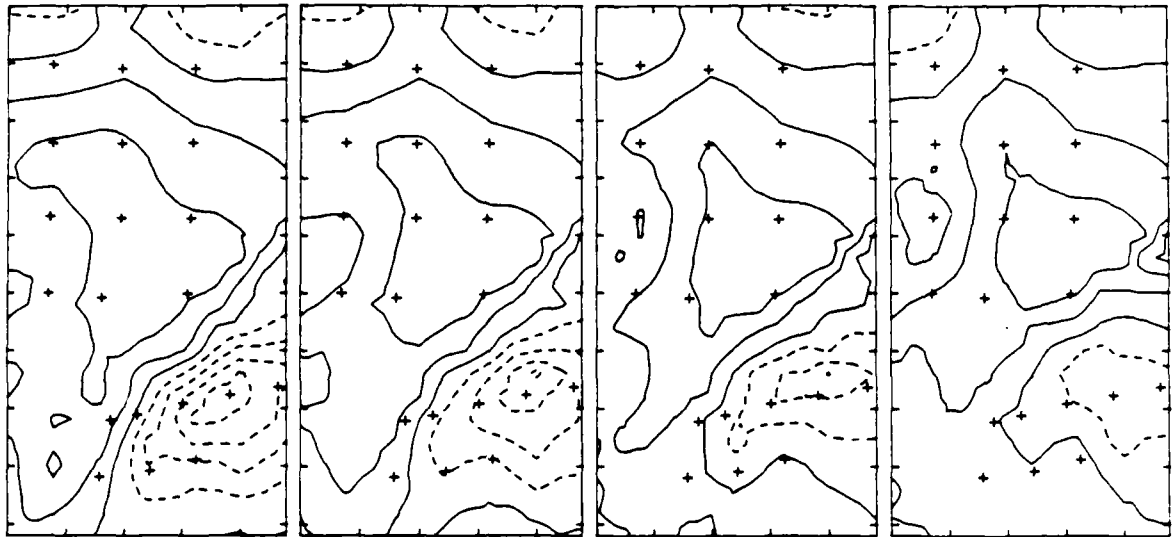


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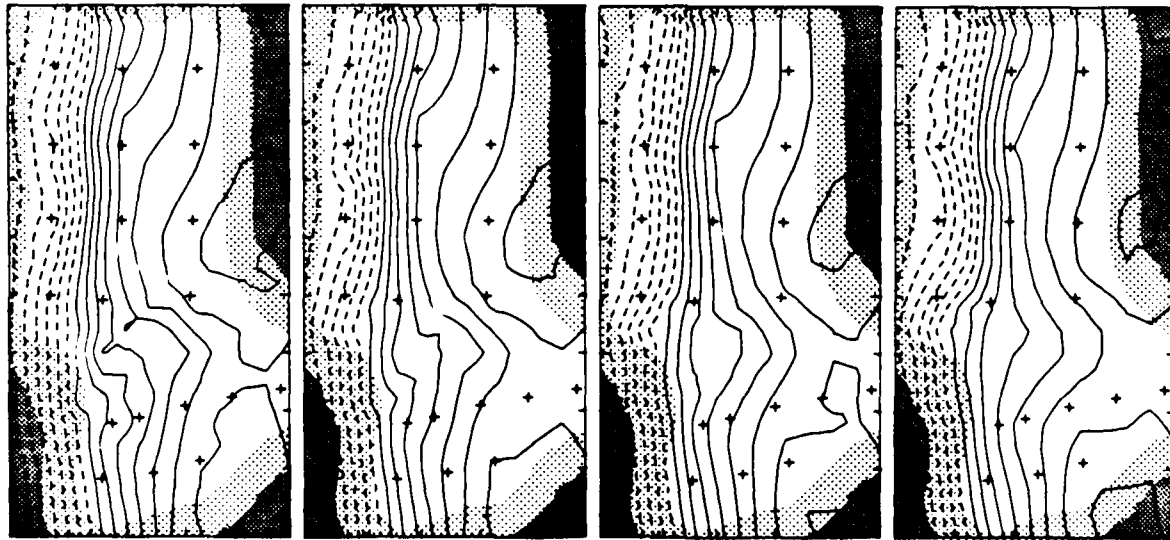
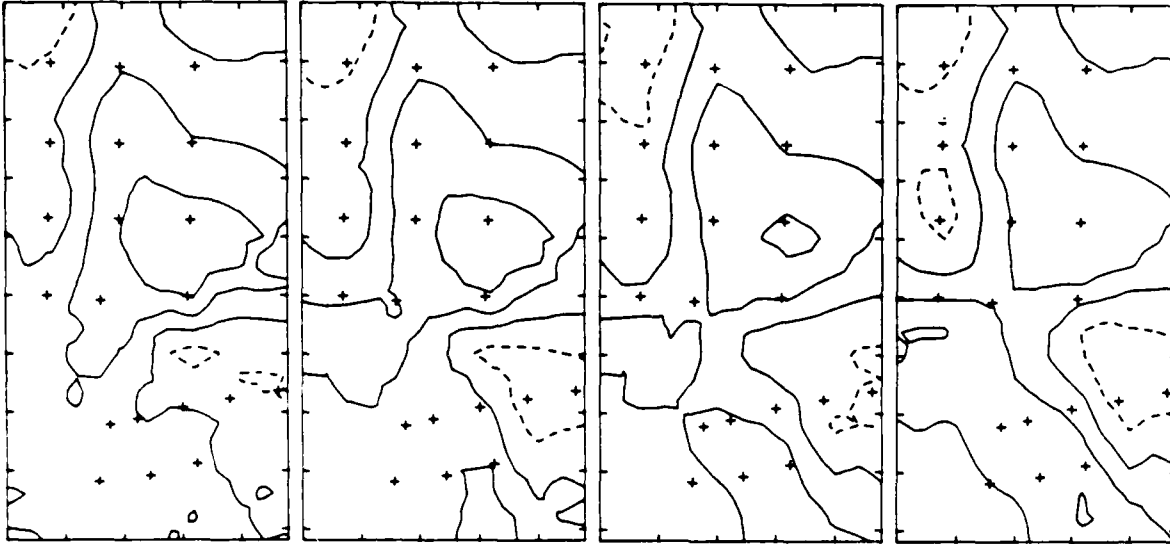


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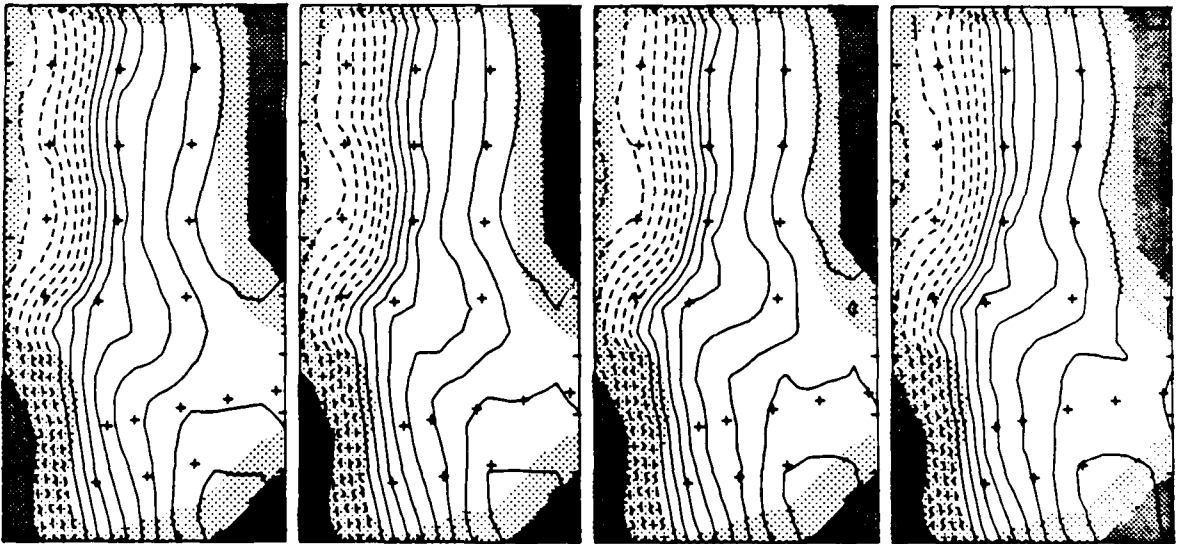


