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The Gulf Stream Dynamics Experiment: Inverted Echo Sounder Data Report for the June 1984 to May 1985 Deployment Period

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TRACEY

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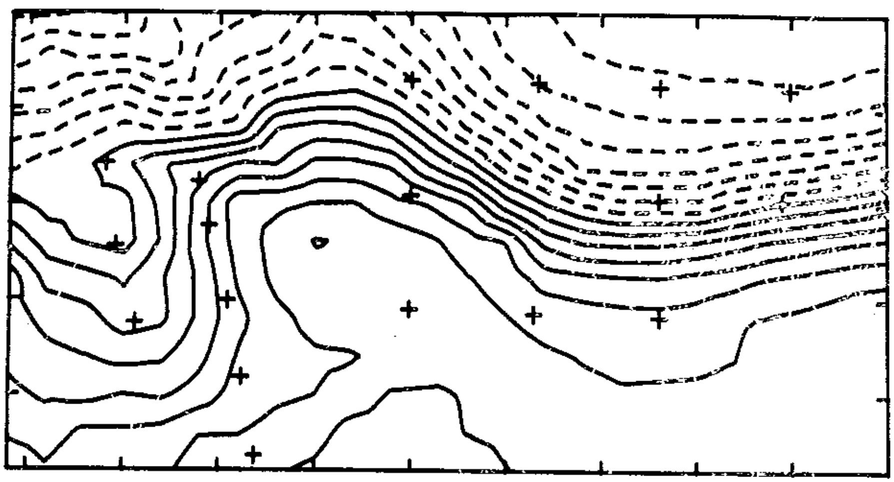

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ABSTRACT

The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from April 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 June 1984 to May 1985. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for eighteen instruments. Bottom pressure and temperature, measured at four 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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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 June 1984 to May 1985. 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 of instrumented from 500 m 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 imagry project (NSF supported) and H. T. Rossby's Rafos float project (ONR/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. The study area is shown in Figure 1. An array of 19 to 20 IESs was maintained from September 1983 to May 1985. The IESs were recovered and redeployed on several cruises throughout this 19-month-long period.

The IES data collected from June 1984 to May 1985 are presented in this report. (Another report will deal with the IES data from April 1983 to June 1984.) During this 11-month period, the array consisted of 19 IESs, located on six sections 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. Additionally, bottom pressure gauges were included at the four northern sites located along line C (indicated by the solid circles). Deployment of 15 of the instruments took place from 1-18 June 1984 on a cruise aboard the R/V ENDEAVOR. Of the remaining four IES, two were launched on an earlier cruise aboard

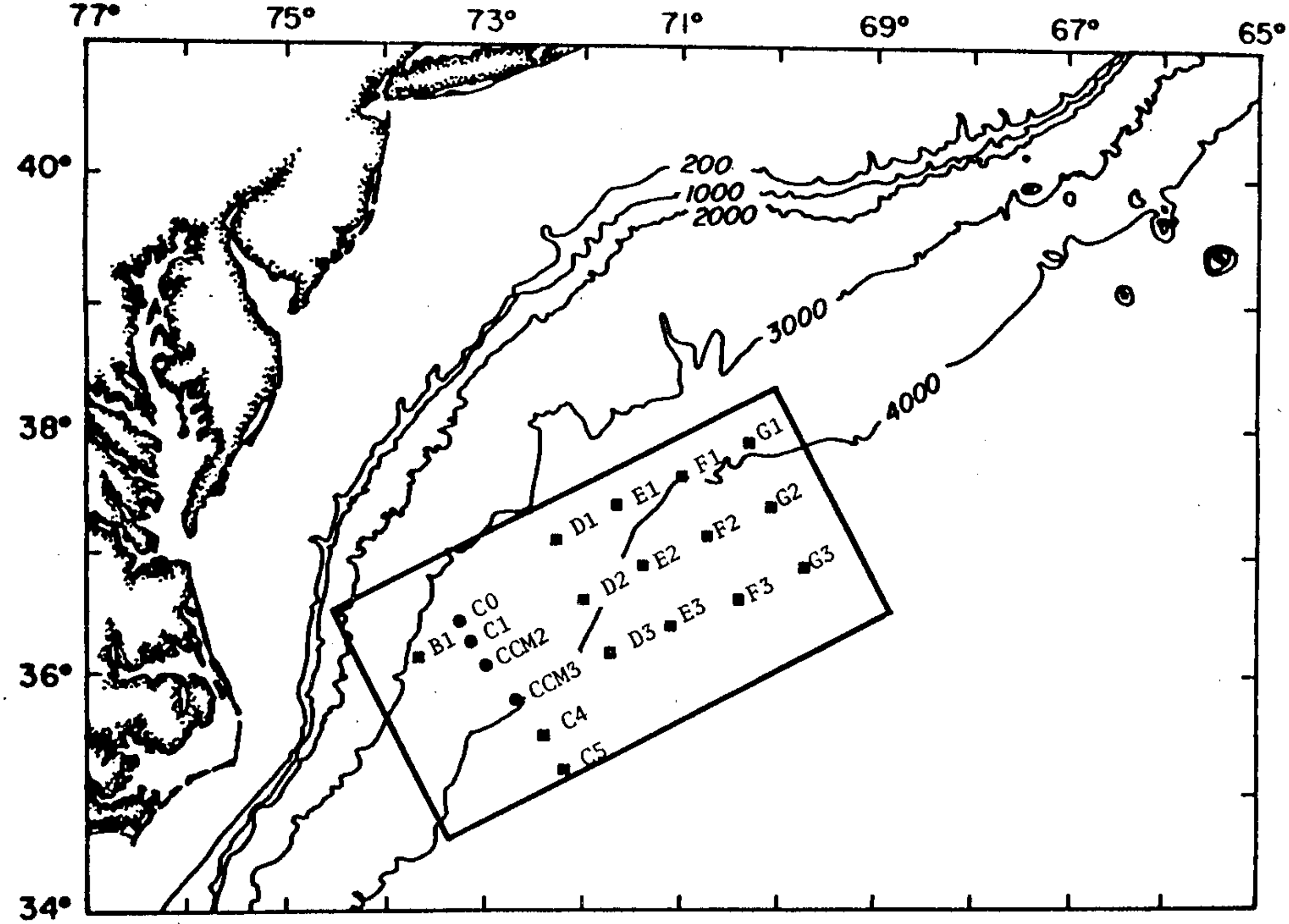


Figure 1. The Gulf Stream Dynamics Study Area. IES sites (boxes and circles) along lines B through G were occupied during 1984-1985. IES with bottom pressure gauges and temperature sesnors were located at the sites shown by the solid circles. The box outlines the 240 km by 460 km region, shown in Figure 12, which has been mapped by objective analysis.

Table 1. Instrument Site Locations and Data Returns.

SITE	LATITUDE (N)	LONGITUDE (W)	1984 1985 JFMAMJJASONDJFMAM
IES85B1	36°08.18	73°41.71	XXXXXXXXXXXX
PIES85C0	36°25.25	73°19.75	XXXXX
PIES85C1	36°15.26	73°09.70	XXXXX
PIES85CCM2	36°05.07	72°59.86	XXXXXXXXXXXX
PIES85CCM3	35°48.23	72°42.57	XXXXXXXXXXXX
IES85C4	35°30.32	72°26.51	XXXXXXXXXXXXXXXXX
IES85C5	35°11.80	72°10.19	XXXXXXXXXXXXXXXXX
IES85D1	37°07.84	72°19.03	XXXXXXXXXXXX
IES85D2	36°38.10	72°01.49	XXXXXXXXXXXX
IES85D3	36°08.71	71°44.54	XXXXXXXXXXXX
IES85E1	37°23.13	71°38.75	XXXXXXXXXXXX
IES85E2	36°53.05	71°21.75	
IES85E3	36°23.09	71°04.63	XXXXXXXXXXXX
IES85F1	37°37.41	70°59.93	XXXXXXXXXXXX
IES85F2	37°08.13	70°42.87	XXXXXXXXXXXX
IES85F3	36°37.98	70°24.78	XXXXXXXXXXXX
IES85G1	37°53.35	70°18.42	XXXXXXXXXXXX
IES85G2	37°23.62	70°03.83	XXXXXXXXXXXX
IES85G3	36°52.38	69°44.99	X

the R/V OCEANUS (9-19 January 1984) and two on a later cruise aboard the R/V ENDEAVOR (11-20 January 1985). All instruments were recovered from 7-21 May 1985 aboard the R/V ENDEAVOR.

1.2 Site Naming Conventions

The six cross-stream sections are designated from west to east by the letters B through G. The IES sites along each section are numbered consecutively from 1 through 5, with site 1 located at the northwestern end of the section. Along section C, an additional instrument deployed on the northern edge of the section was assigned the number 0. In this report, each instrument site is referred to by both the section letter and site number, prefaced by either IES, if it is a standard instrument, or PIES, if it is a combined IES and bottom pressure gauge. For example, IES85D2 is the second site from the northern end of line D. Additionally, if a current meter mooring was located at the same site as an IES, the letters CM were included between the section letter and site number (e.g. PIES85CCM2).

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 however, 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, whereas the pressure and temperature are average measurements over the whole sampling interval.

1.4 Data Processing

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. Since these programs are documented elsewhere (Tracey and Watts, 1985a), the steps are only outlined below.

RAW DATA CASSETTES: Recorded within the instruments. Contain the counts associated with travel time, pressure, and temperature measurements as a series of integer words of varying lengths.

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 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.

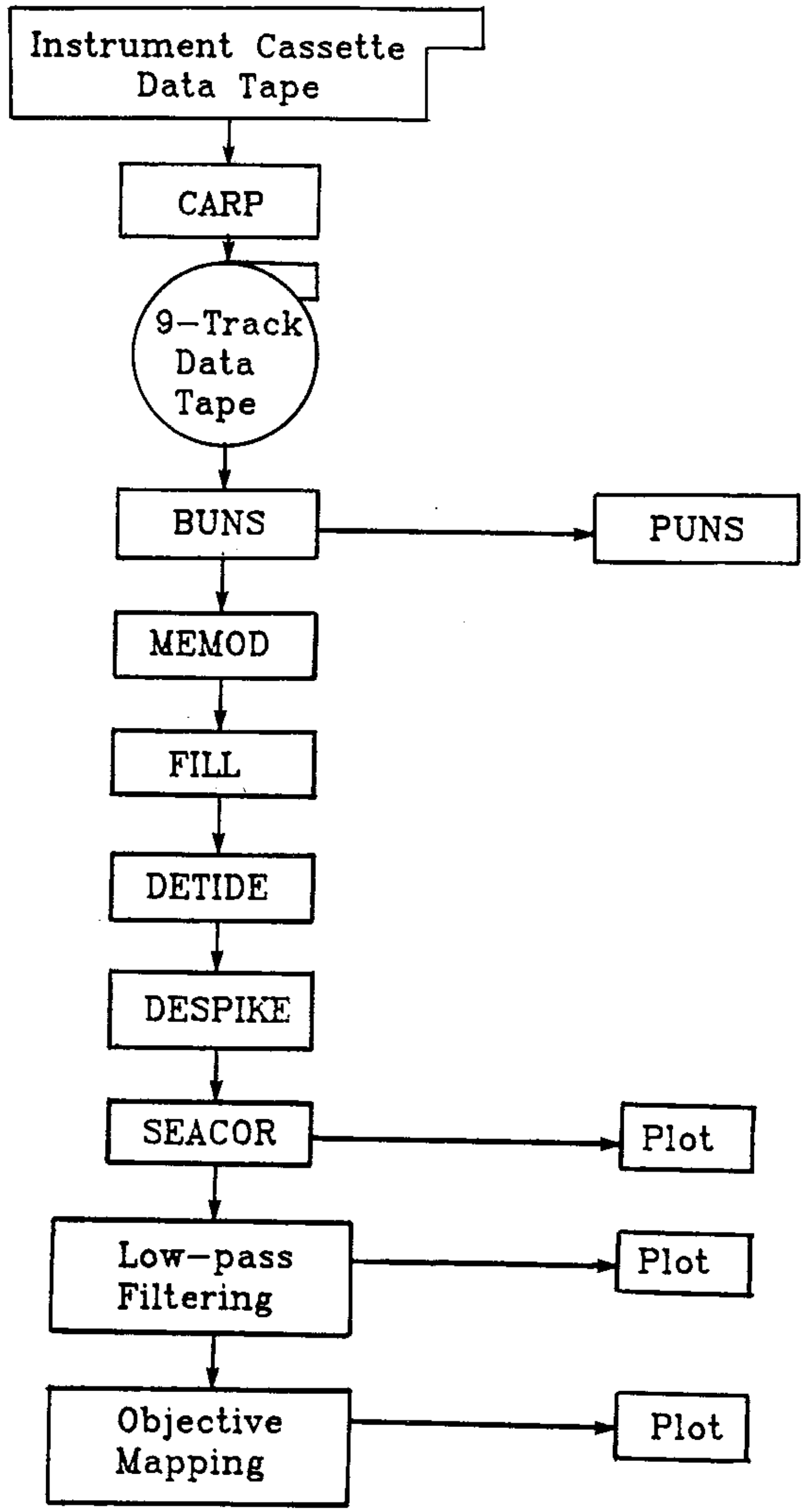


Figure 2. IES Data Processing Flowchart.

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 (τ) into thermocline depths (ξ) 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 τ versus ξ, 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°C isotherm since it situated near the highest temperature gradient of the main thermocline and correlates well with τ (Rossby, 1969; Watts and Johns, 1982). The low-pass filtered travel time records were scaled to the thermocline depths (Z_{12}) and these records are shown in Section 4. The accuracy of the offset parameter B is estimated to be ±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_{12} values are resolved to ±2 m.

1.4.2 Thermocline Depth Mapping

Objective maps of the thermocline (Z_{12}) field in the array region have been produced at daily intervals from these records. The boxed region in Figure 1, oriented 064°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 variance. To represent the mean field, $\overline{Z_{12}}(x,y)$, a third order polynomial was fitted to the mean values observed during the

June 1984 to May 1985 deployment period. The function form of the polynomial was:

$$\overline{Z_{12}}(x,y) = B_0 + B_1x + B_2y + B_{11}x^2 + B_{12}xy + B_{22}y^2 + B_{111}x^3 + B_{112}x^2y + B_{122}xy^2 + B_{222}y^3$$

where (x,y) is the position in kilometers from the origin at 36°00'N, 73°30'W, B_0 is 5.997880E+02, B_1 is 6.122714E-01, B_2 is -3.145789E+00, B_{11} is -1.427472E-03, B_{12} is 5.780502E-03, B_{22} is -7.886405E-03, B_{111} is -3.748734E-07, B_{112} is -1.383396E-05, B_{122} is 5.646291E-06, and B_{222} is 2.626524E-05. The variance field, $\sigma(x,y)$, was defined as a function of the mean field depth, from a Gaussian form representative of all IES records:

$$\sigma(x,y) = A + B \exp -\left[\frac{\overline{Z_{12}}(x,y) - Z_0}{C}\right]^2$$

where A is 50 m, B is (200 m - A), C is 200 m, Z_0 is 470 m, and $\overline{Z_{12}}(x,y)$ is the mean value at that (x,y) location. Figure 10 shows both the mean and variance 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 = ±4 days, 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 a 240 km by 460 km mapping region. The thermocline depth maps (also shown in Figure 12) are obtained by renormalizing the perturbation field by the variance and restoring the mean. The accuracy of these output fields can be obtained from the estimated error fields, which are shown in Figure 11.

1.4.3 Temperature

Temperatures were measured using Sea Data DC-37B electronics and a YSI thermistor, in order to correct the pressure values for the temperature sensitivity of the transducer. The thermistor is inside the instrument, on the pressure tranducer, rather than in the water. However, once the temperature probe has reached equilibrium with the surrounding waters, it also provides accurate measurments 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°C. The accuracy of the temperature measurments is about 0.1°C, and the resolution is 0.0002°C.

1.4.4 Bottom Pressure

Digiquartz pressure sensors (models 46K-032, 75K-002, and 76KB-032) manufactured by Paroscientific, Inc. were used to measure bottom pressure. All pressure measurements were corrected for the temperature sensitivity of the transducer, 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, O(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, 1977) was used to

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

JAN DATE	JAN YEAR DAY	JAN HOUR (0000Z)	FEB DATE	FEB YEAR DAY	FEB HOUR (0000Z)	MAR DATE	MAR YEAR DAY	MAR HOUR (0000Z)	APR DATE	APR YEAR DAY	APR HOUR (0000Z)	MAY DATE	MAY YEAR DAY	MAY HOUR (0000Z)	JUNE DATE	JUNE YEAR DAY	JUNE HOUR (0000Z)
1	1	0	1	32	744	1	60	1416	1	91	2160	1	121	2880	1	152	3624
2	2	24	2	33	768	2	61	1440	2	92	2184	2	122	2904	2	153	3648
3	3	48	3	34	792	3	62	1464	3	93	2208	3	123	2928	3	154	3672
4	4	72	4	35	816	4	63	1488	4	94	2232	4	124	2952	4	155	3696
5	5	96	5	36	840	5	64	1512	5	95	2256	5	125	2976	5	156	3720
6	6	120	6	37	864	6	65	1536	6	96	2280	6	126	3000	6	157	3744
7	7	144	7	38	888	7	66	1560	7	97	2304	7	127	3024	7	158	3768
8	8	168	8	39	912	8	67	1584	8	98	2328	8	128	3048	8	159	3792
9	9	192	9	40	936	9	68	1608	9	99	2352	9	129	3072	9	160	3816
10	10	216	10	41	960	10	69	1632	10	100	2376	10	130	3096	10	161	3840
11	11	240	11	42	984	11	70	1656	11	101	2400	11	131	3120	11	162	3864
12	12	264	12	43	1008	12	71	1680	12	102	2424	12	132	3144	12	163	3888
13	13	288	13	44	1032	13	72	1704	13	103	2448	13	133	3168	13	164	3912
14	14	312	14	45	1056	14	73	1728	14	104	2472	14	134	3192	14	165	3936
15	15	336	15	46	1080	15	74	1752	15	105	2496	15	135	3216	15	166	3960
16	16	360	16	47	1104	16	75	1776	16	106	2520	16	136	3240	16	167	3984
17	17	384	17	48	1128	17	76	1800	17	107	2544	17	137	3264	17	168	4008
18	18	408	18	49	1152	18	77	1824	18	108	2568	18	138	3288	18	169	4032
19	19	432	19	50	1176	19	78	1848	19	109	2592	19	139	3312	19	170	4056
20	20	456	20	51	1200	20	79	1872	20	110	2616	20	140	3336	20	171	4080
21	21	480	21	52	1224	21	80	1896	21	111	2640	21	141	3360	21	172	4104
22	22	504	22	53	1248	22	81	1920	22	112	2664	22	142	3384	22	173	4128
23	23	528	23	54	1272	23	82	1944	23	113	2688	23	143	3408	23	174	4152
24	24	552	24	55	1296	24	83	1968	24	114	2712	24	144	3432	24	175	4176
25	25	576	25	56	1320	25	84	1992	25	115	2736	25	145	3456	25	176	4200
26	26	600	26	57	1344	26	85	2016	26	116	2760	26	146	3480	26	177	4224
27	27	624	27	58	1368	27	86	2040	27	117	2784	27	147	3504	27	178	4248
28	28	648	28	59	1392	28	87	2064	28	118	2808	28	148	3528	28	179	4272
29	29	672				29	88	2088	29	119	2832	29	149	3552	29	180	4296
30	30	696				30	89	2112	30	120	2856	30	150	3576	30	181	4320
31	31	720				31	90	2136				31	151	3600			

JULY DATE	JULY YEAR DAY	JULY HOUR (0000Z)	AUG DATE	AUG YEAR DAY	AUG HOUR (0000Z)	SEPT DATE	SEPT YEAR DAY	SEPT HOUR (0000Z)	OCT DATE	OCT YEAR DAY	OCT HOUR (0000Z)	NOV DATE	NOV YEAR DAY	NOV HOUR (0000Z)	DEC DATE	DEC YEAR DAY	DEC HOUR (0000Z)
1	182	4344	1	213	5088	1	244	5832	1	274	6552	1	305	7296	1	335	8016
2	183	4368	2	214	5112	2	245	5856	2	275	6576	2	306	7320	2	336	8040
3	184	4392	3	215	5136	3	246	5880	3	276	6600	3	307	7344	3	337	8064
4	185	4416	4	216	5160	4	247	5904	4	277	6624	4	308	7368	4	338	8088
5	186	4440	5	217	5184	5	248	5928	5	278	6648	5	309	7392	5	339	8112
6	187	4464	6	218	5208	6	249	5952	6	279	6672	6	310	7416	6	340	8136
7	188	4488	7	219	5232	7	250	5976	7	280	6696	7	311	7440	7	341	8160
8	189	4512	8	220	5256	8	251	6000	8	281	6720	8	312	7464	8	342	8184
9	190	4536	9	221	5280	9	252	6024	9	282	6744	9	313	7488	9	343	8208
10	191	4560	10	222	5304	10	253	6048	10	283	6768	10	314	7512	10	344	8232
11	192	4584	11	223	5328	11	254	6072	11	284	6792	11	315	7536	11	345	8256
12	193	4608	12	224	5352	12	255	6096	12	285	6816	12	316	7560	12	346	8280
13	194	4632	13	225	5376	13	256	6120	13	286	6840	13	317	7584	13	347	8304
14	195	4656	14	226	5400	14	257	6144	14	287	6864	14	318	7608	14	348	8328
15	196	4680	15	227	5424	15	258	6168	15	288	6888	15	319	7632	15	349	8352
16	197	4704	16	228	5448	16	259	6192	16	289	6912	16	320	7656	16	350	8376
17	198	4728	17	229	5472	17	260	6216	17	290	6936	17	321	7680	17	351	8400
18	199	4752	18	230	5496	18	261	6240	18	291	6960	18	322	7704	18	352	8424
19	200	4776	19	231	5520	19	262	6264	19	292	6984	19	323	7728	19	353	8448
20	201	4800	20	232	5544	20	263	6288	20	293	7008	20	324	7752	20	354	8472
21	202	4824	21	233	5568	21	264	6312	21	294	7032	21	325	7776	21	355	8496
22	203	4848	22	234	5592	22	265	6336	22	295	7056	22	326	7800	22	356	8520
23	204	4872	23	235	5616	23	266	6360	23	296	7080	23	327	7824	23	357	8544
24	205	4896	24	236	5640	24	267	6384	24	297	7104	24	328	7848	24	358	8568
25	206	4920	25	237	5664	25	268	6408	25	298	7128	25	329	7872	25	359	8592
26	207	4944	26	238	5688	26	269	6432	26	299	7152	26	330	7896	26	360	8616
27	208	4968	27	239	5712	27	270	6456	27	300	7176	27	331	7920	27	361	8640
28	209	4992	28	240	5736	28	271	6480	28	301	7200	28	332	7944	28	362	8664
29	210	5016	29	241	5760	29	272	6504	29	302	7224	29	333	7968	29	363	8688
30	211	5040	30	242	5784	30	273	6528	30	303	7248	30	334	7992	30	364	8712
31	212	5064	31	243	5808				31	304	7272				31	364	8736

8760

determine the tidal constituents for each instrument. The calculated tides were then removed from the pressure records. The amplitudes, H (dbar), and phases, G° (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 fit a logarithmic function to our data (Wunsch and Wimbush, 1977; Wearn and Larson, 1982). 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. (Further analyses are in progress to improve this estimate.) 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 January 1, 1985 at 0000 GMT, with measurements occurring between January and May 1985 assigned positive yearhours. Negative values correspond to sampling periods from June through December 1984.

1.5 Data Recovery

Table 1 summarizes the data returns from each of the inverted echo sounders. Of the 19 instruments deployed, all but one, IES85E2, were recovered, giving an instrument recovery rate of 95%. The microprocessor controlling IES85G3 ceased functioning properly about one month after the instrument was launched. All the remaining instruments performed successfully, giving a 90% data return for the travel time measurements. Complete records were obtained from all four bottom pressure and temperature gauges; 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 on 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 plots are tabulated. For each plot, the times associated with the first and last data point are supplied. All yearhours are referenced to January 1, 1985 at 0000 GMT; thus measurements occurring in 1984 are given 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.

IES85B1

Serial Number: 060
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°08.18 N, 73°41.71 W   Depth: 3160 m

	DATE	GMT	CRUISE
LAUNCH:	June 7, 1984	1044	EN118
RECOVERY:	May 12, 1985	1912	EN130

TRAVEL TIME RECORDS
(Fig. 3.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	114555	-4980.2347
LAST DATA POINT:	May 12, 1985	184555	3162.7653

Number of Points: 16287
Sampling Interval: 0.50 hrs

Minimum τ = 4.18353 s   Mean = 4.19109 s
Maximum τ = 4.21065 s   Standard Deviation = 0.10660 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.1)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 80161.49 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 8, 1984	180000	-4950.00
LAST DATA POINT:	May 11, 1985	120000	3132.00

Number of Points: 1348
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 195.51 m   Mean = 476.99 m
Maximum Z_{12} = 648.66 m   Standard Deviation = 103.83 m

PIES85CO

Serial Number: 053
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17911

Position: 36°25.25 N, 73°19.75 W — Depth: 3310 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 18, 1985	2007	EN124
RECOVERY:	May 12, 1985	1459	EN130

TRAVEL TIME RECORDS
(Fig. 3.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1985	210159	429.0330
LAST DATA POINT:	May 12, 1985	143159	3158.5330

Number of Points: 5460
Sampling Interval: 0.50 hrs

Minimum τ = 0.36885 s
Maximum τ = 0.39448 s

Mean = 0.37802 s
Standard Deviation = 0.00734 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where $B = 7700.36$ m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 20, 1985	060000	462.00
LAST DATA POINT:	May 11, 1985	060000	3126.00

Number of Points: 445
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 225.40 m
Maximum Z_{12} = 667.84 m

Mean = 516.77 m
Standard Deviation = 95.60 m

PIES85CO (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1985	200004	429.0011
LAST DATA POINT:	May 12, 1985	143004	3158.5011

Number of points: 5460
Sampling Interval: 0.50 hrs

Minimum = 3342.76 dbar
Maximum = 3344.35 dbar
Mean = 3342.48 dbar
Standard deviation = 64.40 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.1)

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

$DRIFT = P_1 \ln(t - t_0) + P_2$
where t = Time of sample in yearhours
t_0 = 417.0011 hrs
P_1 = 0.0000 dbar
P_2 = 0.0014 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43132	.10572	.09210	.02238	.09088	.07117	.03012	.01475
G°:	351.03	334.45	18.33	19.56	182.00	185.80	182.65	183.86

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 19, 1985	090004	441.0011
LAST DATA POINT:	May 12, 1985	143004	3158.0011

Number of points: 5436
Sampling Interval: 0.50 hrs

Minimum = -0.1731 dbar
Maximum = 0.1222 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0417 dbar

PIES85CO (continued)

40HRLP PRESSURE RECORDS
(Fig. 8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 20, 1985	180000	474.0000
LAST DATA POINT:	May 11, 1985	060000	3126.0000

Number of points: 443
Sampling Interval: 6.00 hrs

Minimum = -0.0802 dbar
Maximum = 0.0831 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0369 dbar

TEMPERATURE RECORDS
(Fig. 6.1)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1985	200004	429.0011
LAST DATA POINT:	May 12, 1985	143004	3158.5011

Number of points: 5460
Sampling Interval: 0.50 hrs

Minimum = 2.300 °C
Maximum = 10.436 °C

Mean = 2.373 °C
Standard deviation = 0.140 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 20, 1984	180000	474.0000
LAST DATA POINT:	May 11, 1985	060000	3126.0000

Number of points: 443
Sampling Interval: 6.00 hrs

Minimum = 2.312 °C
Maximum = 2.461 °C

Mean = 3.369 °C
Standard deviation = 0.032 °C

PIES85C1

Serial Number: 035
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17849

Position: 36°15.26 N, 73°09.70 W   Depth: 3475 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 14, 1985	0217	EN124
RECOVERY:	May 12, 1985	1243	EN130

TRAVEL TIME RECORDS
(Fig. 3.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 14, 1985	032648	315.4467
LAST DATA POINT:	May 12, 1985	122648	3156.4467

Number of Points: 5683
Sampling Interval: 0.50 hrs

Minimum τ = 0.20357 s
Maximum τ = 0.22772 s
Mean = 0.21083 s
Standard Deviation = 0.00544 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 4645.73 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 15, 1985	120000	348.00
LAST DATA POINT:	May 11, 1985	060000	3126.00

Number of Points: 464
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 333.63 m
Maximum Z_{12} = 746.05 m
Mean = 638.38 m
Standard Deviation = 79.58 m

PIES85C1 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 14, 1985	032453	315.4147
LAST DATA POINT:	May 12, 1985	122453	3156.4147

Number of points: 5683
Sampling Interval: 0.50 hrs

Minimum = 3529.66 dbar
Maximum = 3531.21 dbar
Mean = 3529.58 dbar
Standard deviation = 54.03 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.2)

$P_{residual} = P_{measured}$ - MEAN - TIDE

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43174	.10568	.09249	.02246	.09047	.06960	.03003	.01404
G°:	351.20	334.39	18.03	19.09	182.40	185.18	182.91	183.49

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 14, 1985	152453	327.4147
LAST DATA POINT:	May 12, 1985	122453	3156.4147

Number of points: 5659
Sampling Interval: 0.50 hrs

Minimum = -0.0891 dbar
Maximum = 0.1065 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0310 dbar

40HRLP PRESSURE RECORDS
(Fig. 8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 16, 1985	000000	360.0000
LAST DATA POINT:	May 11, 1985	060000	3126.0000

Number of points: 462
Sampling Interval: 6.00 hrs

Minimum = -0.0632 dbar
Maximum = 0.0763 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0271 dbar

PIES85C1 (continued)

TEMPERATURE RECORDS
(Fig. 6.2)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 14, 1985	032453	315.4147
LAST DATA POINT:	May 12, 1985	122453	3156.4147

Number of points: 5683
Sampling Interval: 0.50 hrs

Minimum = 2.188 °C
Maximum = 8.291 °C

Mean = 2.280 °C
Standard deviation = 0.111 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 16, 1985	000000	360.0000
LAST DATA POINT:	May 11, 1985	060000	3126.0000

Number of points: 462
Sampling Interval: 6.00 hrs

Minimum = 2.190 °C
Maximum = 2.387 °C

Mean = 2.277 °C
Standard deviation = 0.042 °C

PIES85CCM2

Serial Number: 054
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 8180

Position: 36°05.07 N, 72°59.86 W   Depth: 3660 m

	DATE	GMT	CRUISE
LAUNCH:	June 7, 1984	1705	EN118
RECOVERY:	May 12, 1985	1004	EN130

TRAVEL TIME RECORDS
(Fig. 3.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	181202	-4973.7995
LAST DATA POINT:	May 12, 1985	094202	3153.7005

Number of Points: 16256
Sampling Interval: 0.50 hrs

Minimum τ = 0.06090 s
Maximum τ = 0.08341 s
Mean = 0.06908 s
Standard Deviation = 0.00325 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 1987.69 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	000000	-4944.00
LAST DATA POINT:	May 11, 1985	000000	3120.00

Number of Points: 1345
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 439.37 m
Maximum Z_{12} = 808.30 m
Mean = 673.79 m
Standard Deviation = 49.64 m

PIES85CCM2 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	181007	-4973.8314
LAST DATA POINT:	May 12, 1985	094007	3153.6686

Number of points: 16256
Sampling Interval: 0.50 hrs

Minimum = 3732.42 dbar
Maximum = 3734.33 dbar

Mean = 3730.33 dbar
Standard deviation = 116.61 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.3)

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

DRIFT = $P_1 \ln(t - t_0) + P_2$
where t = Time of sample in yearhours
t_0 = -4973.8314 hrs
P_1 = 0.088609 dbar
P_2 = -0.709164 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43341	.10592	.08873	.02120	.08852	.06976	.02935	.01447
G°:	352.60	335.00	19.74	20.77	181.13	186.05	181.82	184.82

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 8, 1984	061007	-4961.8314
LAST DATA POINT:	May 12, 1985	094007	3153.6686

Number of points: 16232
Sampling Interval: 0.50 hrs

Minimum = -0.1098 dbar
Maximum = 0.1493 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0364 dbar

PIES85CCM2 (continued)

40HRLP PRESSURE RECORDS
(Fig. 8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	120000	-4932.0000
LAST DATA POINT:	May 11, 1985	000000	3120.0000

Number of points: 1343
Sampling Interval: 6.00 hrs

Minimum = -0.0945 dbar
Maximum = 0.1267 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0332 dbar

TEMPERATURE RECORDS
(Fig. 6.3)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	181007	-4973.8314
LAST DATA POINT:	May 12, 1985	094007	3153.6686

Number of points: 16256
Sampling Interval: 0.50 hrs

Minimum = 2.204 °C
Maximum = 4.619 °C

Mean = 2.256 °C
Standard deviation = 0.071 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	120000	-4932.0000
LAST DATA POINT:	May 11, 1985	000000	3120.0000

Number of points: 1343
Sampling Interval: 6.00 hrs

Minimum = 2.205 °C
Maximum = 2.334 °C

Mean = 2.257 °C
Standard deviation = 0.036 °C

PIES85CCM3

Serial Number: 058
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 19327

Position: 35°48.23 N, 72°42.57 W — Depth: 3890 m

	DATE	GMT	CRUISE
LAUNCH:	June 7, 1984	2239	EN118
RECOVERY:	May 12, 1985	0635	EN130

TRAVEL TIME RECORDS
(Fig. 3.5)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 8, 1984	000115	-4967.9792
LAST DATA POINT:	May 12, 1985	063115	3150.5208

Number of Points: 16238
Sampling Interval: 0.50 hrs

Minimum τ = 0.39382 s
Maximum τ = 0.41069 s
Mean = 0.40178 s
Standard Deviation = 0.01095 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 8363.22 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	060000	-4938.00
LAST DATA POINT:	May 11, 1985	000000	3120.00

Number of Points: 1344
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 600.12 m
Maximum Z_{12} = 865.12 m
Mean = 723.77 m
Standard Deviation = 48.39 m

PIES85CCM3 (continued)

MEASURED PRESSURE RECORDS
(Fig. 4.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	235920	-4968.0111
LAST DATA POINT:	May 12, 1985	062920	3150.4889

Number of points: 16238
Sampling Interval: 0.50 hrs

Minimum = 3988.66 dbar
Maximum = 3990.25 dbar

Mean = 3986.22 dbar
Standard deviation = 110.82 dbar

RESIDUAL PRESSURE RECORDS
(Fig. 5.4)

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

DRIFT = $P_1 \ln(t - t_0) + P_2$
where t = Time of sample in yearhours
t_0 = -4968.5111 hrs
P_1 = -0.03511 dbar
P_2 = 0.281740 dbar

TIDE calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	.43211	.10560	.08885	.02127	.08816	.06896	.02922	.01424
G°:	352.83	335.33	20.12	21.21	181.19	186.55	181.94	185.23

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 8, 1984	115920	-4956.0111
LAST DATA POINT:	May 12, 1985	062920	3150.4889

Number of points: 16214
Sampling Interval: 0.50 hrs

Minimum = -0.1197 dbar
Maximum = 0.1630 dbar

Mean = 0.0000 dbar
Standard deviation = 0.0416 dbar

PIES85CCM3 (continued)

40HRLP PRESSURE RECORDS
(Fig. 8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	180000	-4926.0000
LAST DATA POINT:	May 11, 1985	000000	3120.0000

Number of points: 1342
Sampling Interval: 6.00 hrs

Minimum = -0.0980 dbar
Maximum = 0.1369 dbar
Mean = 0.0000 dbar
Standard deviation = 0.0384 dbar

TEMPERATURE RECORDS
(Fig. 6.4)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 7, 1984	235920	-4968.0111
LAST DATA POINT:	May 12, 1985	062920	3150.4889

Number of points: 16238
Sampling Interval: 0.50 hrs

Minimum = 2.375 °C
Maximum = 5.983 °C
Mean = 2.414 °C
Standard deviation = 0.077 °C

40HRLP TEMPERATURE RECORDS
(Fig. 9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	180000	-4926.0000
LAST DATA POINT:	May 11, 1985	000000	3120.0000

Number of points: 1342
Sampling Interval: 6.00 hrs

Minimum = 2.377 °C
Maximum = 2.512 °C
Mean = 2.415 °C
Standard deviation = 0.024 °C

IES85C4

Serial Number: 030
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 35°30.32 N, 72°26.51 W   Depth: 4180 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 16, 1984	1323	OC144
RECOVERY:	May 8, 1985	2252	EN130

TRAVEL TIME RECORDS
(Fig. 3.6)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 16, 1984	142635	-8409.5569
LAST DATA POINT:	May 8, 1985	222058	3070.3494

Number of Points: 22960
Sampling Interval: 0.49999594 hrs

Minimum τ = 5.58453 s
Maximum τ = 5.62001 s
Mean = 5.59327 s
Standard Deviation = 0.15310 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 106987.14 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 18, 1984	000000	-8376.00
LAST DATA POINT:	May 7, 1985	120000	3036.00

Number of Points: 1903
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 468.27 m
Maximum Z_{12} = 874.50 m
Mean = 735.99 m
Standard Deviation = 79.23 m

IES85C5

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

Position: 35°11.80 N, 72°10.19 W — Depth: 4320 m

	DATE	GMT	CRUISE
LAUNCH:	Jan 12, 1984	0943	OC144
RECOVERY:	May 9, 1985	0235	EN130

TRAVEL TIME RECORDS
(Fig. 3.7)

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 12, 1984	110533	-8508.9078
LAST DATA POINT:	May 9, 1985	020533	3074.0922

Number of Points: 23167
Sampling Interval: 0.50 hrs

Minimum τ = 5.74490 s
Maximum τ = 5.78033 s
Mean = 5.75305 s
Standard Deviation = 0.15519 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.2)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 110094.40 m
τd = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	Jan 13, 1984	180000	-8478.00
LAST DATA POINT:	May 7, 1985	180000	3042.00

Number of Points: 1921
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 314.021 m
Maximum Z_{12} = 918.951 m
Mean = 688.78 m
Standard Deviation = 128.52 m

IES85D1

Serial Number: 041
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°07.84 N
72°19.03 W

Depth: 3365 m

	DATE	GMT	CRUISE
LAUNCH:	June 9, 1984	0108	EN118
RECOVERY:	May 11, 1985	1911	EN130

TRAVEL TIME RECORDS
(Fig. 3.8)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 9, 1984	020539	-4941.9058
LAST DATA POINT:	May 11, 1985	183539	3138.5942

Number of Points: 16162
Sampling Interval: 0.50 hrs

Minimum τ = 4.47870 s
Maximum τ = 4.51534 s

Mean = 4.49048 s
Standard Deviation = 0.10745 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 85807.15 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 10, 1984	120000	-4908.00
LAST DATA POINT:	May 10, 1985	120000	3108.00

Number of Points: 1337
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 380.77 m
Maximum Z_{12} = 684.03 m

Mean = 432.52 m
Standard Deviation = 178.45 m

IES85D2

Serial Number: 061
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°38.10 N 72°01.49 W   Depth: 3780 m

	DATE	GMT	CRUISE
LAUNCH:	June 8, 1984	1928	EN118
RECOVERY:	May 11, 1985	2345	EN130

TRAVEL TIME RECORDS
(Fig. 3.9)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 8, 1984	202628	-4947.5589
LAST DATA POINT:	May 11, 1985	232628	3143.4411

Number of Points: 16183
Sampling Interval: 0.50 hrs

Minimum τ = 5.05355 s
Maximum τ = 5.08066 s
Mean = 5.05812 s
Standard Deviation = 0.15971 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 96914.21 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 10, 1984	060000	-4914.00
LAST DATA POINT:	May 10, 1985	180000	3114.00

Number of Points: 1339
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 407.80 m
Maximum Z_{12} = 864.42 m
Mean = 710.19 m
Standard Deviation = 65.62 m

IES85D3

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

Position: 36°08.71 N
71°44.54 W

Depth: 4125 m

	DATE	GMT	CRUISE
LAUNCH:	June 11, 1984	1810	EN118
RECOVERY:	May 9, 1985	0941	EN130

TRAVEL TIME RECORDS
(Fig. 3.10)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 11, 1984	192101	-4876.6497
LAST DATA POINT:	May 9, 1985	092101	3081.3503

Number of Points: 15917
Sampling Interval: 0.50 hrs

Minimum τ = 5.47094 s
Maximum τ = 5.48245 s

Mean = 5.47294 s
Standard Deviation = 0.15323 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.3)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 104825.63 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 13, 1984	060000	-4842.00
LAST DATA POINT:	May 8, 1985	000000	3048.00

Number of Points: 1316
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 697.82 m
Maximum Z_{12} = 862.23 m

Mean = 766.02 m
Standard Deviation = 33.86 m

IES85E1

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

Position: 37°23.13 N Depth: 3600 m
71°38.75 W

	DATE	GMT	CRUISE
LAUNCH:	June 12, 1984	1913	EN118
RECOVERY:	May 11, 1985	1325	EN130

TRAVEL TIME RECORDS
(Fig. 3.11)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 12, 1984	200625	-4851.8930
LAST DATA POINT:	May 11, 1985	130625	3133.1069

Number of Points: 15971
Sampling Interval: 0.50 hrs

Minimum τ = 4.75682 s
Maximum τ = 4.79422 s
Mean = 4.76826 s
Standard Deviation = 0.12841 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.4)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 91149.73 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 14, 1984	060000	-4818.00
LAST DATA POINT:	May 10, 1985	060000	3102.00

Number of Points: 1321
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 103.24 m
Maximum Z_{12} = 745.66 m
Mean = 487.45 m
Standard Deviation = 202.80 m

IES85E3

Serial Number: 036
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°23.09 N 71°04.63 W   Depth: 4290 m

	DATE	GMT	CRUISE
LAUNCH:	June 14, 1984	1045	EN118
RECOVERY:	May 11, 1985	0250	EN130

TRAVEL TIME RECORDS
(Fig. 3.12)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 14, 1984	120112	-4811.9800
LAST DATA POINT:	May 11, 1985	023112	3122.5200

Number of Points: 15870
Sampling Interval: 0.50 hrs

Minimum τ = 5.72716 s
Maximum τ = 5.73730 s
Mean = 5.72644 s
Standard Deviation = 0.21841 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.4)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 109712.55 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 15, 1984	180000	-4782.00
LAST DATA POINT:	May 9, 1985	180000	3090.00

Number of Points: 1313
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 730.58 m
Maximum Z_{12} = 871.00 m
Mean = 795.29 m
Standard Deviation = 25.23 m

IES85F1

Serial Number: 057
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°37.41 N, 70°59.93 W   Depth: 3970 m

	DATE	GMT	CRUISE
LAUNCH:	June 12, 1984	1218	EN118
RECOVERY:	May 17, 1985	2114	EN130

TRAVEL TIME RECORDS
(Fig. 3.13)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 12, 1984	131056	-4858.8178
LAST DATA POINT:	May 17, 1985	211056	3285.1822

Number of Points: 16289
Sampling Interval: 0.50 hrs

Minimum τ = 5.28317 s   Mean = 5.29528 s
Maximum τ = 5.32045 s   Standard Deviation = 0.15368 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 101137.69 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 14, 1984	000000	-4824.00
LAST DATA POINT:	May 16, 1985	120000	3252.00

Number of Points: 1347
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 86.21 m   Mean = 449.88 m
Maximum Z_{12} = 729.99 m   Standard Deviation = 208.40 m

IES85F2

Serial Number: 046
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°08.13 N 70°42.87 W   Depth: 4195 m

	DATE	GMT	CRUISE
LAUNCH:	June 12, 1984	0630	EN118
RECOVERY:	May 15, 1985	1935	EN130

TRAVEL TIME RECORDS
(Fig. 3.14)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 12, 1984	072611	-4864.5636
LAST DATA POINT:	May 15, 1985	192611	3235.4364

Number of Points: 16201
Sampling Interval: 0.50 hrs

Minimum τ = 5.60160 s
Maximum τ = 5.63901 s
Mean = 5.60510 s
Standard Deviation = 0.19320 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 107279.03 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 13, 1984	180000	-4830.00
LAST DATA POINT:	May 14, 1985	120000	3204.00

Number of Points: 1340
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 159.90 m
Maximum Z_{12} = 810.46 m
Mean = 681.79 m
Standard Deviation = 126.12 m

IES85F3

Serial Number: 044
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°37.98 N, 70°24.78 W — Depth: 4375 m

	DATE	GMT	CRUISE
LAUNCH:	June 14, 1984	1626	EN118
RECOVERY:	May 10, 1985	2154	EN130

TRAVEL TIME RECORDS
(Fig. 3.15)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 14, 1984	174135	-4806.3069
LAST DATA POINT:	May 10, 1985	213512	3117.5867

Number of Points: 15849
Sampling Interval: 0.49999333 hrs

Minimum τ = 5.83805 s
Maximum τ = 5.84860 s
Mean = 5.83715 s
Standard Deviation = 0.21713 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.5)

Z_{12} Conversion Equation: $Z_{12} = (-19000ms^{-1})(\tau_d) + B$
where B = 111801.858 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 16, 1984	000000	-4776.00
LAST DATA POINT:	May 9, 1985	120000	3084.00

Number of Points: 1311
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 703.24 m
Maximum Z_{12} = 855.57 m
Mean = 790.31 m
Standard Deviation = 25.91 m

IES85G1

Serial Number: 059
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 37°53.35 N, 70°18.42 W — Depth: 3855 m

	DATE	GMT	CRUISE
LAUNCH:	June 15, 1984	1136	EN118
RECOVERY:	May 16, 1985	1018	EN130

TRAVEL TIME RECORDS
(Fig. 3.16)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 15, 1984	124105	-4787.3153
LAST DATA POINT:	May 16, 1985	101105	3250.1847

Number of Points: 16076
Sampling Interval: 0.50 hrs

Minimum τ = 5.10530 s
Maximum τ = 5.14109 s
Mean = 5.12095 s
Standard Deviation = 0.13716 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000\,ms^{-1})(\tau_d) + B$
where B = 97717.84 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 16, 1984	180000	-4758.00
LAST DATA POINT:	May 15, 1985	000000	3216.00

Number of Points: 1330
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 70.72 m
Maximum Z_{12} = 694.53 m
Mean = 352.86 m
Standard Deviation = 190.50 m

IES85G2

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

Position: 37°23.62 N, 70°03.83 W — Depth: 4220 m

	DATE	GMT	CRUISE
LAUNCH:	June 15, 1984	0501	EN118
RECOVERY:	May 16, 1985	0327	EN130

TRAVEL TIME RECORDS
(Fig. 3.17)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 15, 1984	055213	-4794.1297
LAST DATA POINT:	May 16, 1985	032213	3243.3703

Number of Points: 16076
Sampling Interval: 0.50 hrs

Minimum τ = 5.62687 s — Mean = 5.63177 s
Maximum τ = 5.66155 s — Standard Deviation = 0.17821 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000 ms^{-1})(\tau_d) + B$
where B = 107723.09 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 16, 1984	120000	-4764.00
LAST DATA POINT:	May 14, 1985	180000	3210.00

Number of Points: 1330
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 180.71 m — Mean = 633.37 m
Maximum Z_{12} = 784.20 m — Standard Deviation = 138.36 m

IES85G3

Serial Number: 048
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 20
Additional Sensors: None

Position: 36°52.38 N, 69°44.99 W — Depth: 4355 m

	DATE	GMT	CRUISE
LAUNCH:	June 14, 1984	2224	EN118
RECOVERY:	May 10, 1985	1453	EN130

TRAVEL TIME RECORDS
(Fig. 3.18)

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 14, 1984	234635	-4800.2236
LAST DATA POINT:	June 28, 1985	074635	-4480.2236

Number of Points: 641
Sampling Interval: 0.50 hrs

Minimum τ = 5.81595 s
Maximum τ = 5.82078 s
Mean = 5.81831 s
Standard Deviation = 0.02828 s

40HRLP THERMOCLINE DEPTH RECORDS
(Fig. 7.6)

Z_{12} Conversion Equation: $Z_{12} = (-19000\text{ms}^{-1})(\tau_d) + B$
where B = 111293.02 m
τ_d = Travel Time (sec) with tide removed

	DATE	GMT	YEARHOUR
1st DATA POINT:	June 16, 1984	000000	-4776.00
LAST DATA POINT:	June 26, 1984	120000	-4524.00

Number of Points: 43
Sampling Interval: 6.00 hrs

Minimum Z_{12} = 728.55 m
Maximum Z_{12} = 759.97 m
Mean = 739.76 m
Standard Deviation = 8.71 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, to 0.5 dbar for the bottom pressure measurements, to 0.05 dbar for the residual bottom pressure data, and to 0.02°C for the temperatures.