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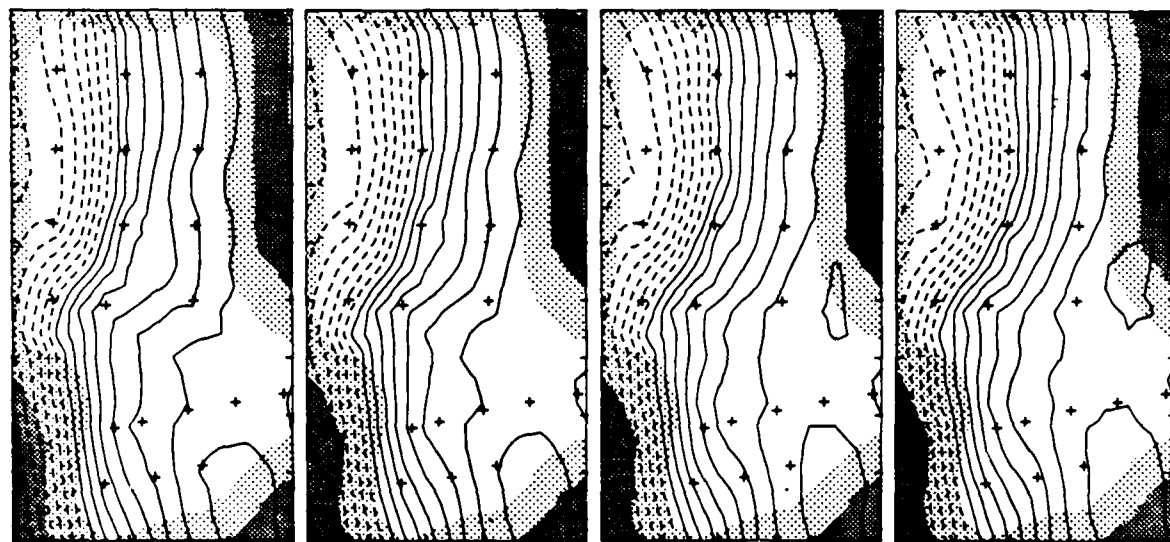
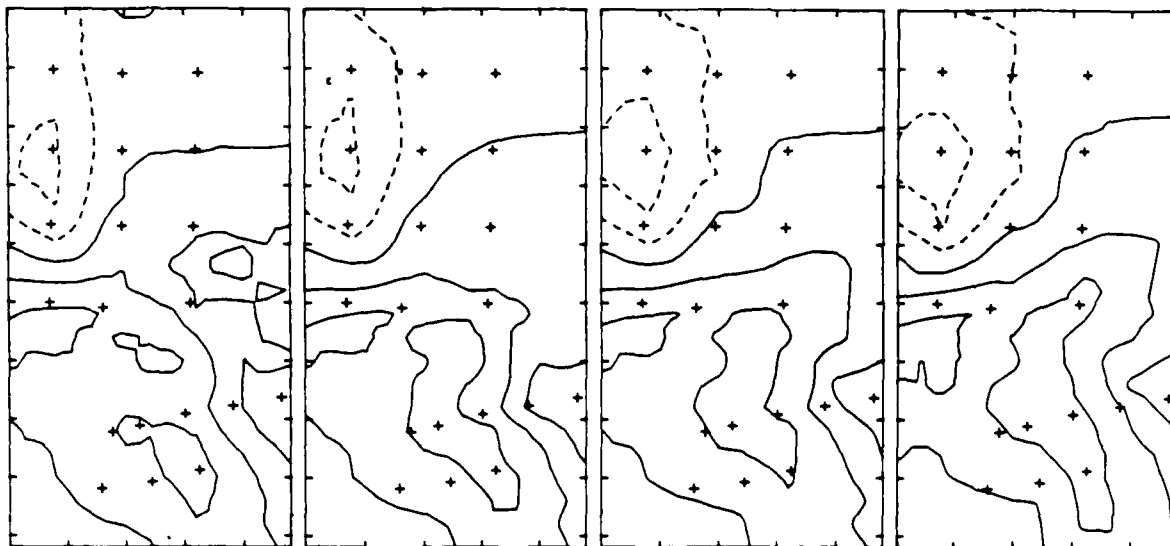


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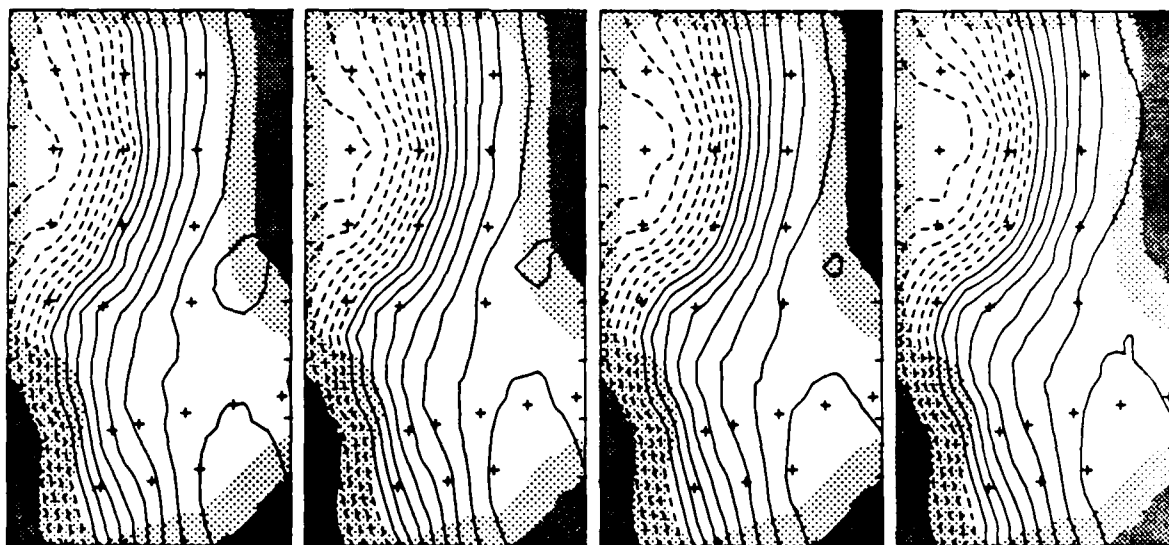
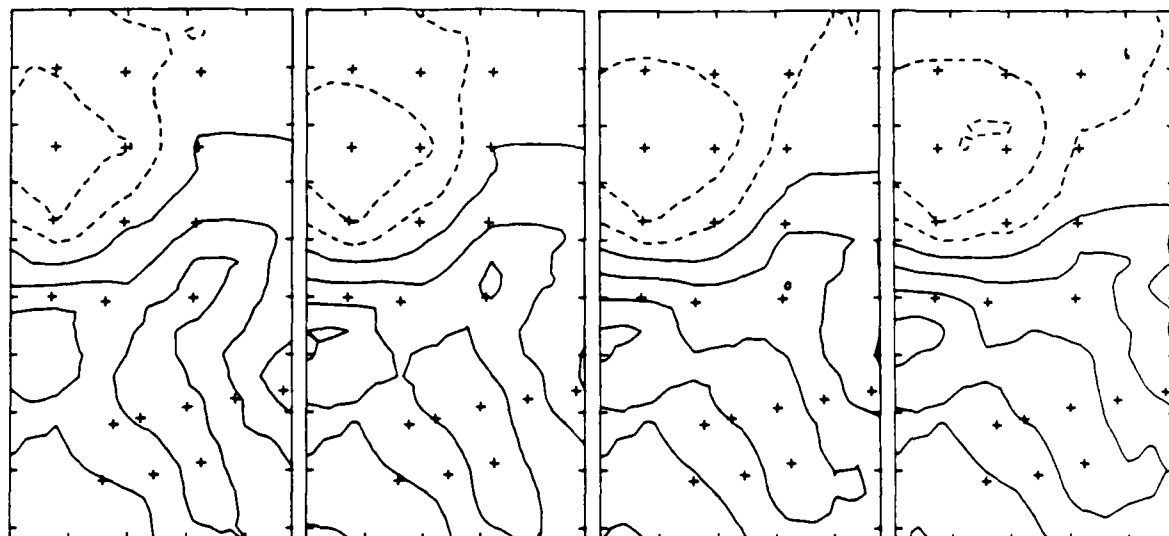


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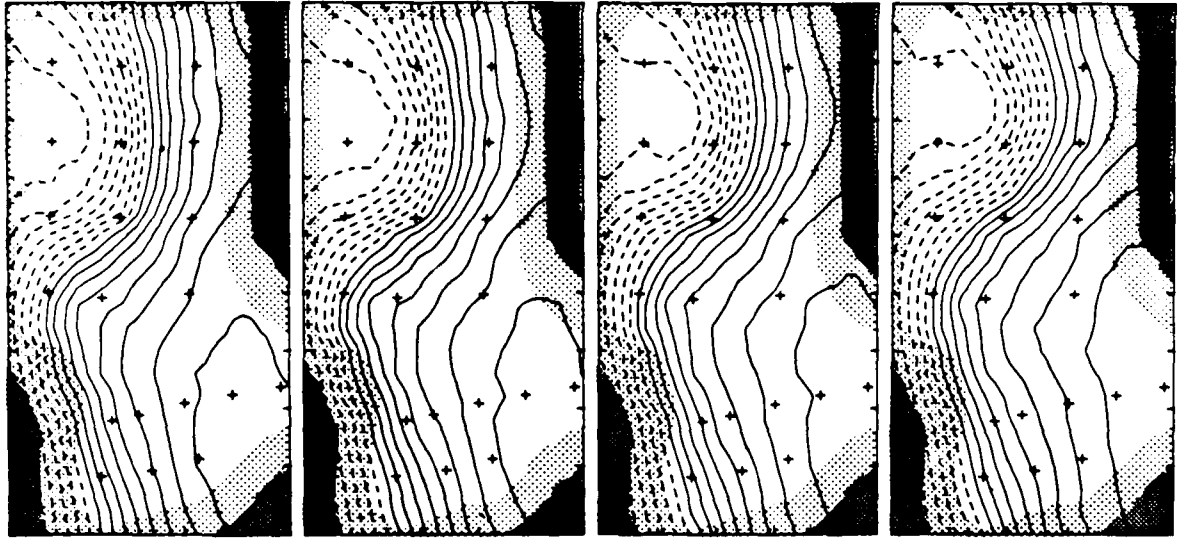