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

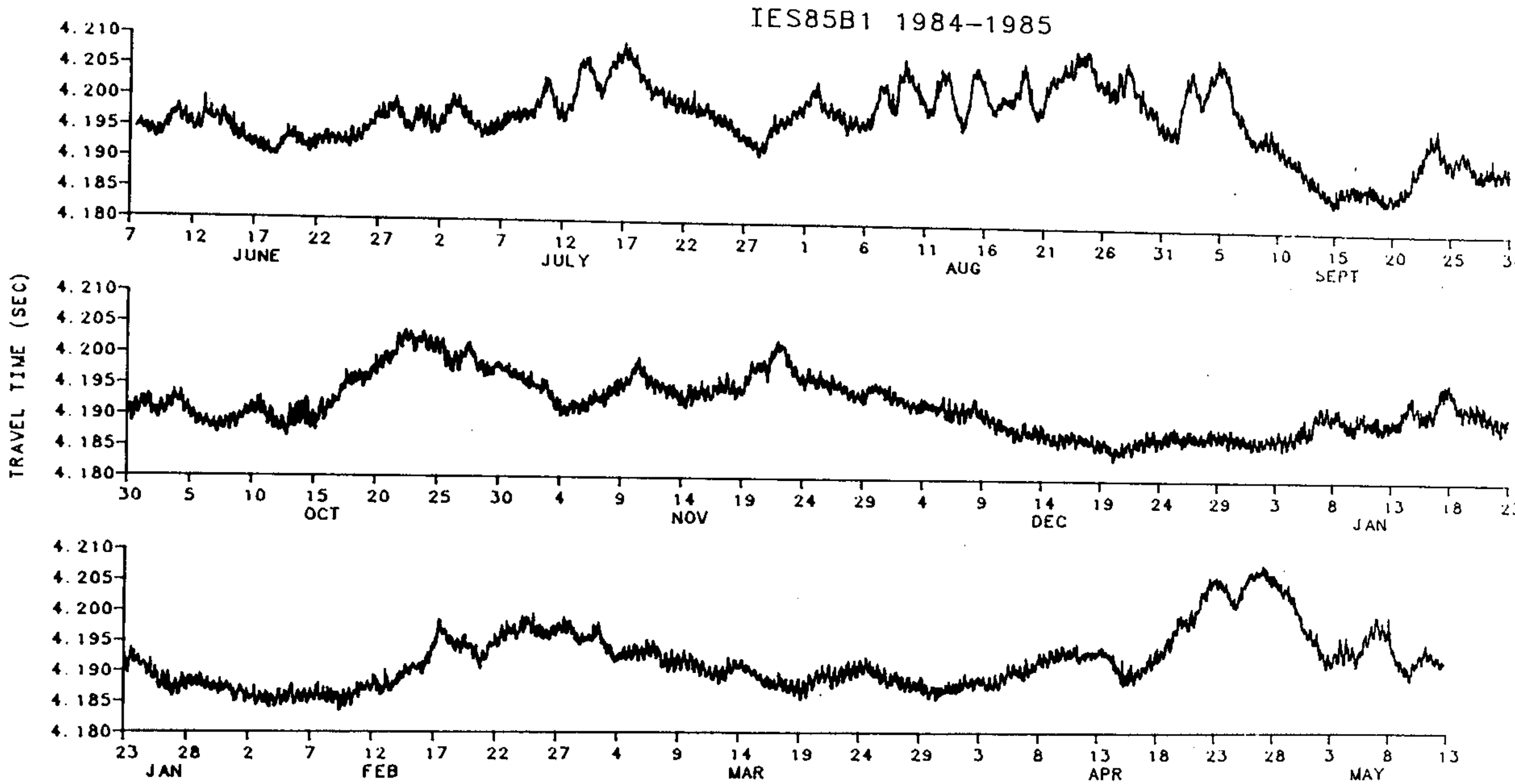
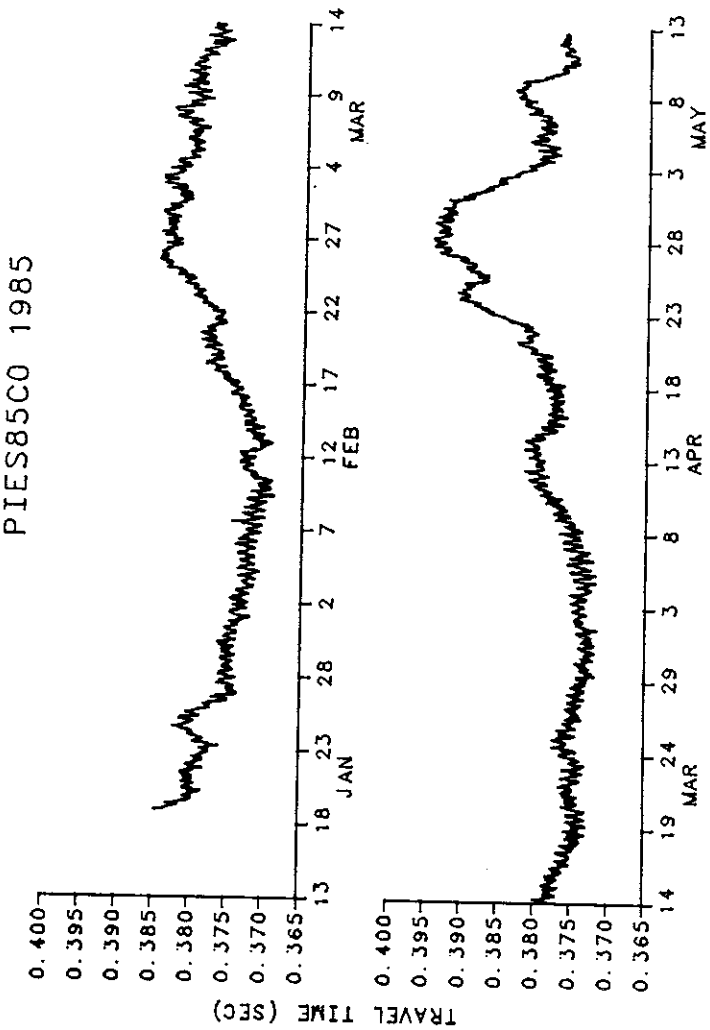


Figure 3.1

Figure 3.1-18. Full travel time records for each instrument at half-hourly intervals. The start and end times and record lengths are listed in Section 2.



PIES85CO 1985
TRAVEL TIME (SEC)
0.400
0.395
0.390
0.385
0.380
0.375
0.370
0.365
13 18 23 28 2 7 12 17 22 27 4 9 14
JAN FEB MAR
14 19 24 29 3 8 13 18 23 28 3 8 13
MAR APR MAY

Figure 3.2

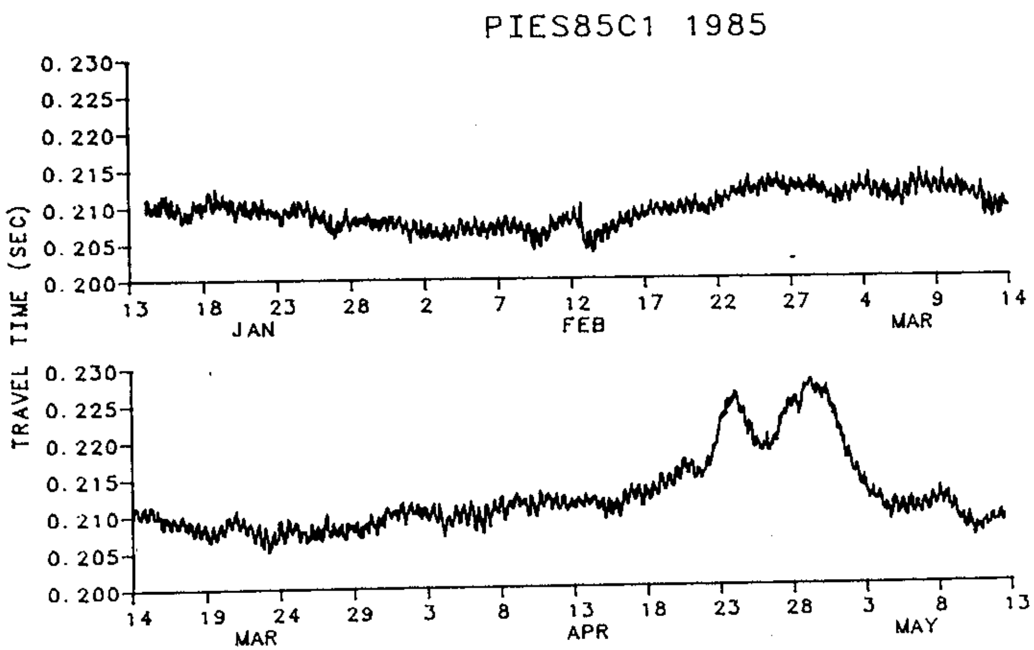

PIES85C1 1985
TRAVEL TIME (SEC)
0.230
0.225
0.220
0.215
0.210
0.205
0.200
13
18
23
JAN
28
2
7
12
FEB
17
22
27
4
9
MAR
14
14
19
24
MAR
29
3
8
13
APR
18
23
28
3
8
MAY
13

Figure 3.3

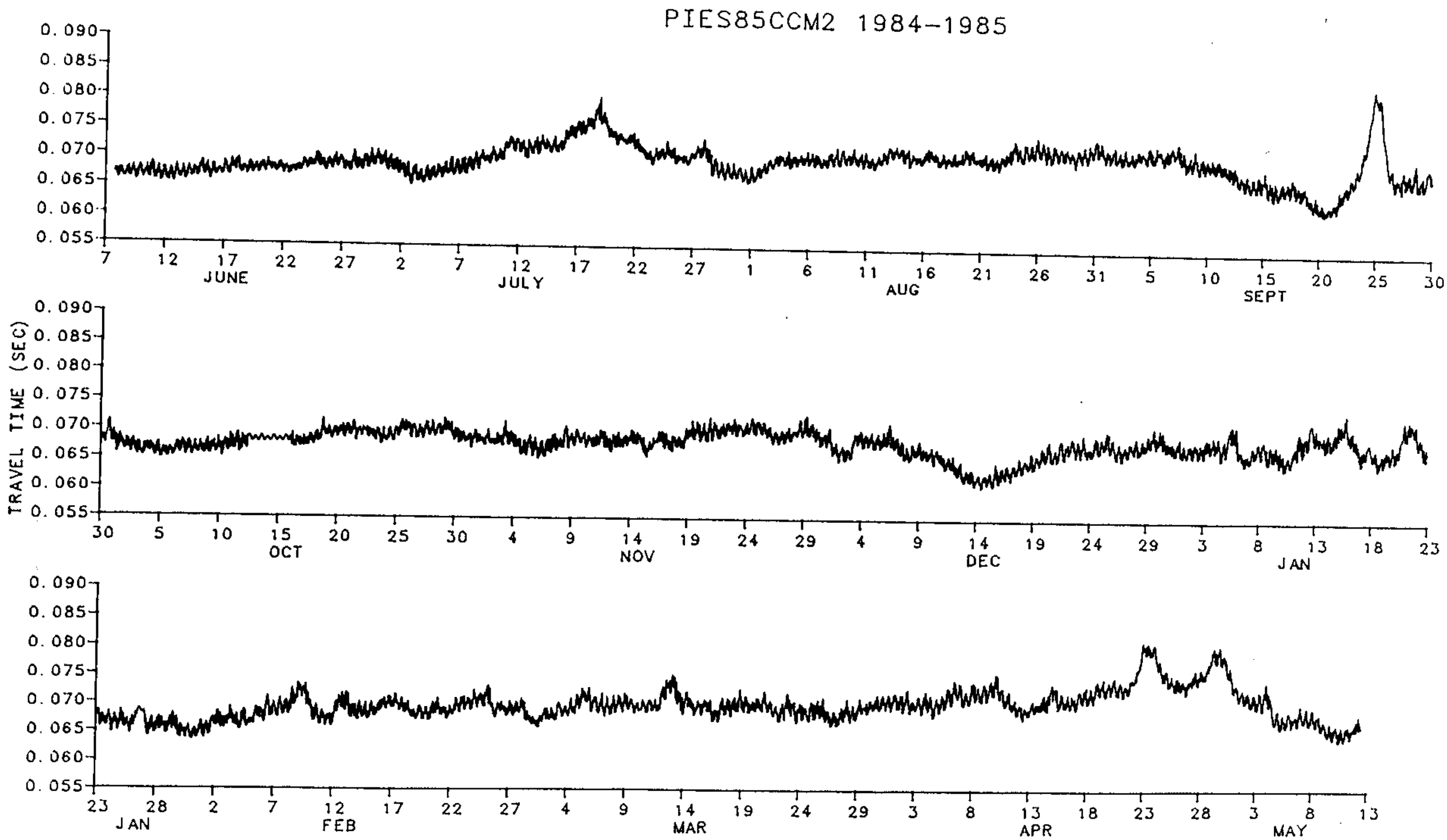

PIES85CCM2 1984–1985
TRAVEL TIME (SEC)
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.4

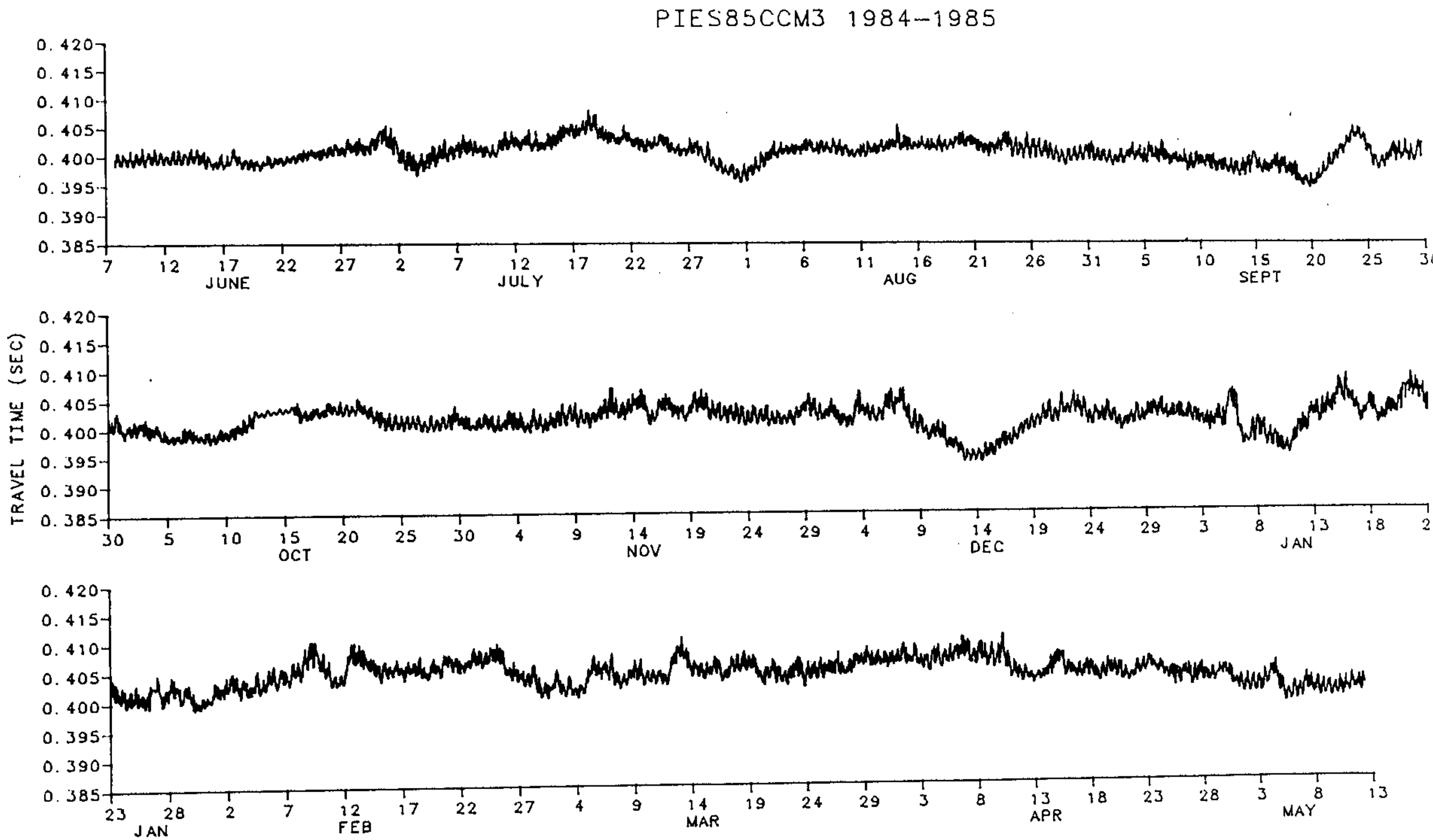

PIES85CCM3 1984–1985
TRAVEL TIME (SEC)
0.420
0.415
0.410
0.405
0.400
0.395
0.390
0.385
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.5

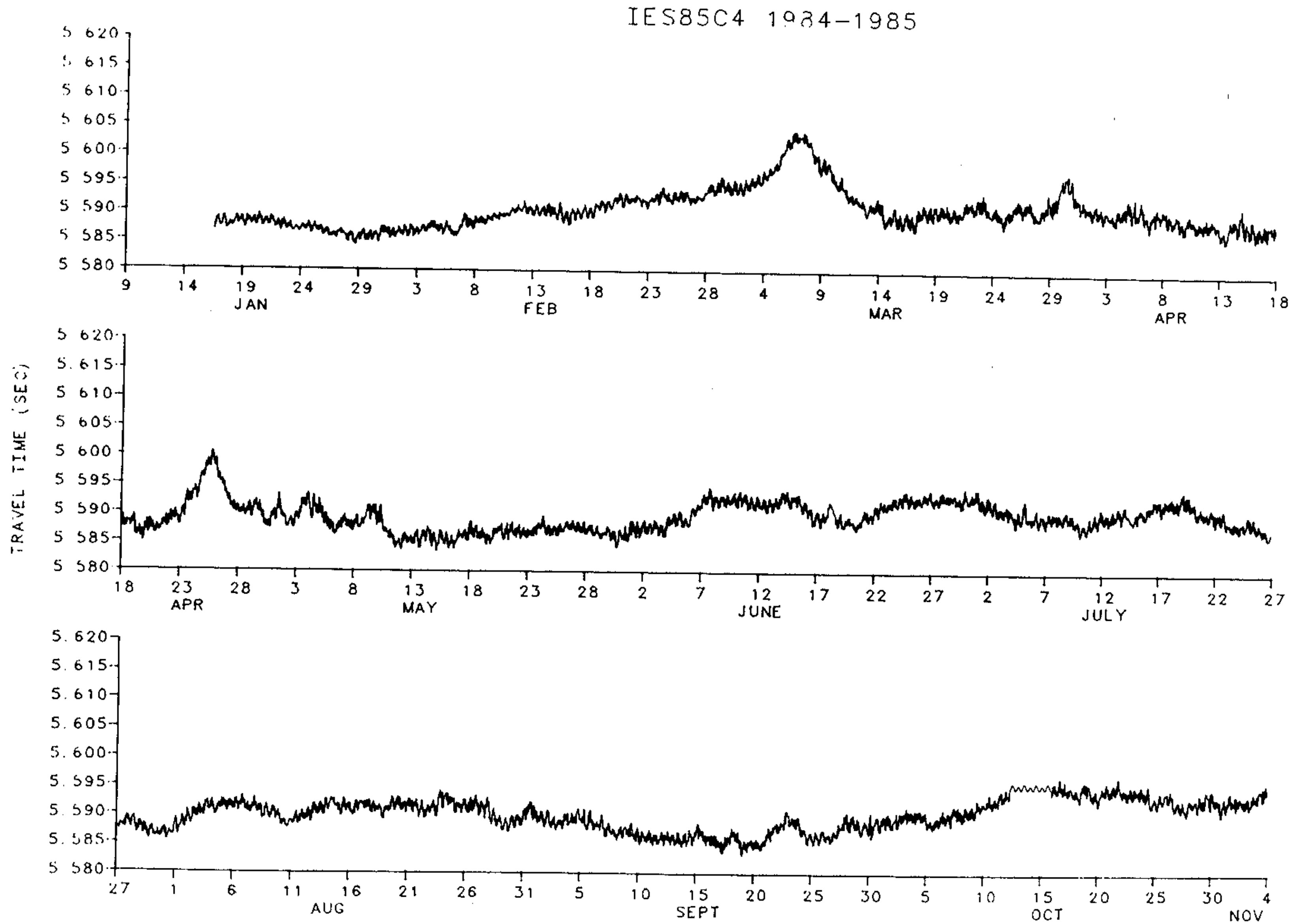

IES85C4 1984-1985
TRAVEL TIME (SEC)
5.620
5.615
5.610
5.605
5.600
5.595
5.590
5.585
5.580
9 14 19 24 29 3 8 13 18 23 28 4 9 14 19 24 29 3 8 13 18
JAN
FEB
MAR
APR
18 23 28 3 8 13 18 23 28 2 7 12 17 22 27 2 7 12 17 22 27
APR
MAY
JUNE
JULY
27 1 6 11 16 21 26 31 5 10 15 20 25 30 5 10 15 20 25 30 4
AUG
SEPT
OCT
NOV

Figure 3.6

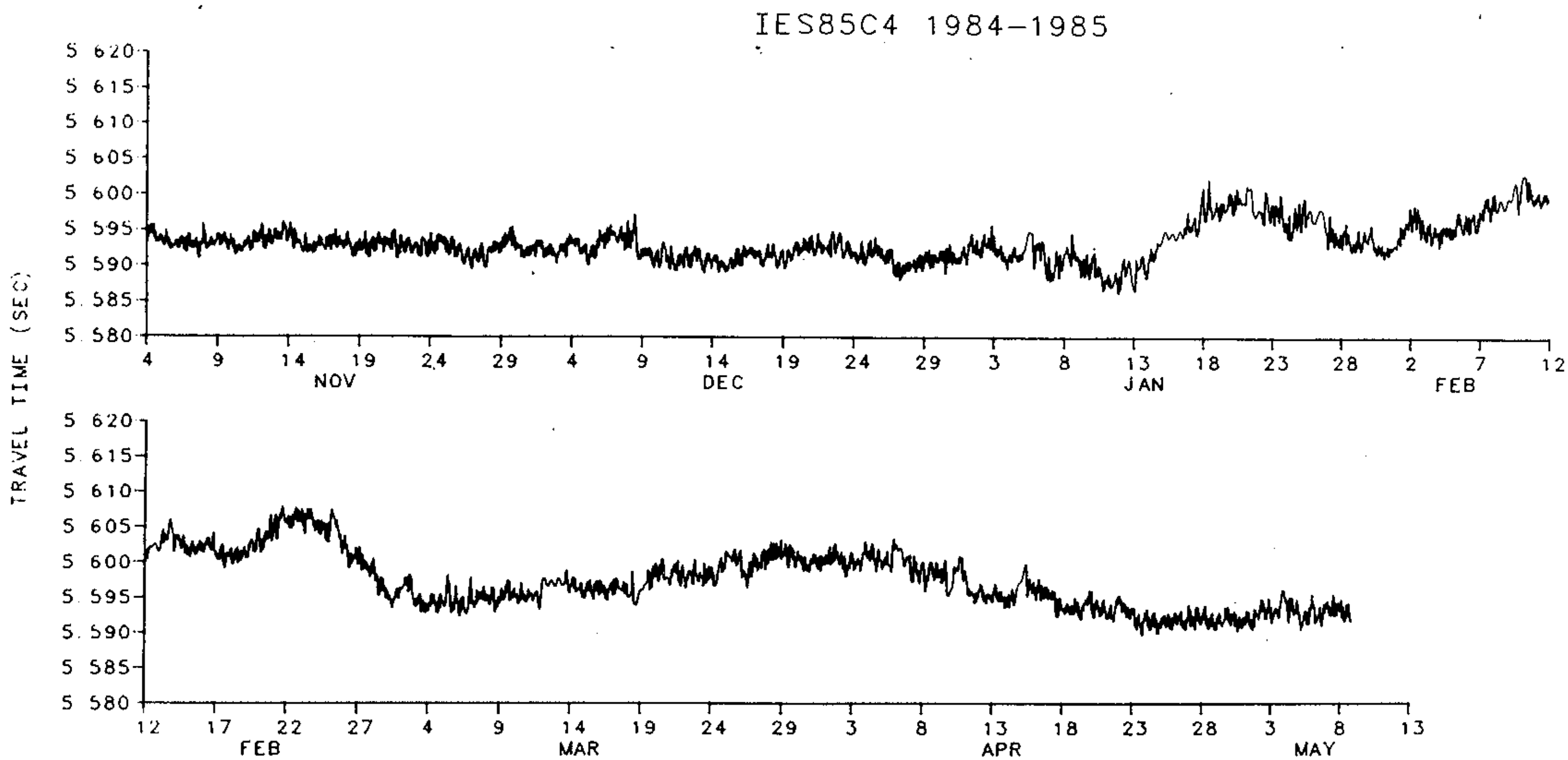


Figure 3.6 (continued)

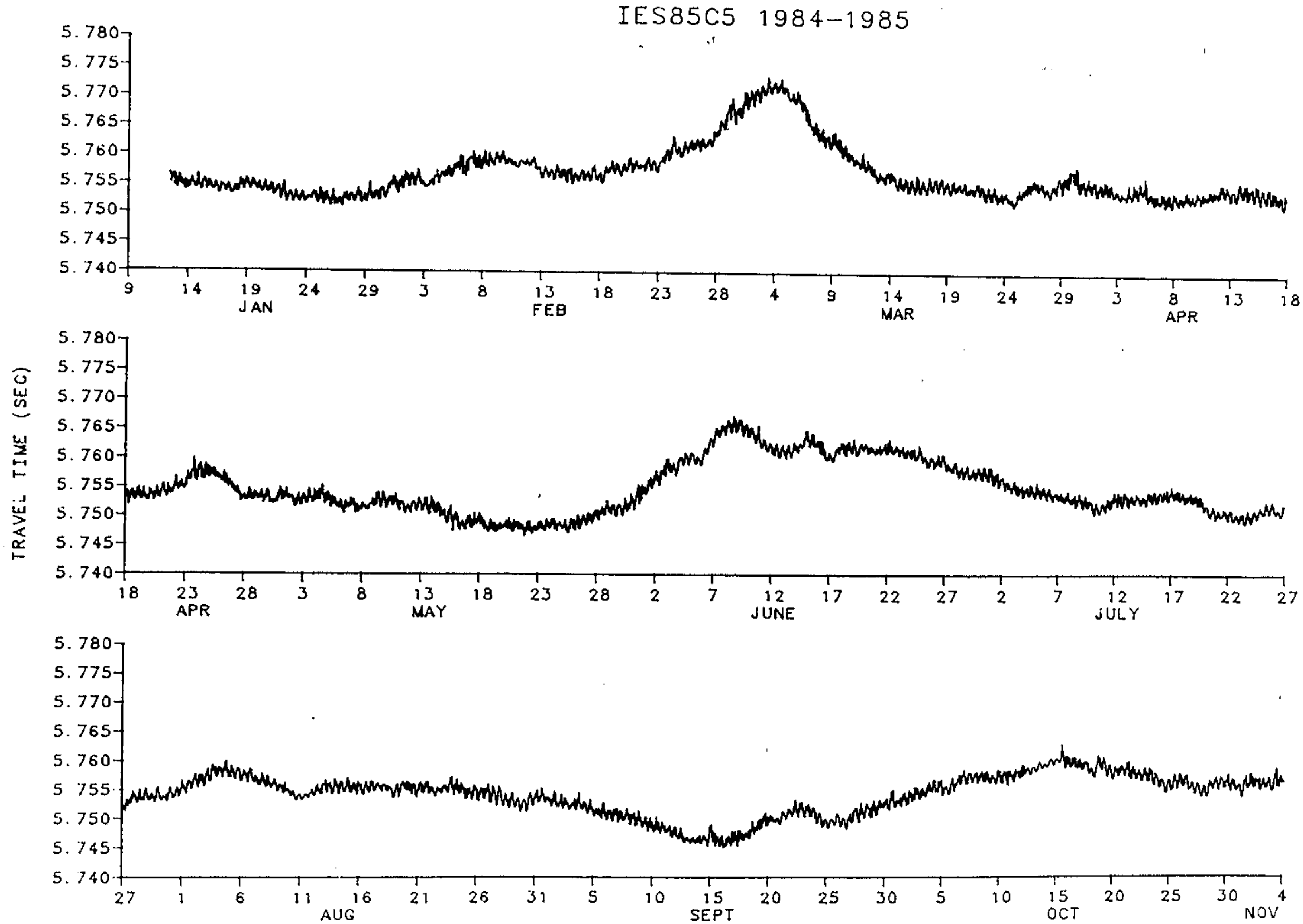

IES85C5 1984-1985
TRAVEL TIME (SEC)
5.780
5.775
5.770
5.765
5.760
5.755
5.750
5.745
5.740
9 14 19 24 29 3 8 13 18 23 28 4 9 14 19 24 29 3 8 13 18
JAN
FEB
MAR
APR
18 23 28 3 8 13 18 23 28 2 7 12 17 22 27 2 7 12 17 22 27
APR
MAY
JUNE
JULY
27 1 6 11 16 21 26 31 5 10 15 20 25 30 5 10 15 20 25 30 4
AUG
SEPT
OCT
NOV

Figure 3.7

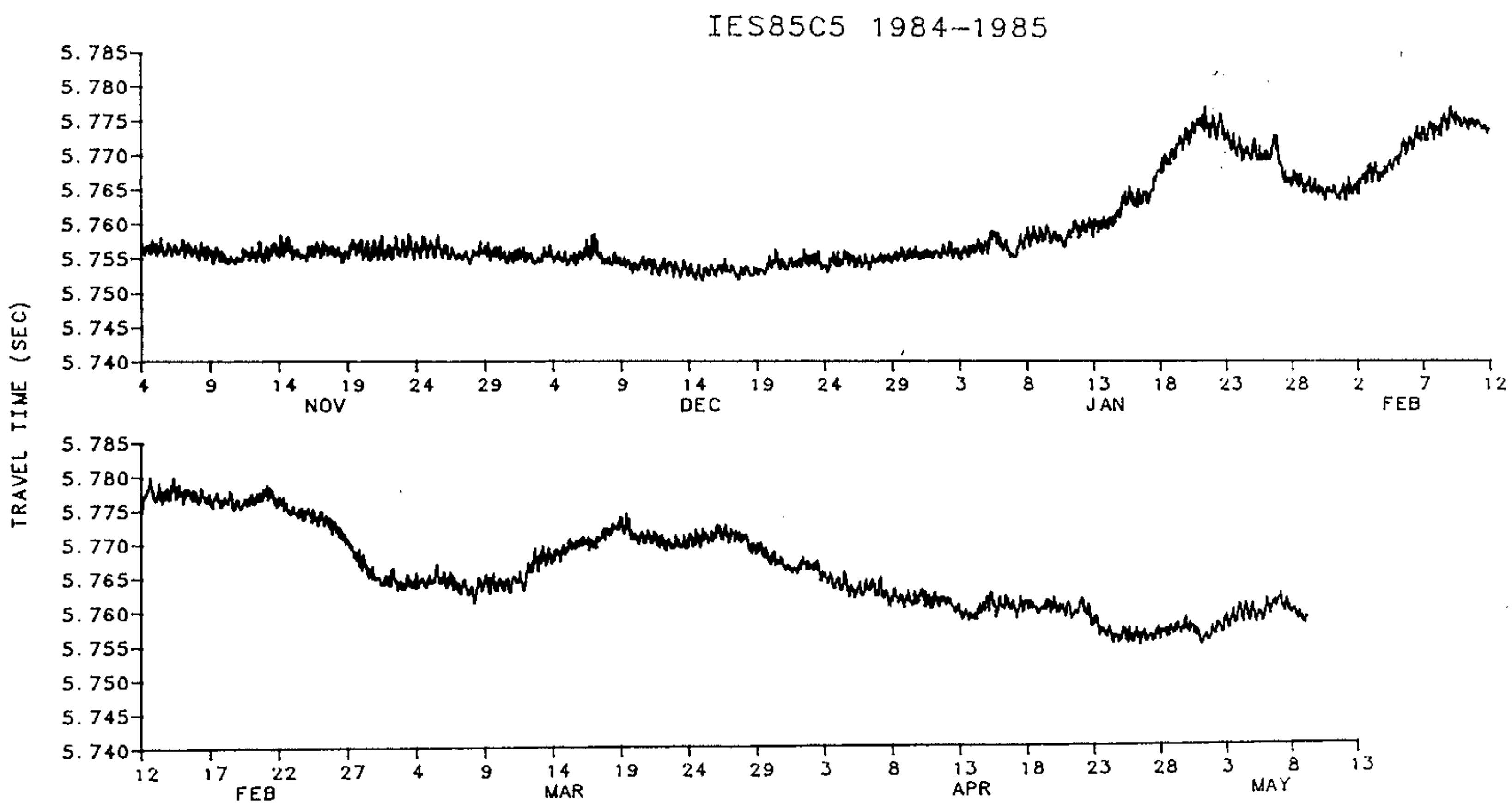


Figure 3.7 (continued)

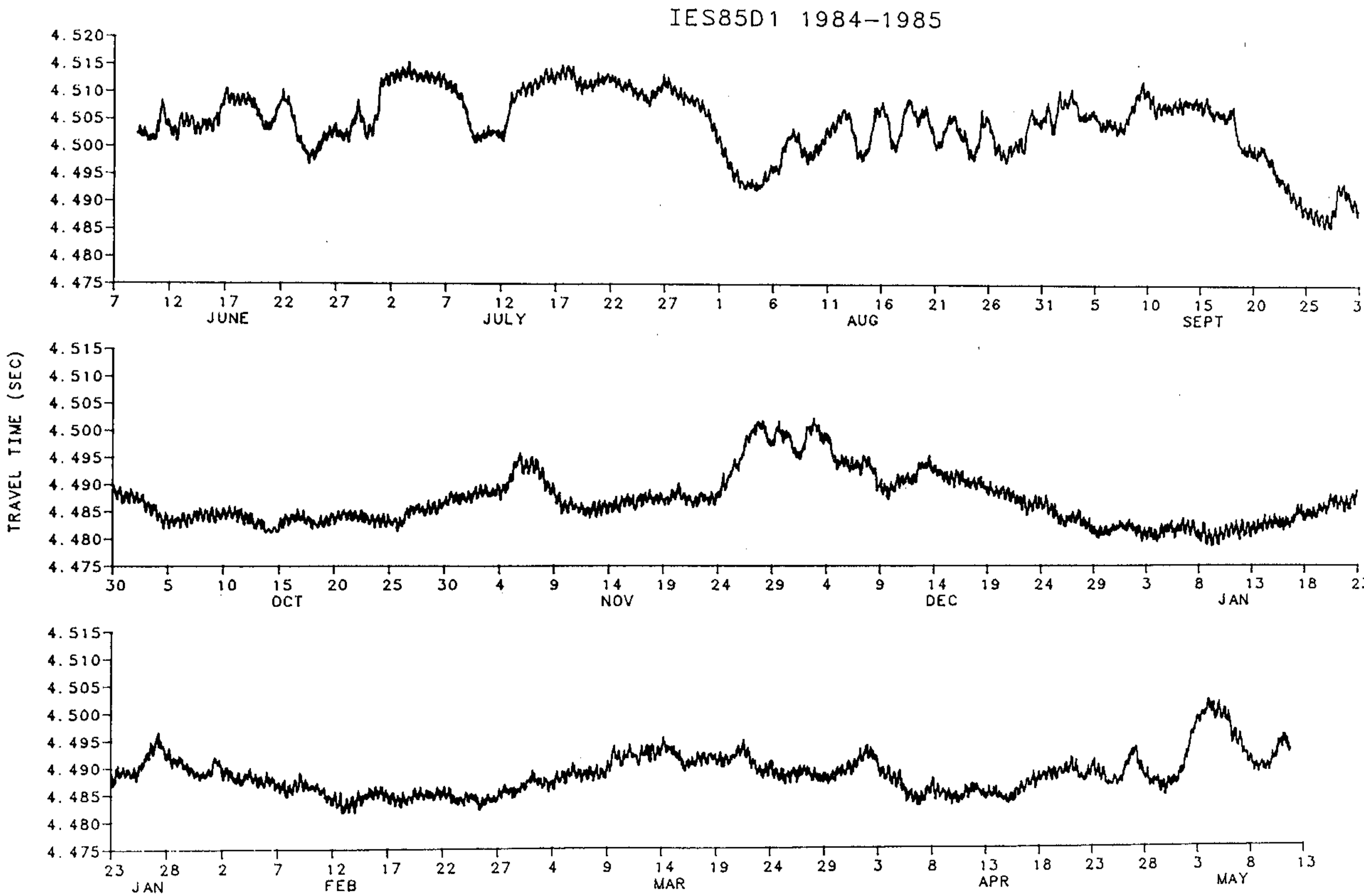

IES85D1 1984–1985
TRAVEL TIME (SEC)
4.520
4.515
4.510
4.505
4.500
4.495
4.490
4.485
4.480
4.475
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.8

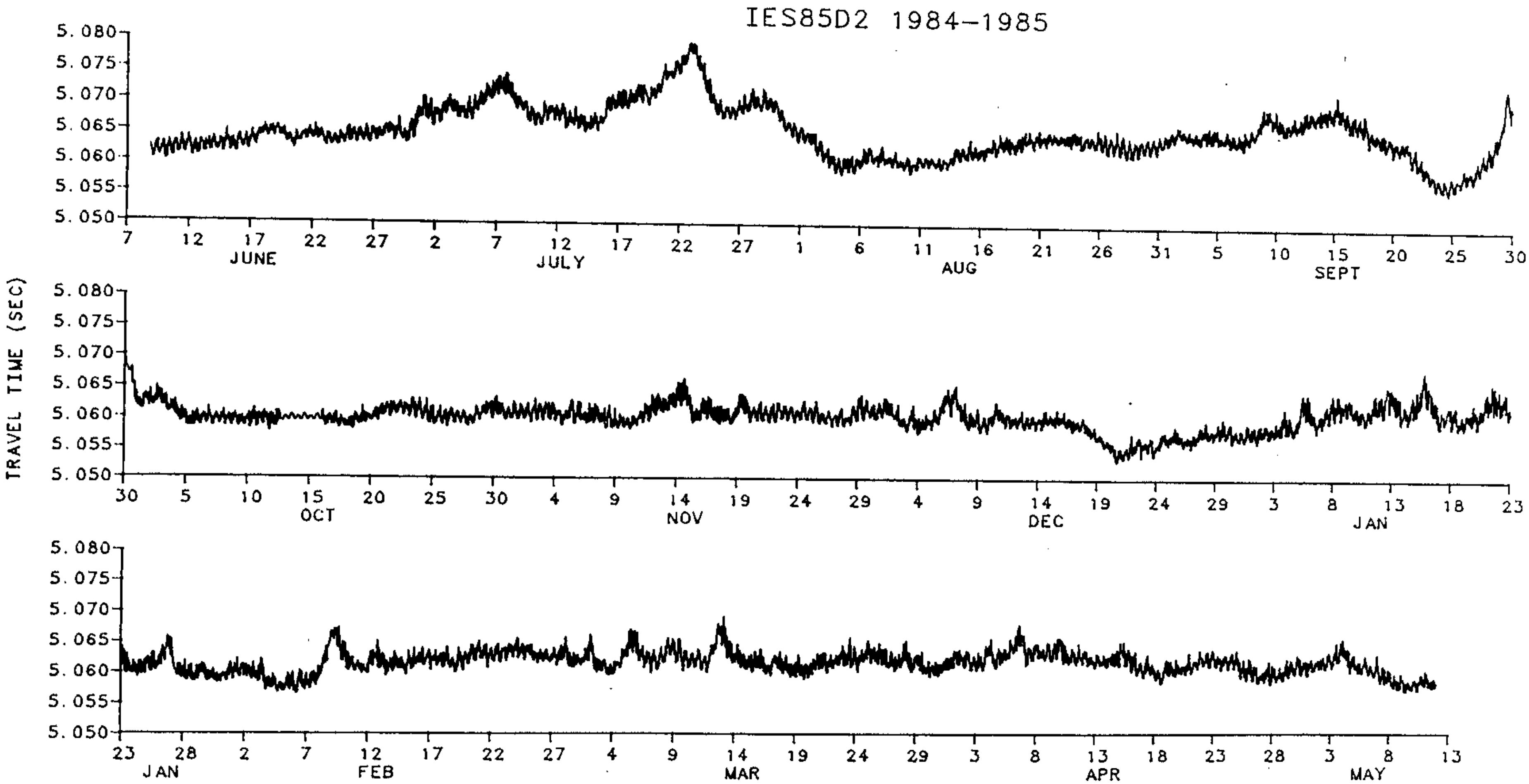

IES85D2 1984–1985
TRAVEL TIME (SEC)
5.080
5.075
5.070
5.065
5.060
5.055
5.050
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.9

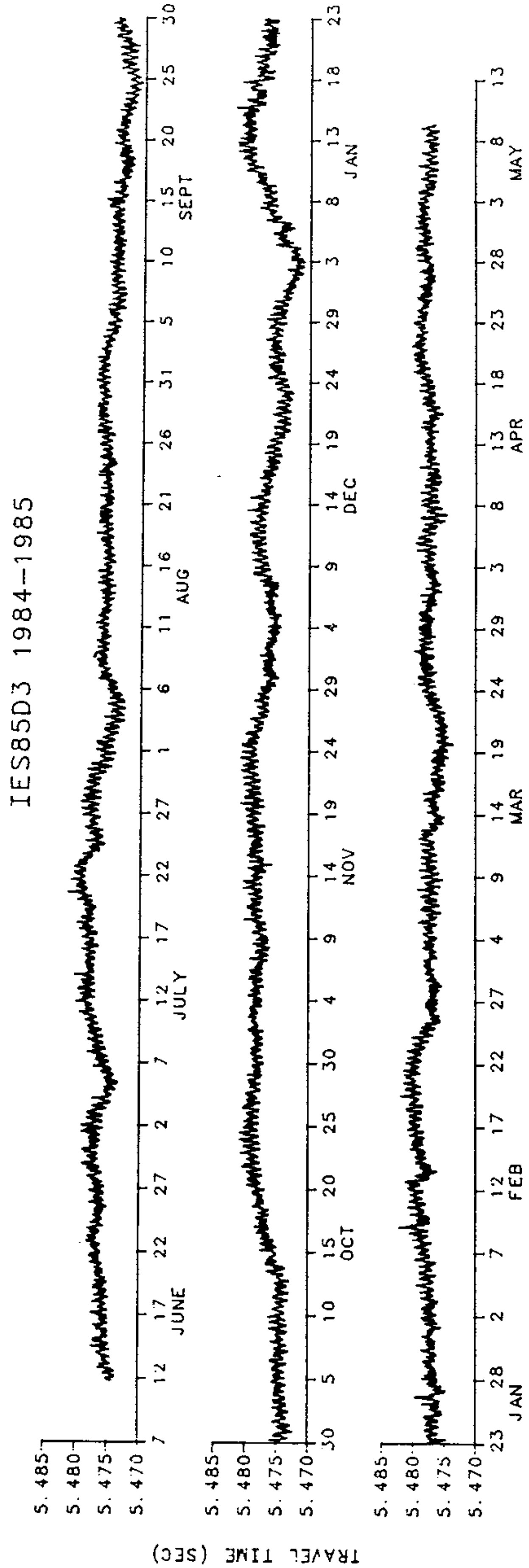

IES85D3 1984-1985
TRAVEL TIME (SEC)
5.485
5.480
5.475
5.470
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 3.10

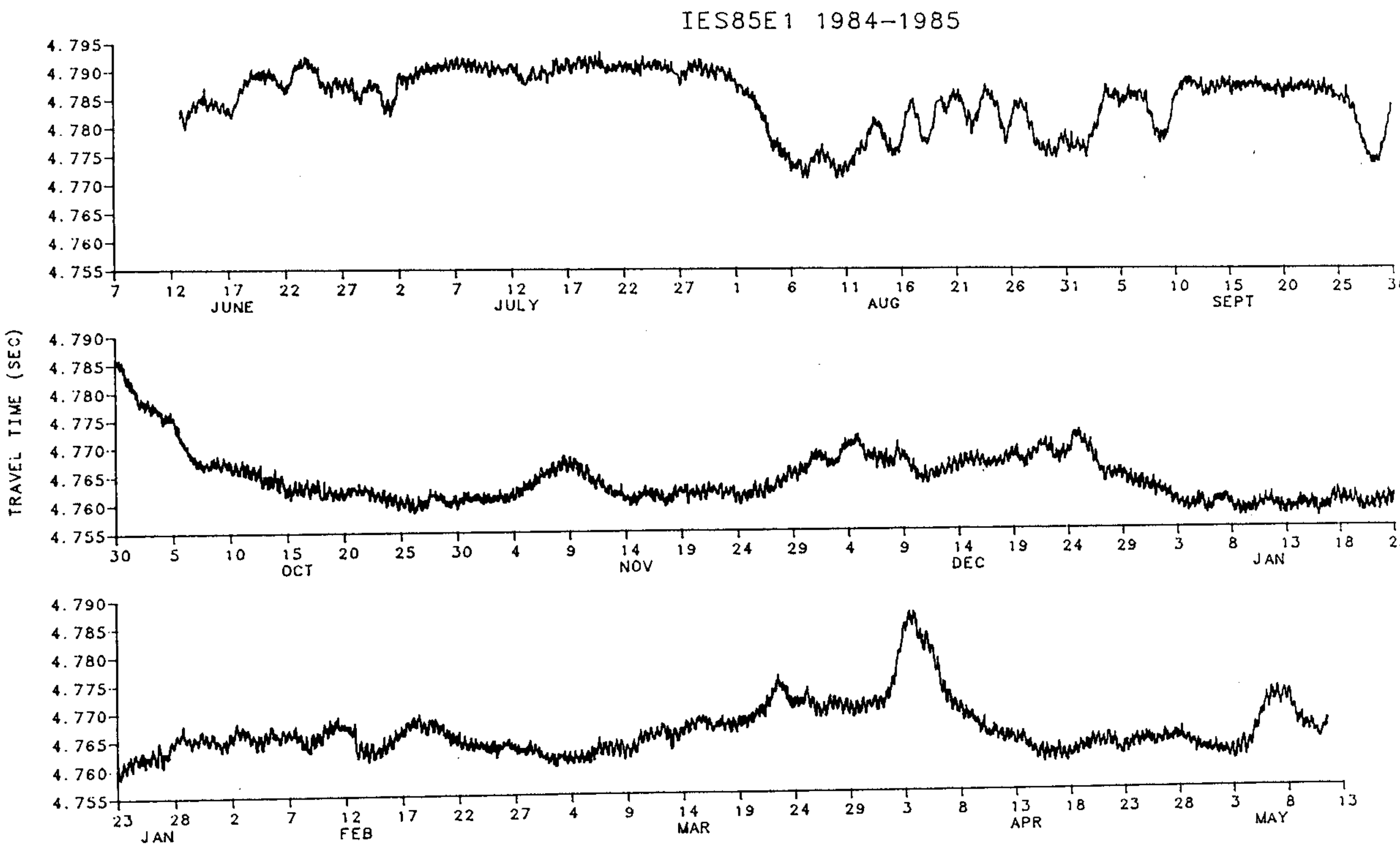

IES85E1 1984-1985
TRAVEL TIME (SEC)
4.795
4.790
4.785
4.780
4.775
4.770
4.765
4.760
4.755
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.11

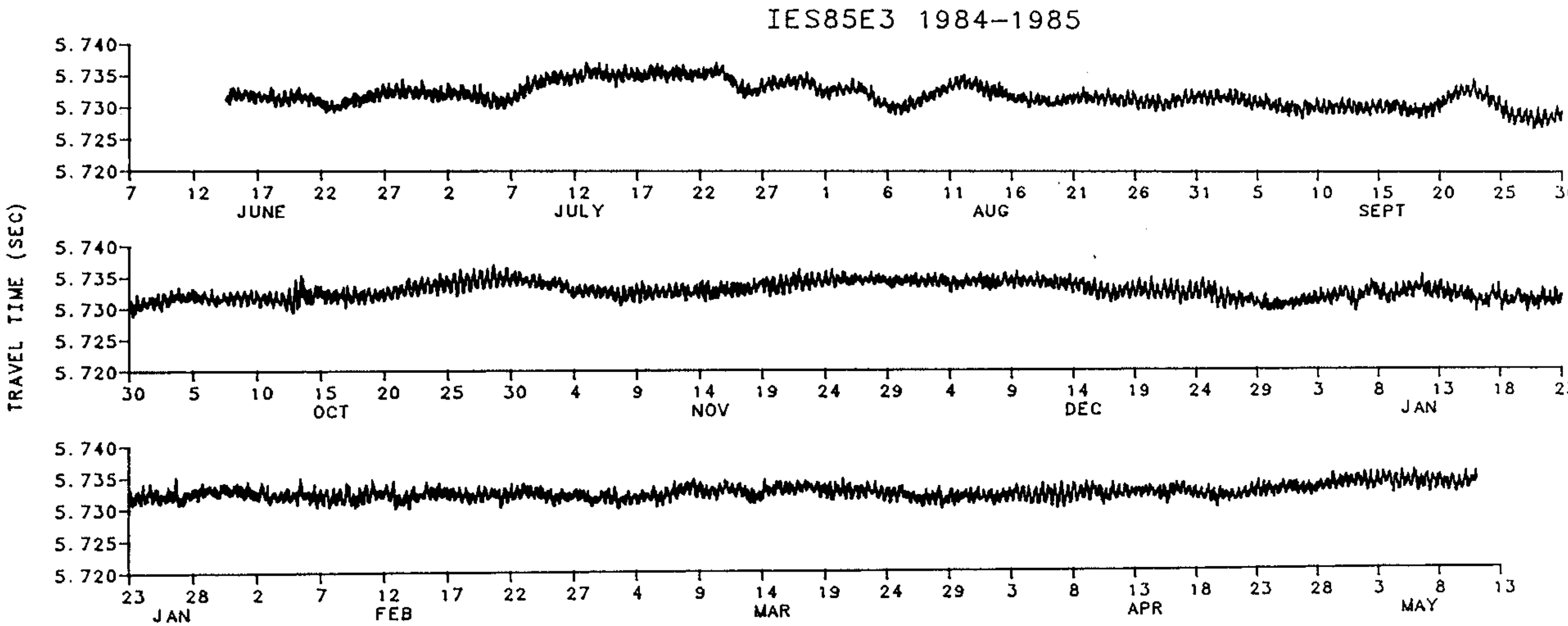

IES85E3 1984–1985
TRAVEL TIME (SEC)
5.740
5.735
5.730
5.725
5.720
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.12

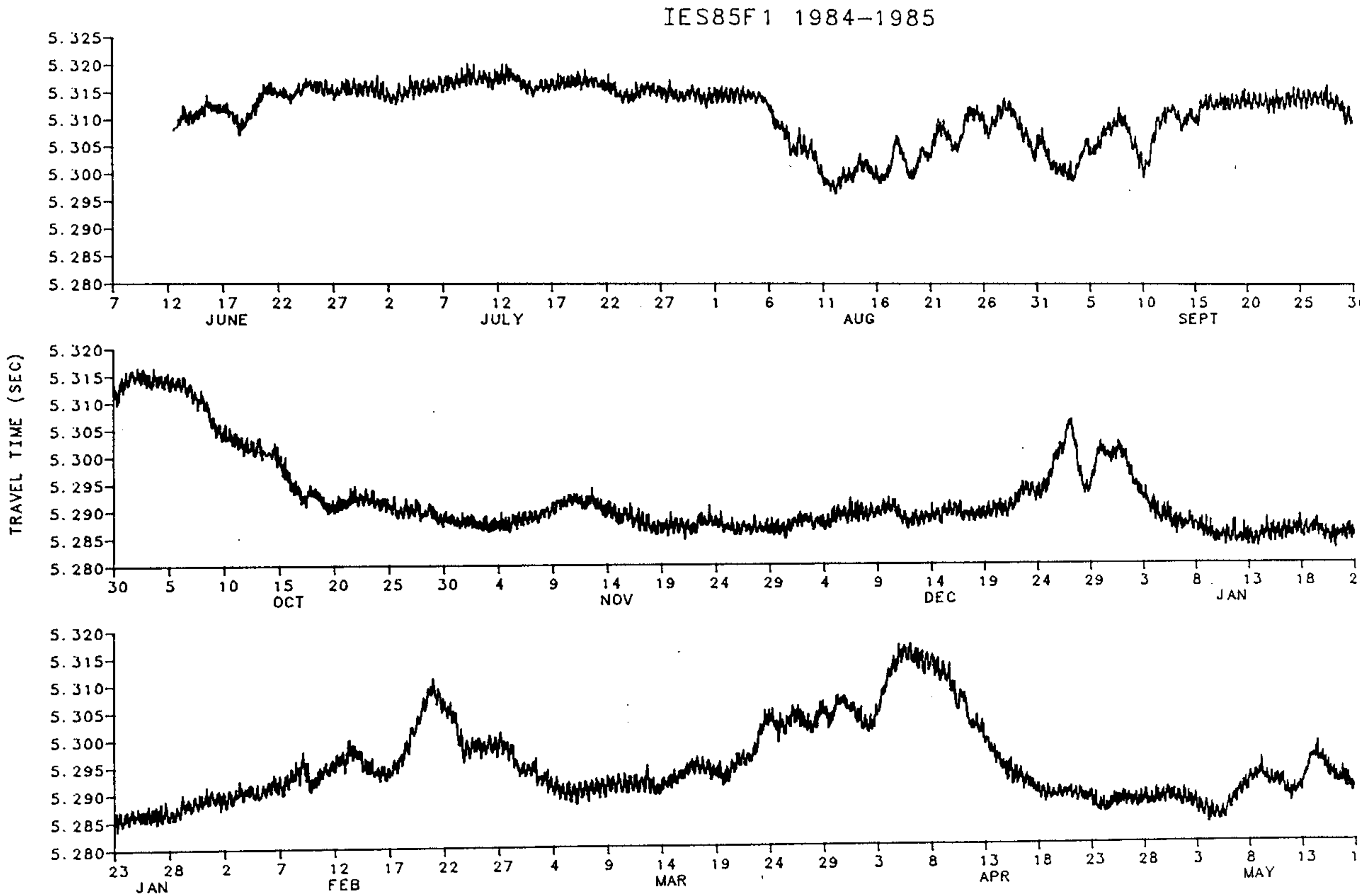

IES85F1 1984–1985
TRAVEL TIME (SEC)
5.325
5.320
5.315
5.310
5.305
5.300
5.295
5.290
5.285
5.280
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 3.13

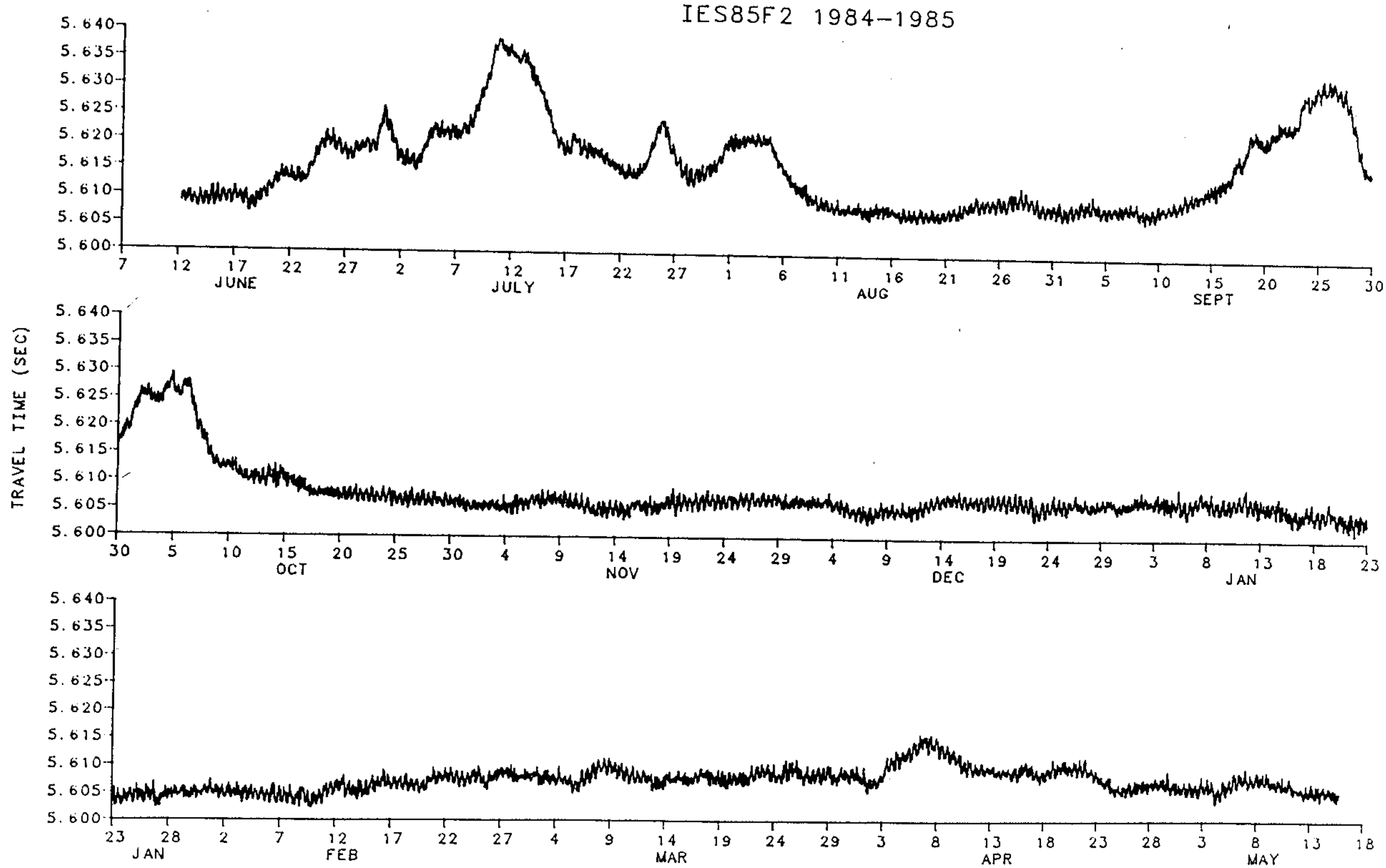

IES85F2 1984-1985
TRAVEL TIME (SEC)
5.640
5.635
5.630
5.625
5.620
5.615
5.610
5.605
5.600
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 3.14

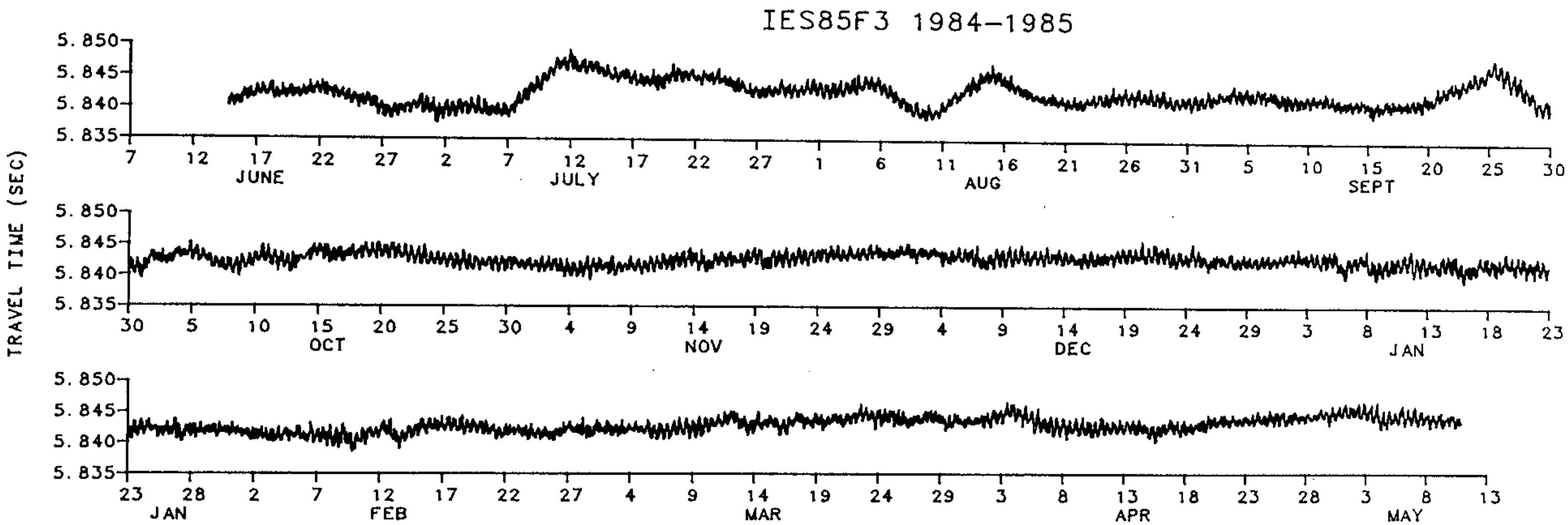

IES85F3 1984–1985
TRAVEL TIME (SEC)
5.850
5.845
5.840
5.835
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 3.15

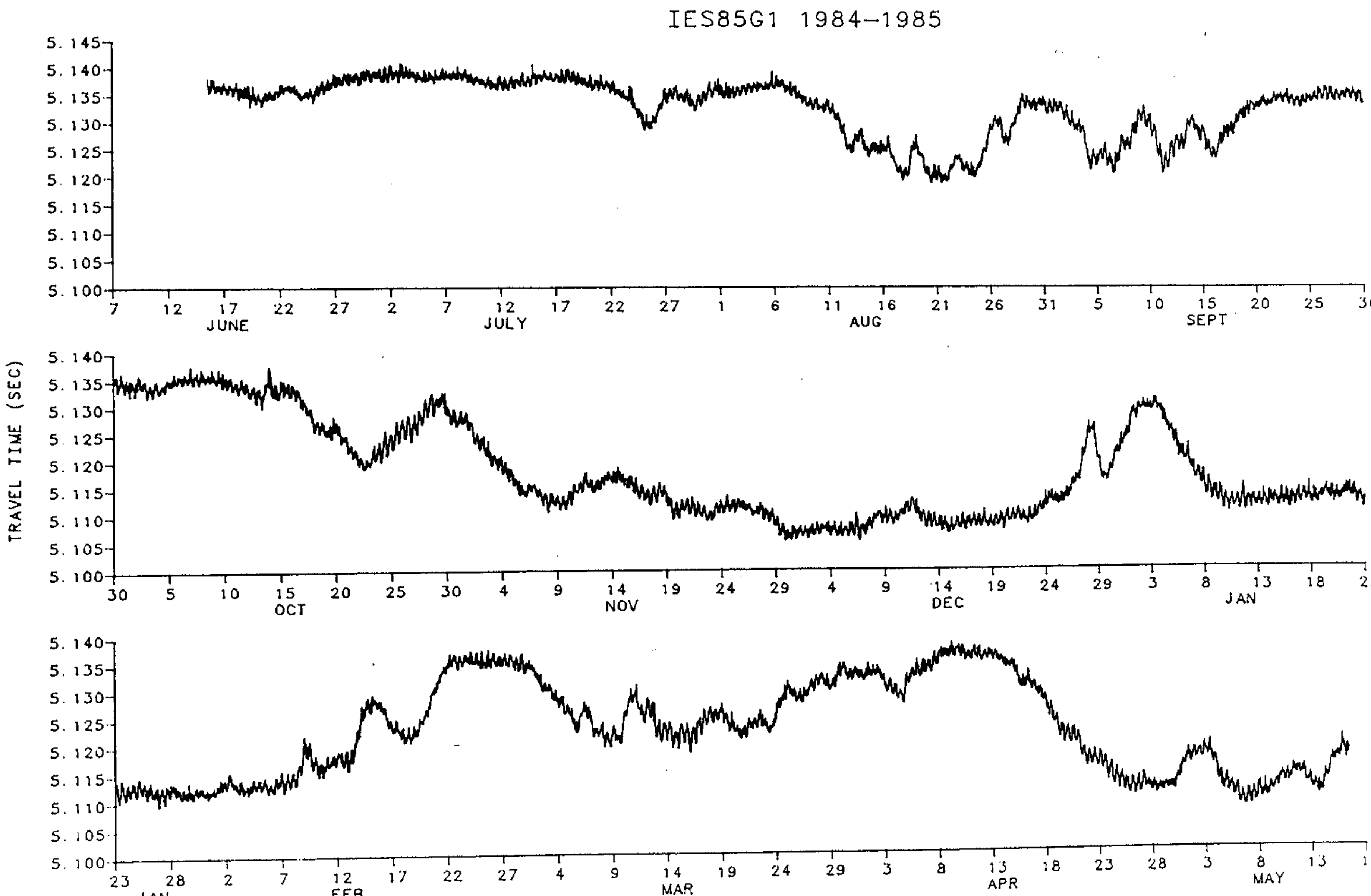

IES85G1 1984–1985
TRAVEL TIME (SEC)
5.145
5.140
5.135
5.130
5.125
5.120
5.115
5.110
5.105
5.100
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18
JAN
FEB
MAR
APR
MAY

Figure 3.16

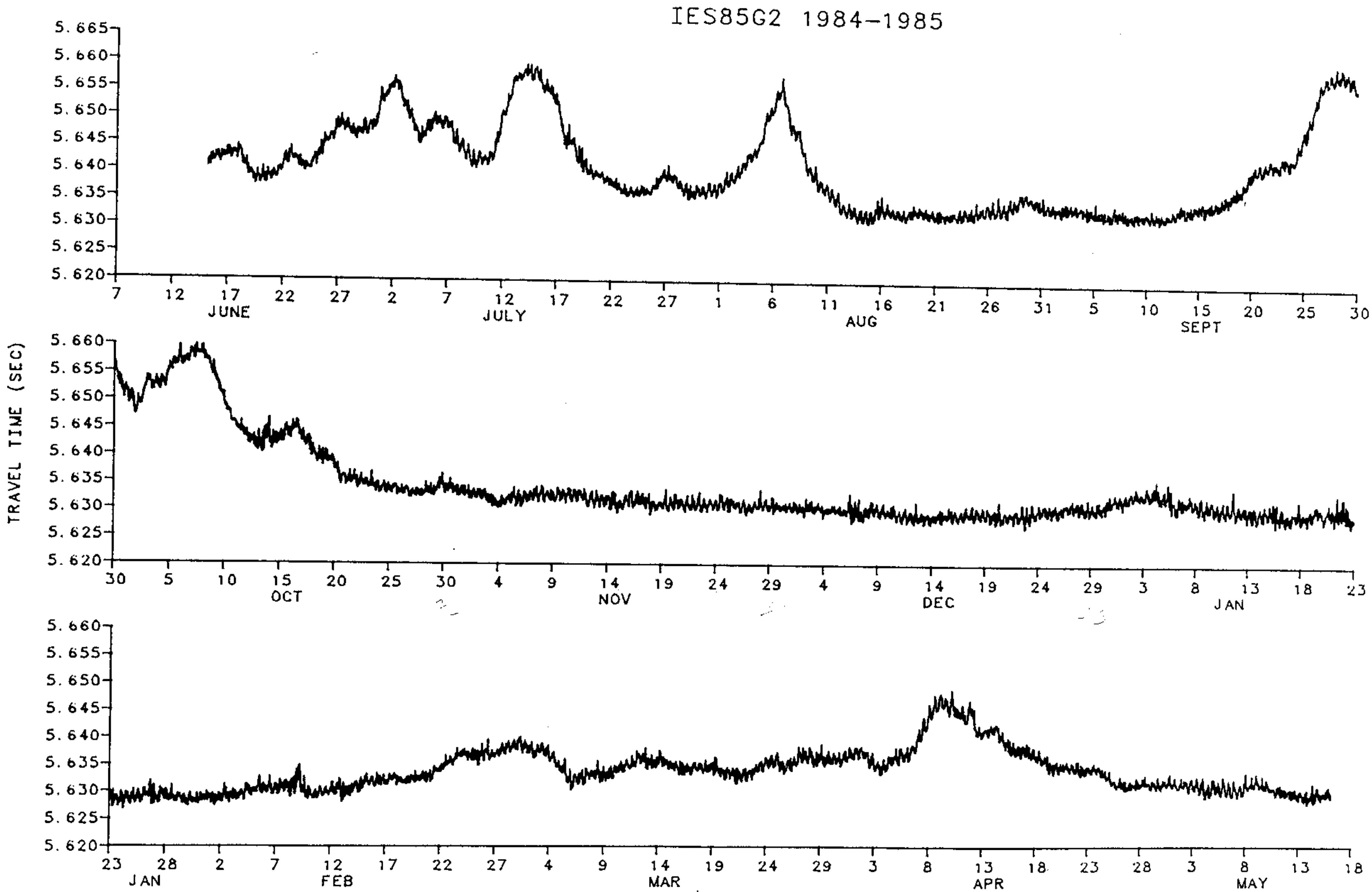

IES85G2 1984-1985
TRAVEL TIME (SEC)
5.665
5.660
5.655
5.650
5.645
5.640
5.635
5.630
5.625
5.620
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13 18
JAN
FEB
MAR
APR
MAY

Figure 3.17

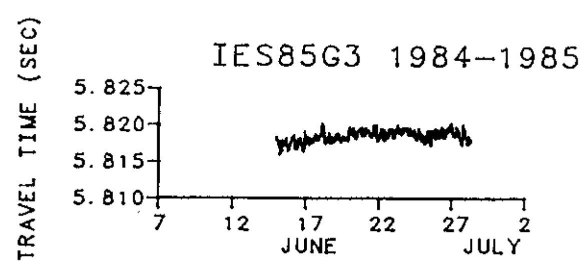

IES85G3 1984–1985
TRAVEL TIME (SEC)
5.825
5.820
5.815
5.810
7
12
17
JUNE
22
27
2
JULY

Figure 3.18

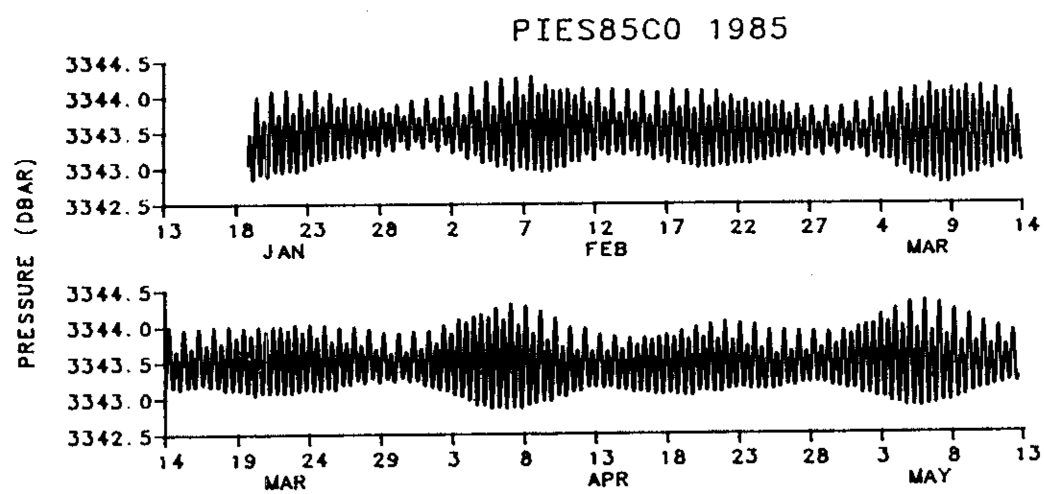


Figure 4.1

Figure 4.1-4. Full measured bottom pressure records at half-hourly intervals.

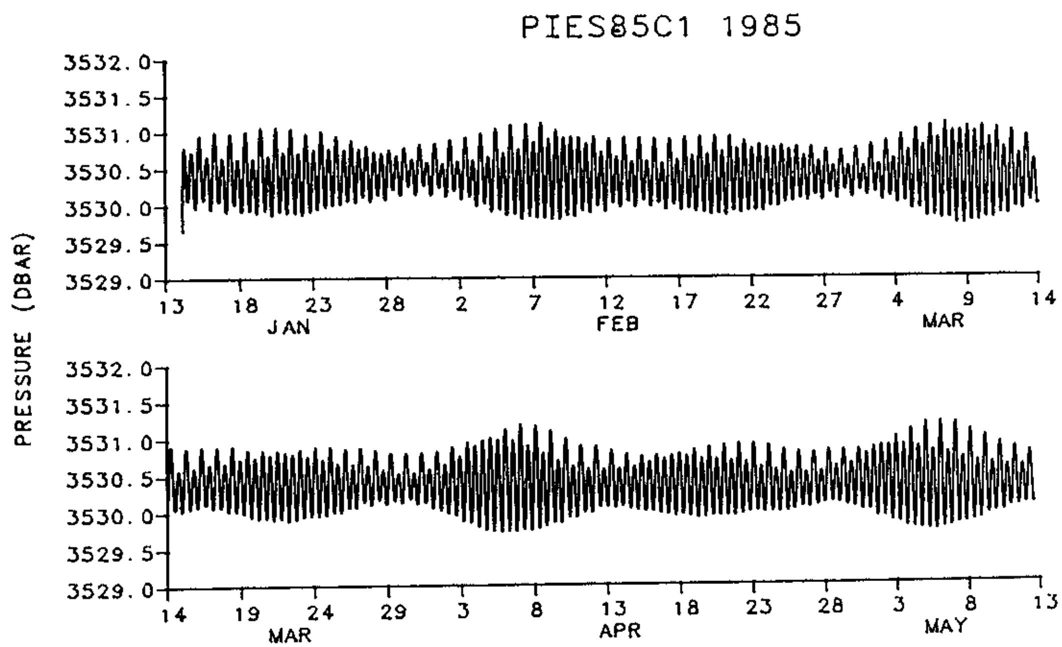

PIES85C1 1985
PRESSURE (DBAR)
3532.0
3531.5
3531.0
3530.5
3530.0
3529.5
3529.0
13 18 23 28 2 7 12 17 22 27 4 9 14
JAN
FEB
MAR
14 19 24 29 3 8 13 18 23 28 3 8 13
MAR
APR
MAY

Figure 4.2

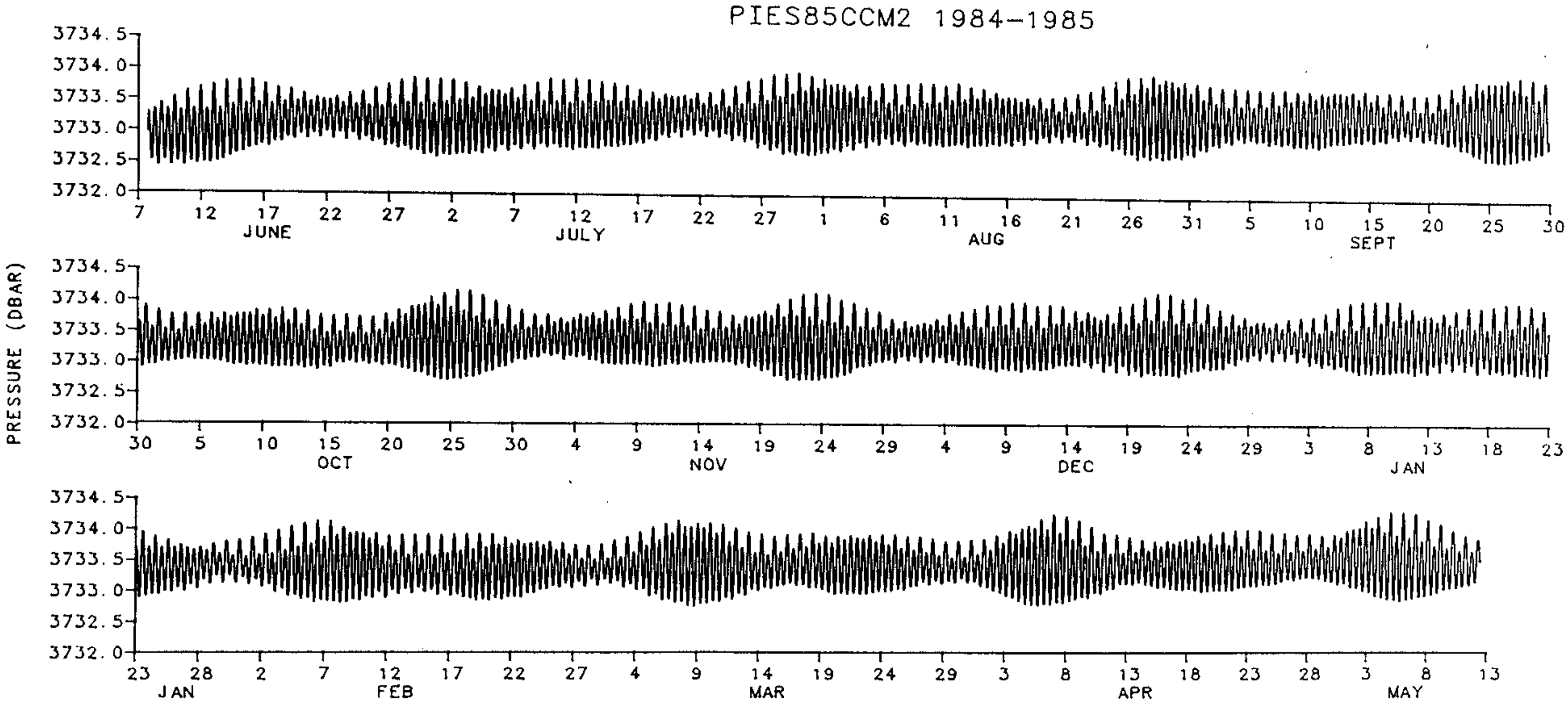

PIES85CCM2 1984–1985
PRESSURE (DBAR)
3734.5
3734.0
3733.5
3733.0
3732.5
3732.0
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 4.3

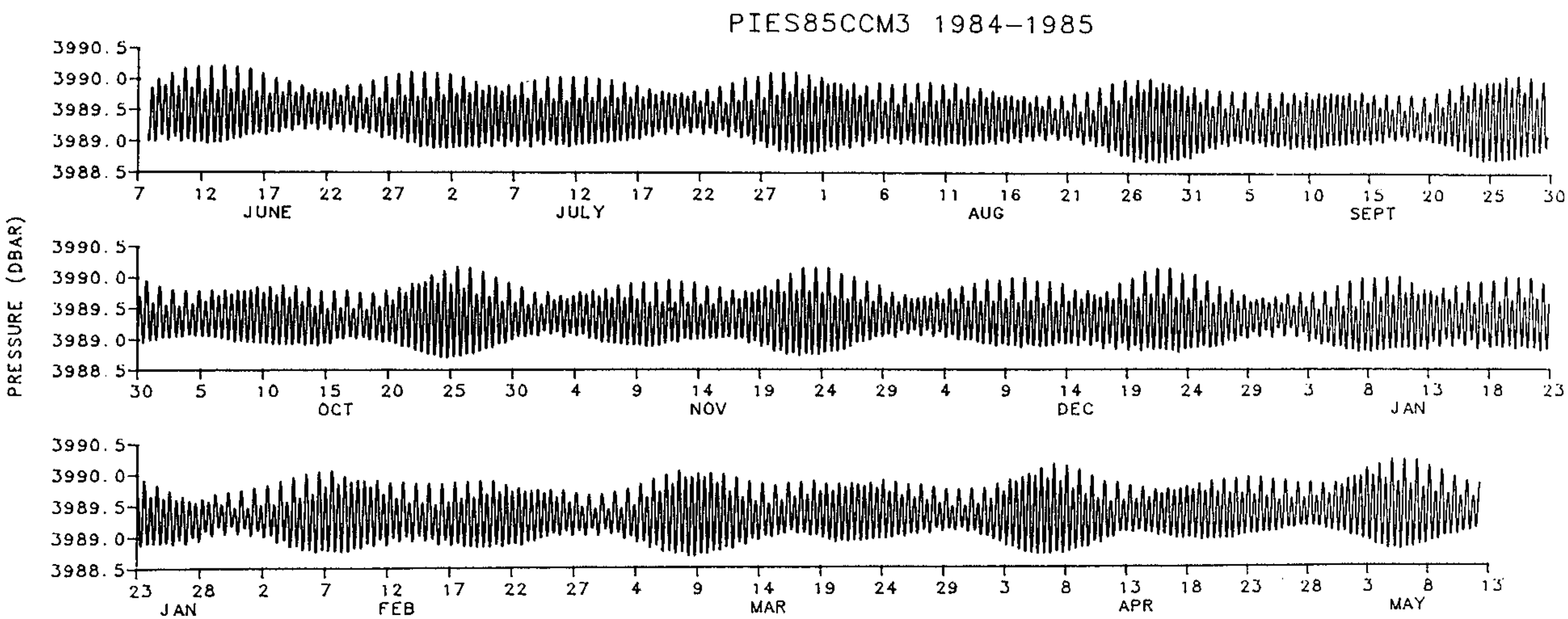

PIES85CCM3 1984–1985
PRESSURE (DBAR)
3990.5
3990.0
3989.5
3989.0
3988.5
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 4.4

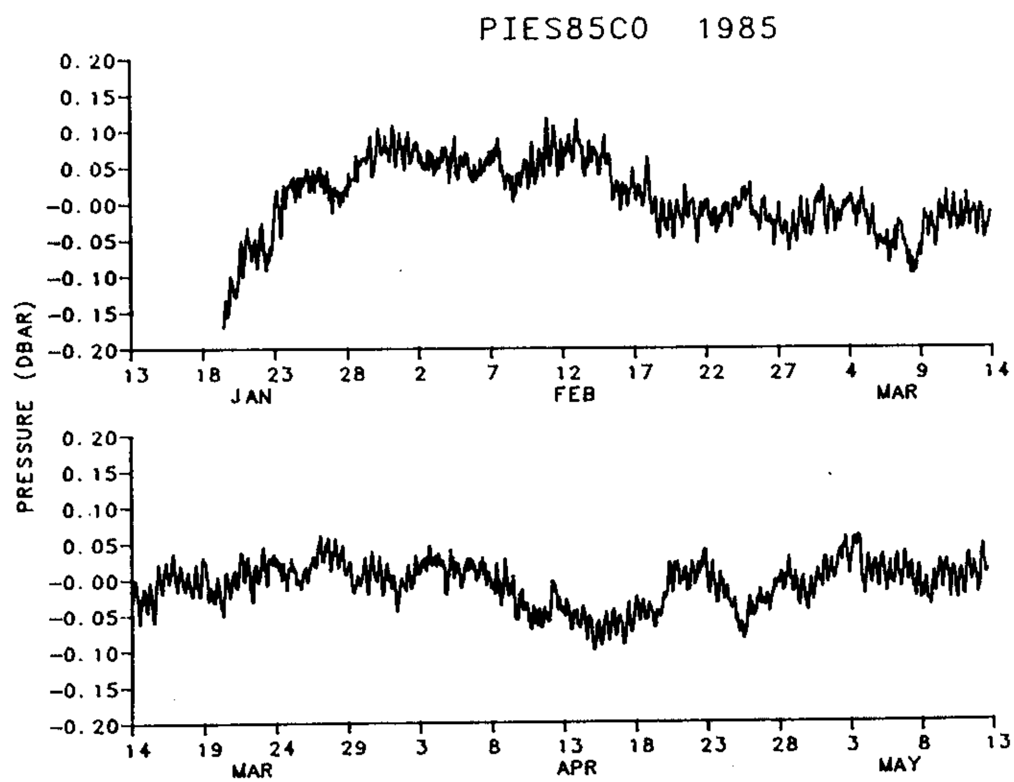


Figure 5.1

Figure 5.1-4. Residual bottom pressure records at half-hourly intervals. The tides, long term drifts, and means, which have been removed, are given in Section 2.