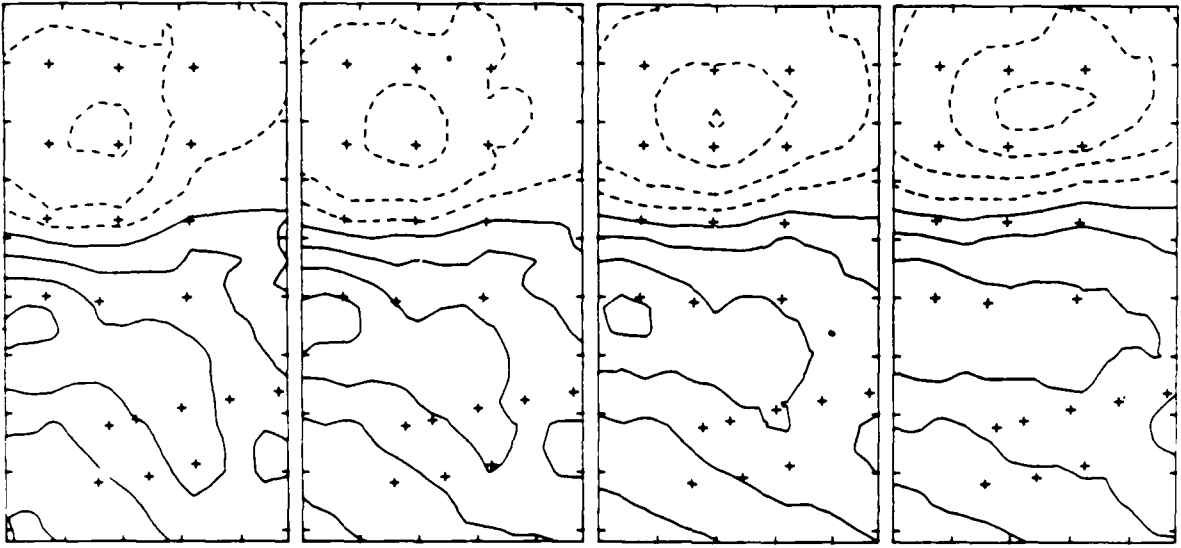


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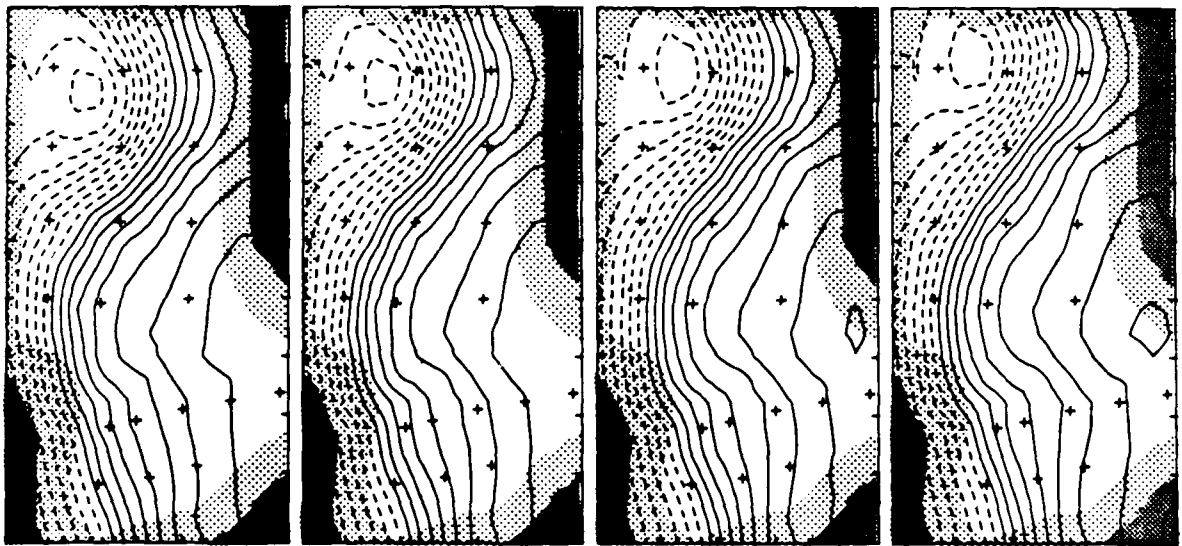
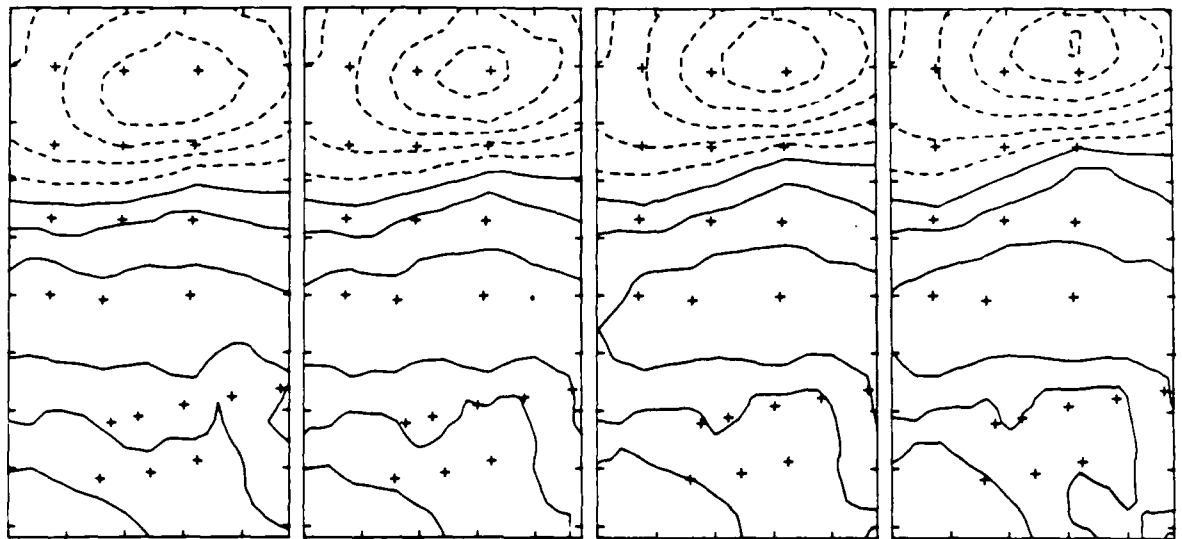


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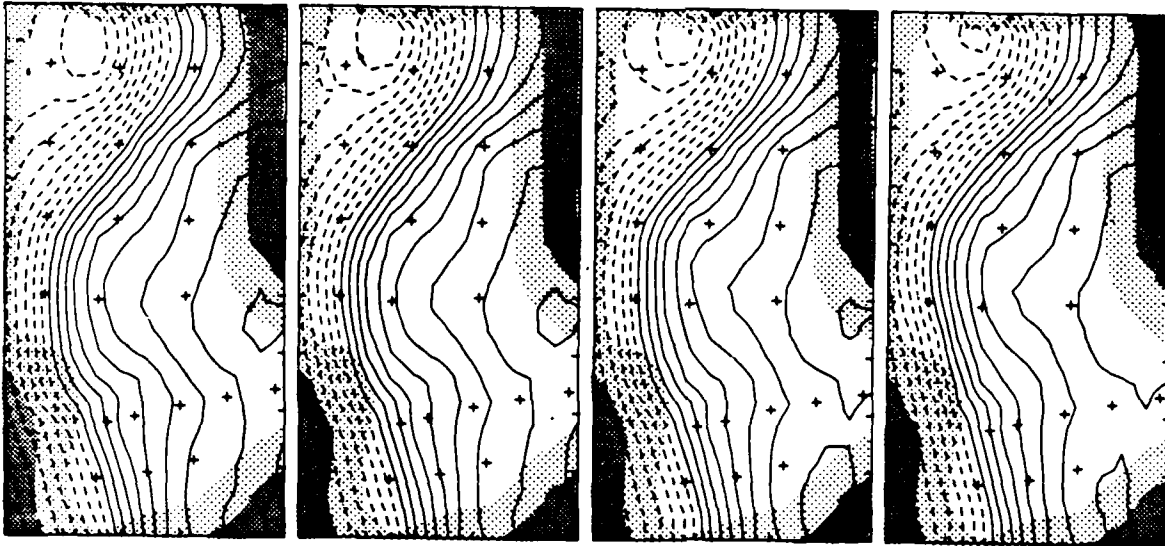
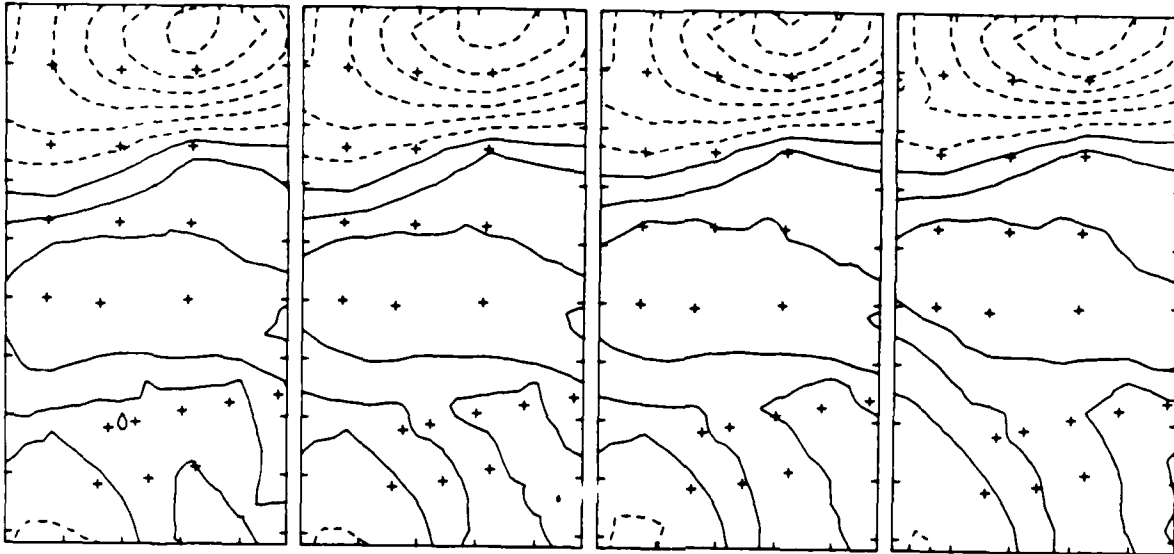