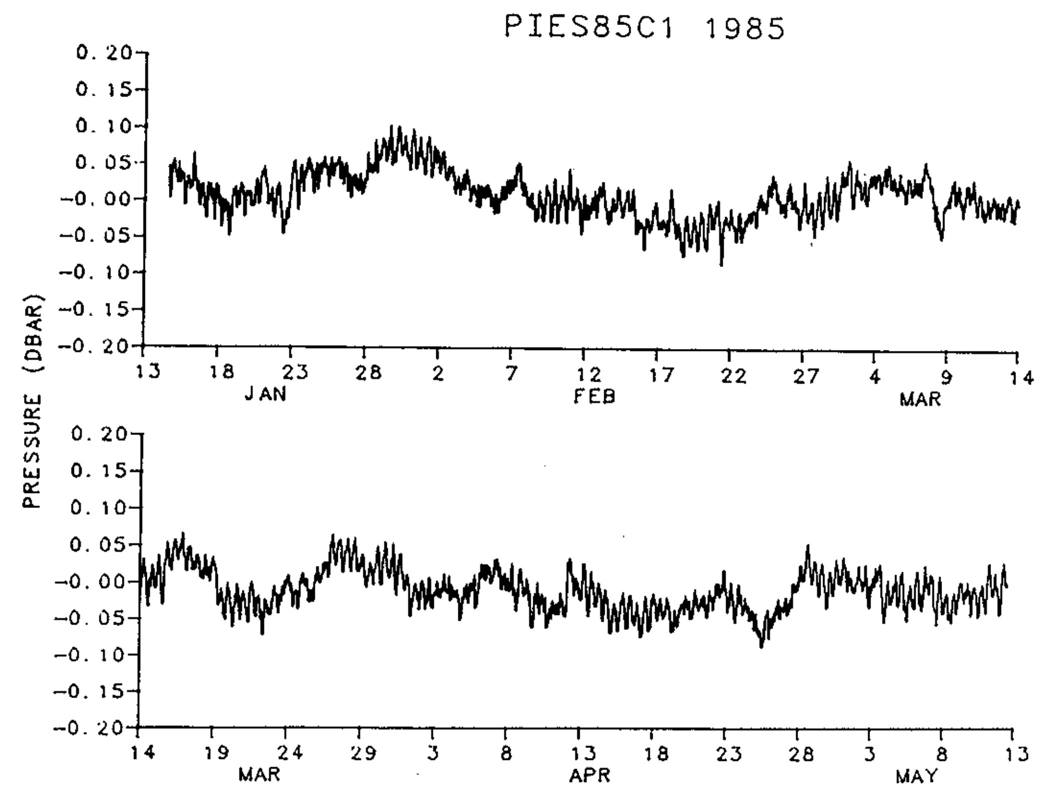

PIES85C1 1985
PRESSURE (DBAR)
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
-0.20
13 18 23 28 2 7 12 17 22 27 4 9 14
JAN
FEB
MAR
14 19 24 29 3 8 13 18 23 28 3 8 13
MAR
APR
MAY

Figure 5.2

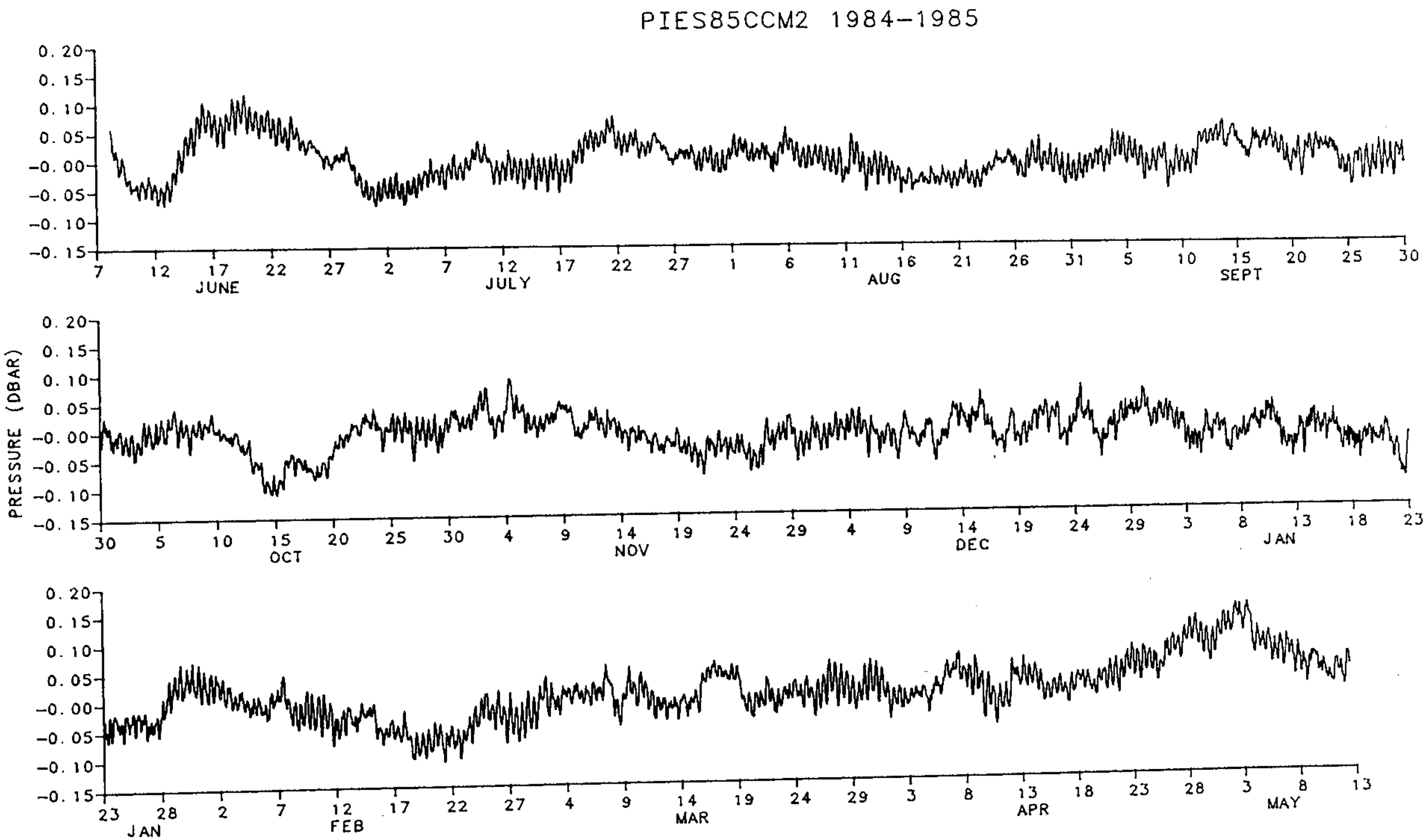

PIES85CCM2 1984–1985
PRESSURE (DBAR)
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 5.3

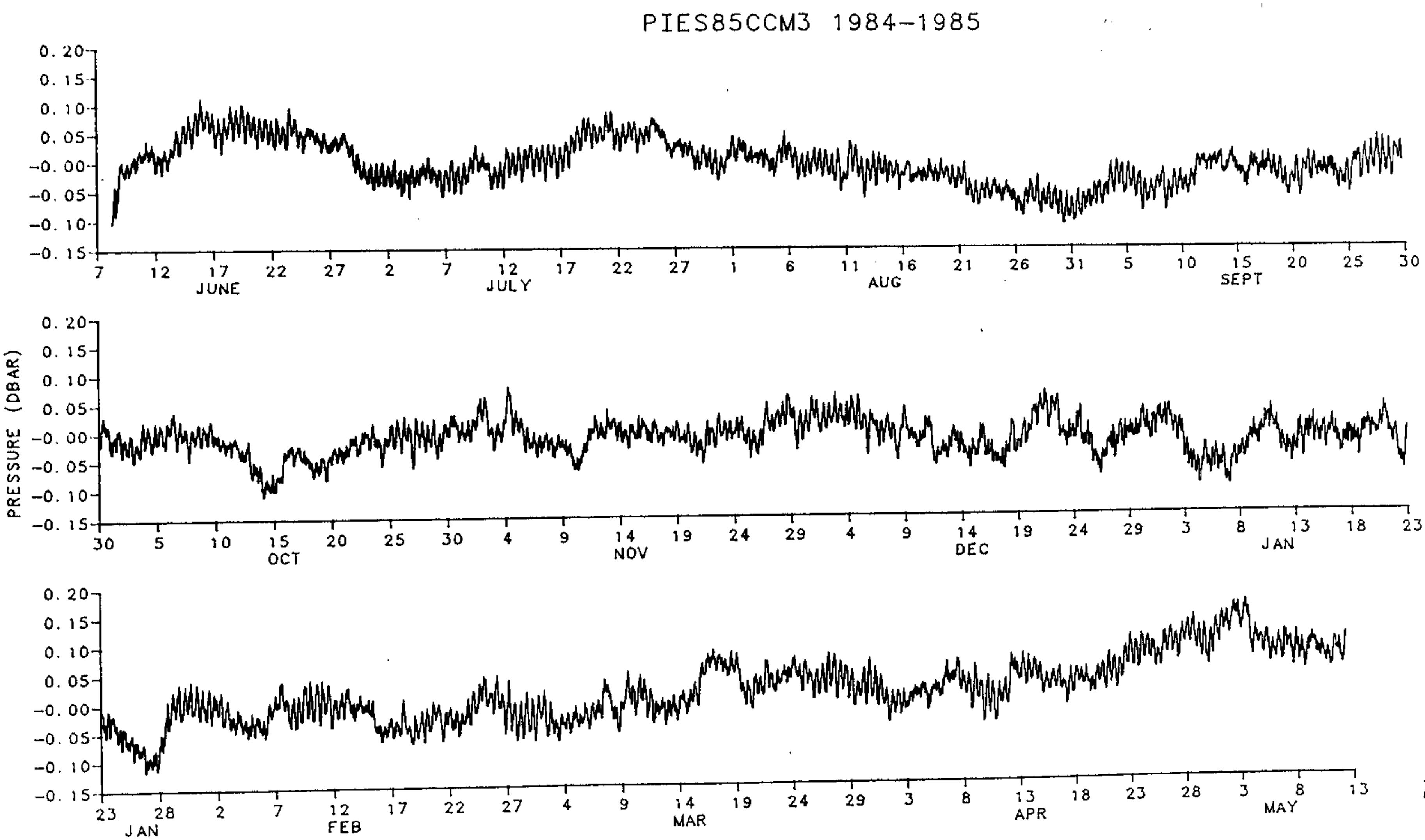

PIES85CCM3 1984-1985
PRESSURE (DBAR)
0.20
0.15
0.10
0.05
-0.00
-0.05
-0.10
-0.15
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE
JULY
AUG
SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT
NOV
DEC
JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN
FEB
MAR
APR
MAY

Figure 5.4

PIES85CO 1985

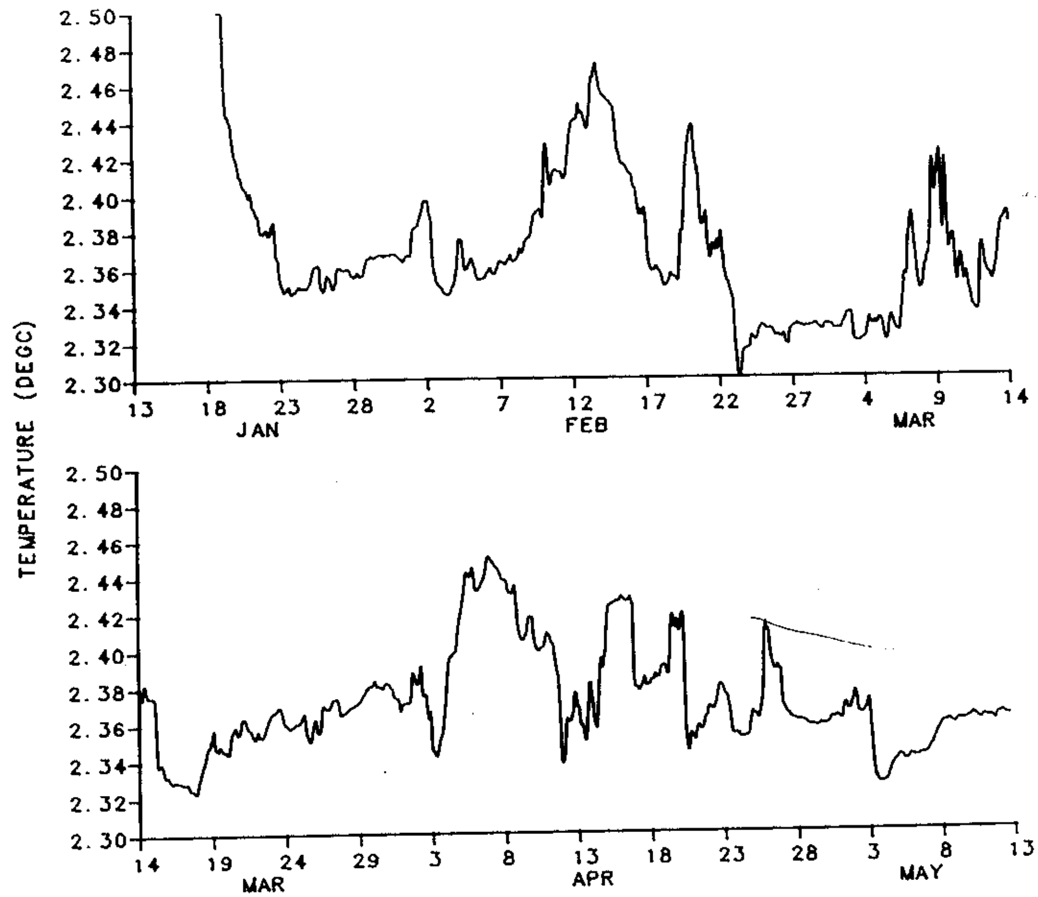


Figure 6.1

Figure 6.1-4. Full bottom temperature records at half-hourly intervals.

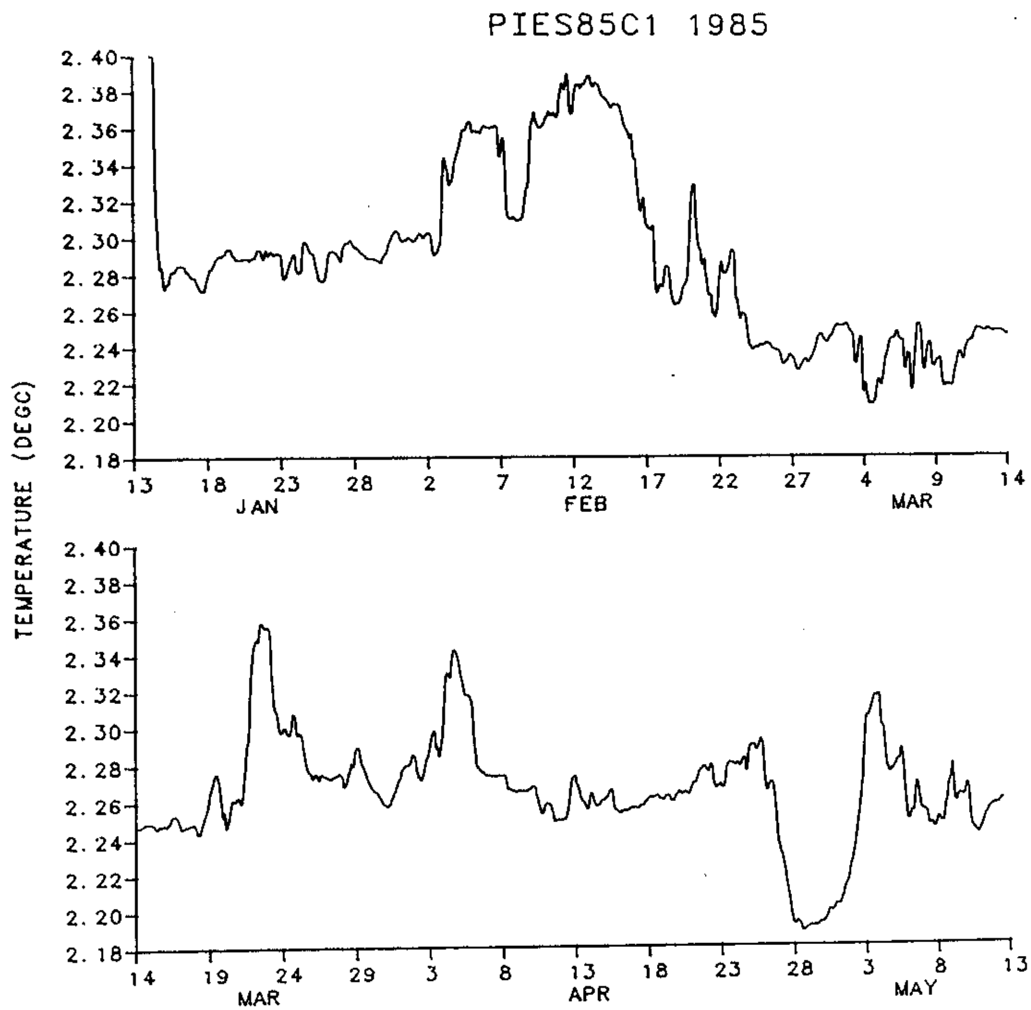

PIES85C1 1985
TEMPERATURE (DEGC)
2.40
2.38
2.36
2.34
2.32
2.30
2.28
2.26
2.24
2.22
2.20
2.18
13 18 23 28 2 7 12 17 22 27 4 9 14
JAN
FEB
MAR
14 19 24 29 3 8 13 18 23 28 3 8 13
MAR
APR
MAY

Figure 6.2

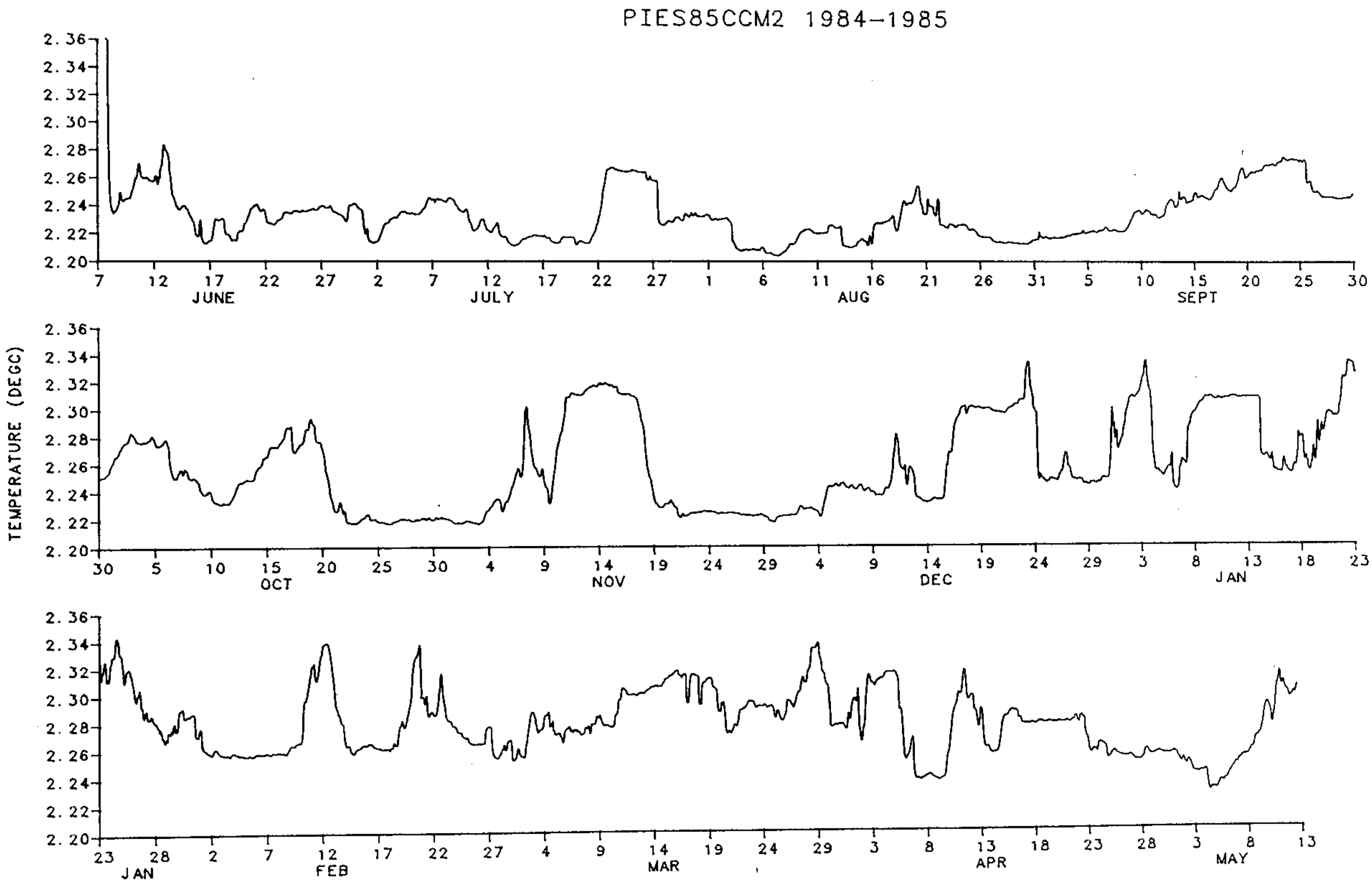
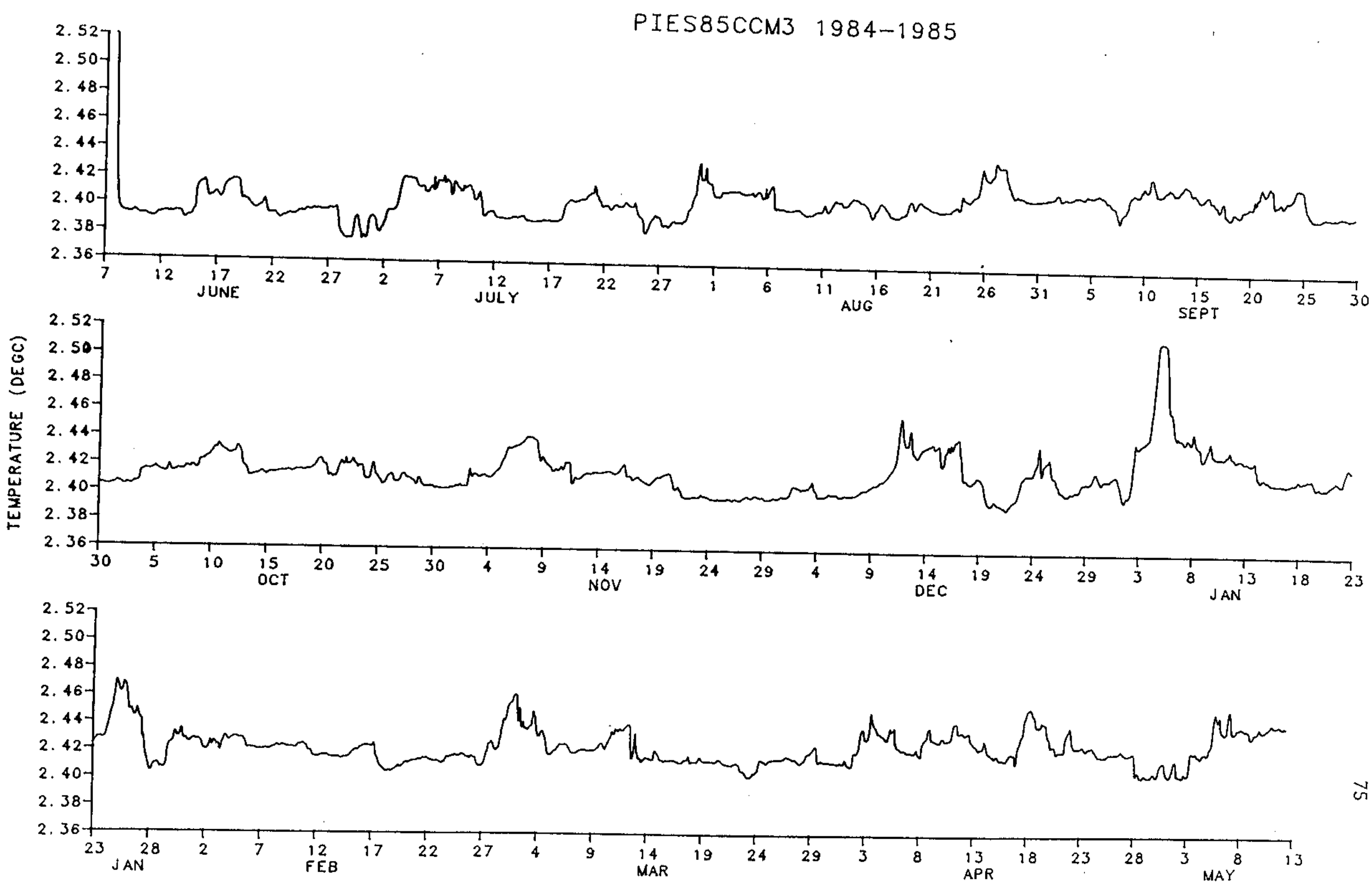

PIES85CCM2 1984–1985
TEMPERATURE (DEGC)
2.20 2.22 2.24 2.26 2.28 2.30 2.32 2.34 2.36
7 12 17 22 27 2 7 12 17 22 27 1 6 11 16 21 26 31 5 10 15 20 25 30
JUNE JULY AUG SEPT
30 5 10 15 20 25 30 4 9 14 19 24 29 4 9 14 19 24 29 3 8 13 18 23
OCT NOV DEC JAN
23 28 2 7 12 17 22 27 4 9 14 19 24 29 3 8 13 18 23 28 3 8 13
JAN FEB MAR APR MAY

Figure 6.3



PIES85CCM3 1984-1985
TEMPERATURE (DEGC)
2.52
2.50
2.48
2.46
2.44
2.42
2.40
2.38
2.36
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY

Figure 6.4

SECTION 4

40 HRLP Data For Each Cross-Stream Section

The 40 HRLP thermocline depth (Z_{12}), 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_{12} 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_{12} records, to 0.05 dbar for the bottom pressure measurements, and to 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 the Section 2.

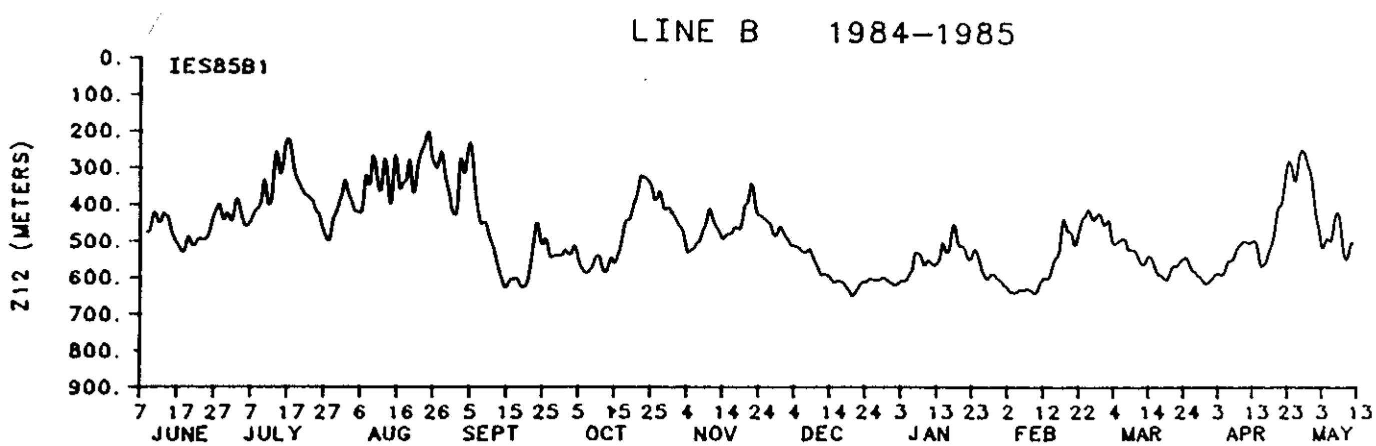


Figure 7.1

Figure 7.1–6. 40 HRLP thermocline depth records at 6 hour intervals along lines B through G. For each instrument, the equation used to convert travel time to Z_{12} is given in Section 2.

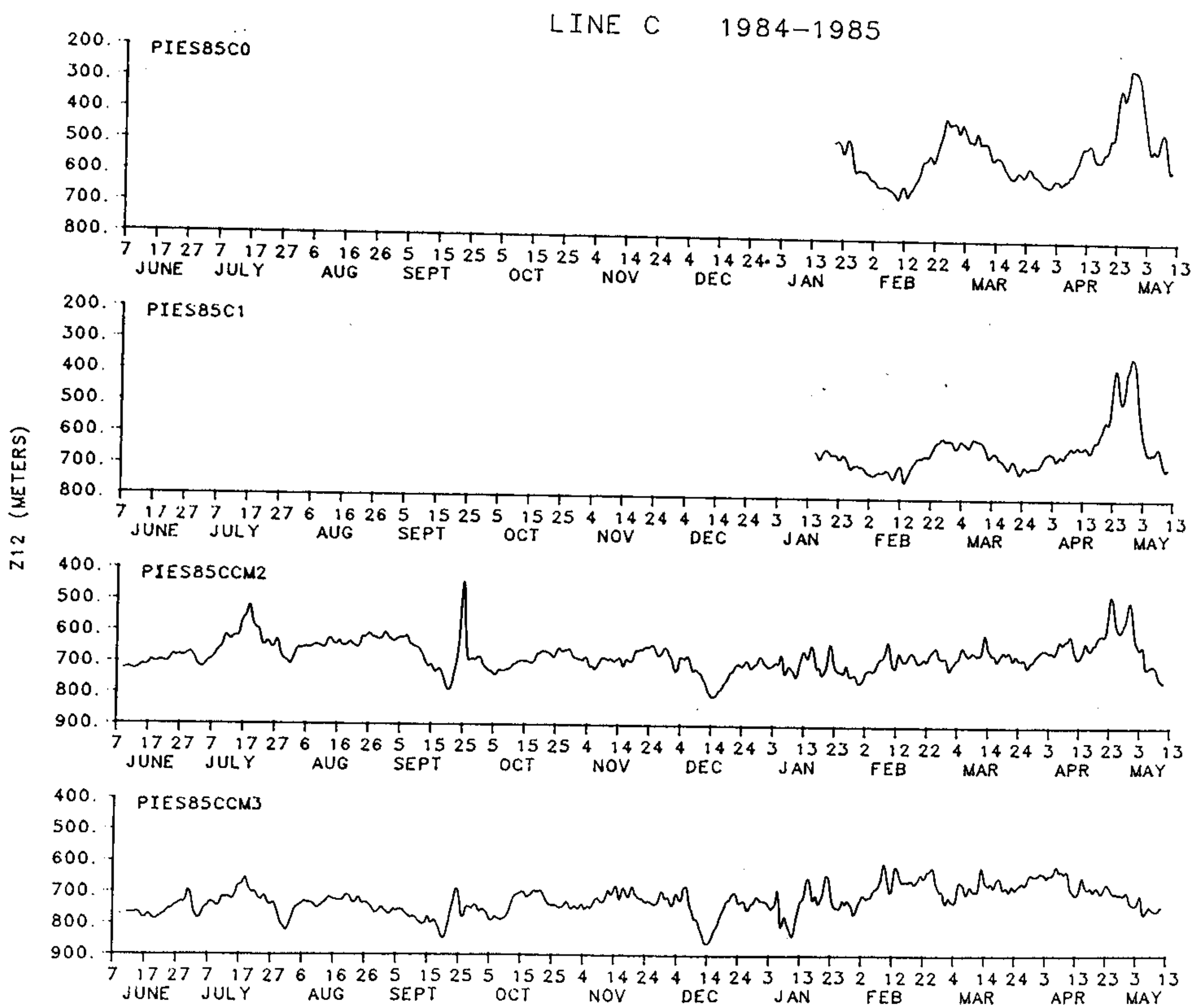

LINE C 1984–1985
PIES85C0
PIES85C1
PIES85CCM2
PIES85CCM3
Z12 (METERS)
200. 300. 400. 500. 600. 700. 800. 900.
7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13 23 2 12 22 4 14 24 3 13 23 3 13
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY

Figure 7.2

LINE C 1984-1985

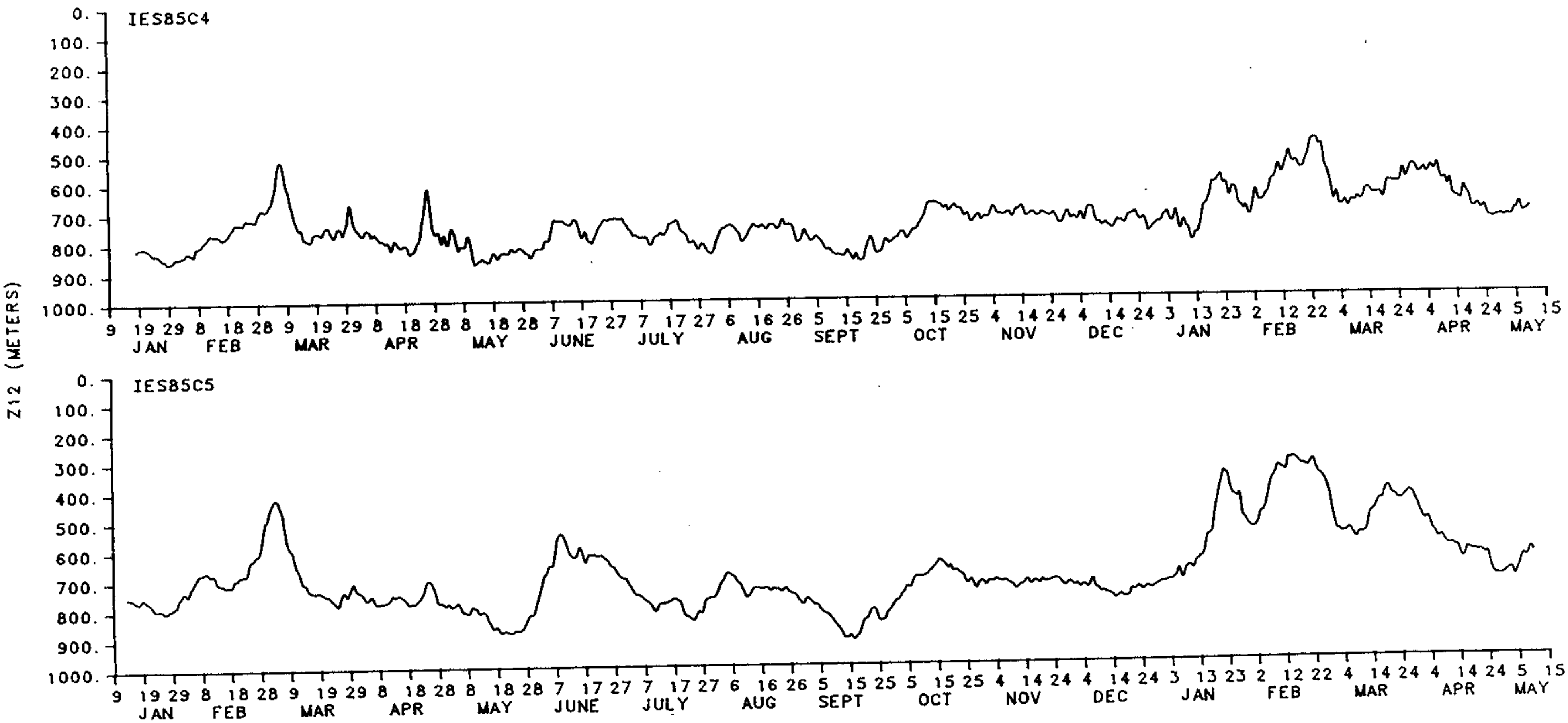


Figure 7.2 (continued)

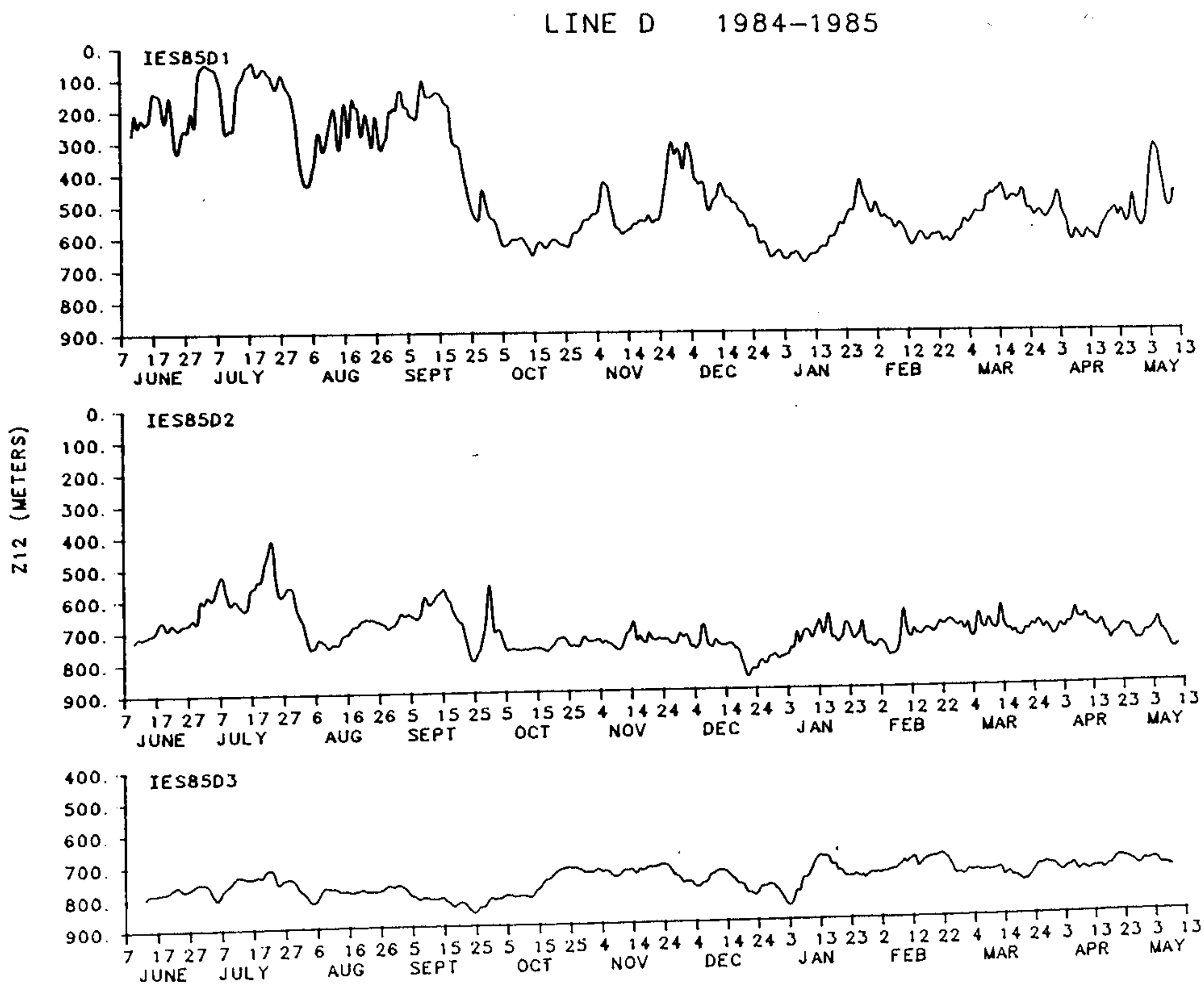

LINE D 1984-1985
IES85D1
IES85D2
IES85D3
Z12 (METERS)
0. 100. 200. 300. 400. 500. 600. 700. 800. 900.
400. 500. 600. 700. 800. 900.
7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13 23 2 12 22 4 14 24 3 13 23 3 13
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY

Figure 7.3

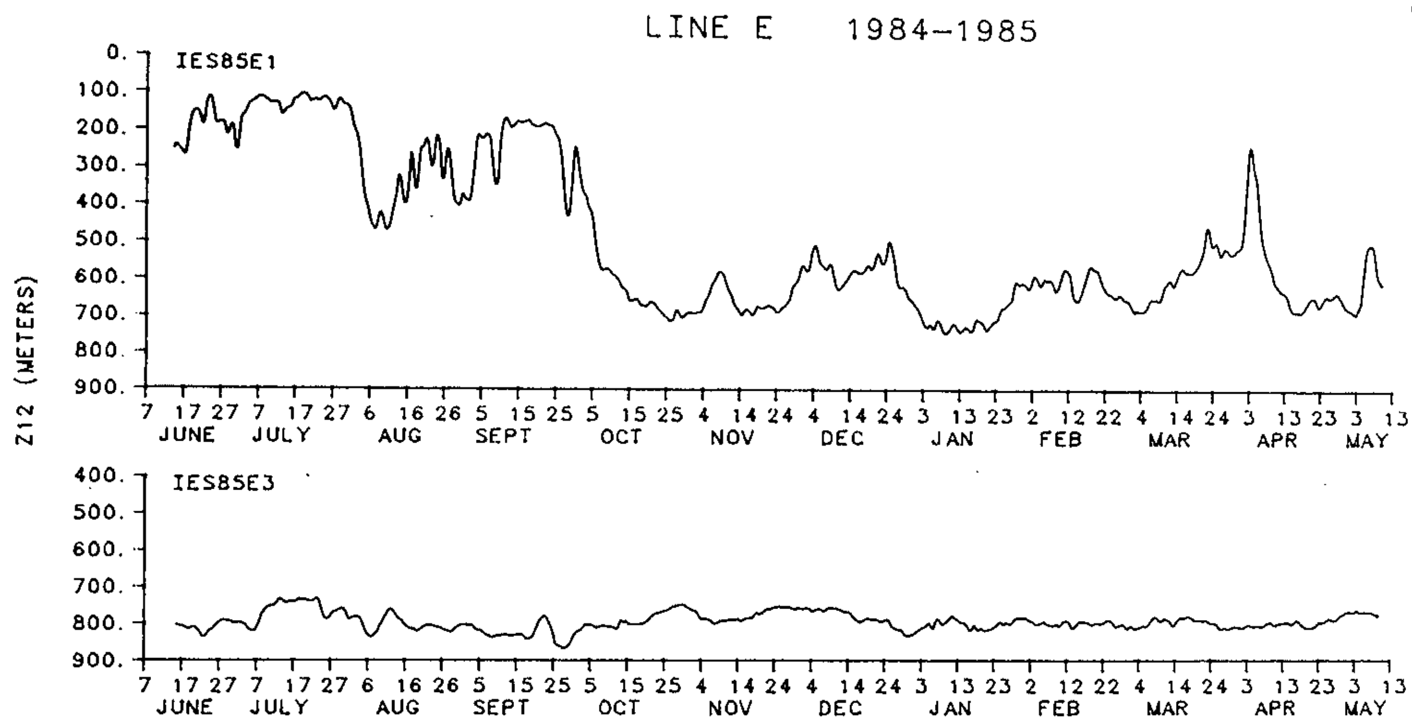

LINE E 1984–1985
IES85E1
IES85E3
Z12 (METERS)
0.
100.
200.
300.
400.
500.
600.
700.
800.
900.
7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13 23 2 12 22 4 14 24 3 13 23 3 13
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY

Figure 7.4

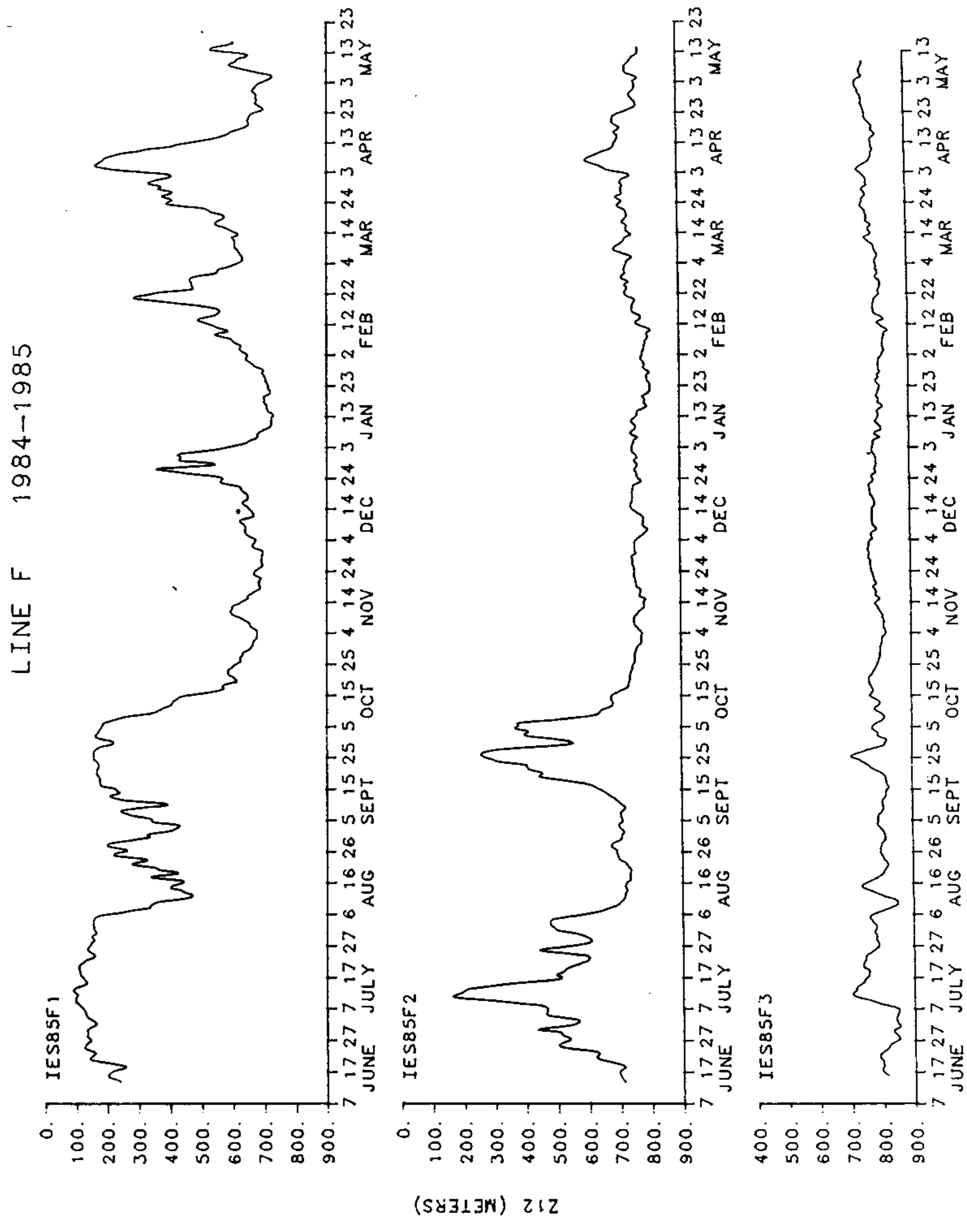

LINE F 1984-1985
IES85F1
IES85F2
IES85F3
Z12 (METERS)
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY

Figure 7.5

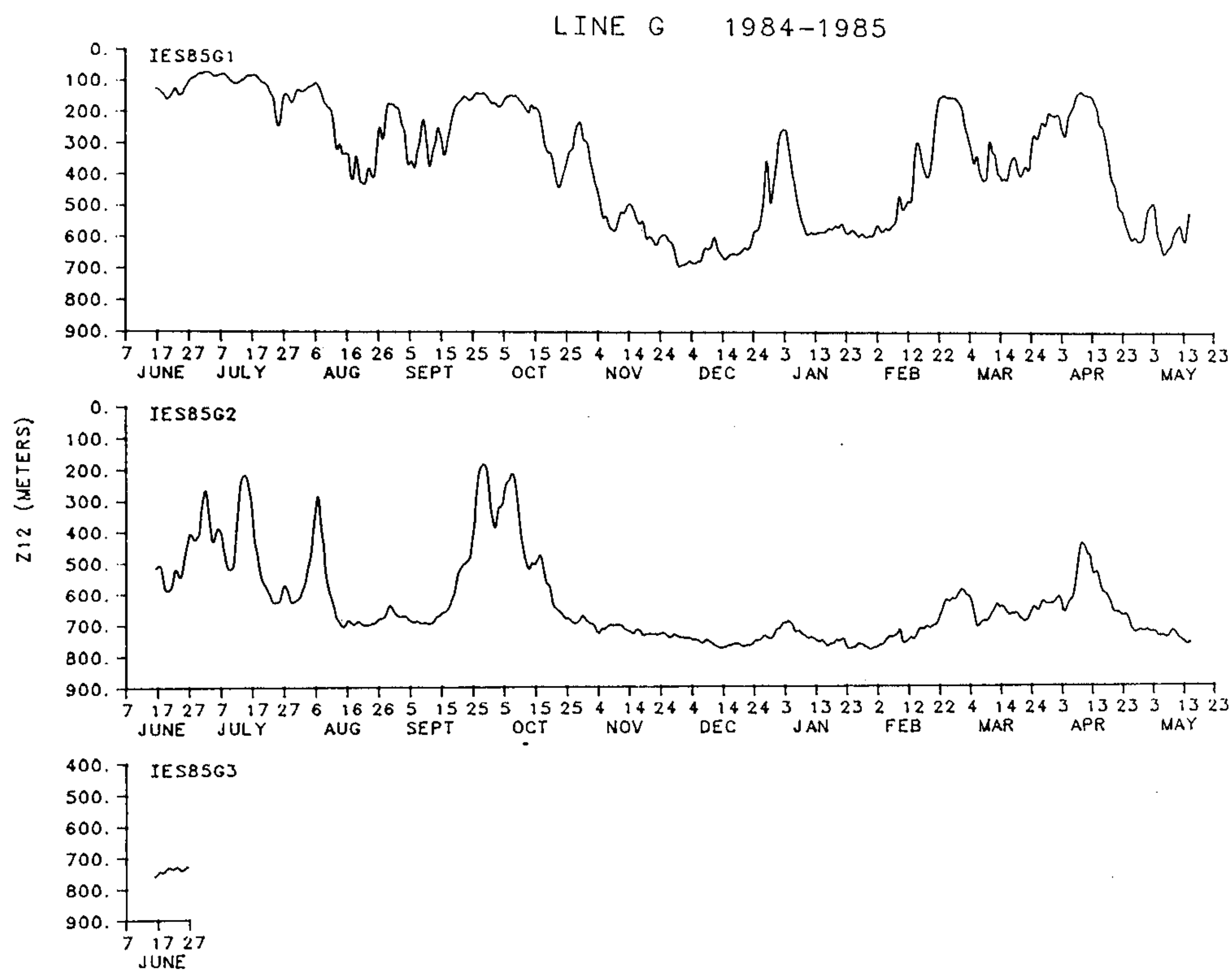

LINE G 1984-1985
IES85G1
IES85G2
IES85G3
Z12 (METERS)
0. 100. 200. 300. 400. 500. 600. 700. 800. 900.
7 17 27 7 17 27 6 16 26 5 15 25 5 15 25 4 14 24 4 14 24 3 13 23 2 12 22 4 14 24 3 13 23 3 13 23
JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APR MAY
400. 500. 600. 700. 800. 900.
7 17 27
JUNE

Figure 7.6

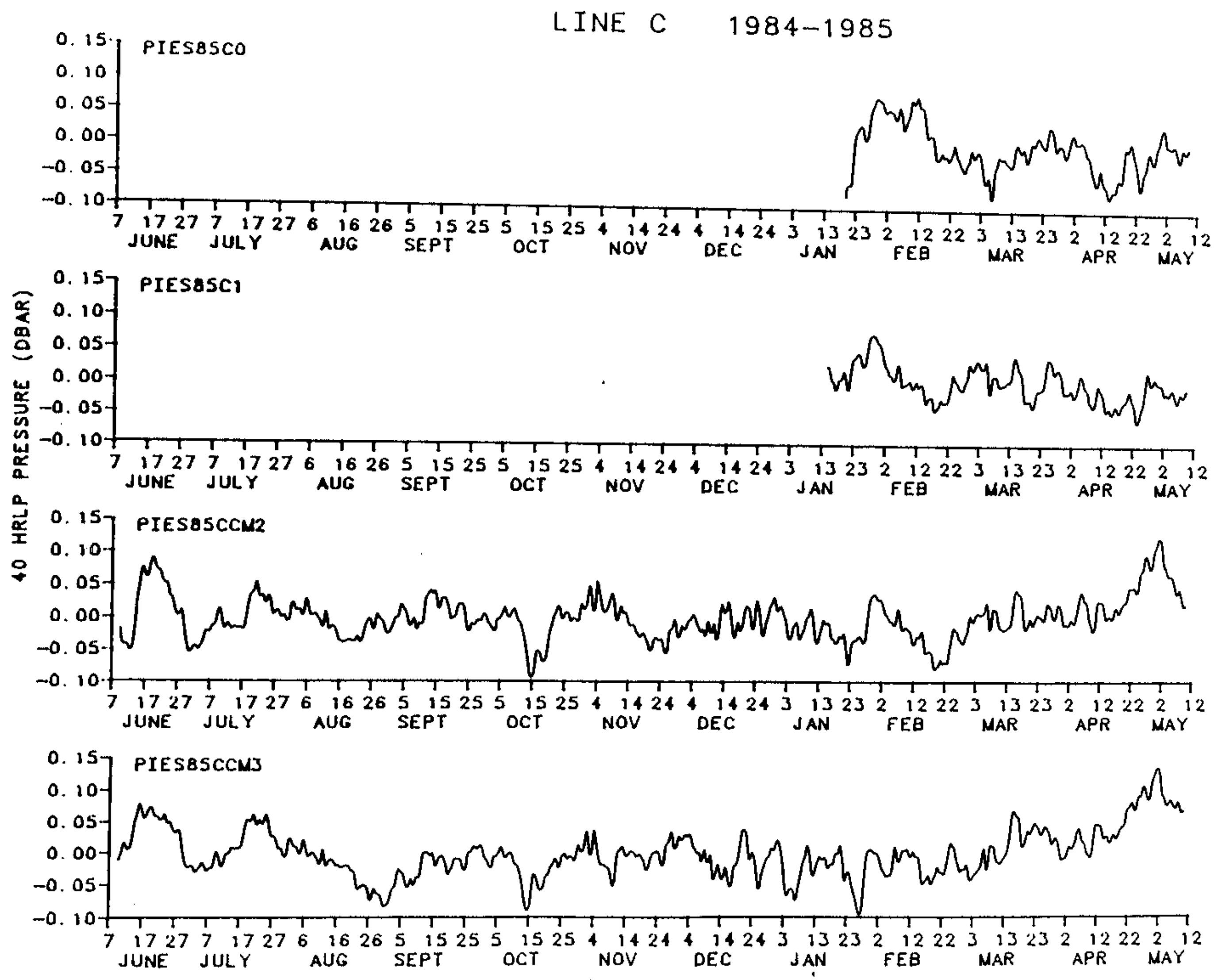


Figure 8

Figure 8. 40 HRLP residual bottom pressure records at 6 hour intervals along line C.

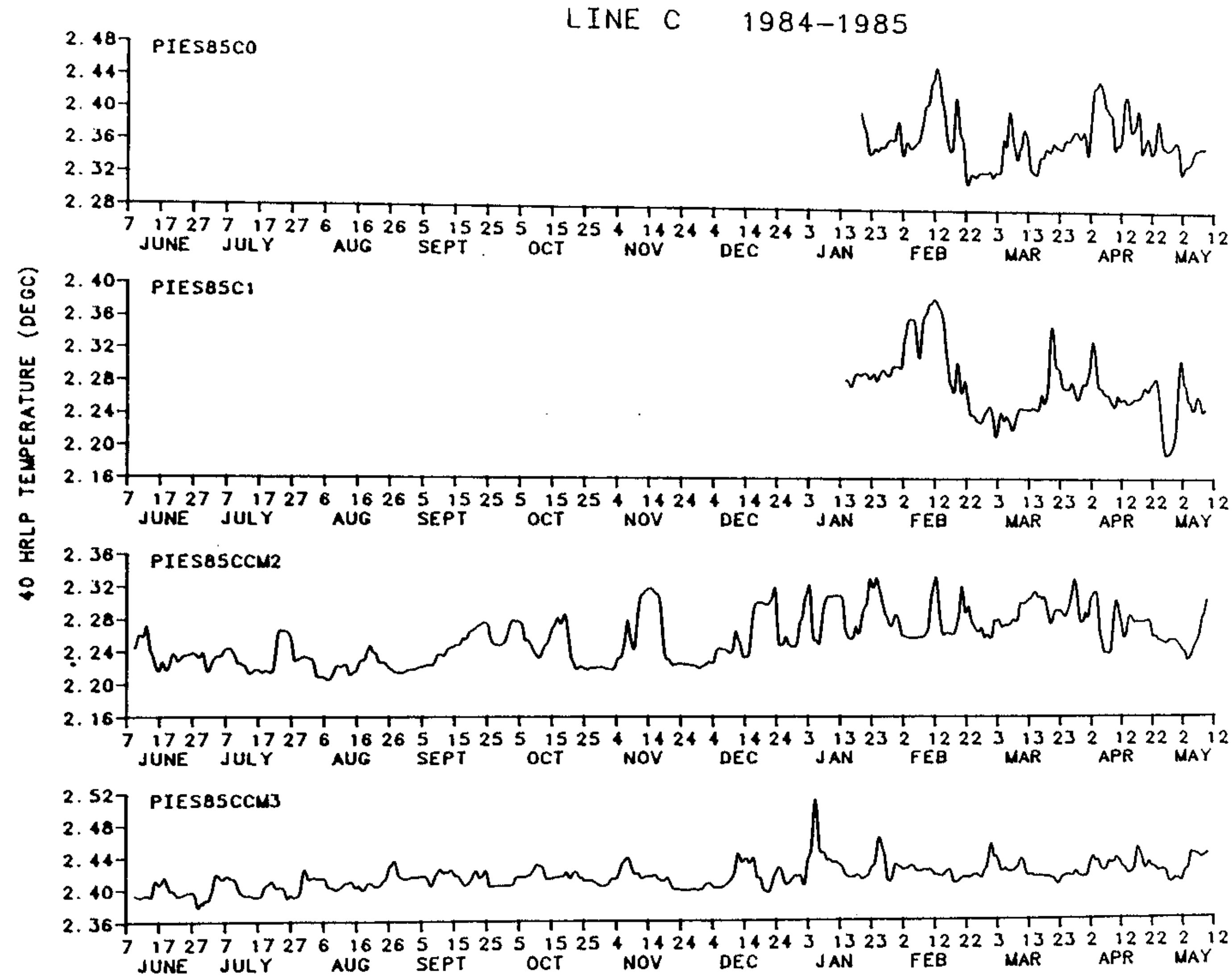


Figure 9

Figure 9. 40 HRLP bottom temperature records at 6 hour intervals along line C.

SECTION 5

Thermocline Depth Maps

Contour plots of the mean and variance fields, the error fields, the thermocline depth (Z_{12}) fields, and the perturbation fields are presented.

Each of the contoured frames corresponds to the 240 km by 460 km boxed region shown in Figure 1. This region is oriented 064°T, and north is indicated by the arrow in Figure 10. The horizontal scales labelled in Figure 10 apply to all the frames.

Each frame consists of a grid of 312 points, at 20 km spacing. The actual IES sites are indicated by the + marks and the positions are listed in Table 1. From June 1984 to January 1985, Z_{12} data was available from three additional IES. These data have been included in the mapped fields. The positions of these instruments and their data records are presented in another data report (Tracey and Watts, 1985b).

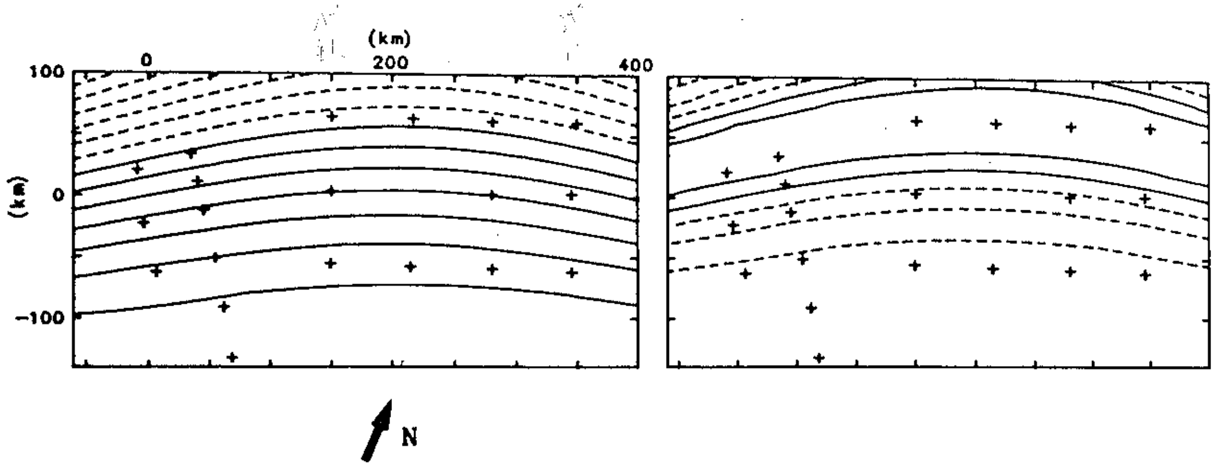


Figure 10. Mean field (left) for the June 1984 to May 1985 data, and root-mean-square variance field (right) are contoured in plan view. Contour interval of the mean field is 50 m, with dashed lines indicating $Z_{12} \leq 500$ m. Contour interval of the variance field is 25 m with the dashed region corresponding to variance ≤ 150 m rms. North is indicated by the arrow.

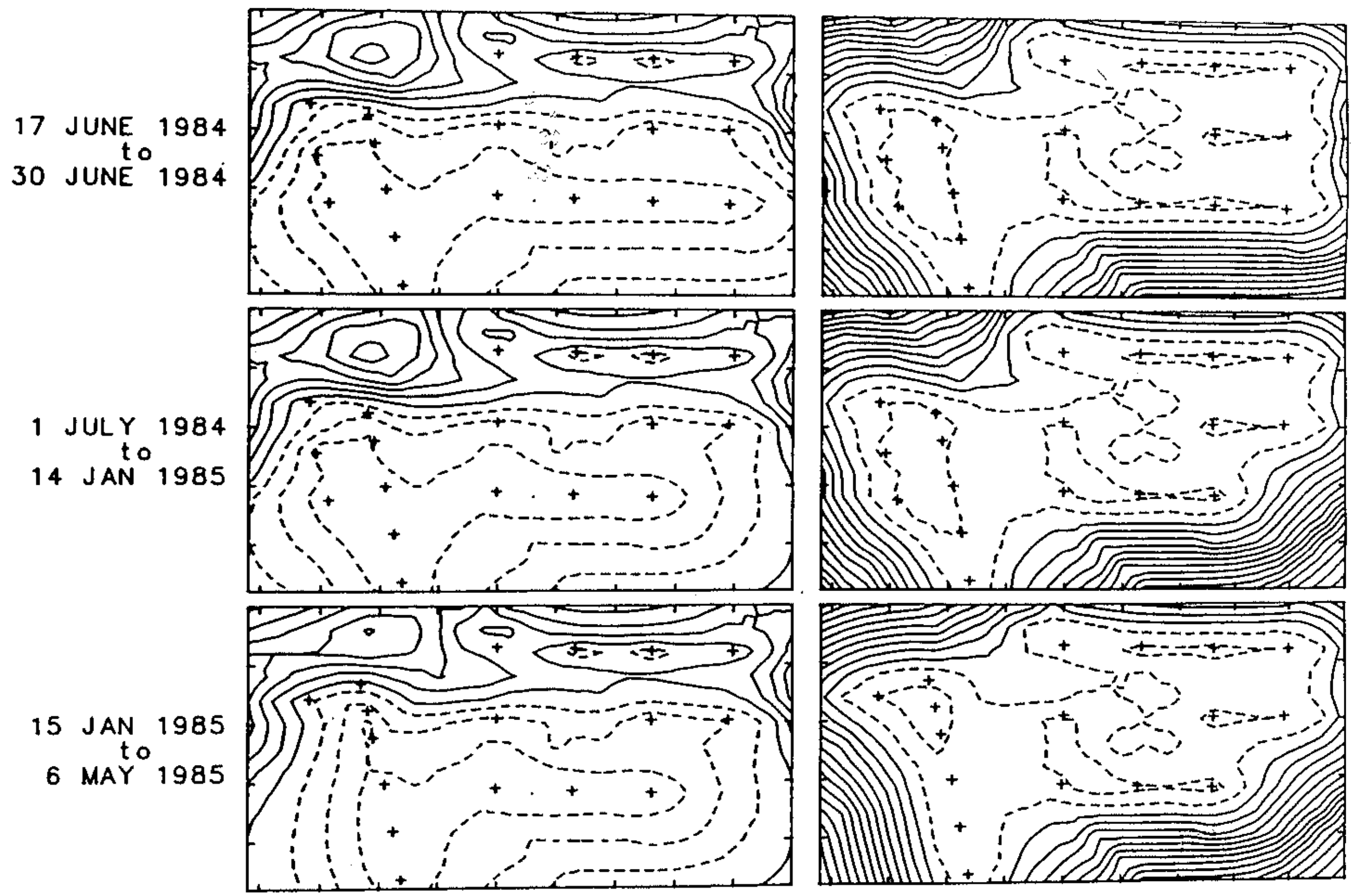
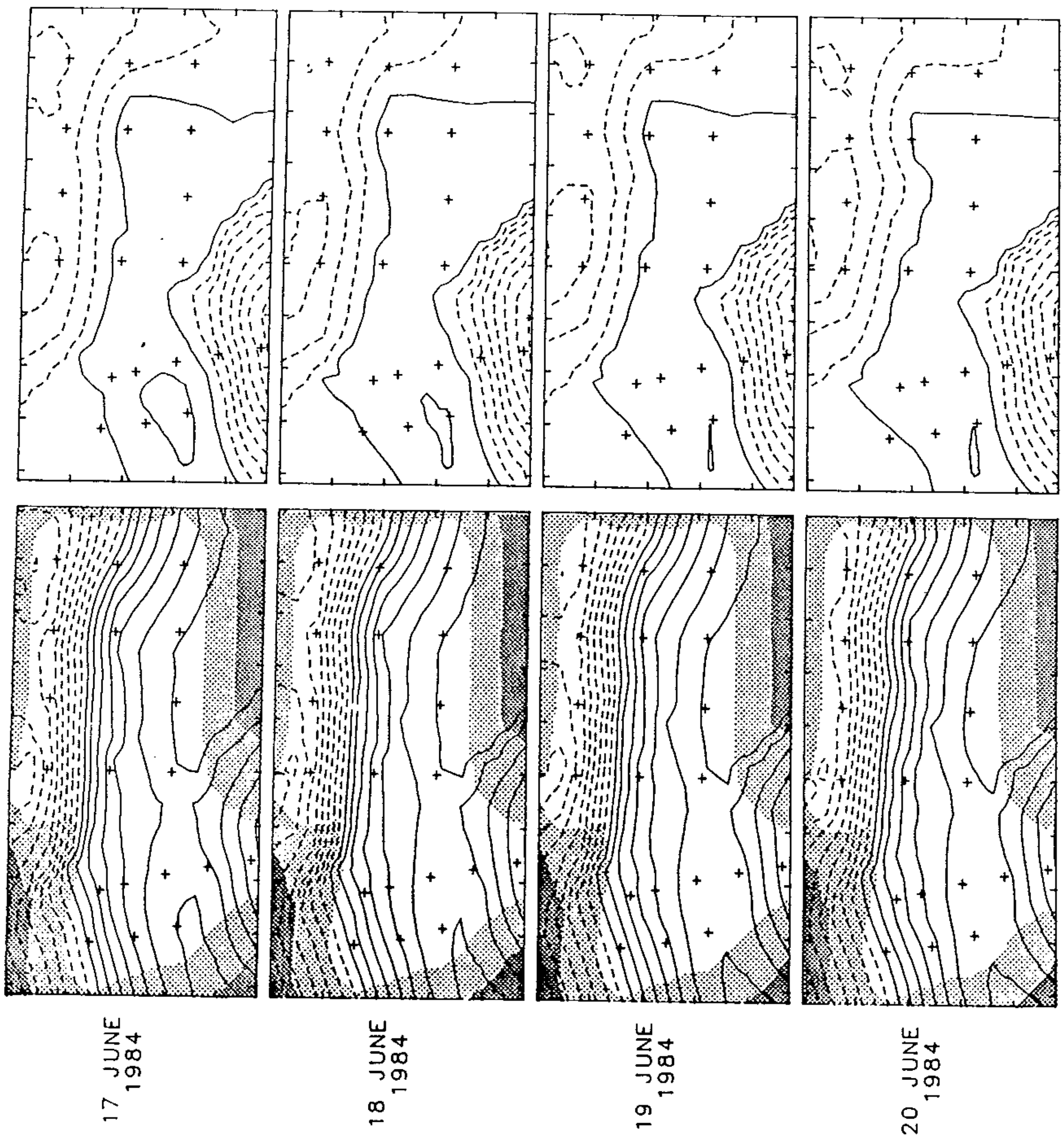
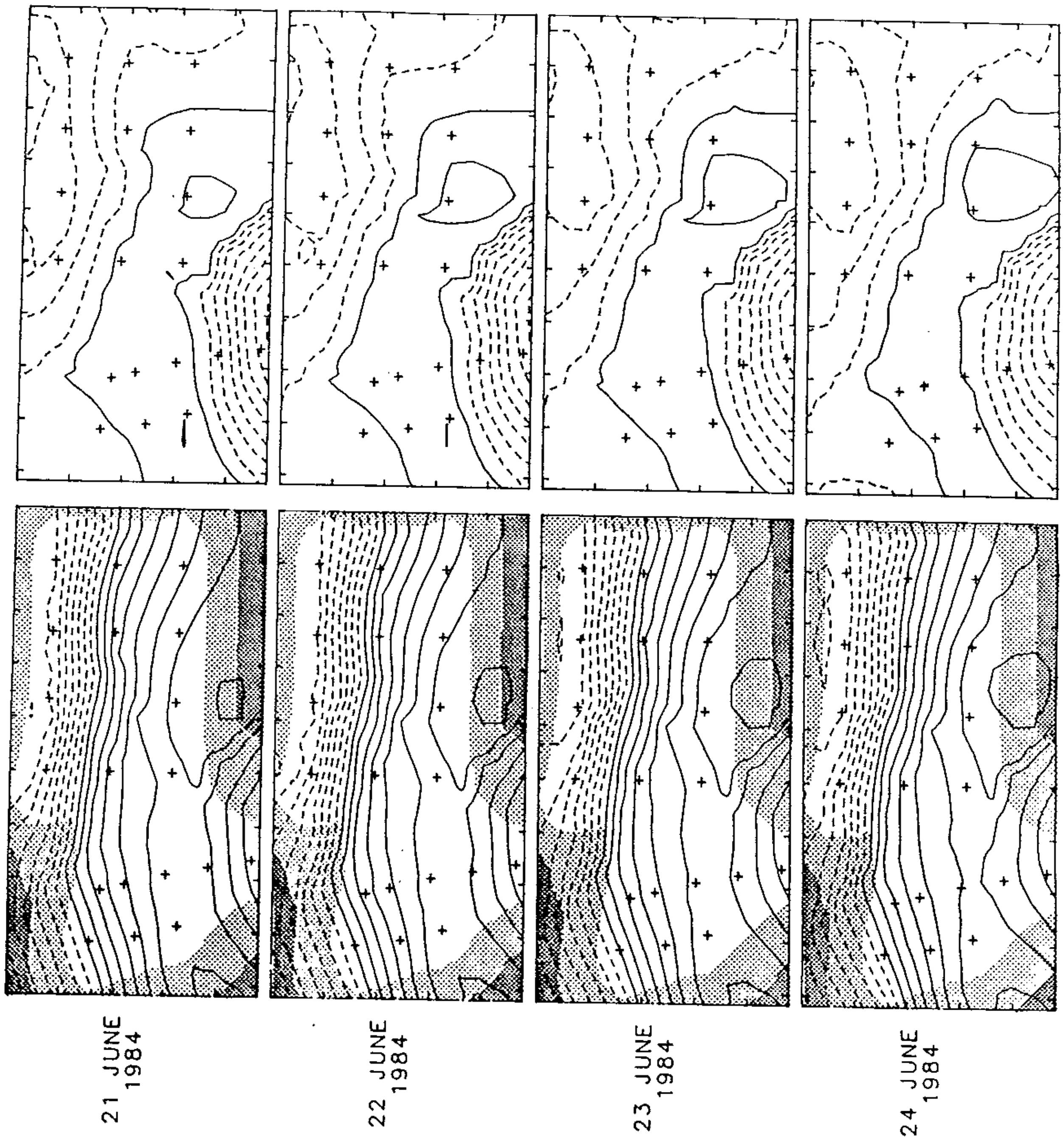
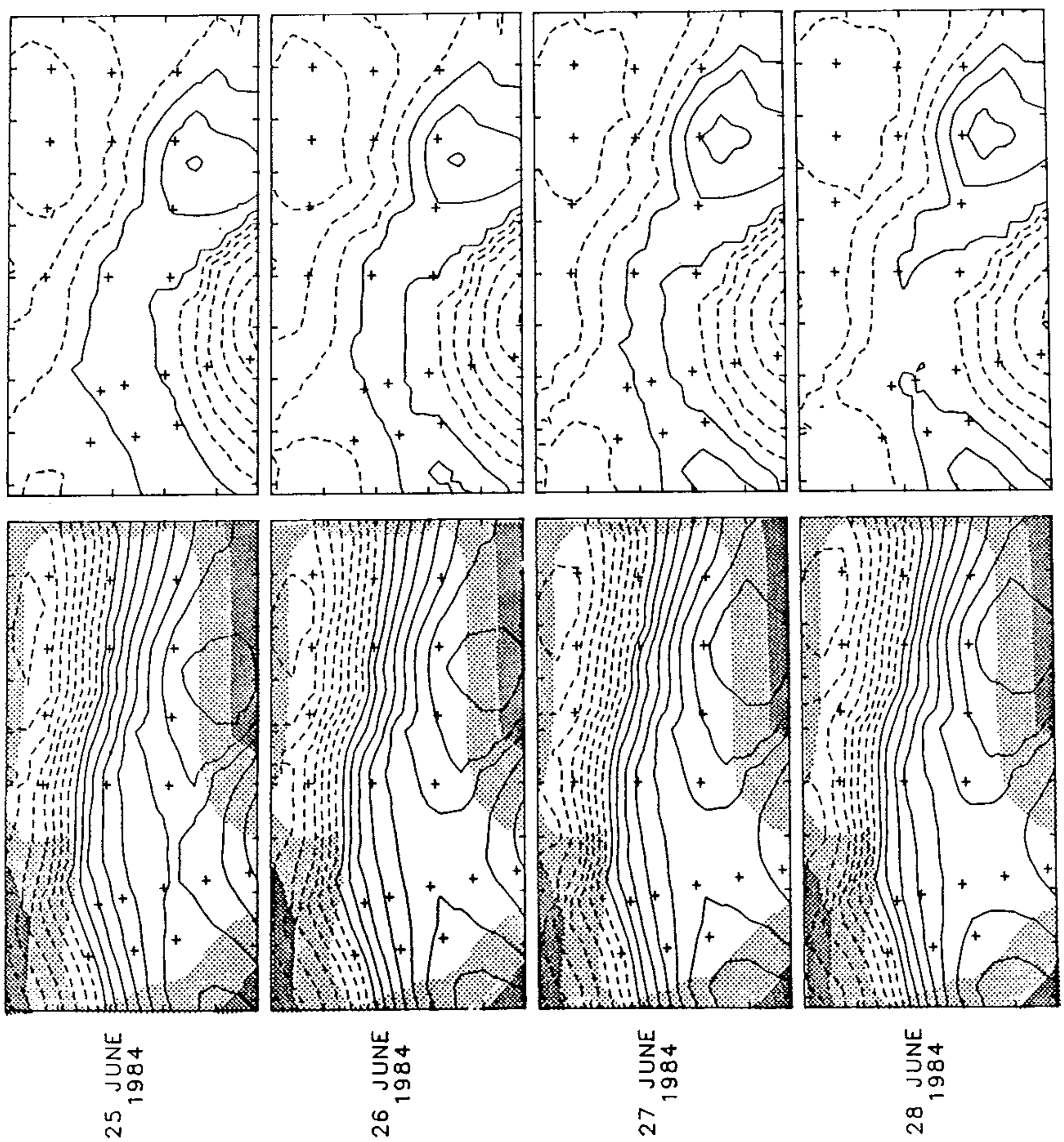


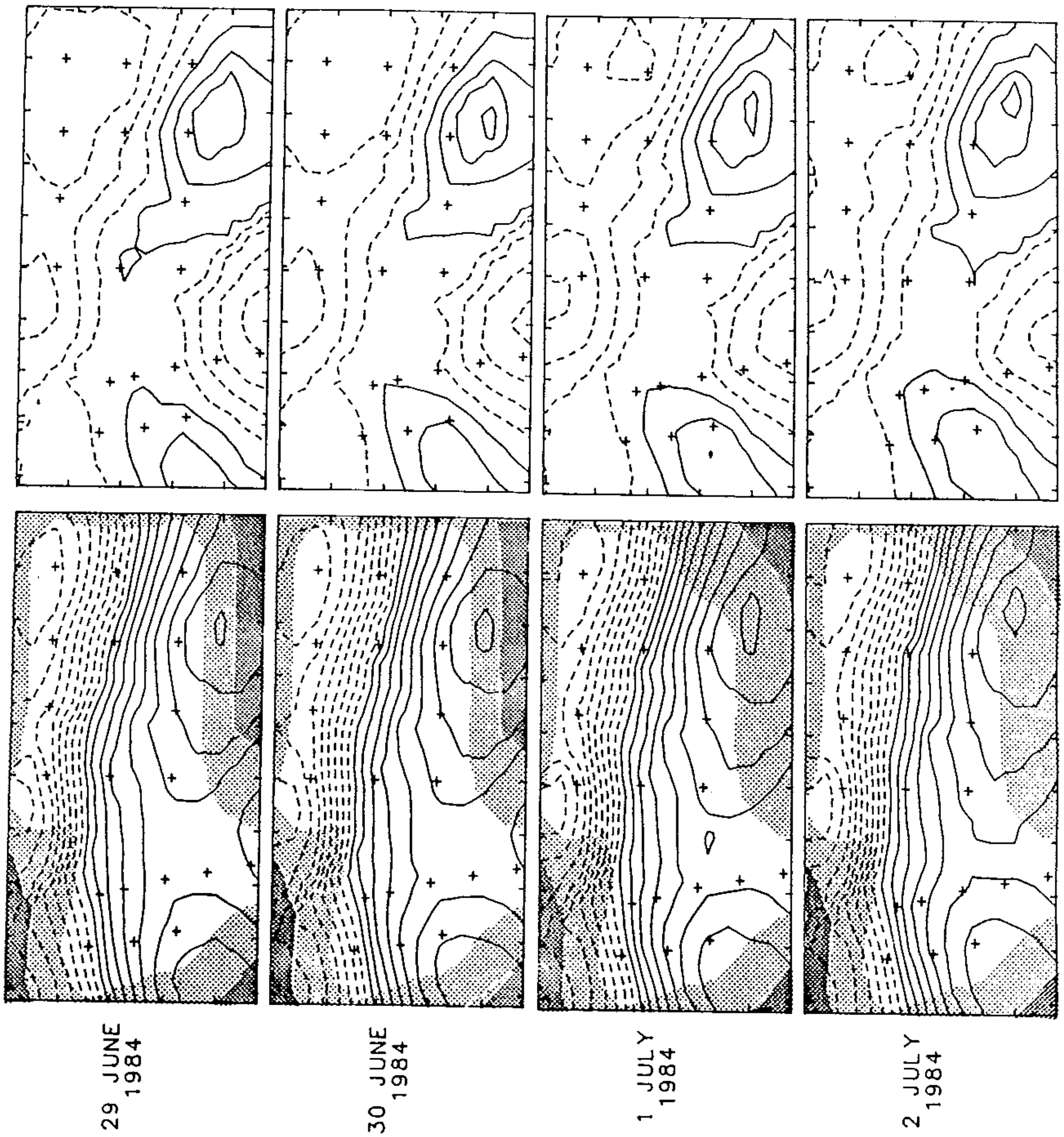
Figure 11. The error (percent variance) fields, shown at right, are contoured at 5% intervals, with the dashed region corresponding to < 15% error. The error-bar fields (left) have a contour interval of 10 m and the dashed region corresponds to errors < 50 m. The error maps apply to the Z_{12} and perturbation fields in Figure 12 for the dates shown. The axes are identical to those labelled in Figure 10.

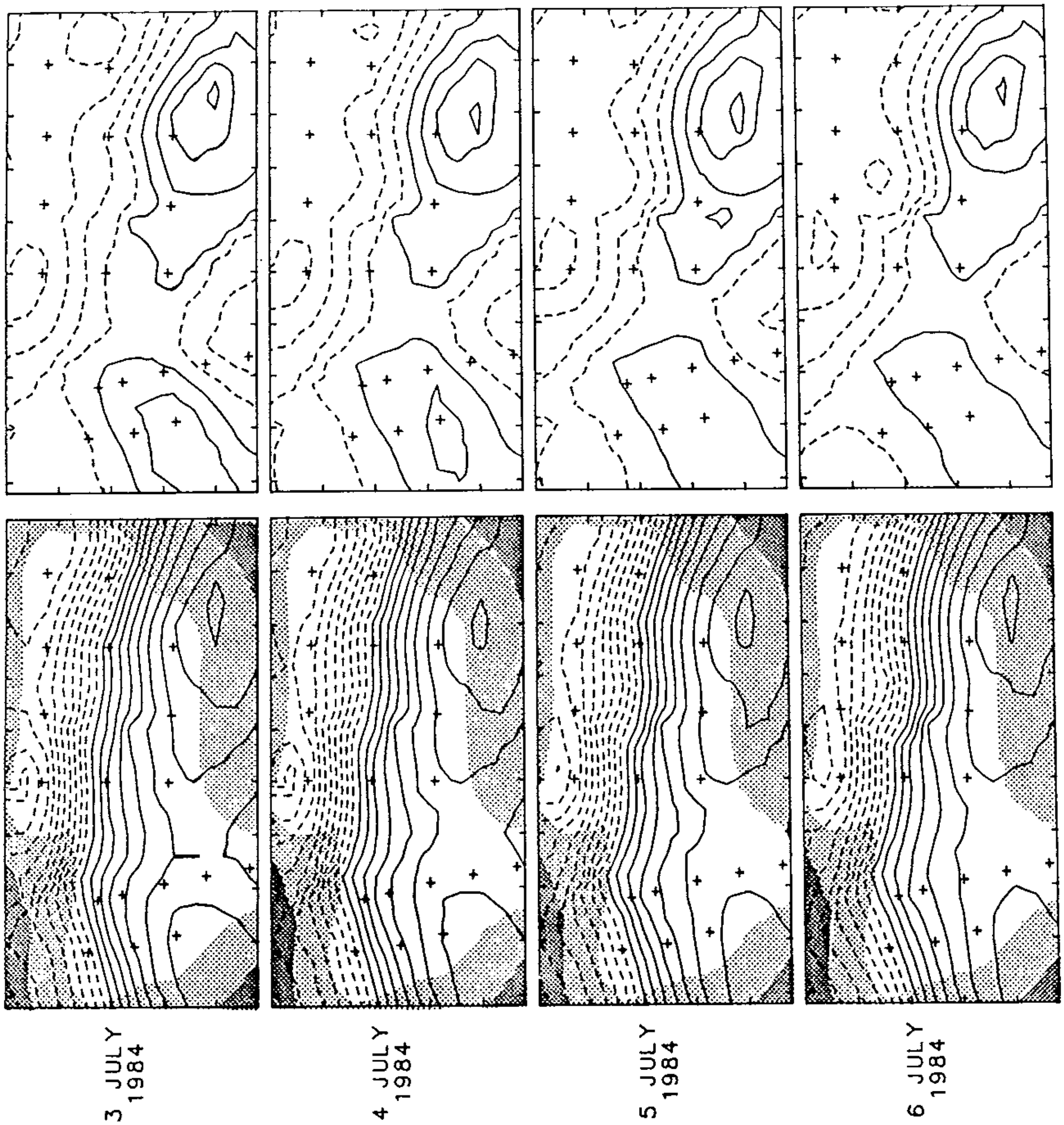
Figure 12. The 12°C isotherm depth, Z_{12}, field (left) and the perturbation field (right) are shown at daily intervals from 17 June 1984 to 6 May 1985. The maps are shown for 1200 GMT on the date indicated at the left. Contour interval of the perturbation field is 0.5 with the dashed region corresponding 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 ≥15% estimated error and the darker shading to errors of ≥35% from the error maps shown in Figure 11.