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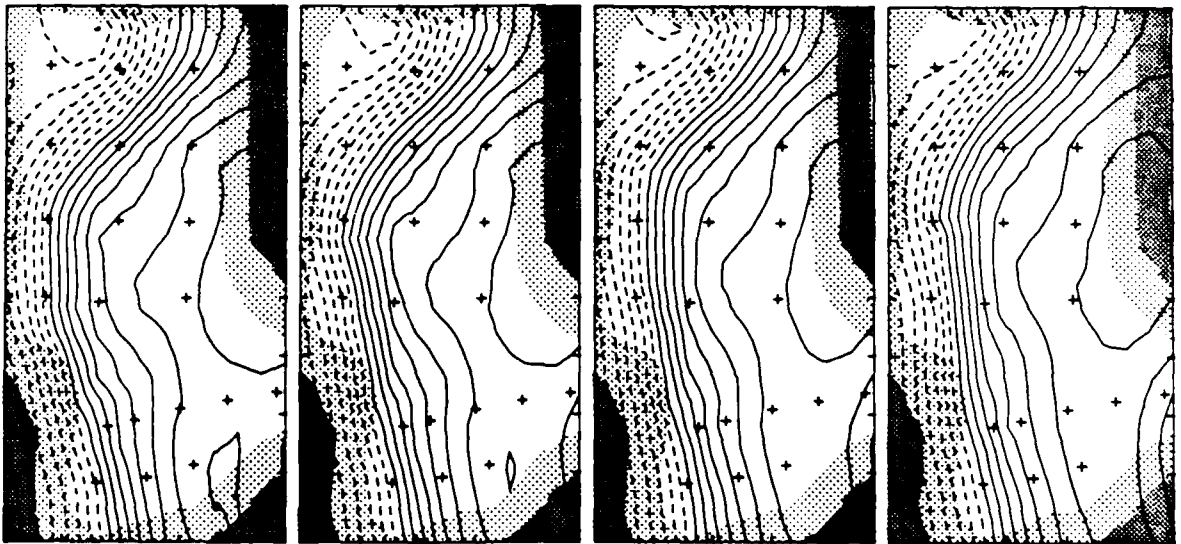
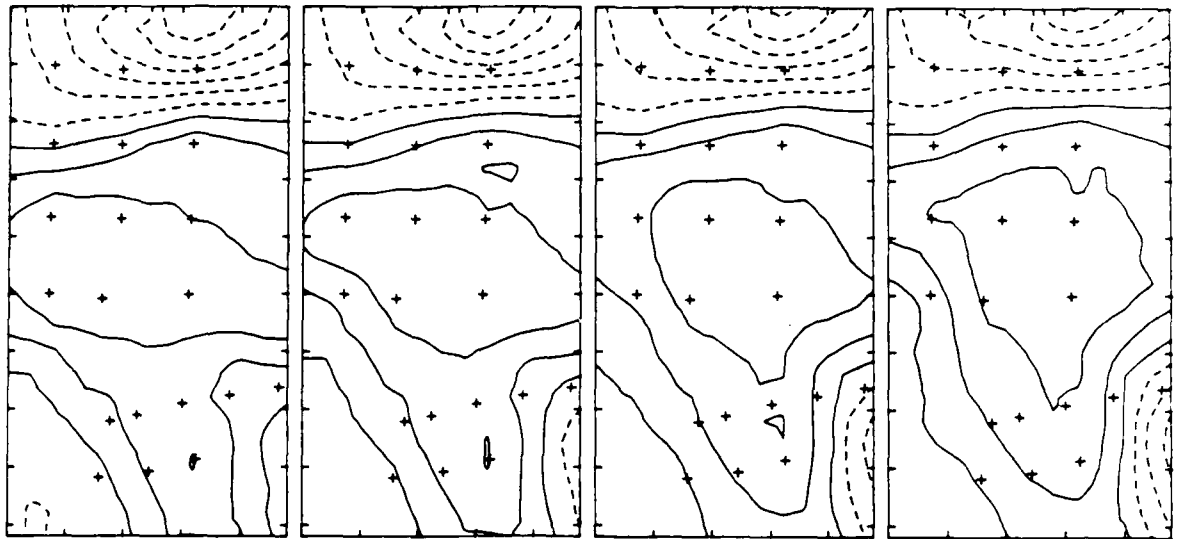


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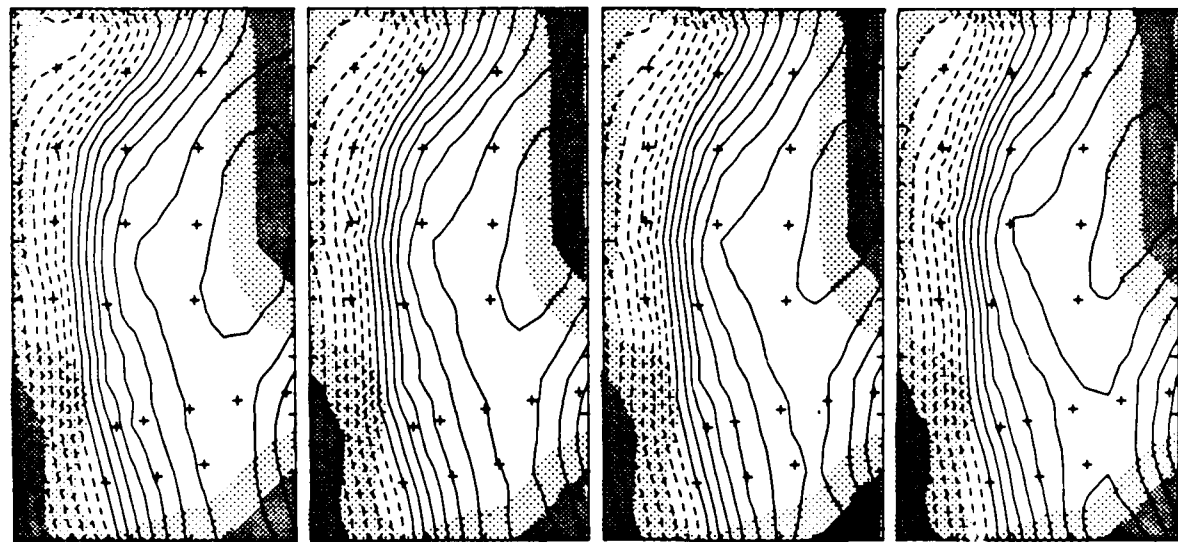
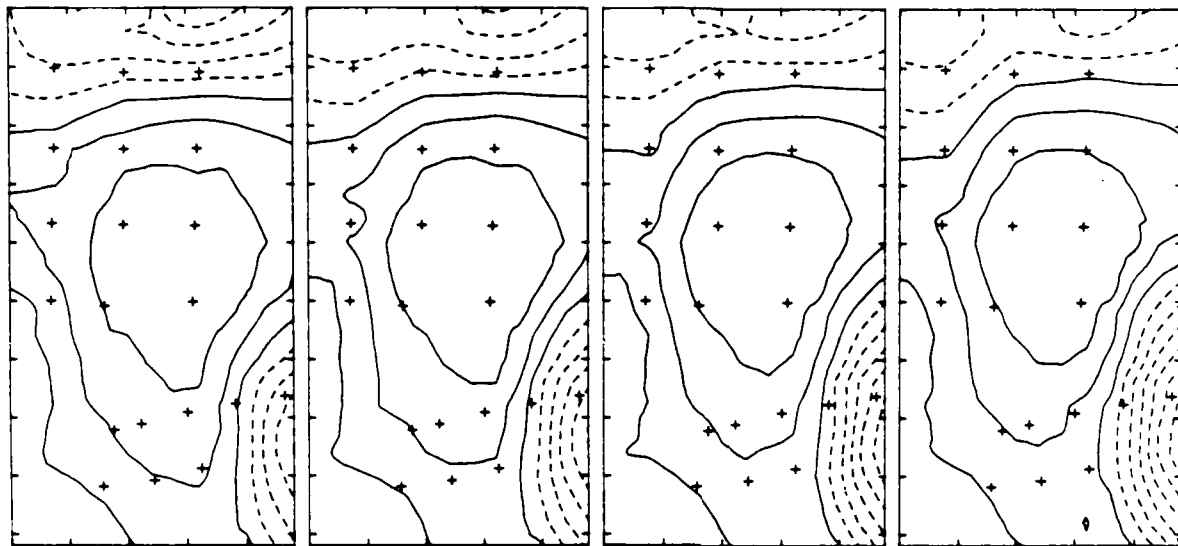