17 JUNE 1984
18 JUNE 1984
19 JUNE 1984
20 JUNE 1984

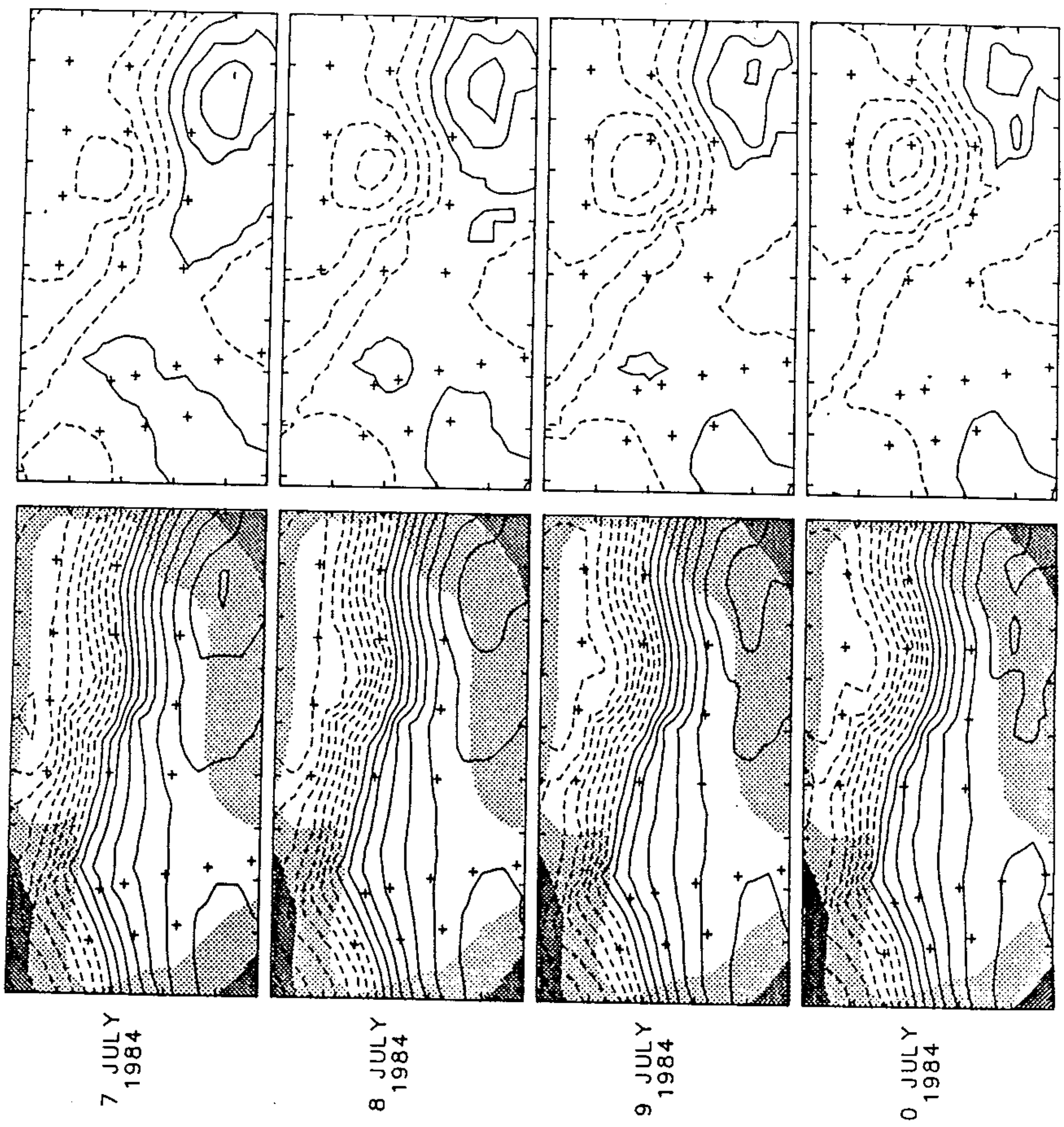

21 JUNE 1984
22 JUNE 1984
23 JUNE 1984
24 JUNE 1984

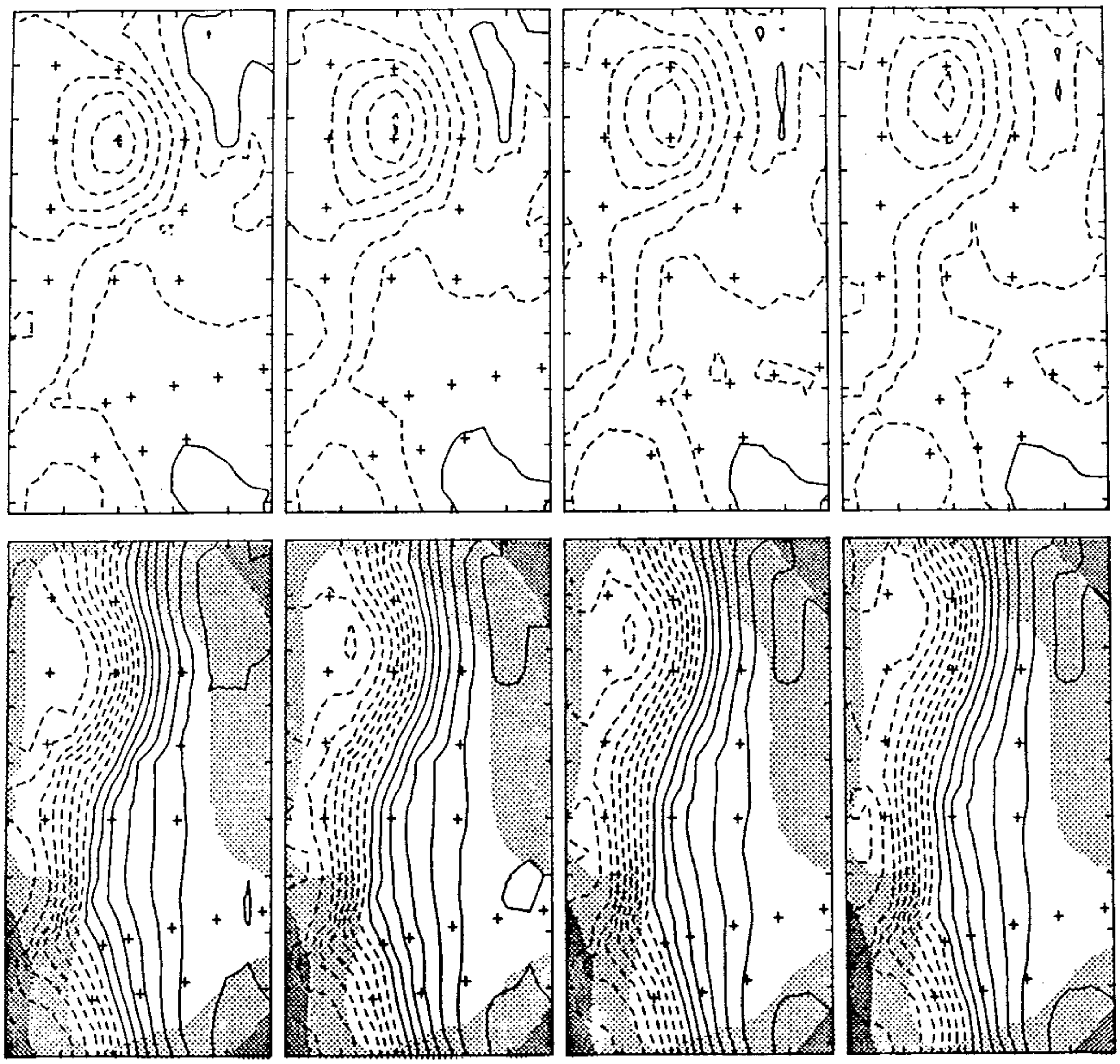

25 JUNE 1984
26 JUNE 1984
27 JUNE 1984
28 JUNE 1984


29 JUNE 1984
30 JUNE 1984
1 JULY 1984
2 JULY 1984



3 JULY 1984
4 JULY 1984
5 JULY 1984
6 JULY 1984


7 JULY 1984
8 JULY 1984
9 JULY 1984
10 JULY 1984

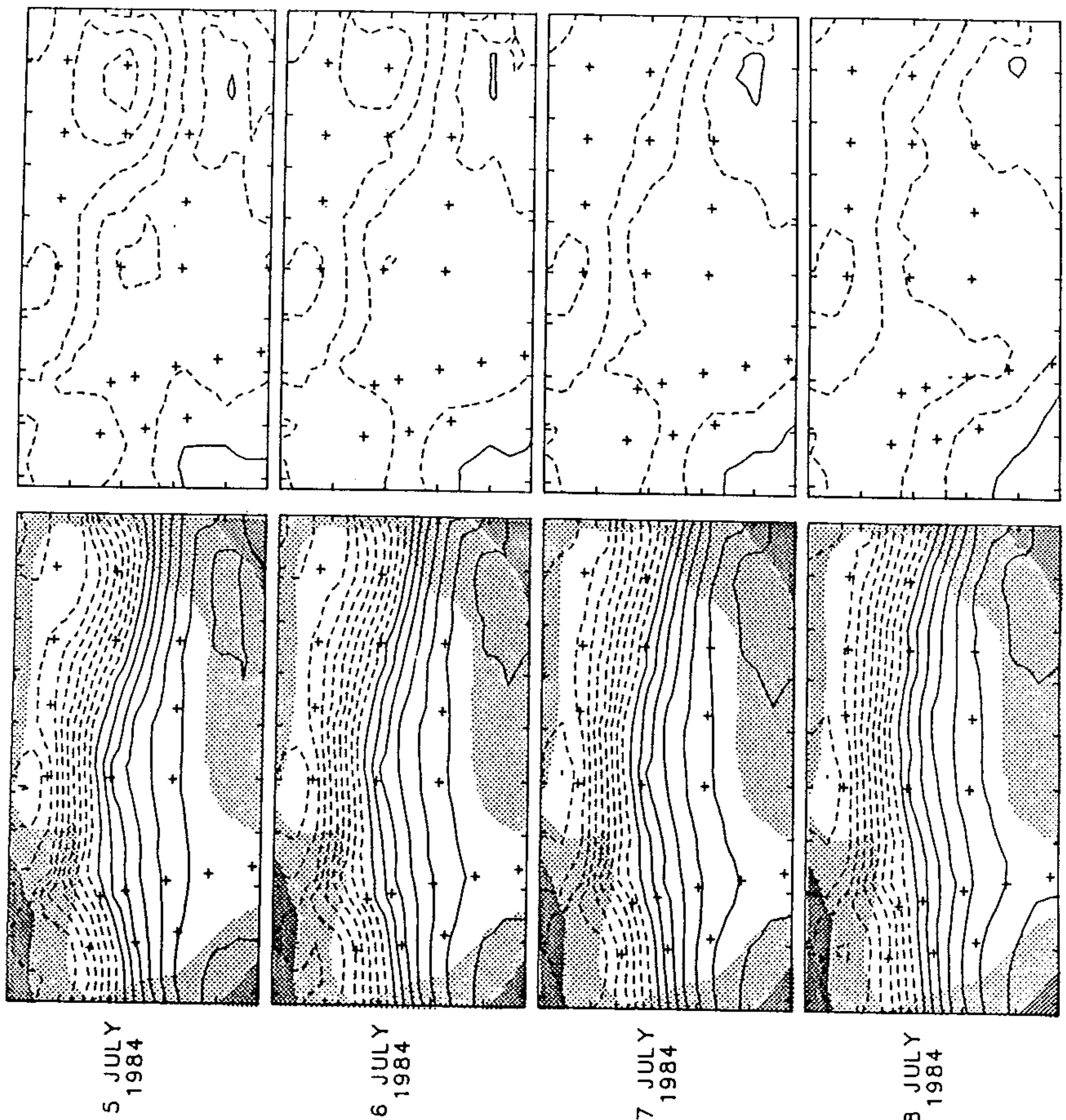


11 JULY 1984

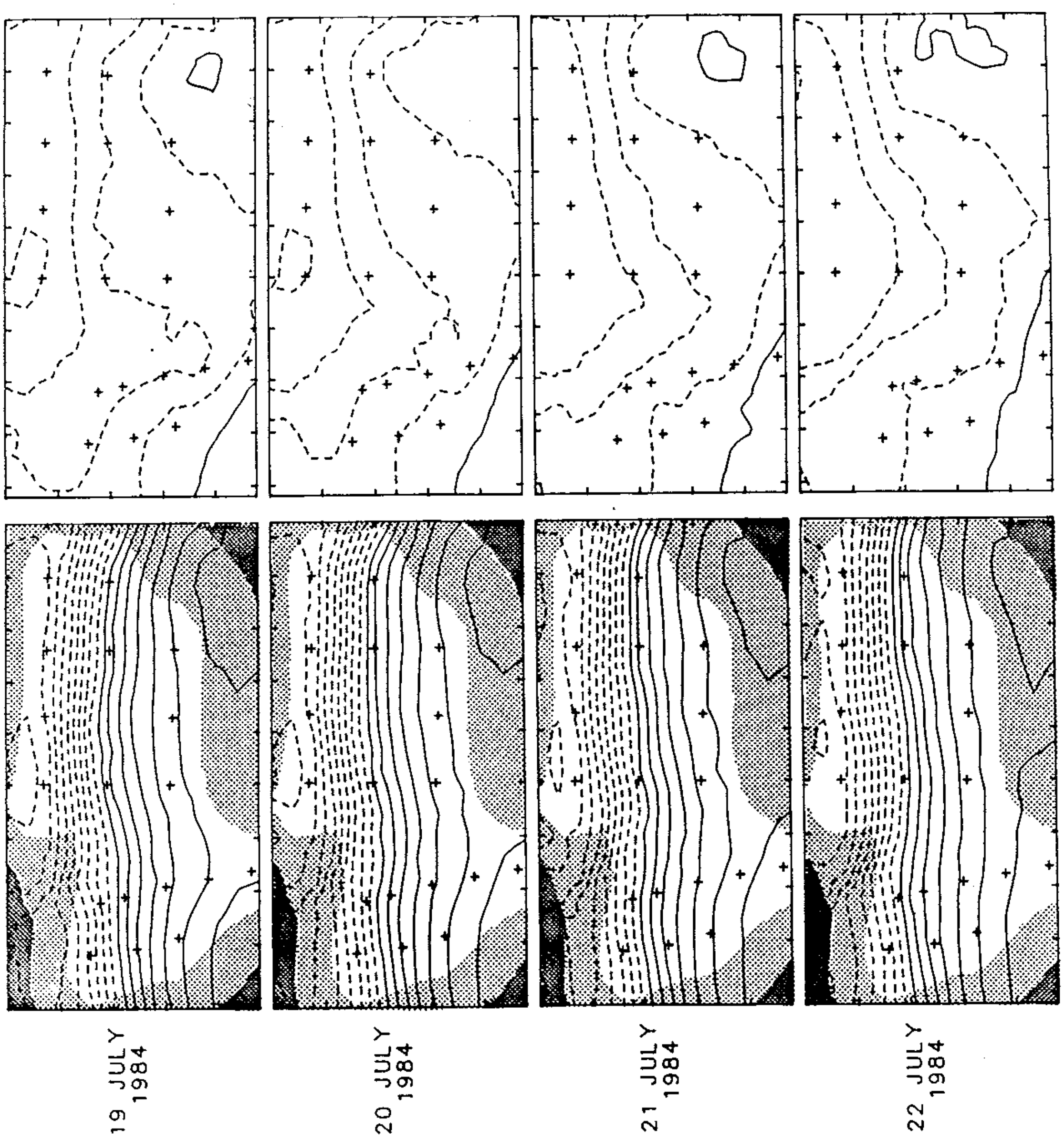
12 JULY 1984

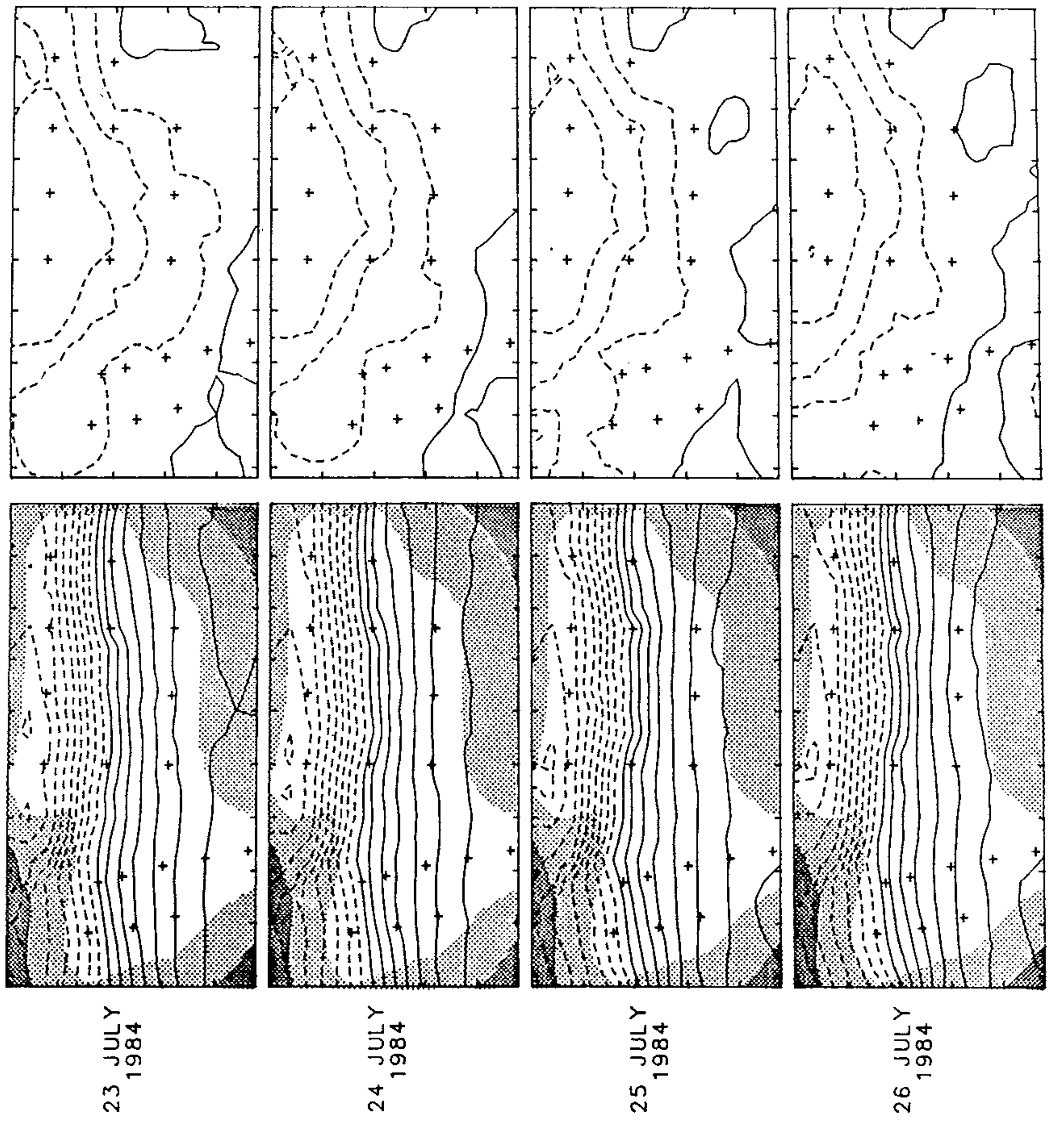
13 JULY 1984

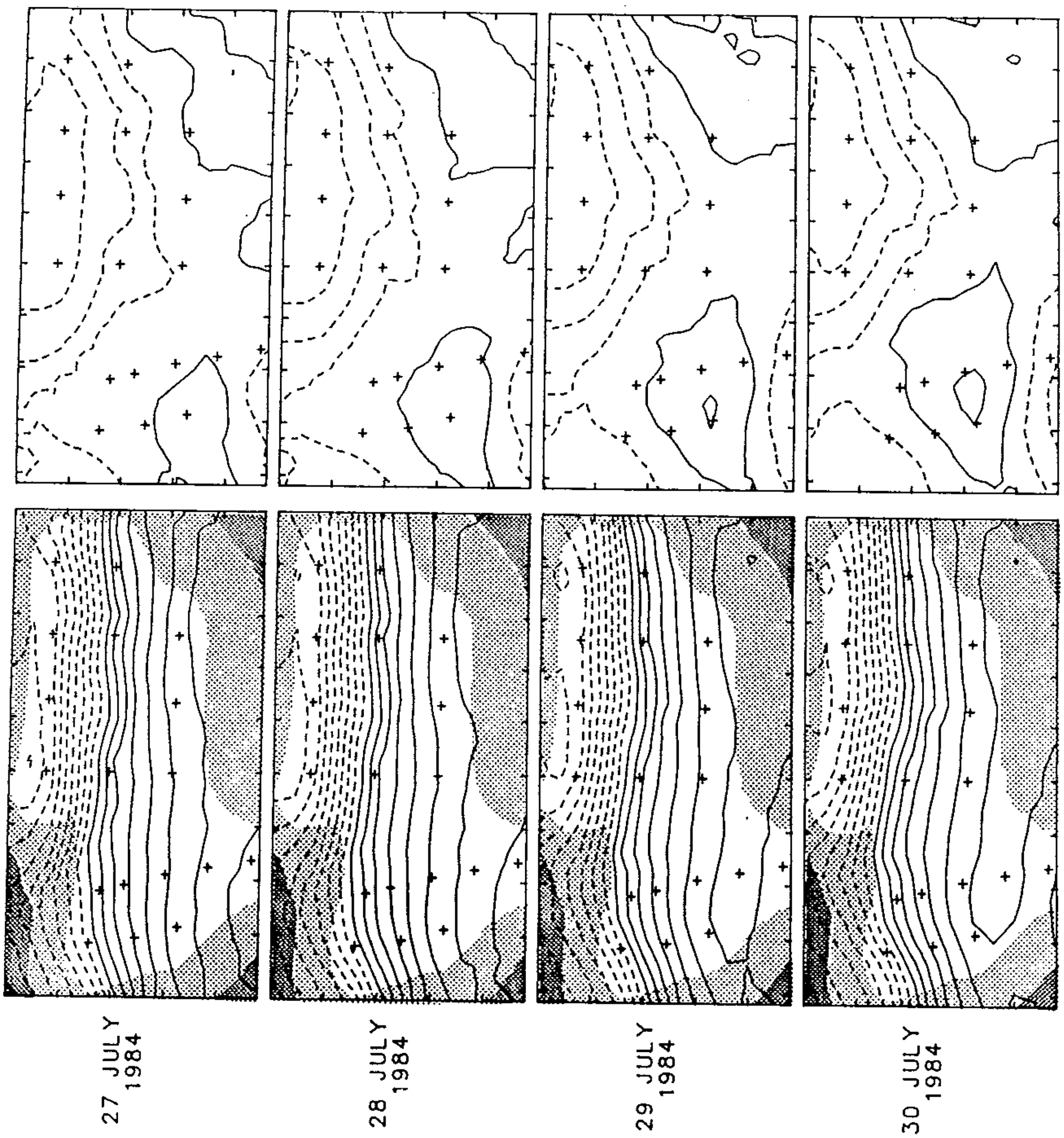
14 JULY 1984

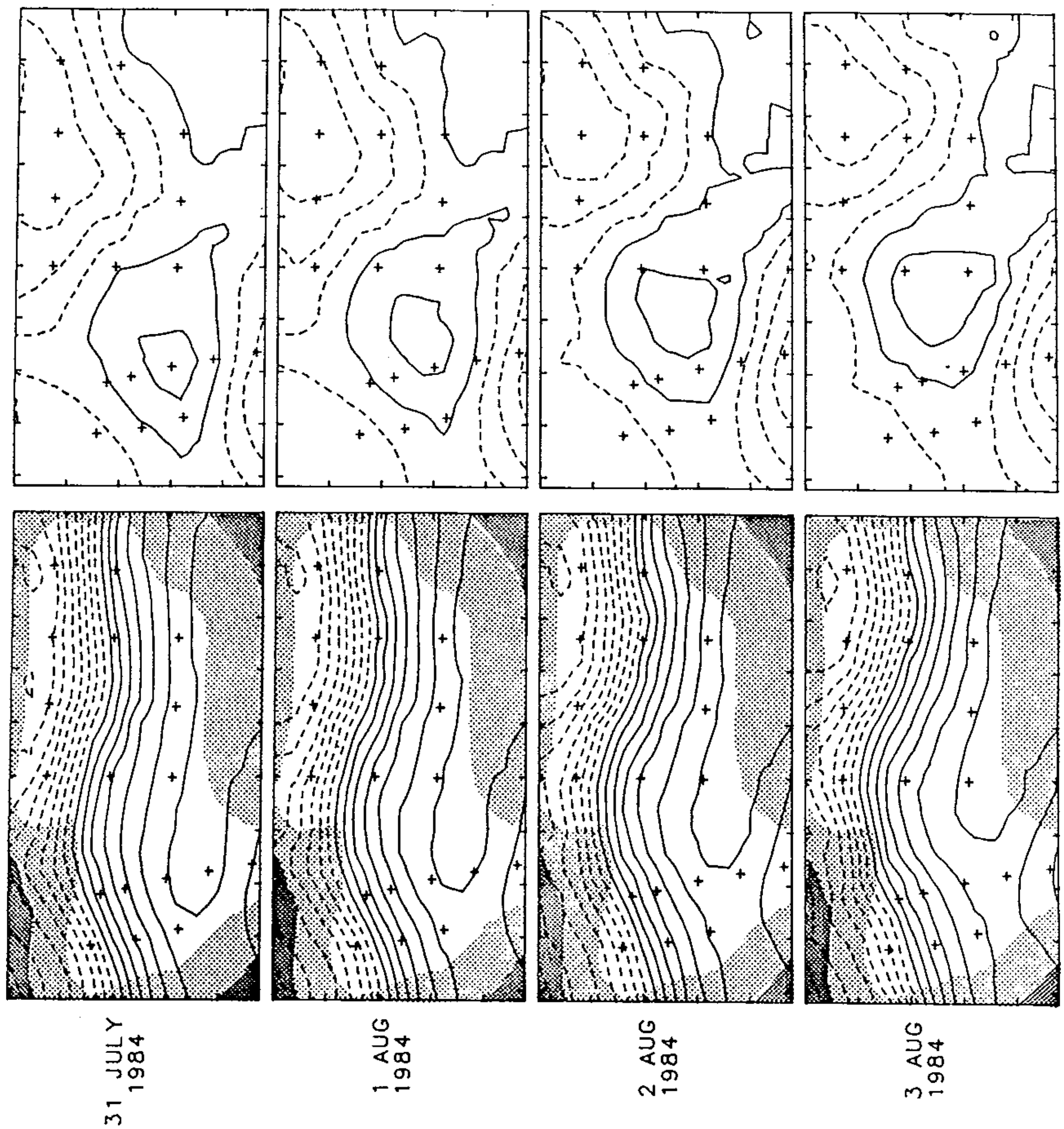


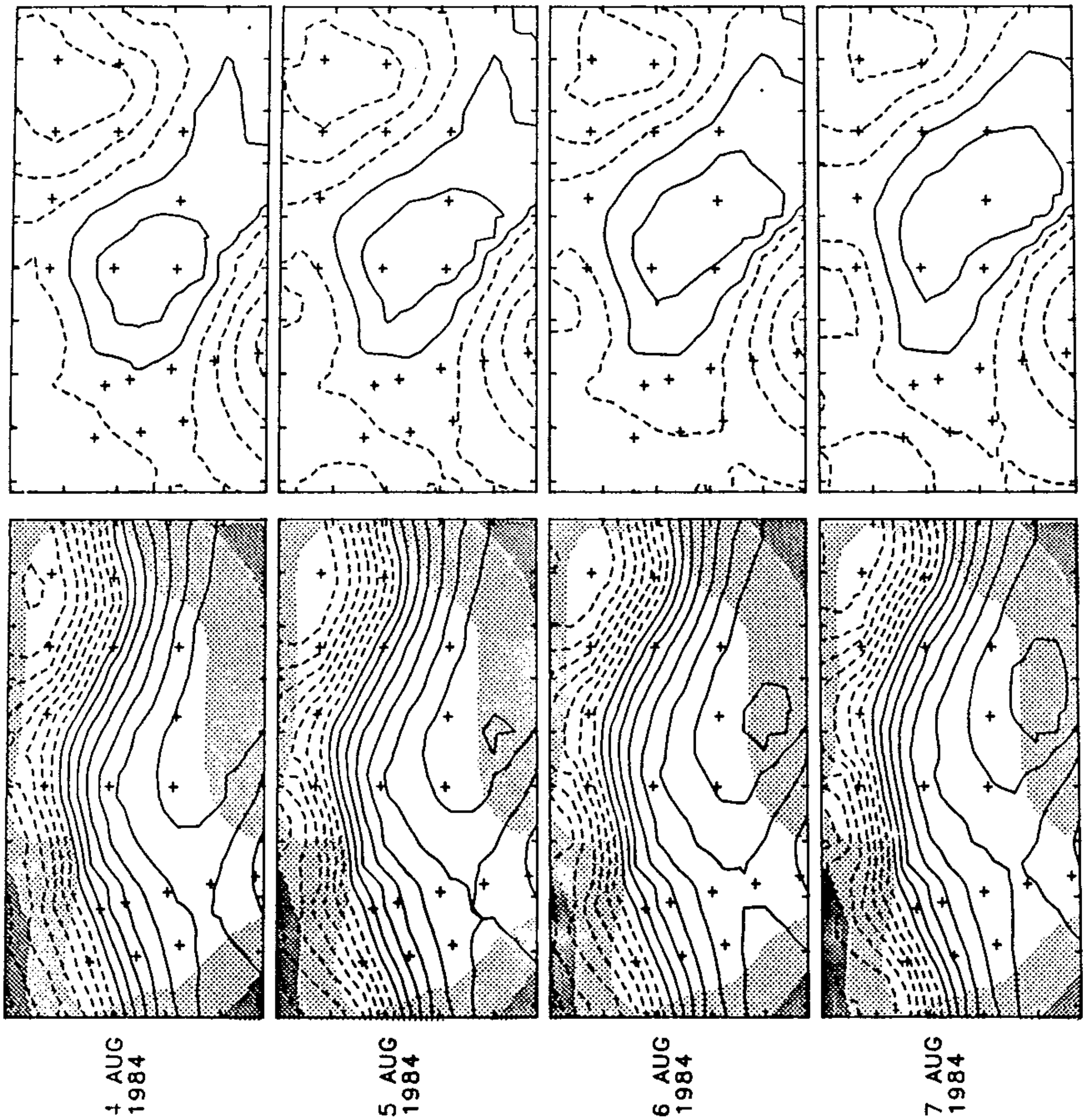
15 JULY 1984
16 JULY 1984
17 JULY 1984
18 JULY 1984