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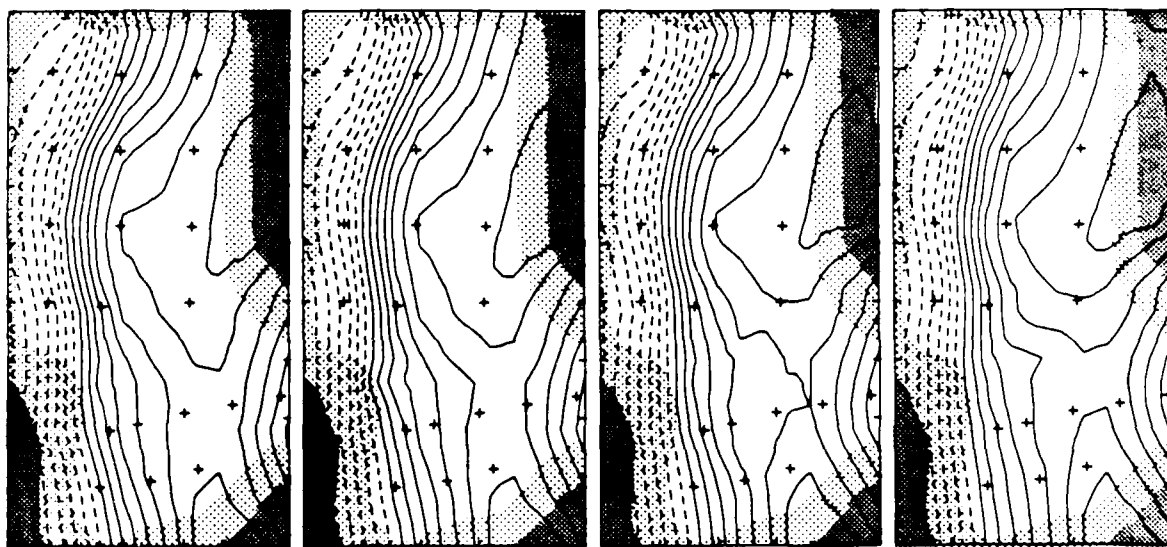
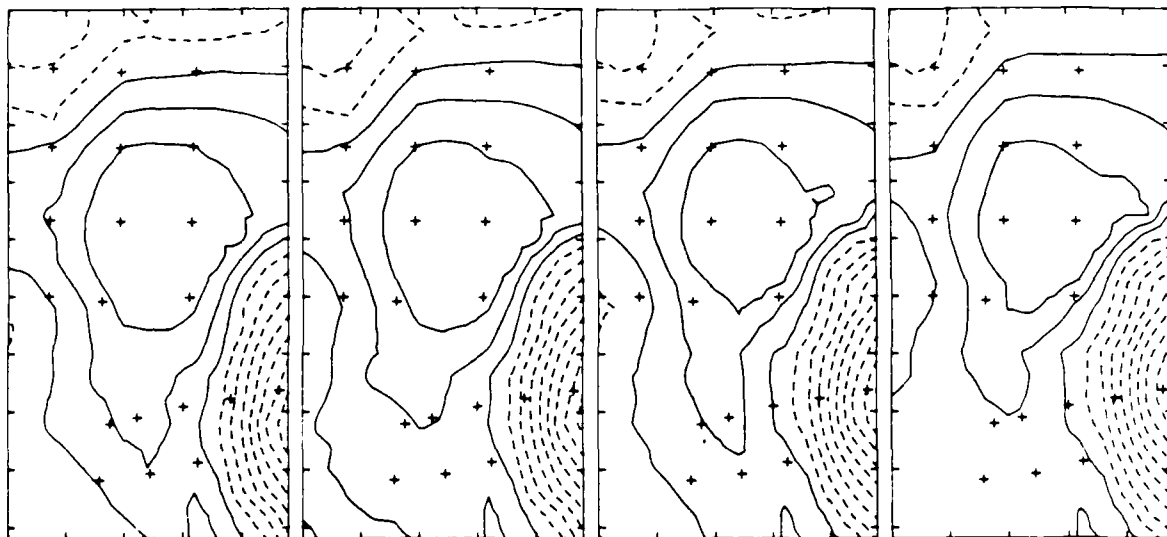


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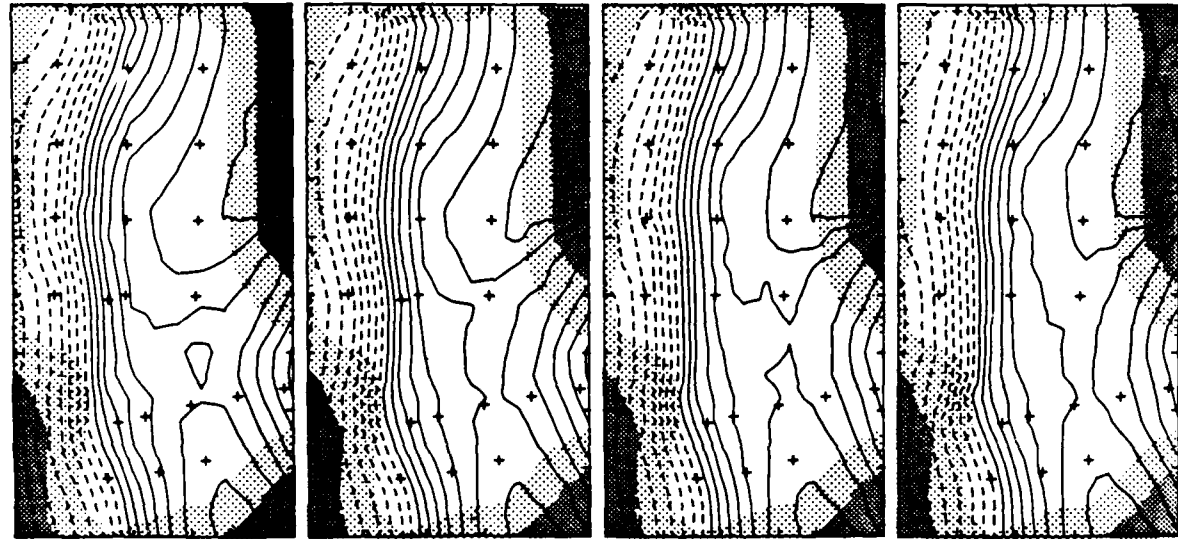
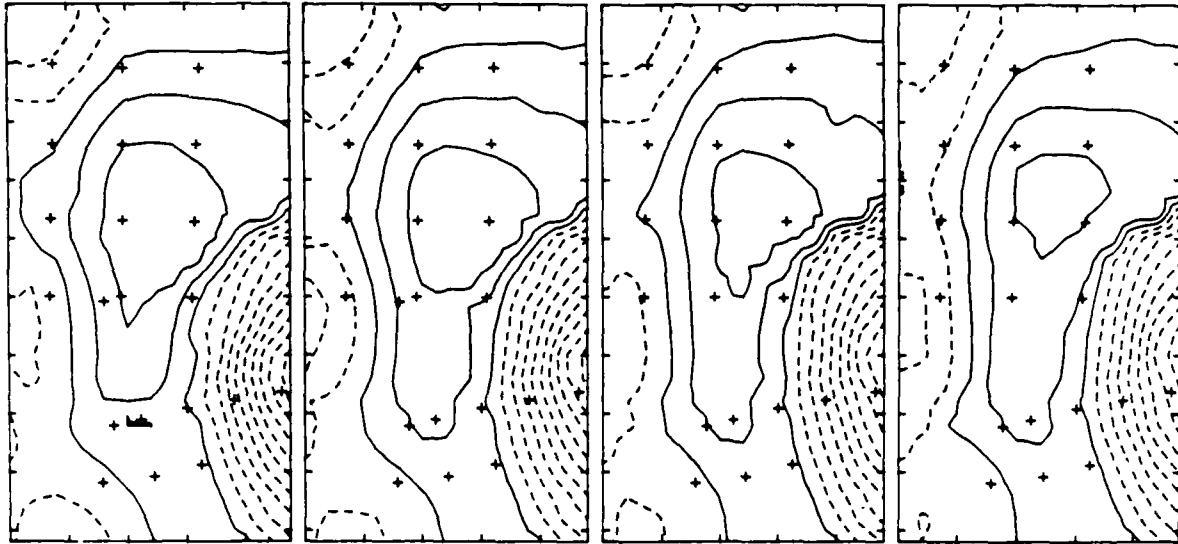


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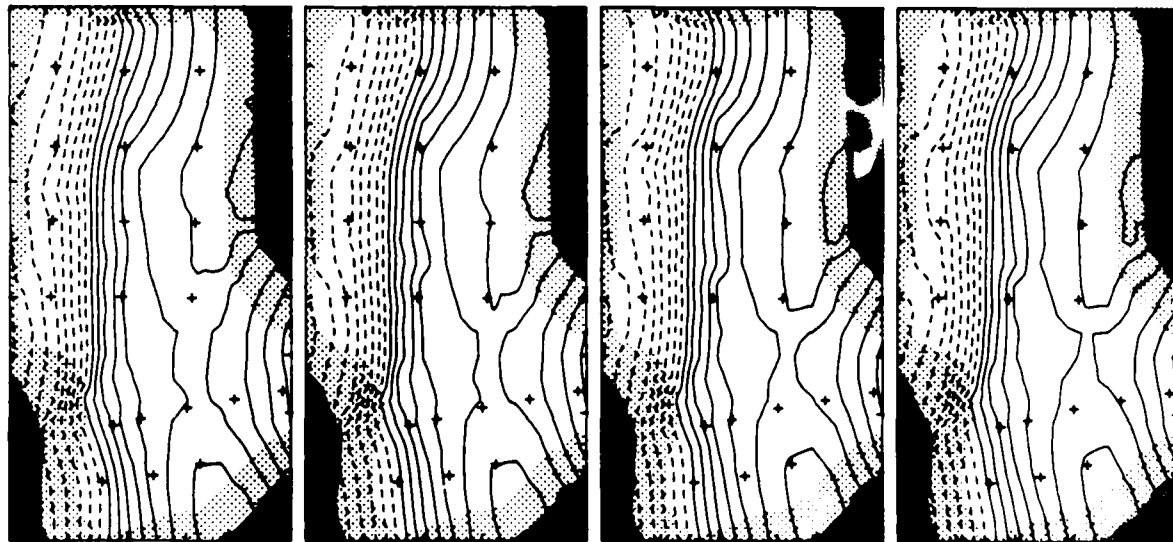