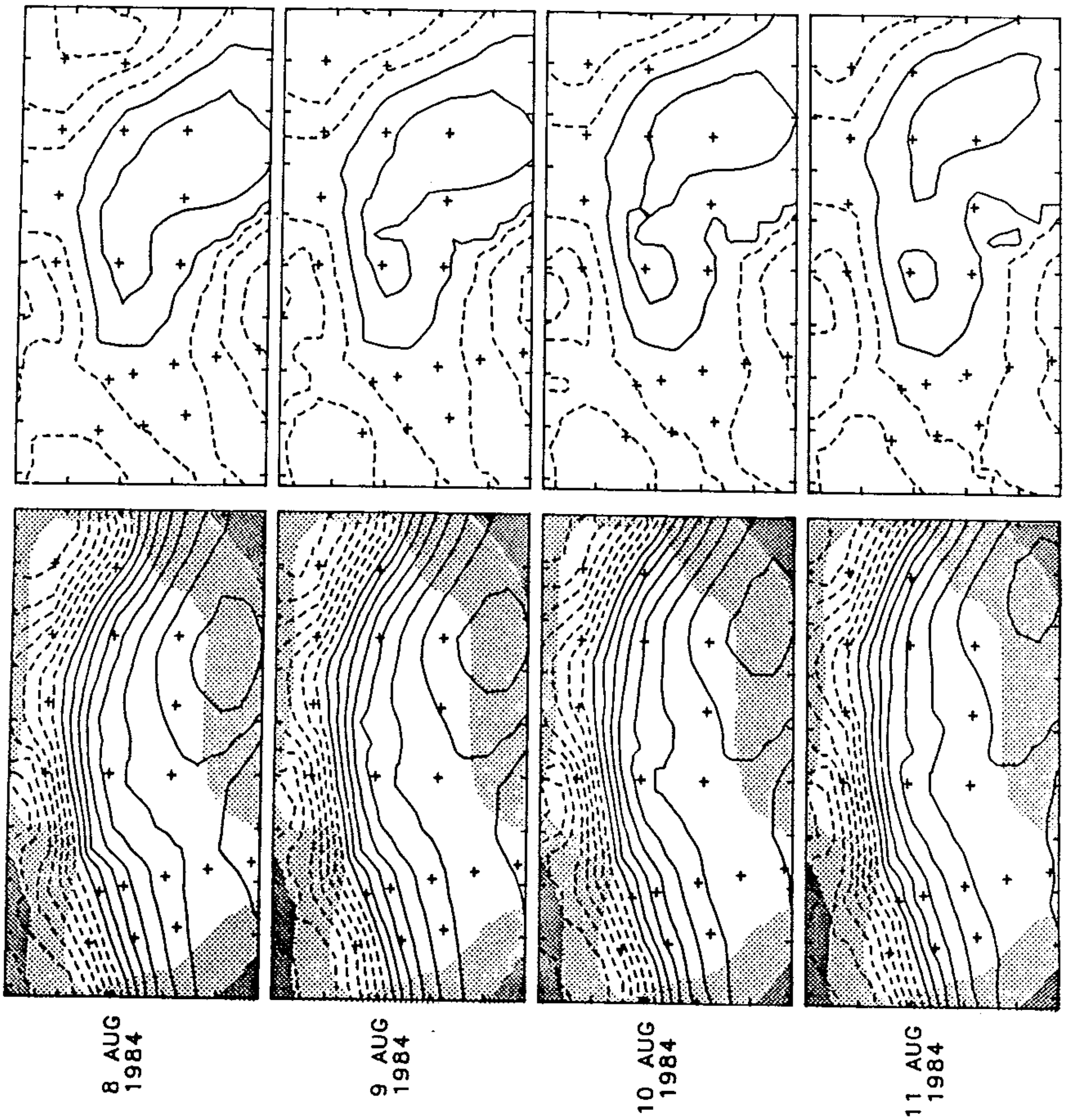

19 JULY 1984
20 JULY 1984
21 JULY 1984
22 JULY 1984

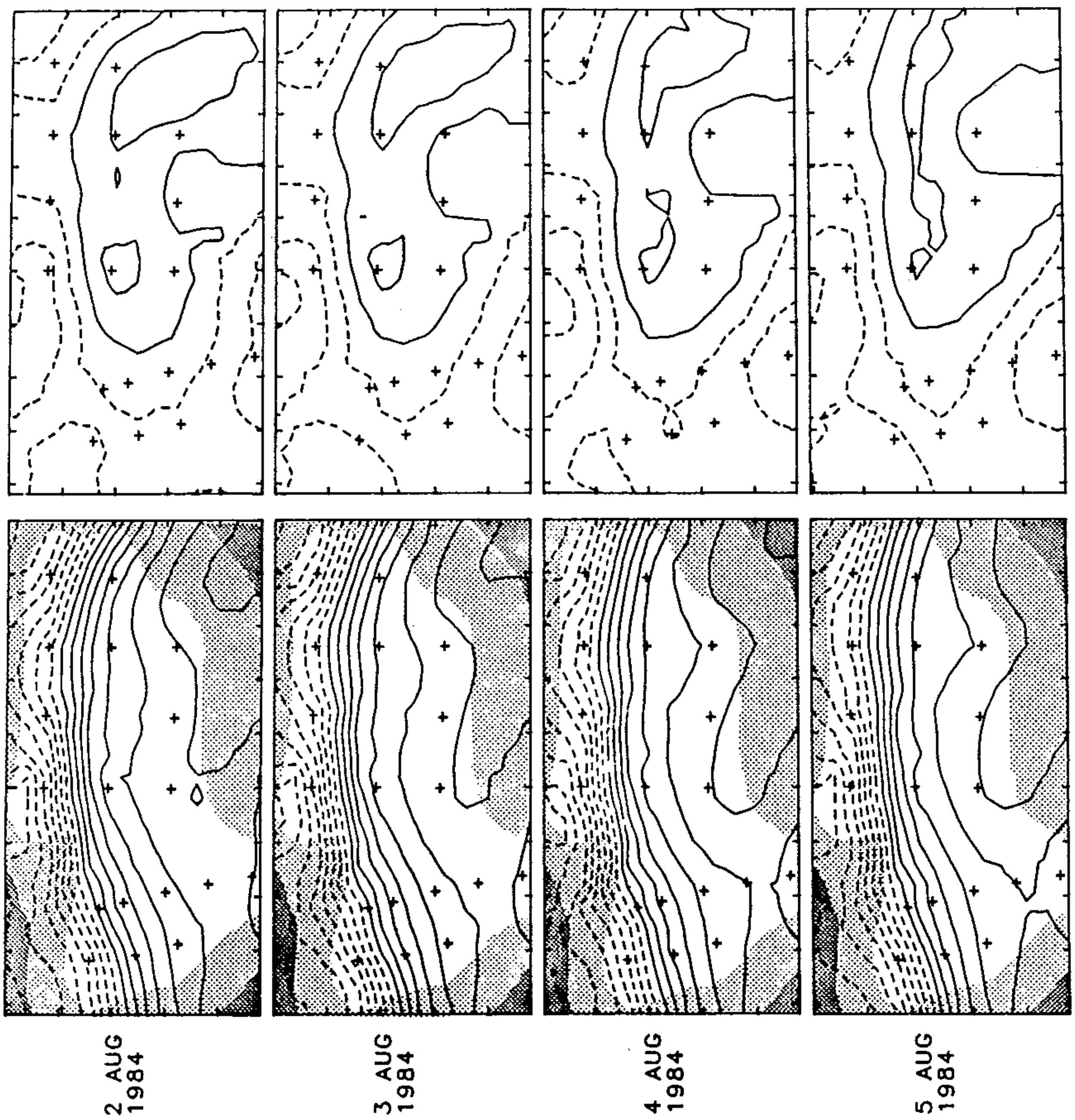

23 JULY 1984
24 JULY 1984
25 JULY 1984
26 JULY 1984

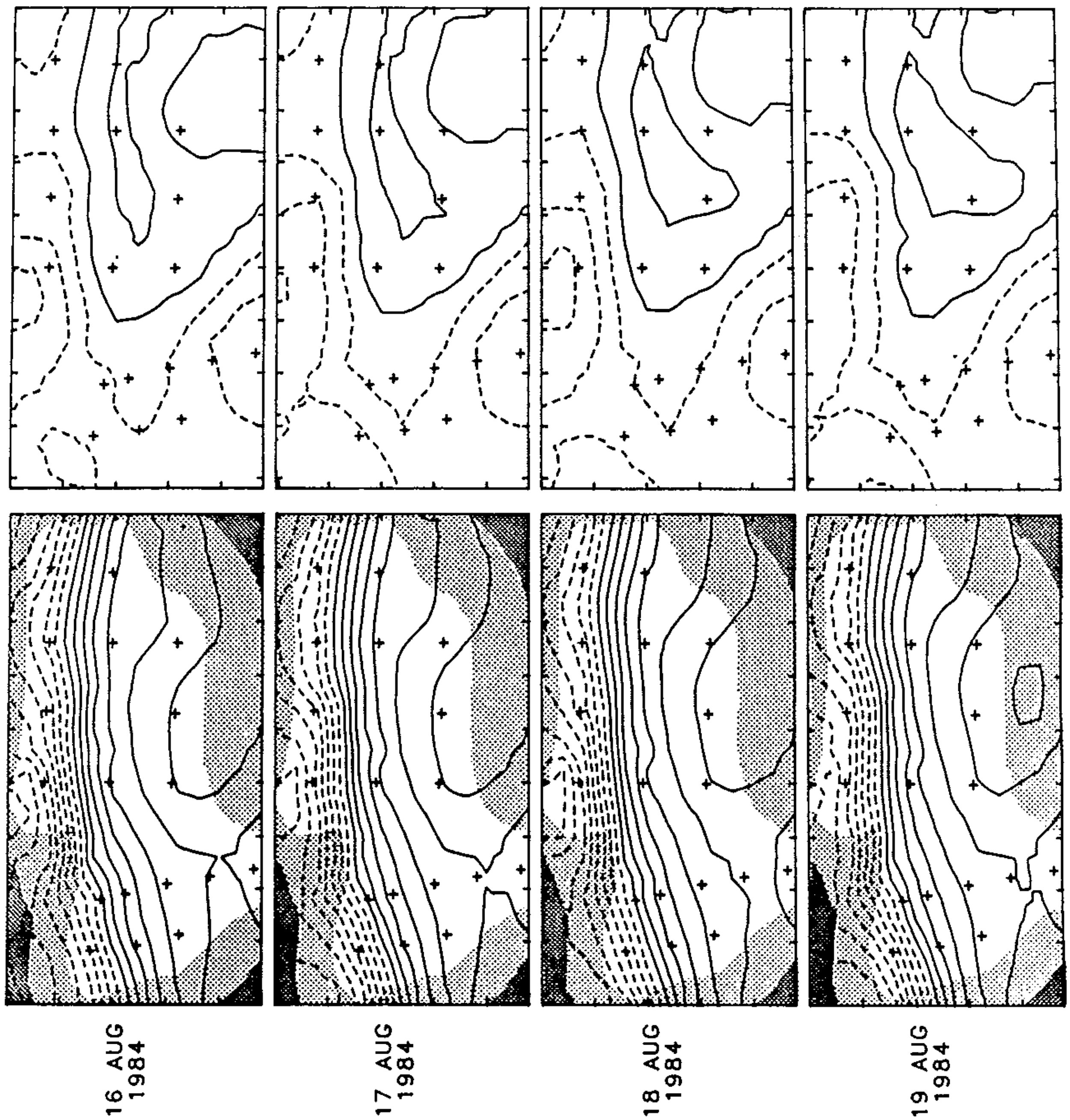

27 JULY
1984
28 JULY
1984
29 JULY
1984
30 JULY
1984

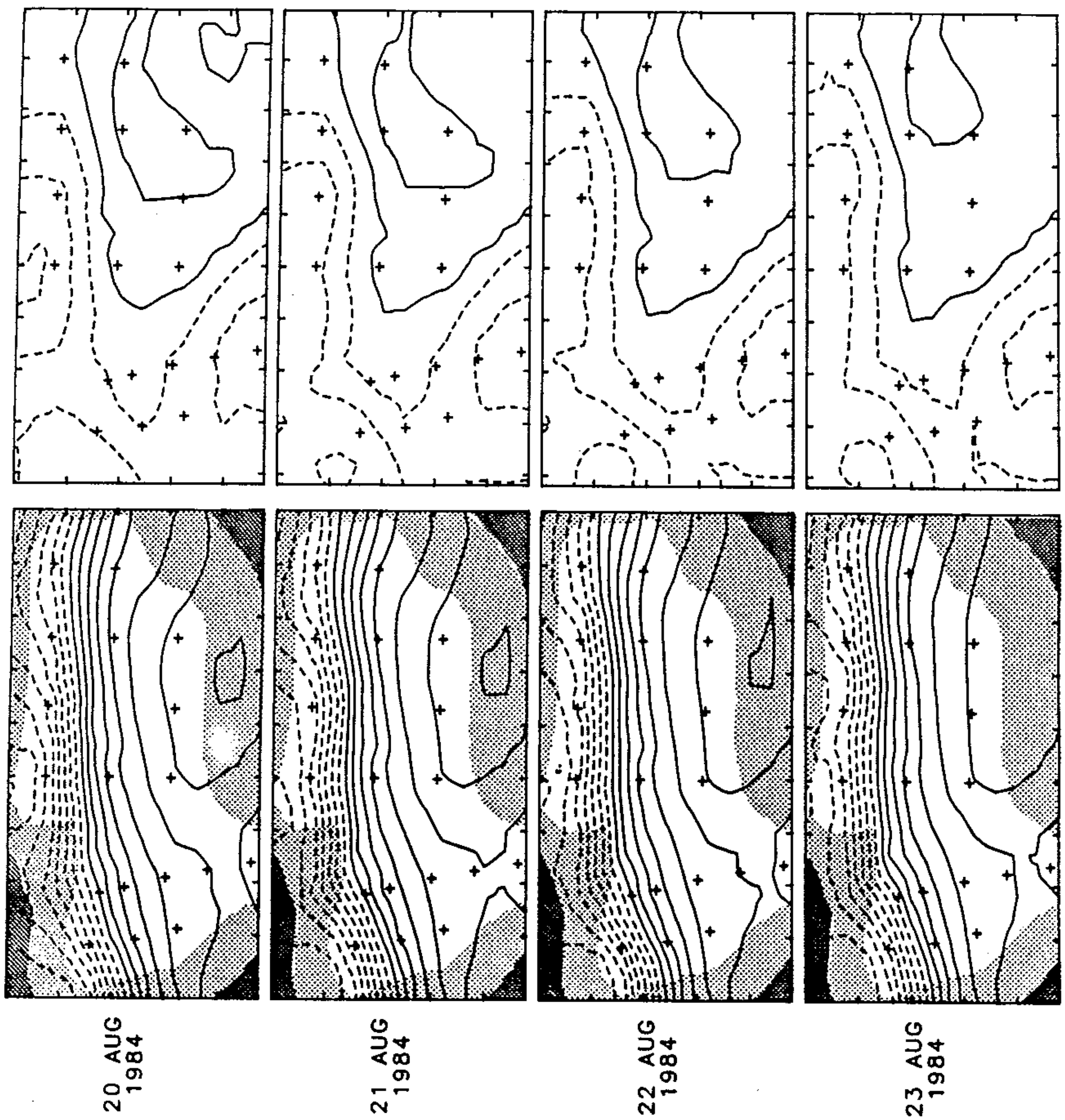

31 JULY 1984
1 AUG 1984
2 AUG 1984
3 AUG 1984

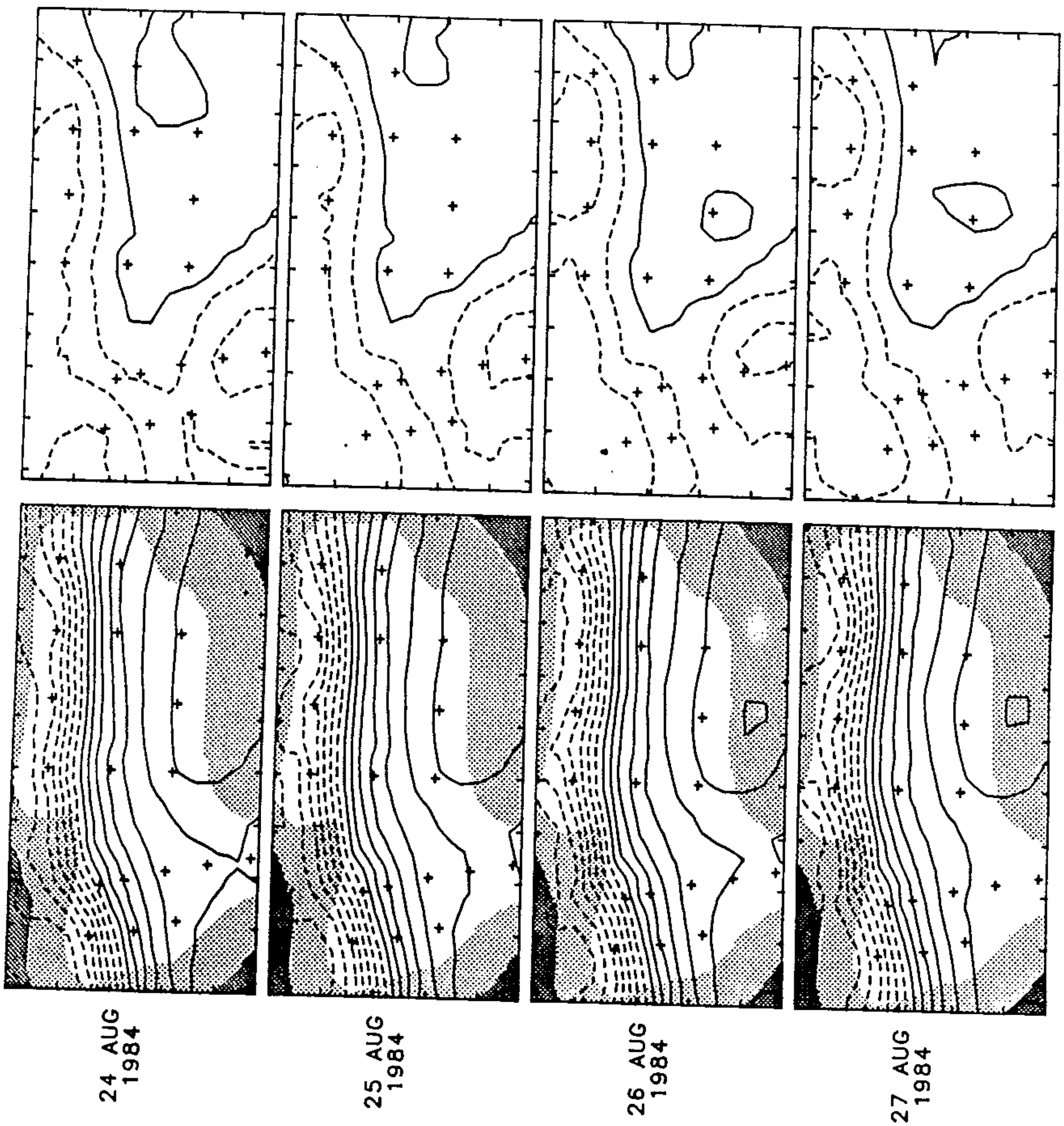

AUG 1984
5 AUG 1984
6 AUG 1984
7 AUG 1984

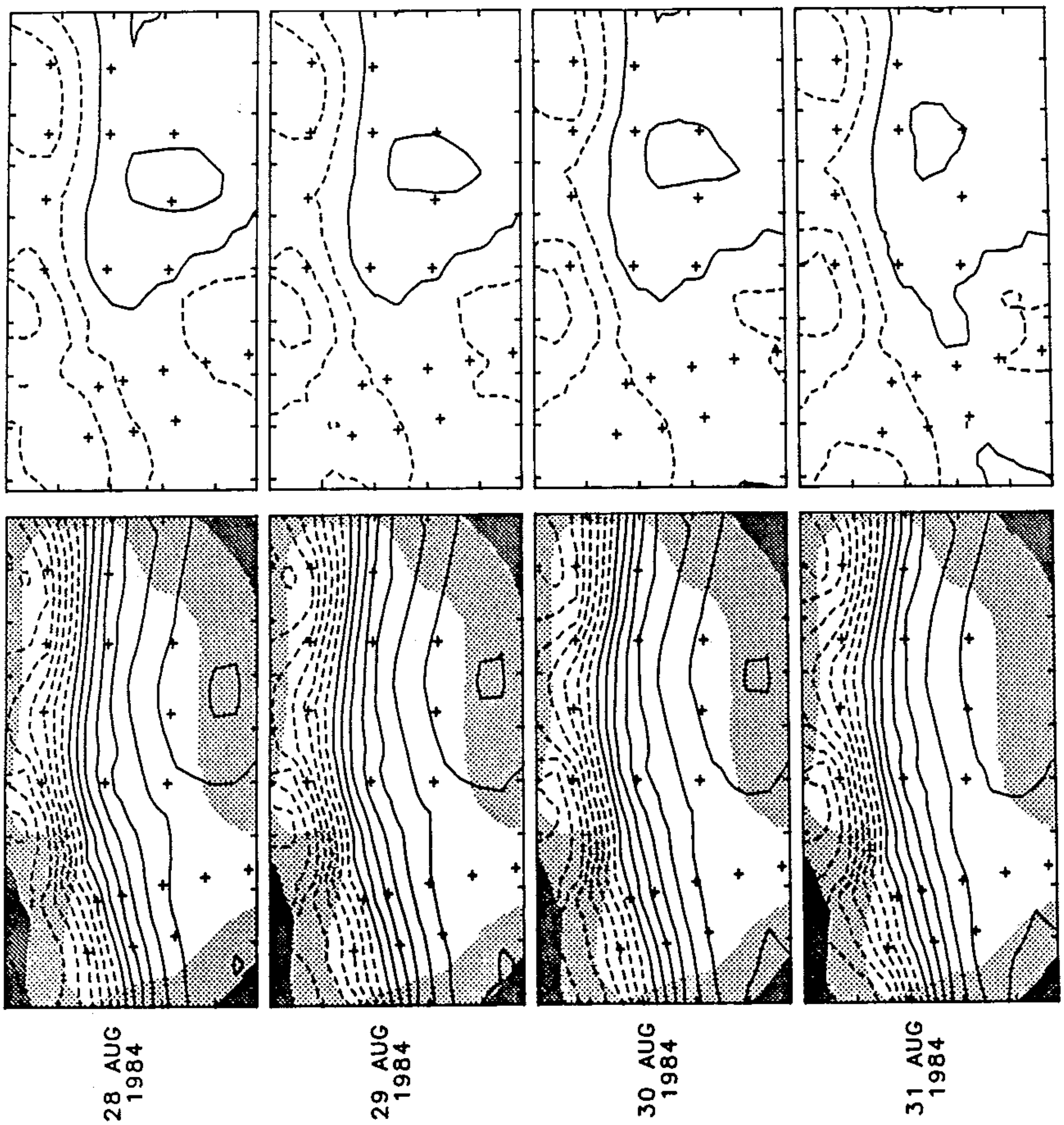

8 AUG 1984
9 AUG 1984
10 AUG 1984
11 AUG 1984


12 AUG 1984
13 AUG 1984
14 AUG 1984
15 AUG 1984

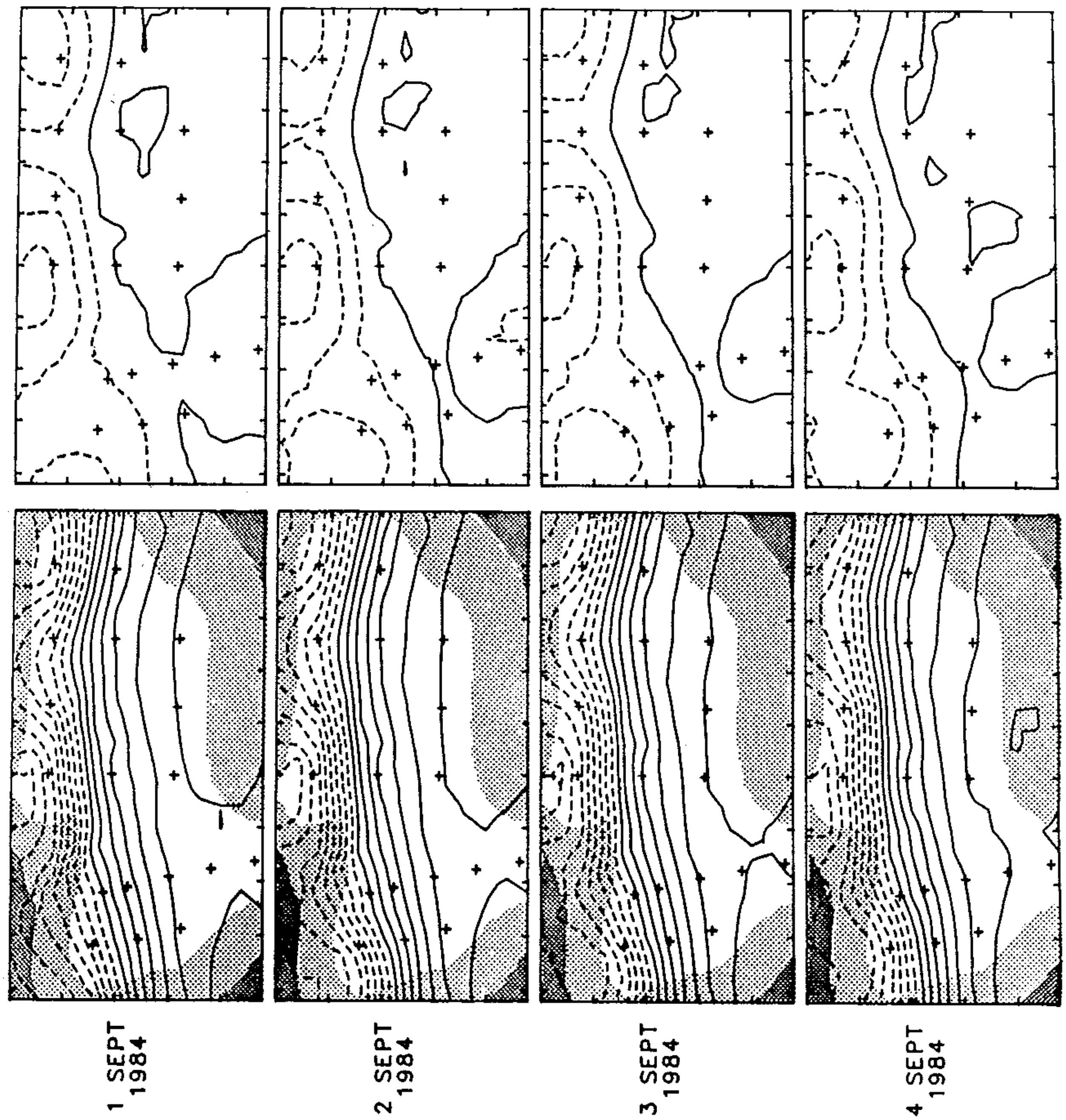

16 AUG 1984
17 AUG 1984
18 AUG 1984
19 AUG 1984

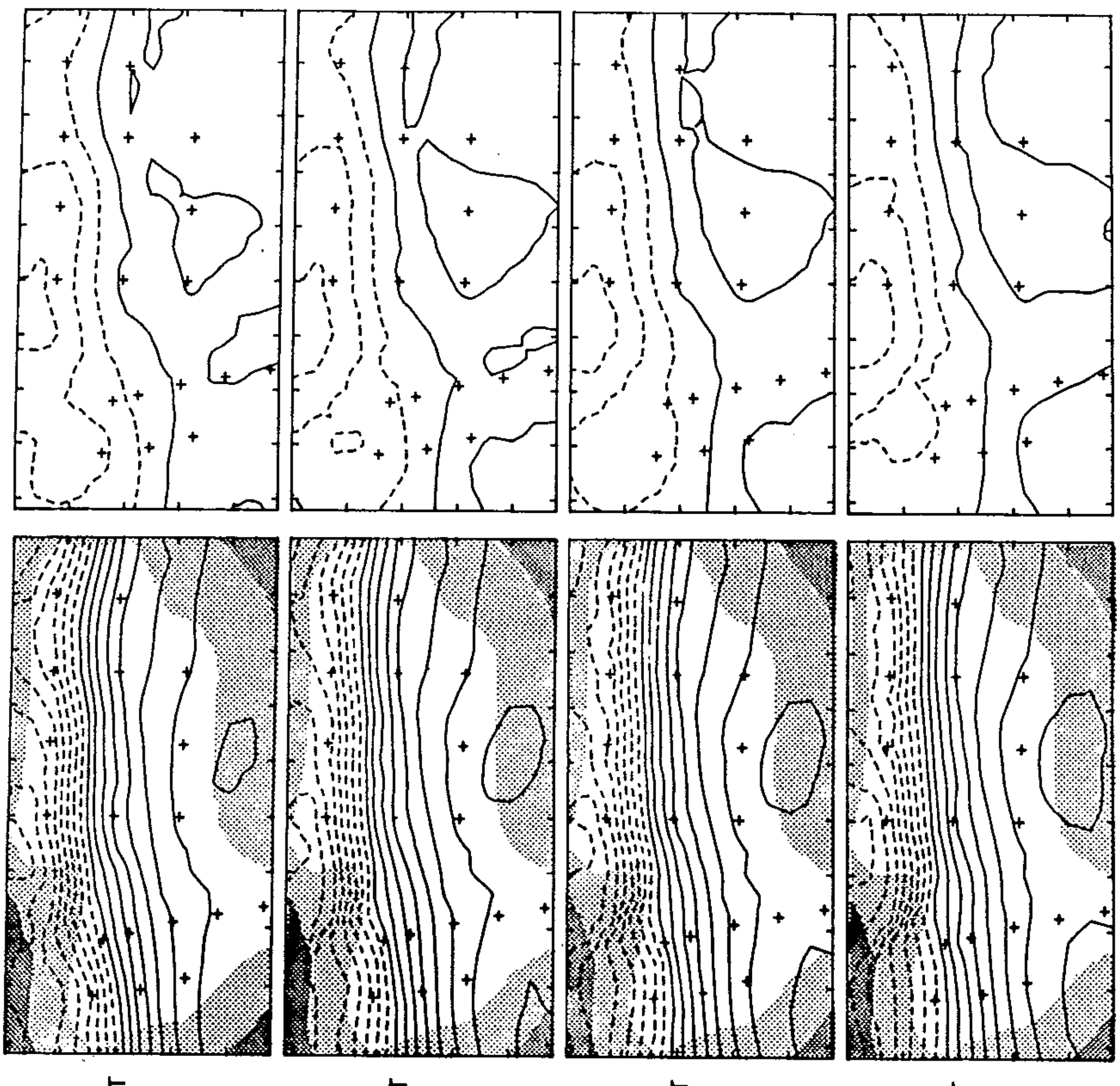

20 AUG 1984
21 AUG 1984
22 AUG 1984
23 AUG 1984


24 AUG 1984
25 AUG 1984
26 AUG 1984
27 AUG 1984



28 AUG 1984
29 AUG 1984
30 AUG 1984
31 AUG 1984


1 SEPT 1984
2 SEPT 1984
3 SEPT 1984
4 SEPT 1984



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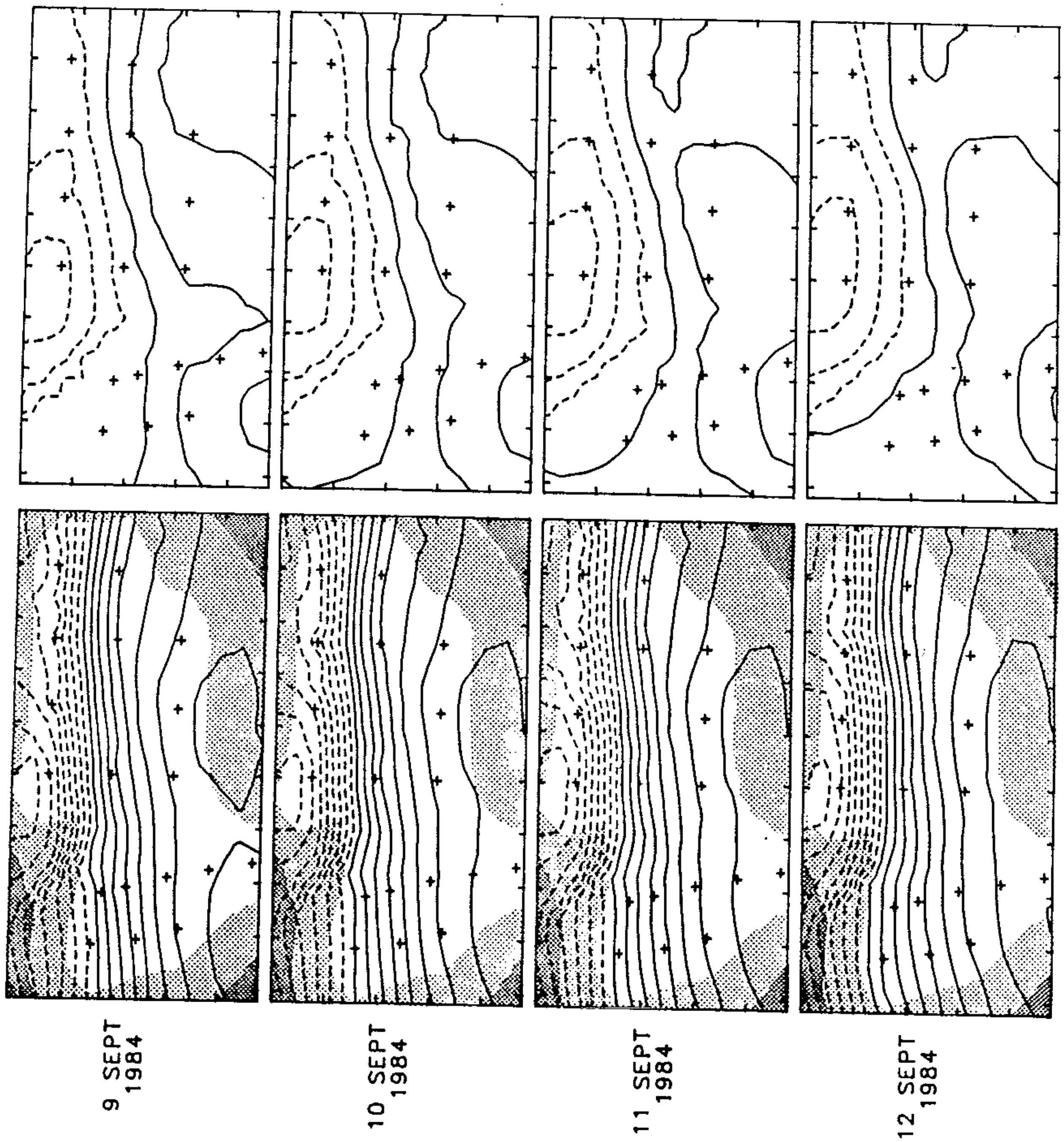
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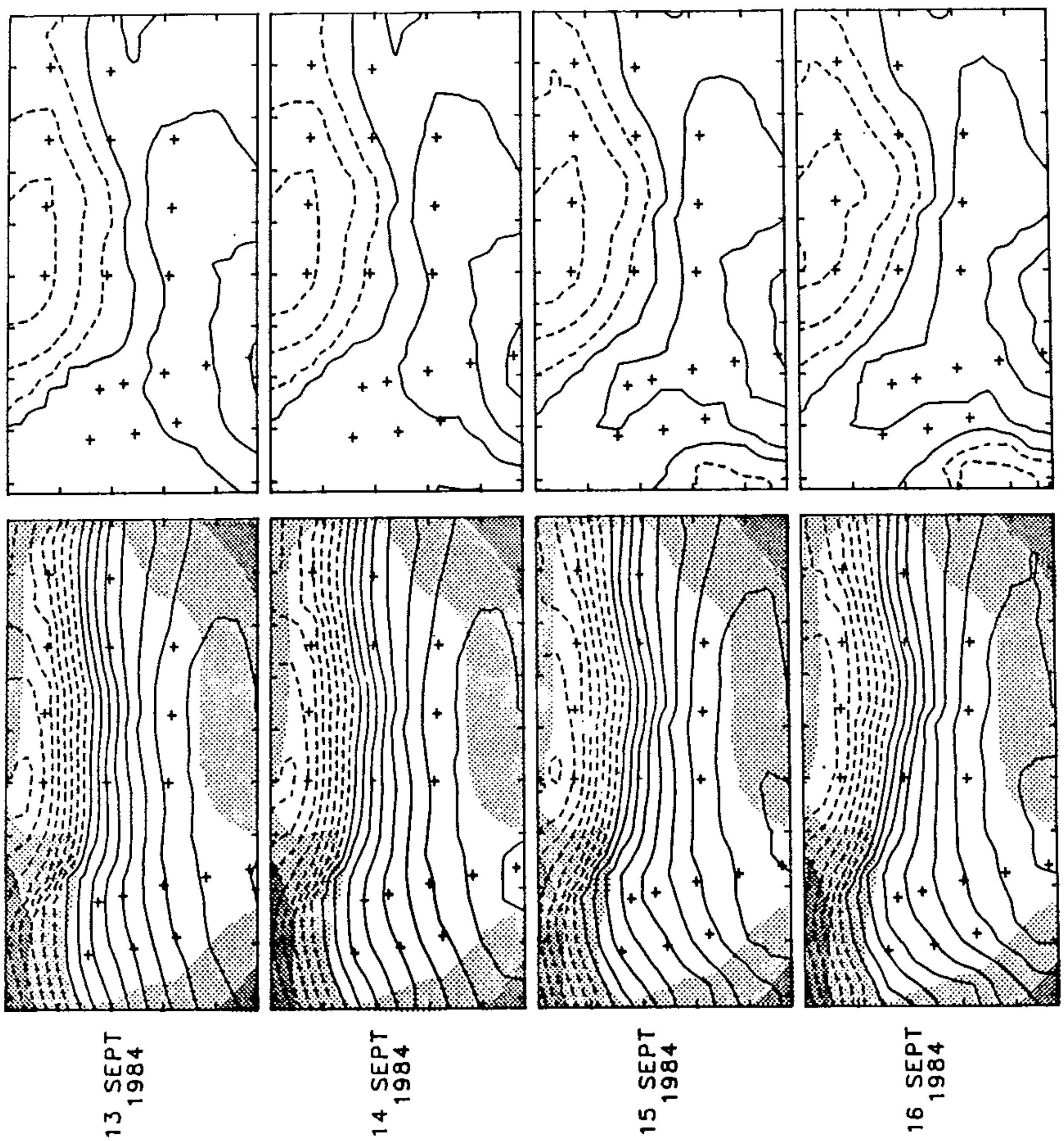

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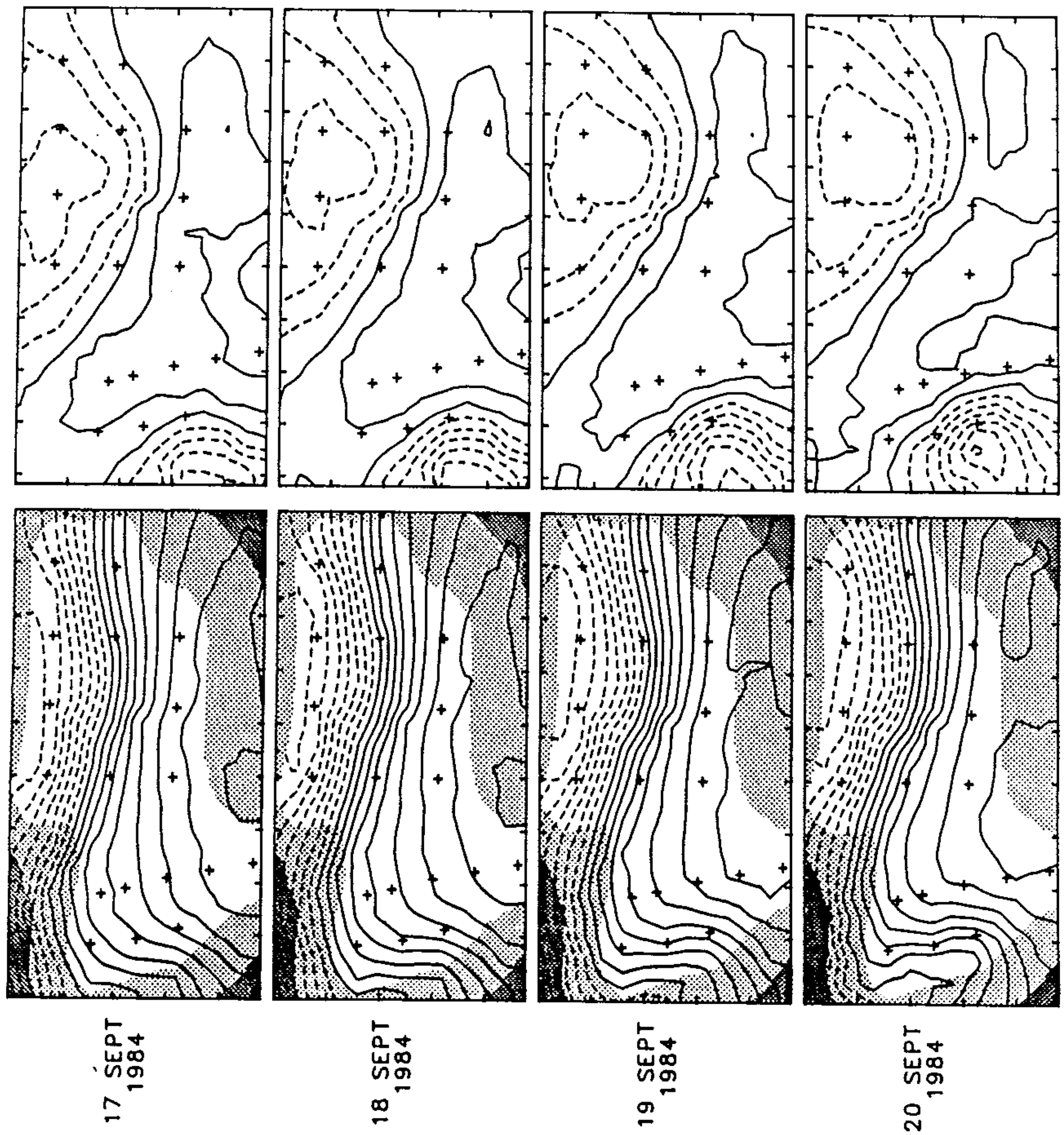
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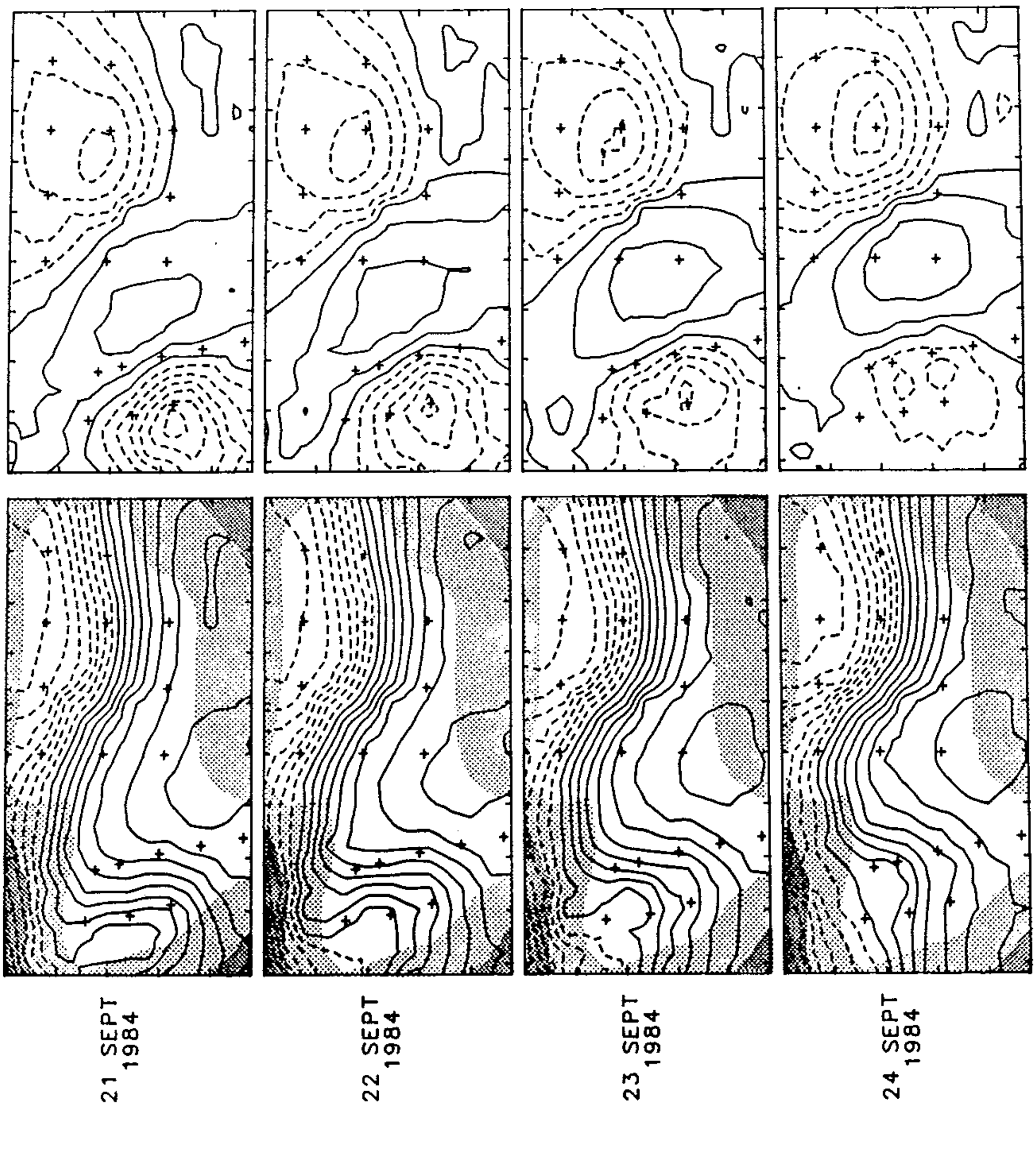

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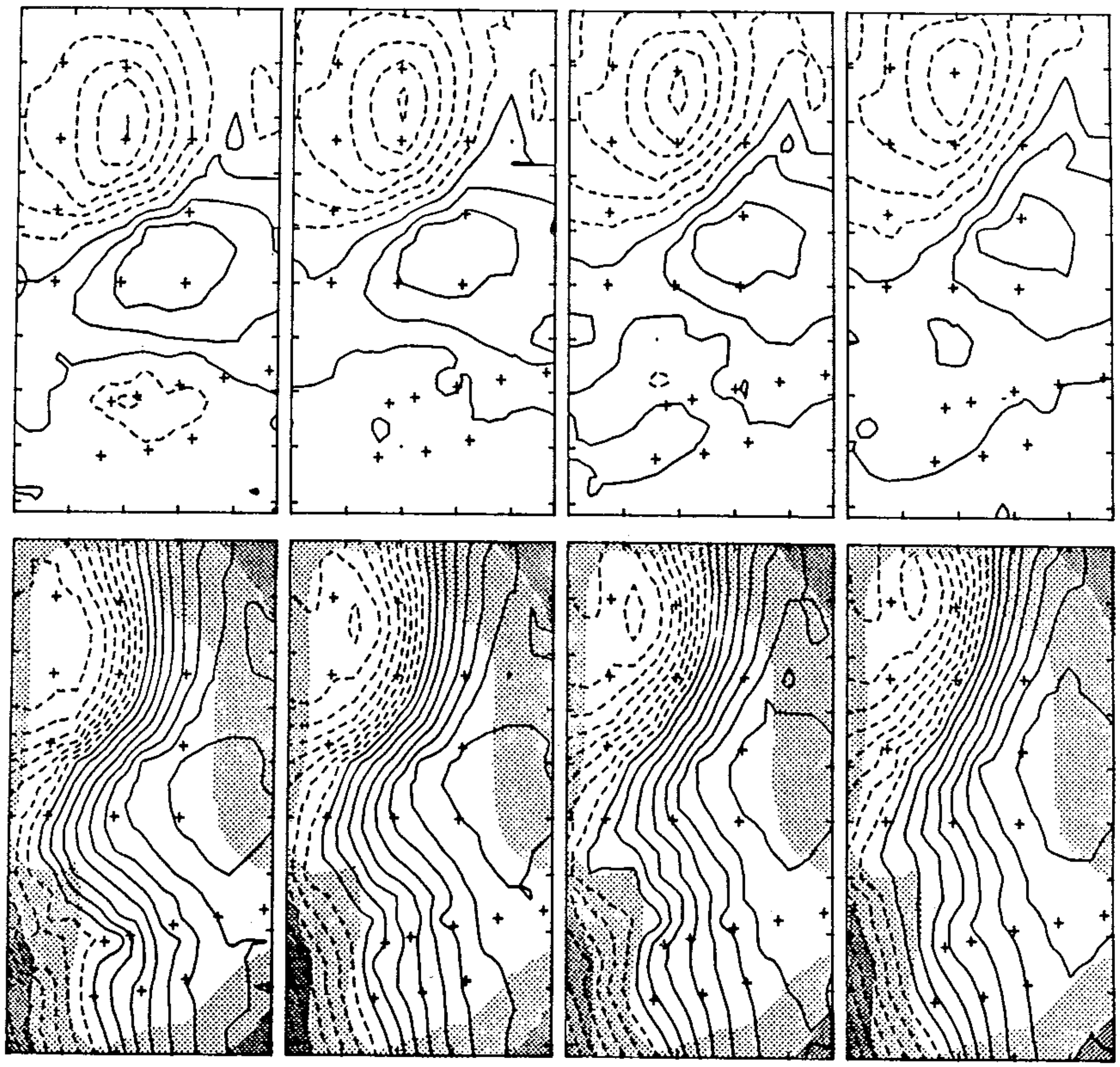