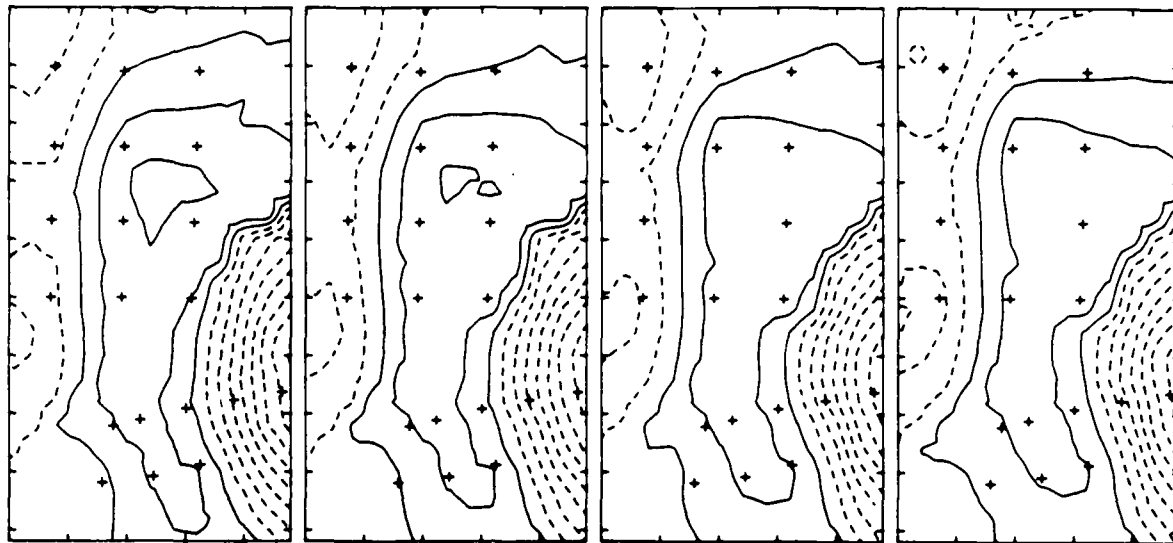


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<p>The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from September 1983 to May 1985 to study the propagation and growth characteristics of Gulf Stream meanders. Data collected as part of the field experiment included inverted echo sounders, current meter moorings, and AXBT survey flights. This report documents the inverted echo sounder data collected from September 1983 to June 1984, as well as additional measurements made from April to September 1983. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for twenty-two instruments. Bottom pressure and temperature, measured at seven of the sites, are also plotted. Basic statistics are given for all the data records shown. Maps of the thermocline depth field in a 240 km by 460 km region are presented at daily intervals.</p>			
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