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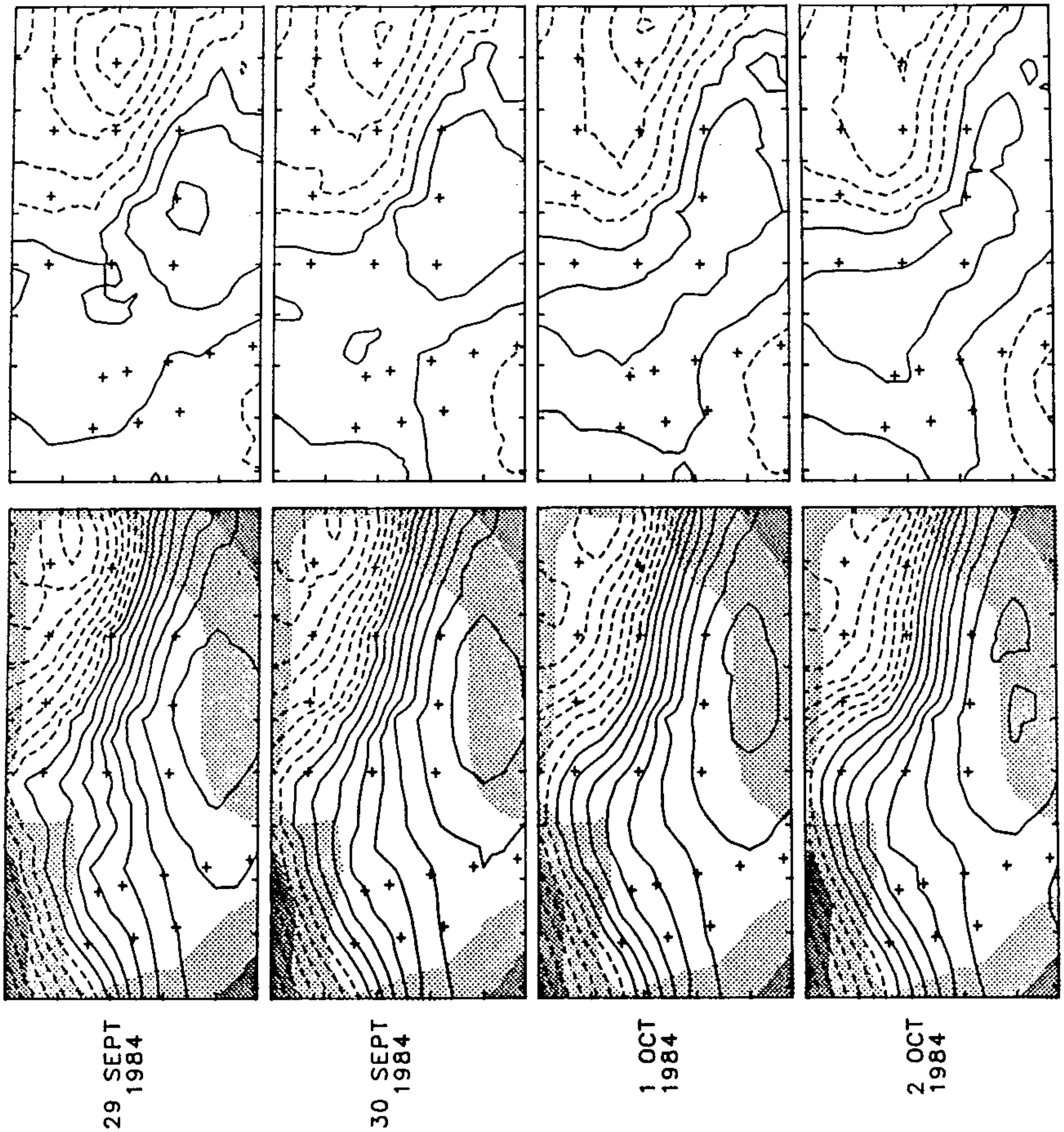
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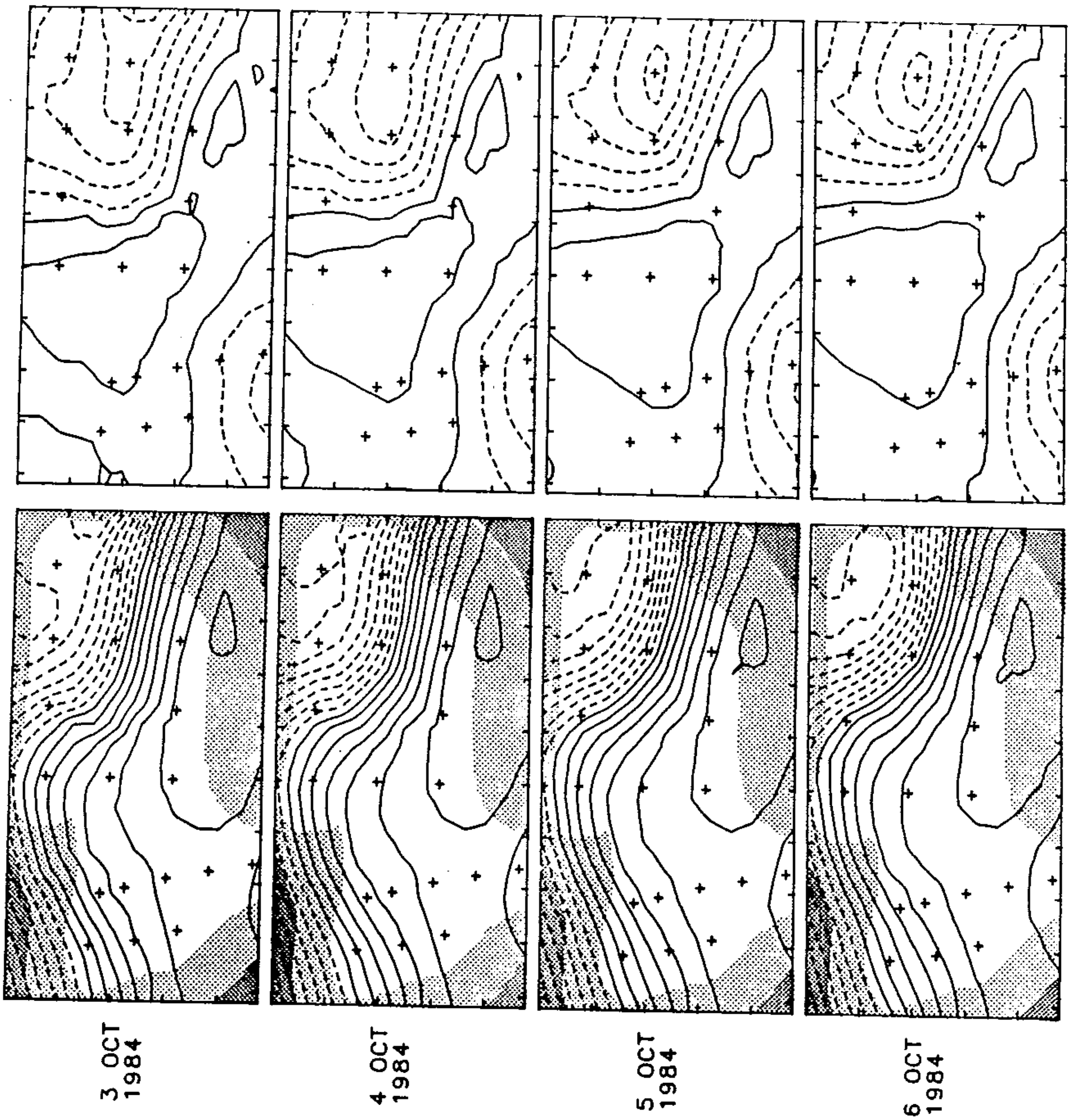
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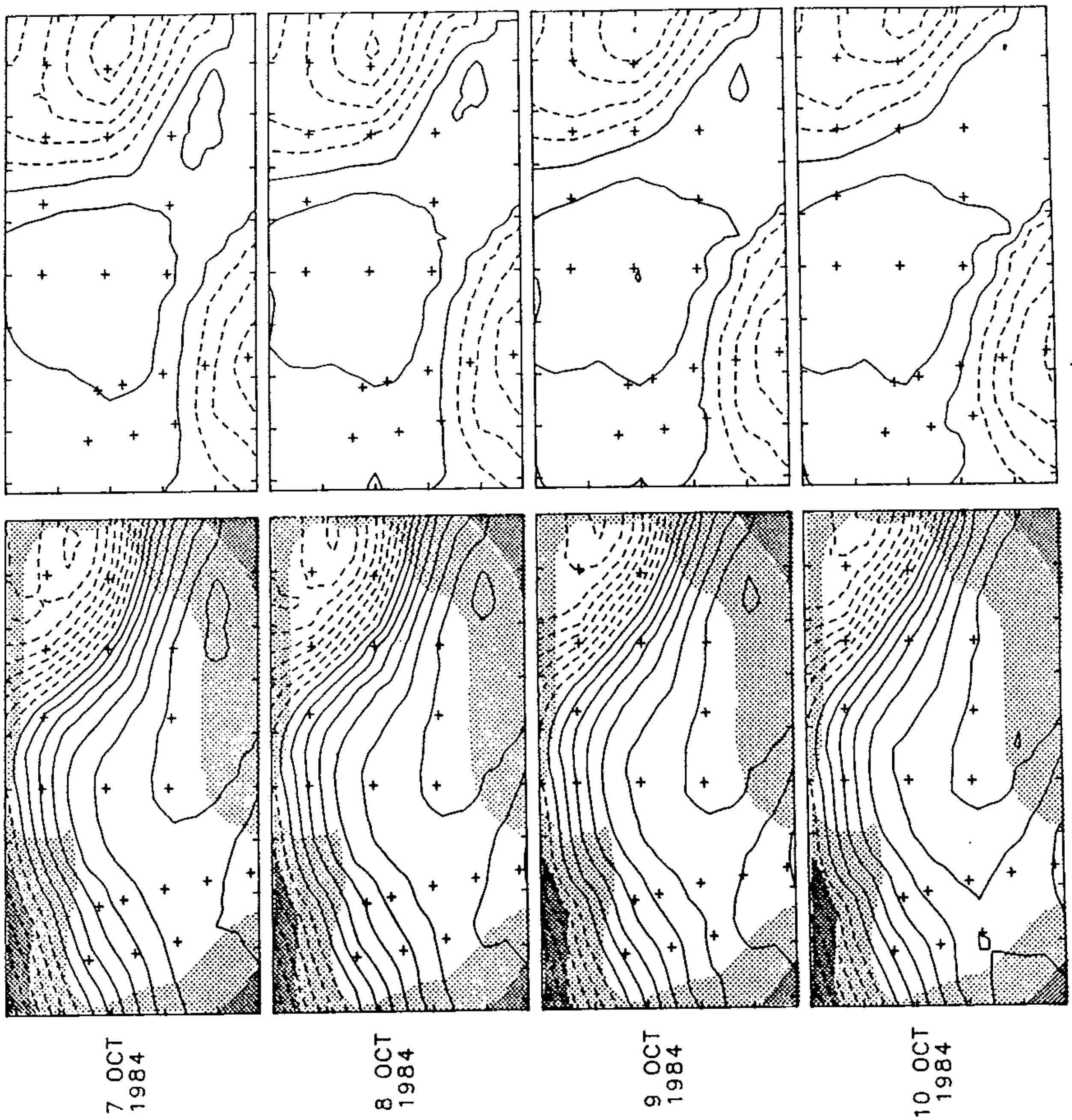
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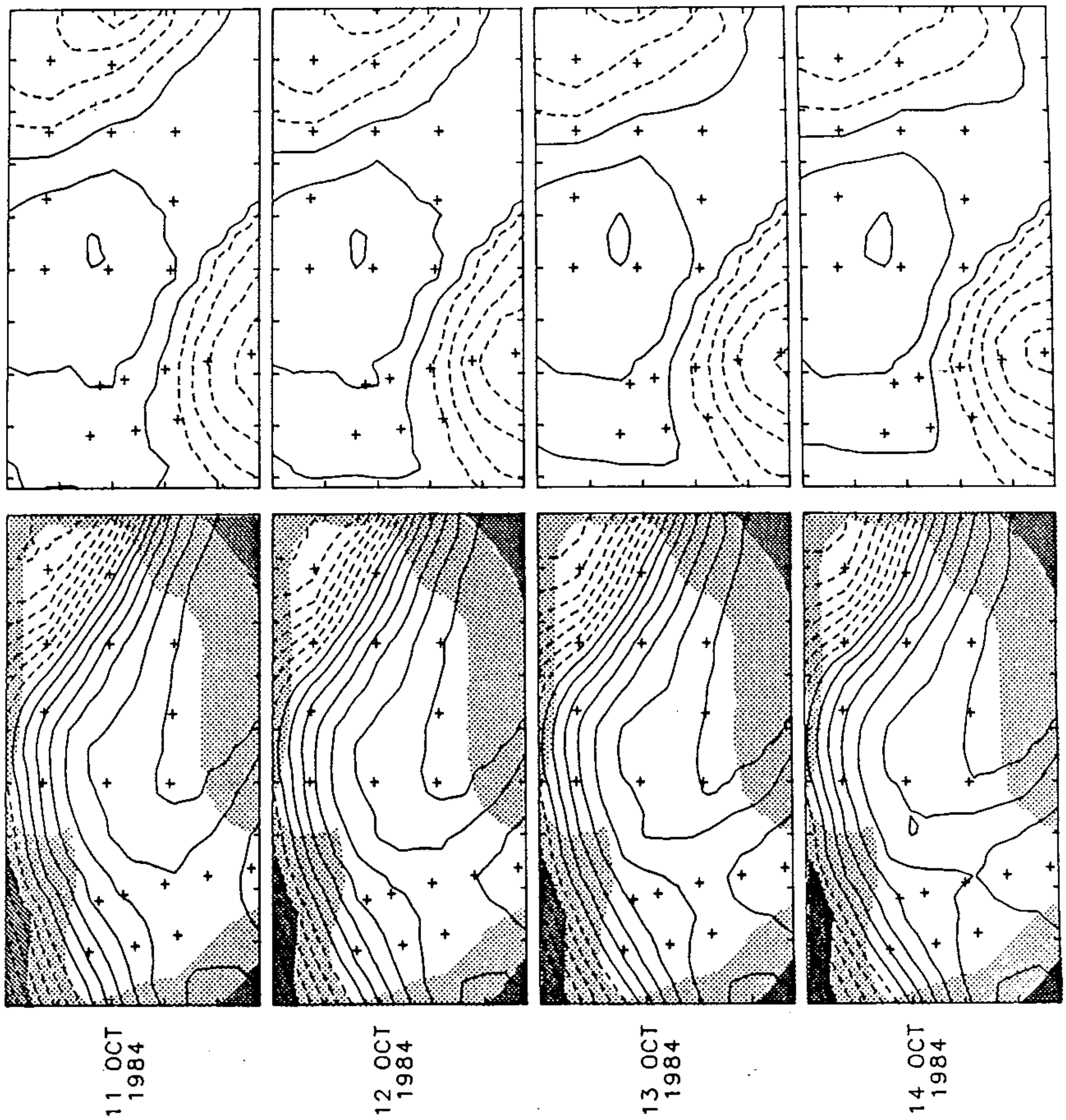
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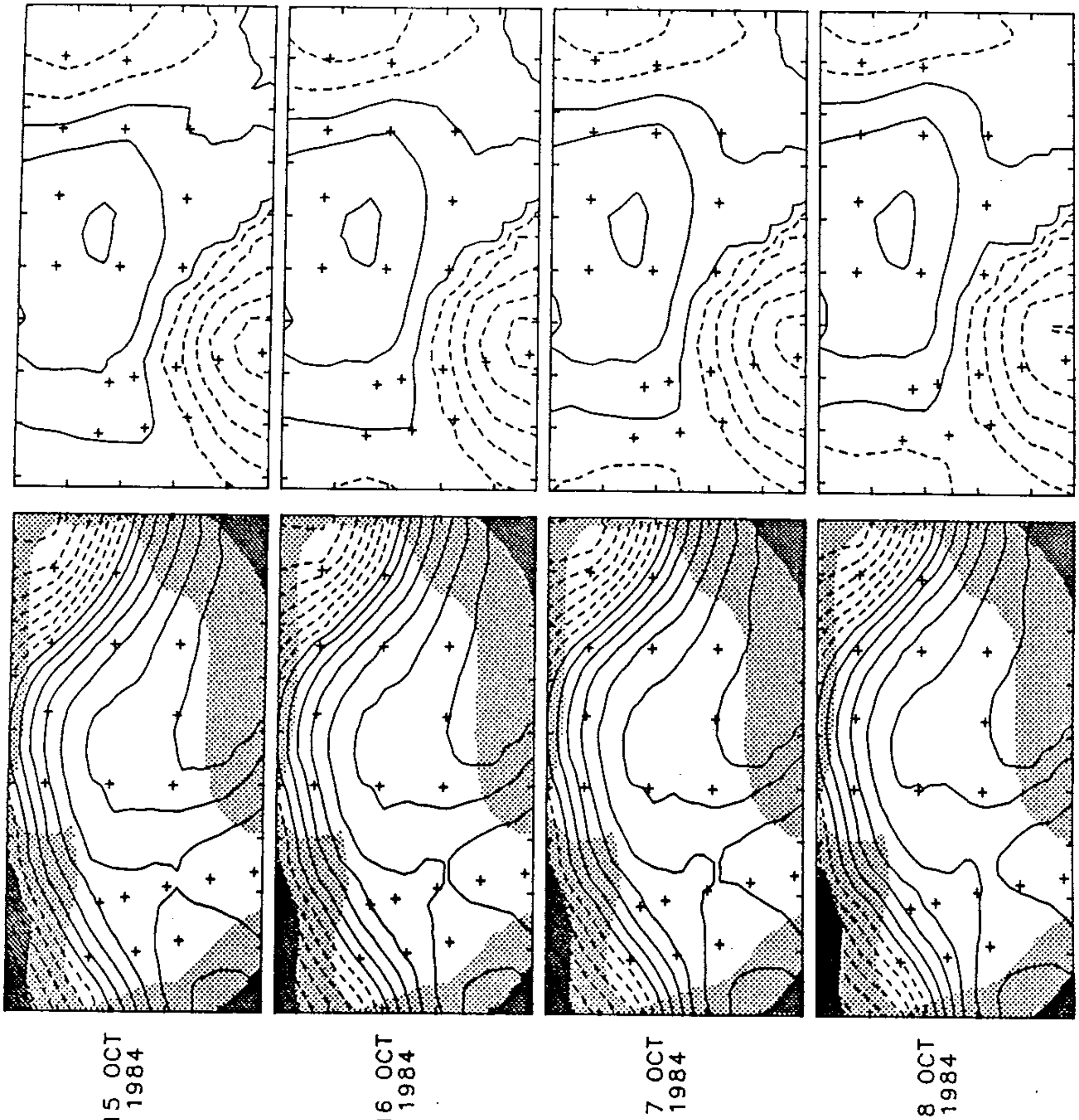
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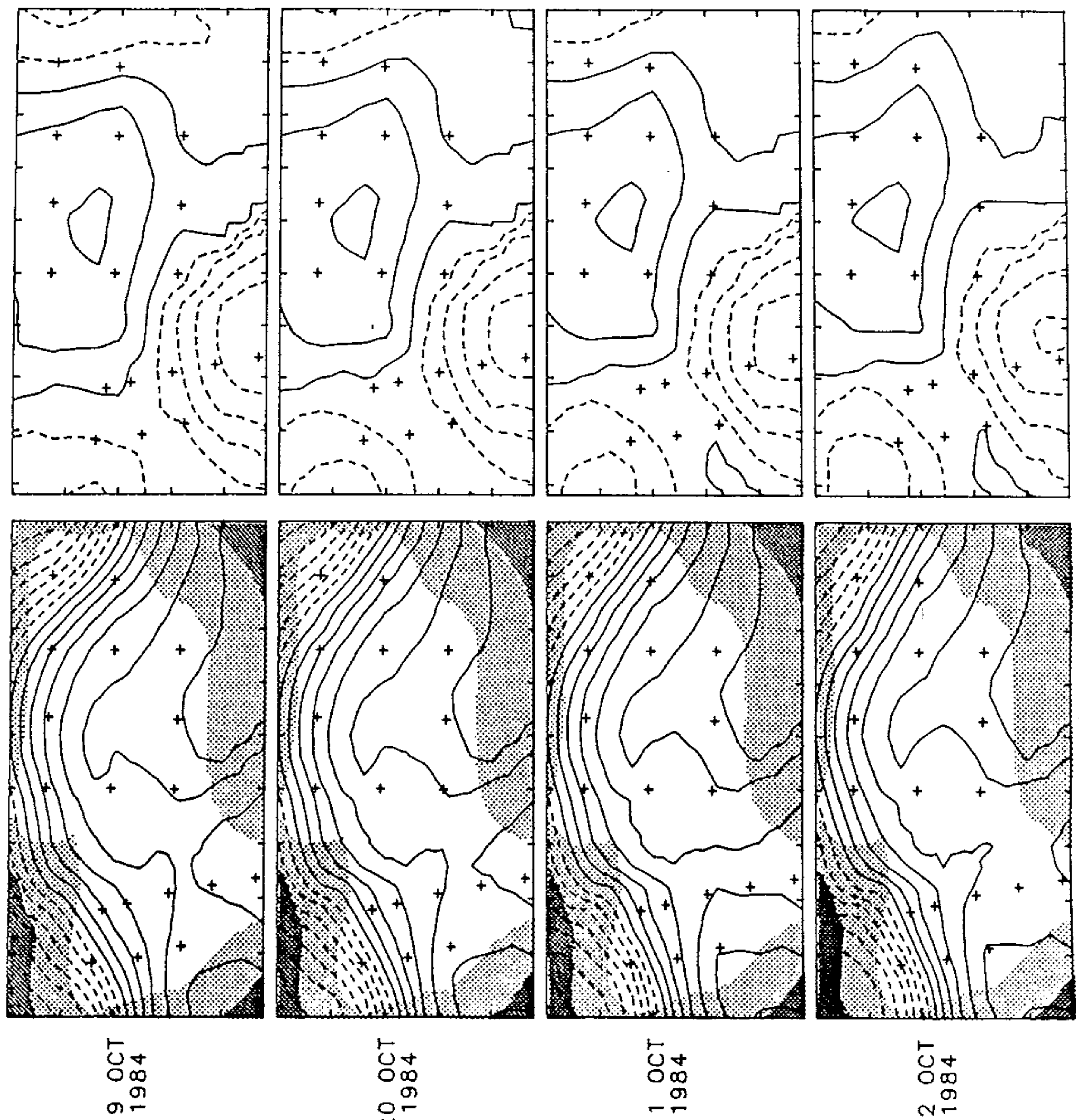
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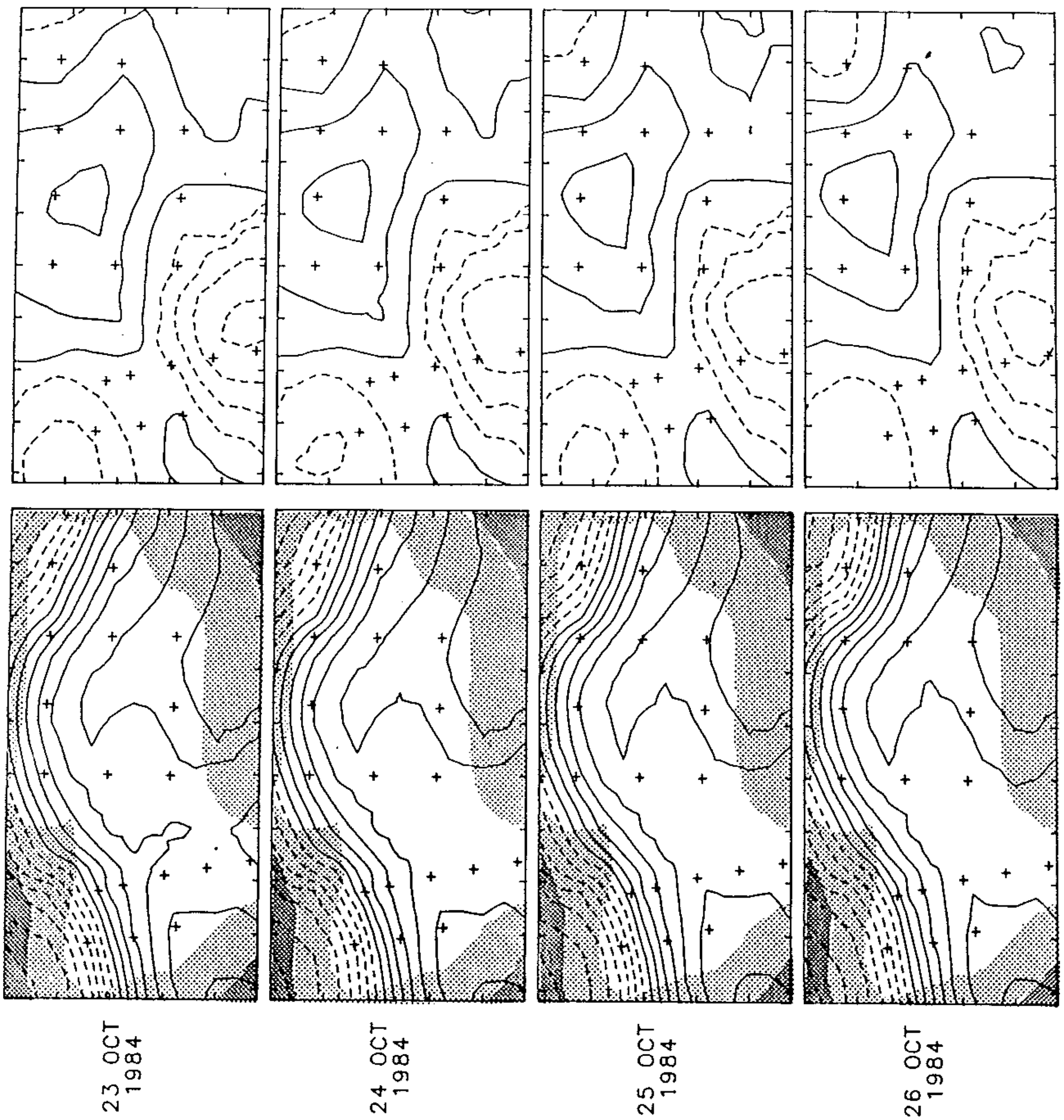
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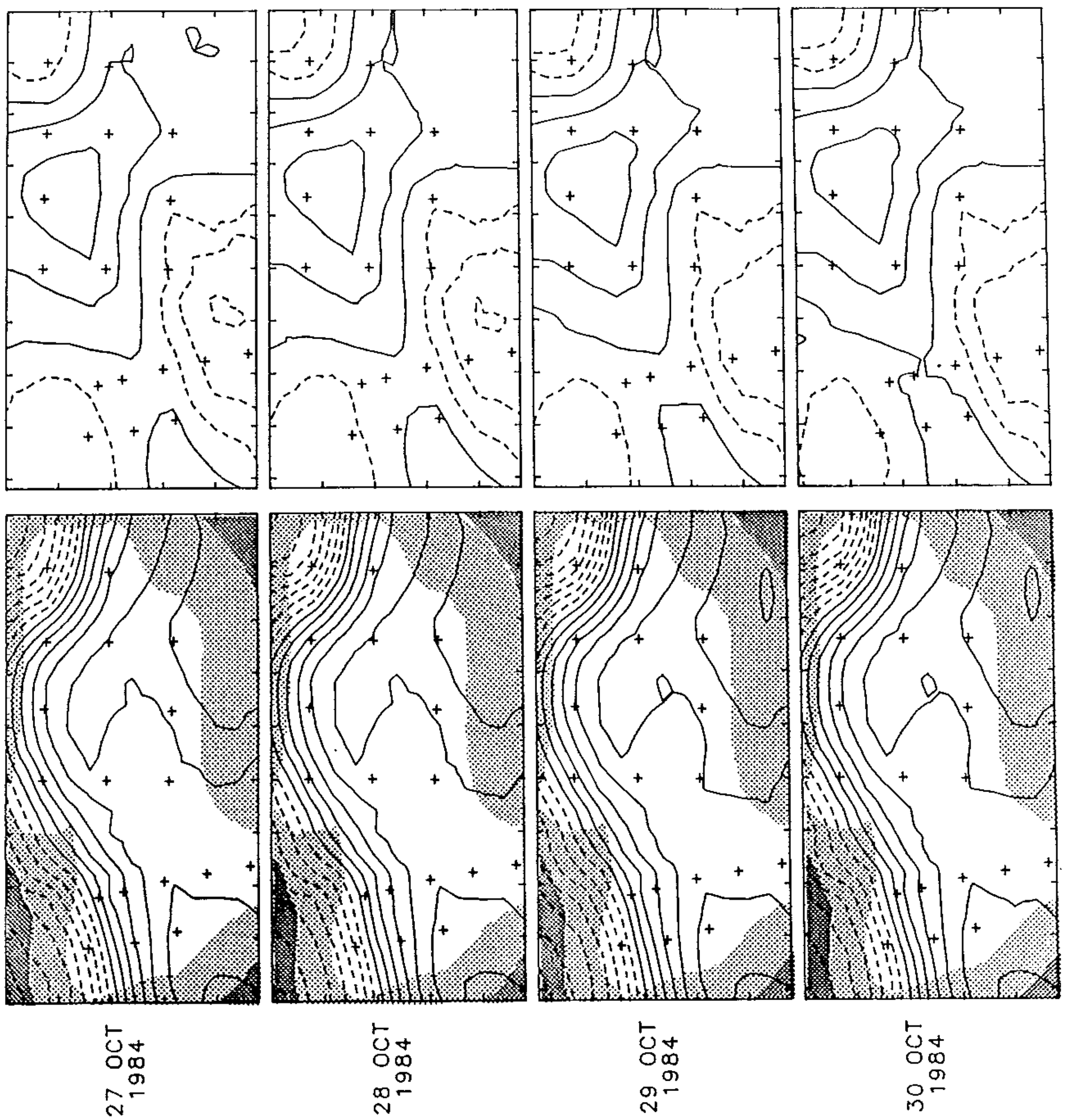
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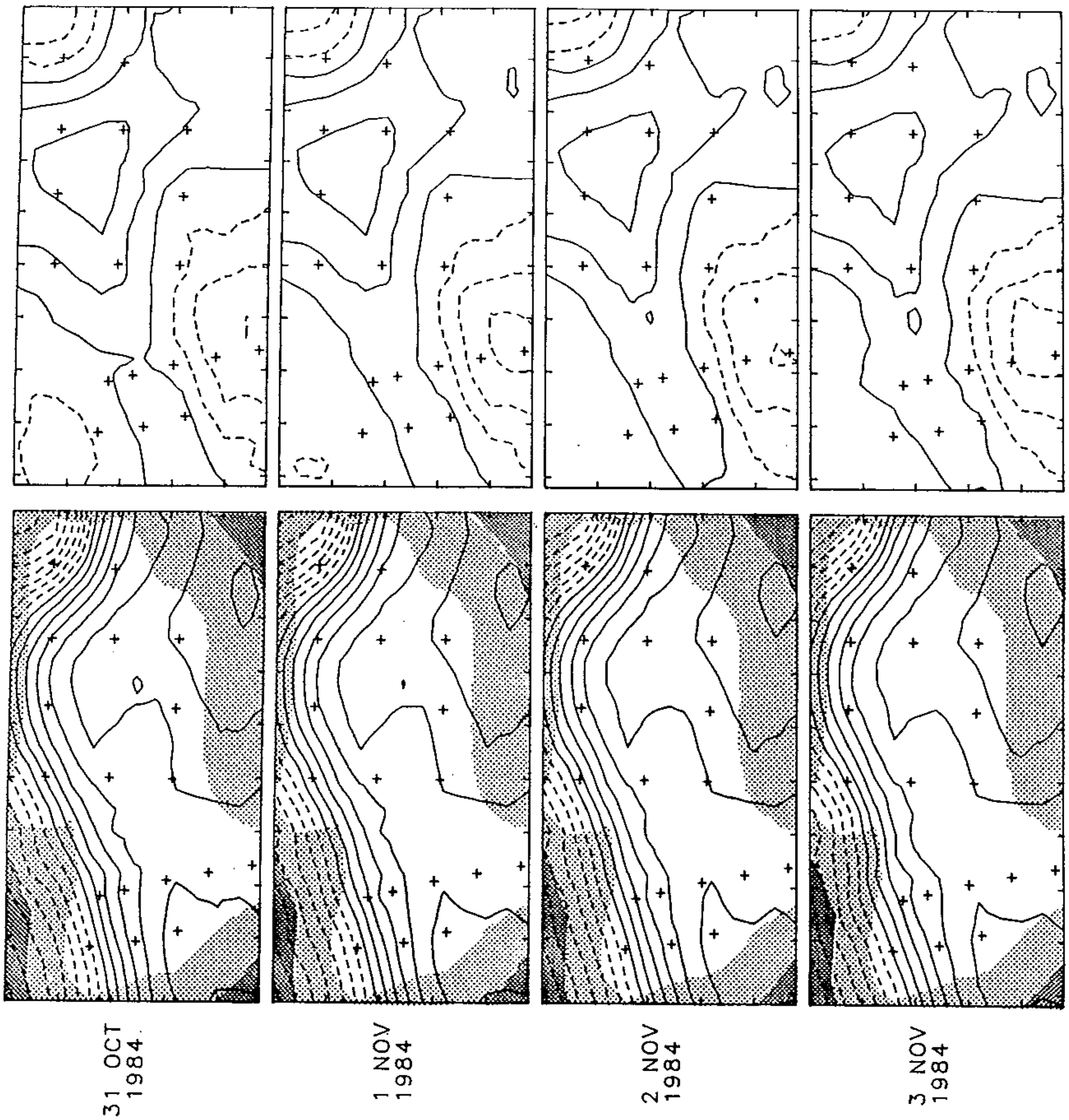
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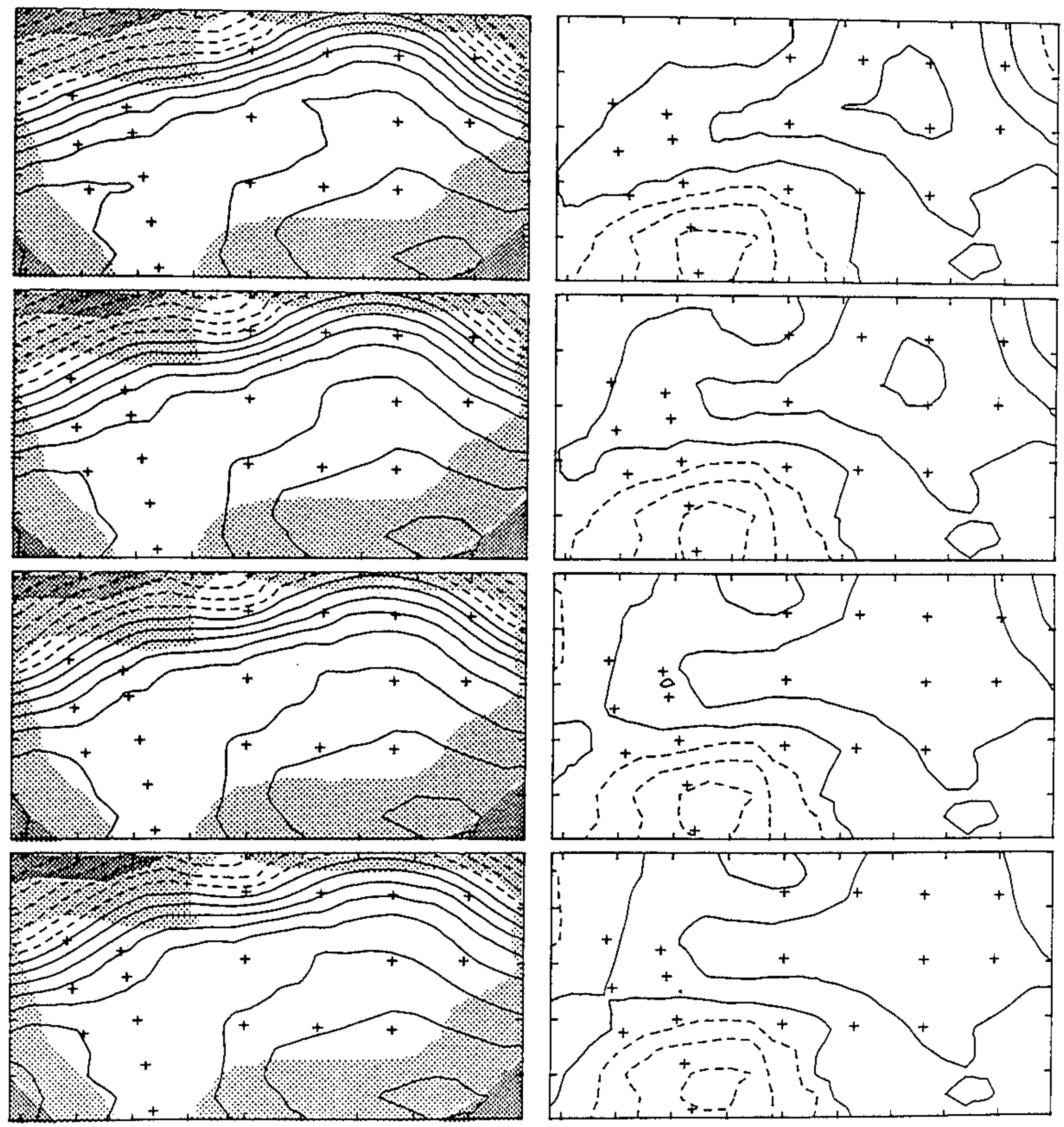

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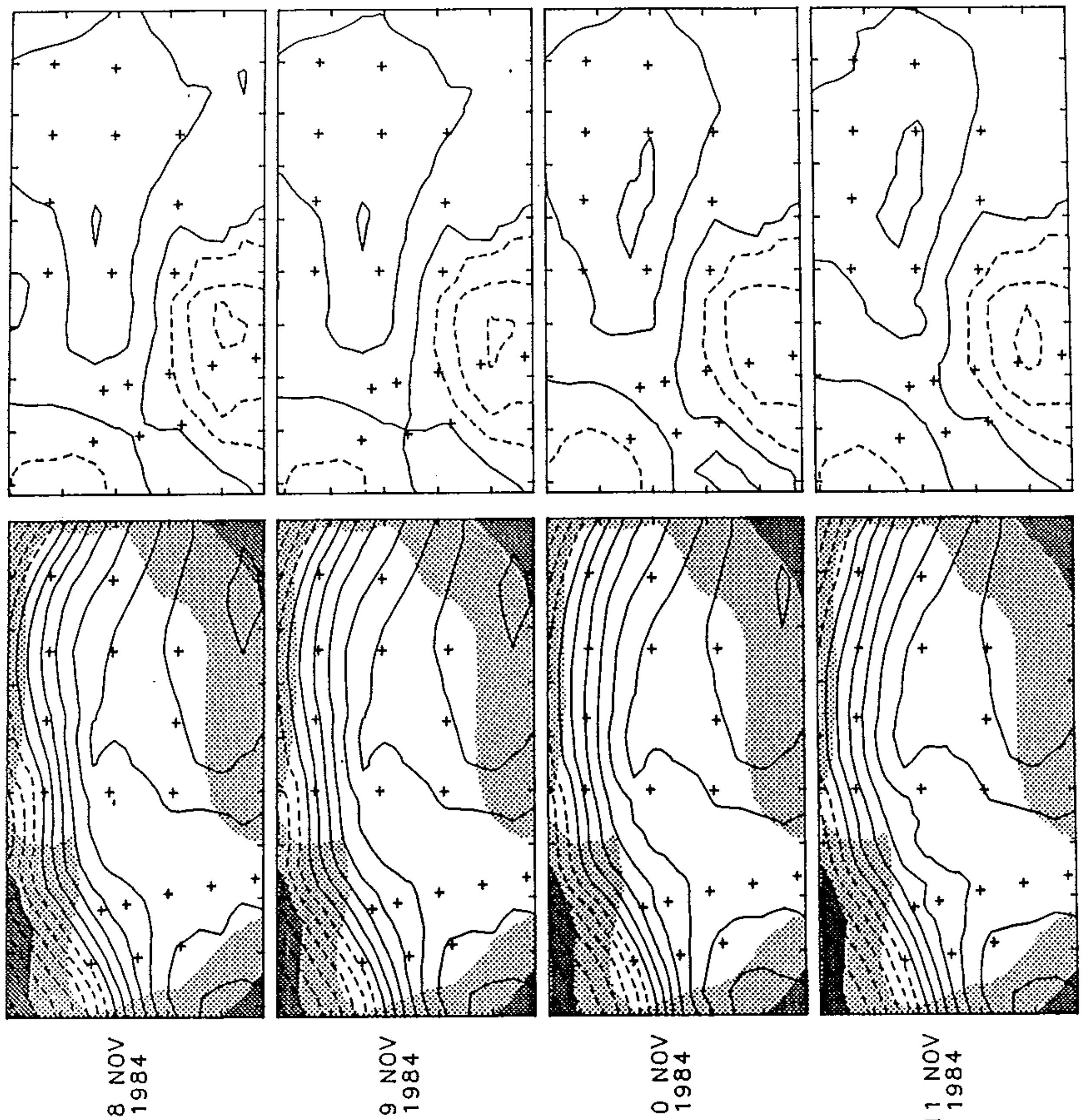
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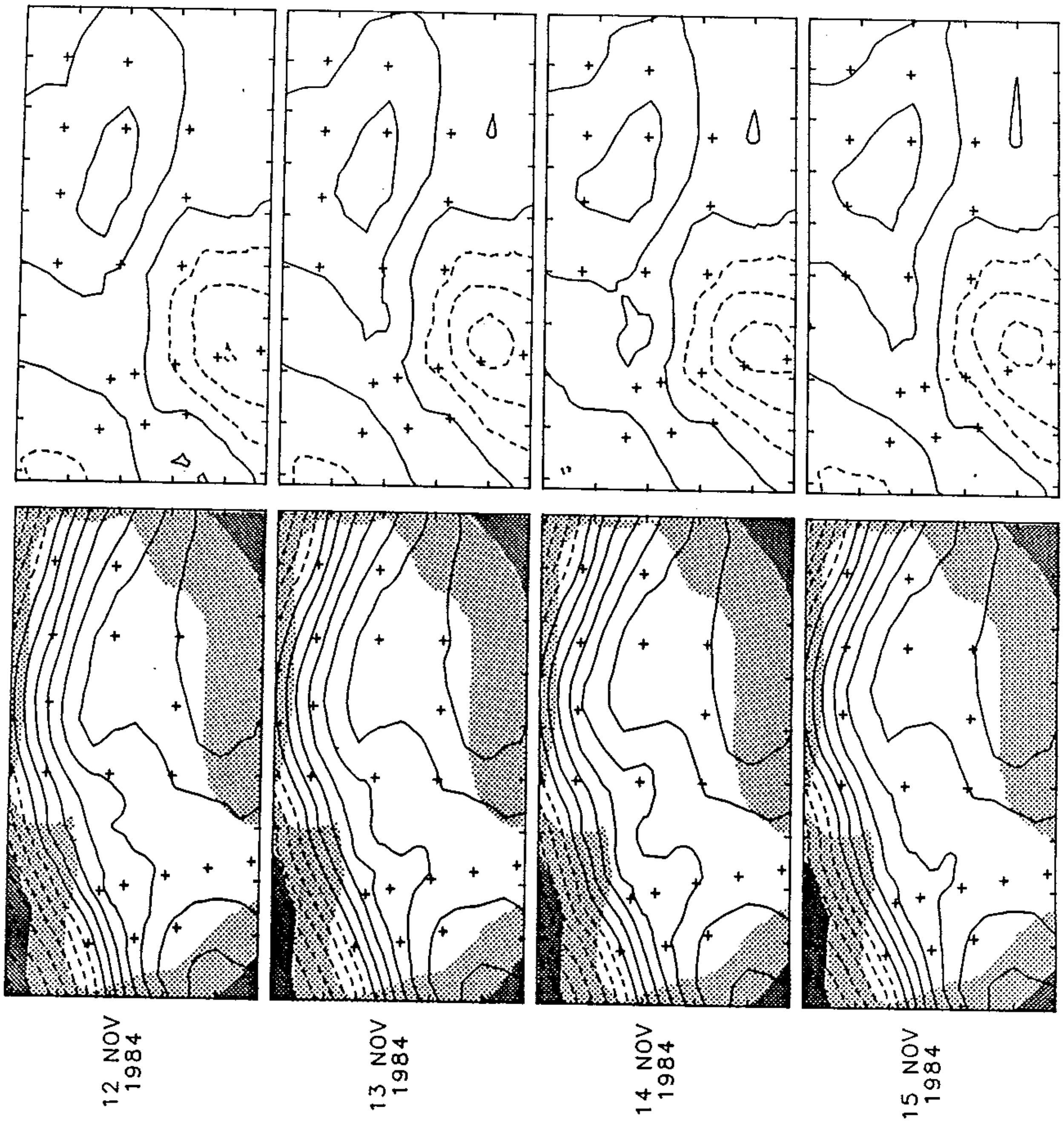
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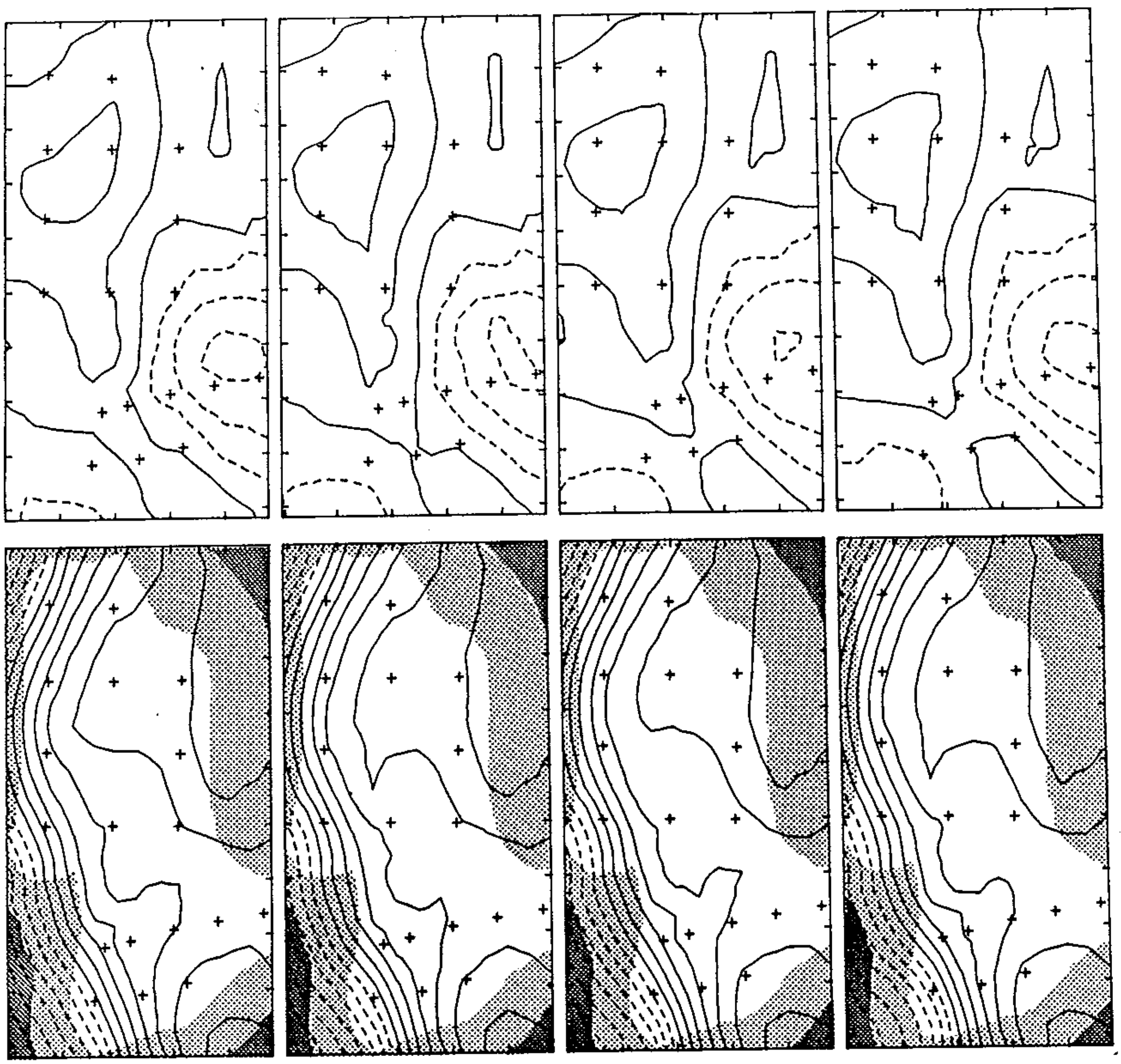

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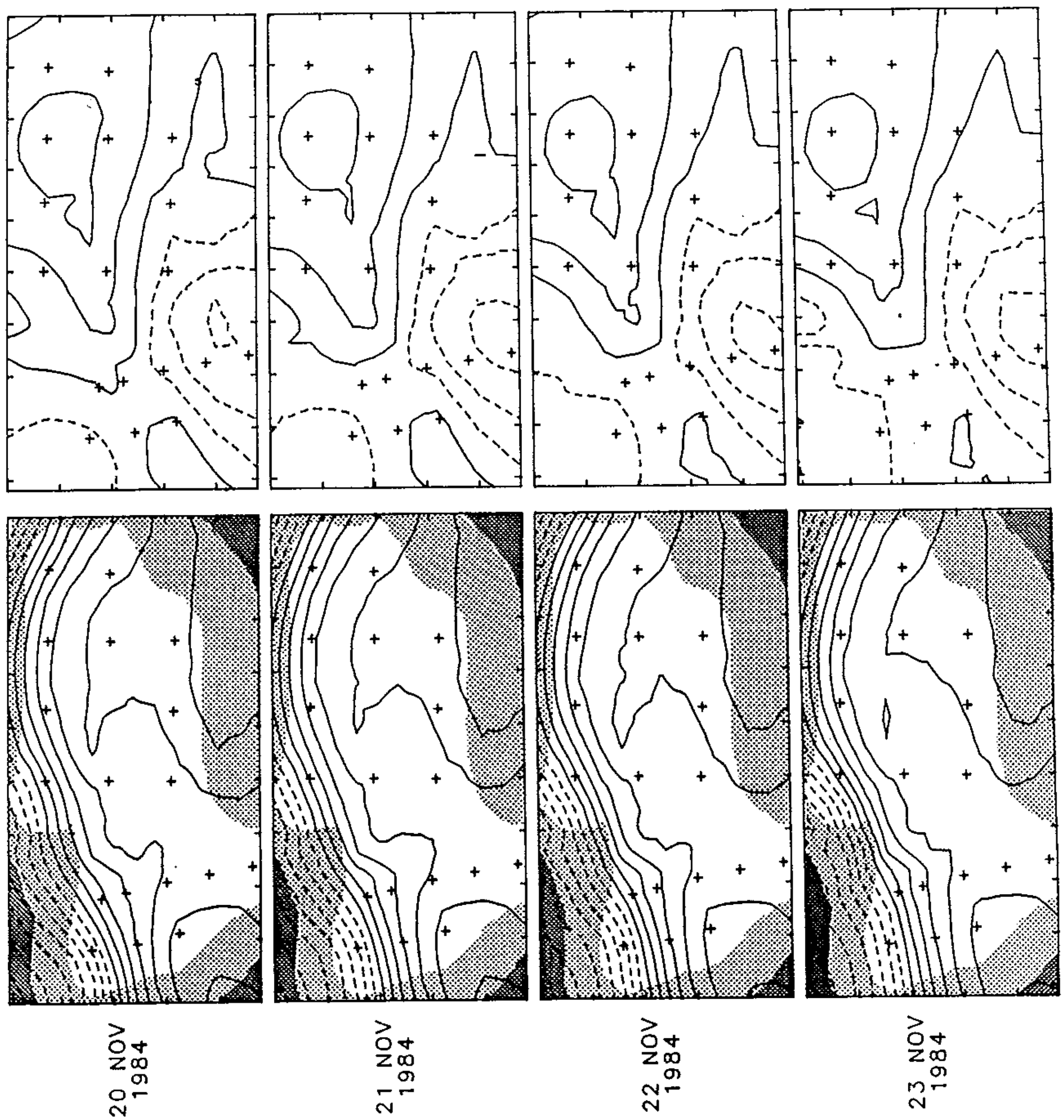
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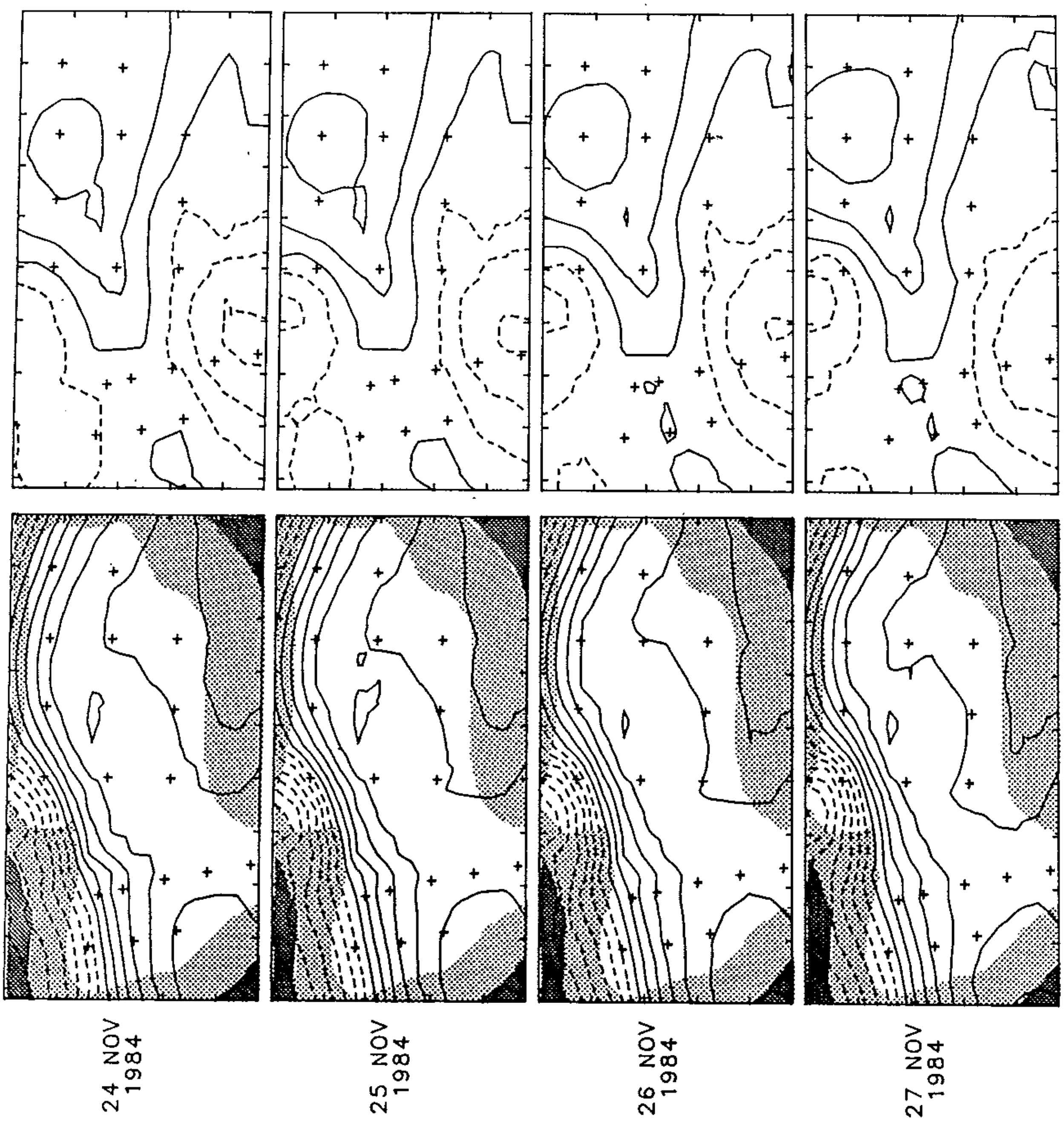
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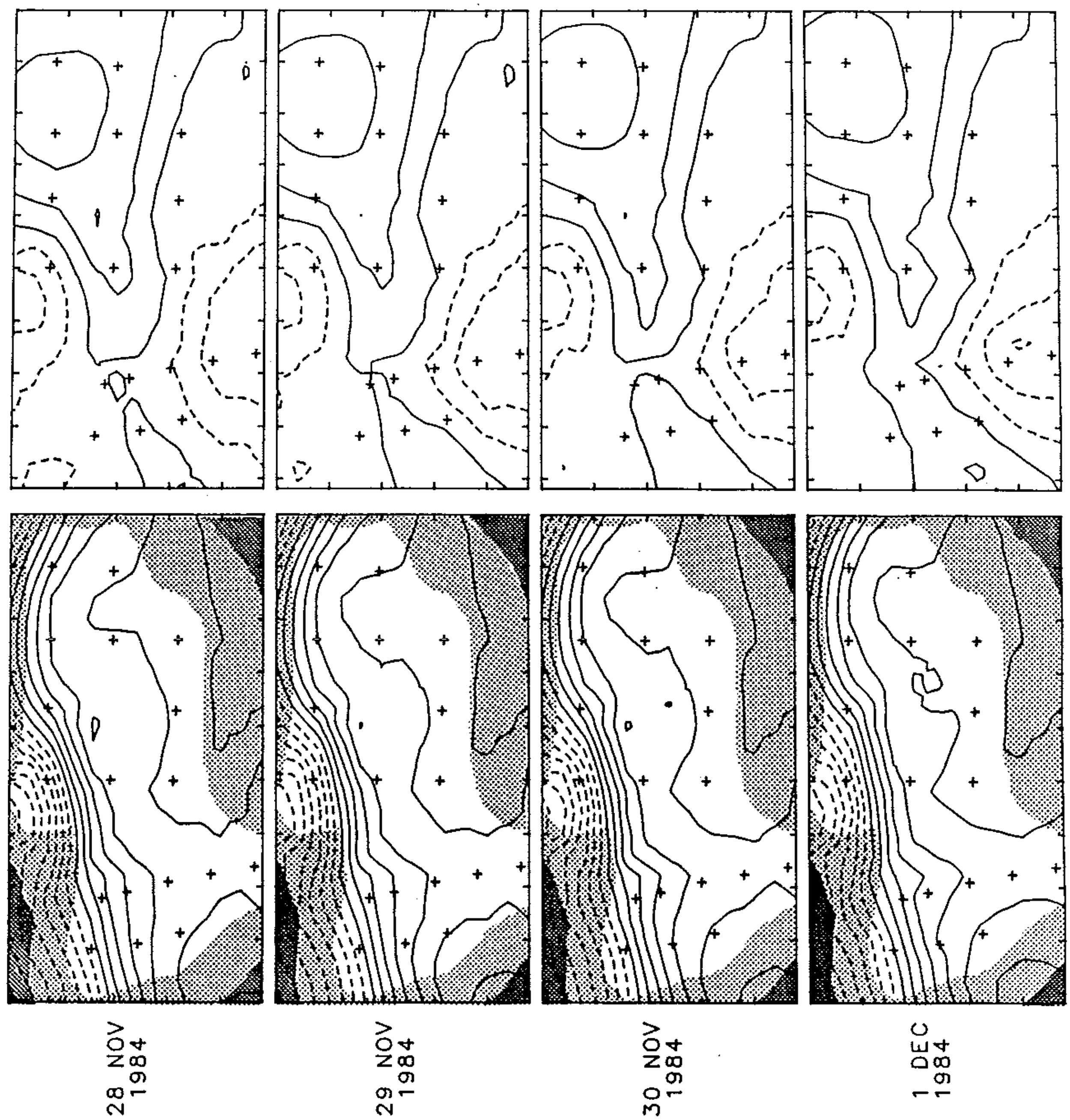
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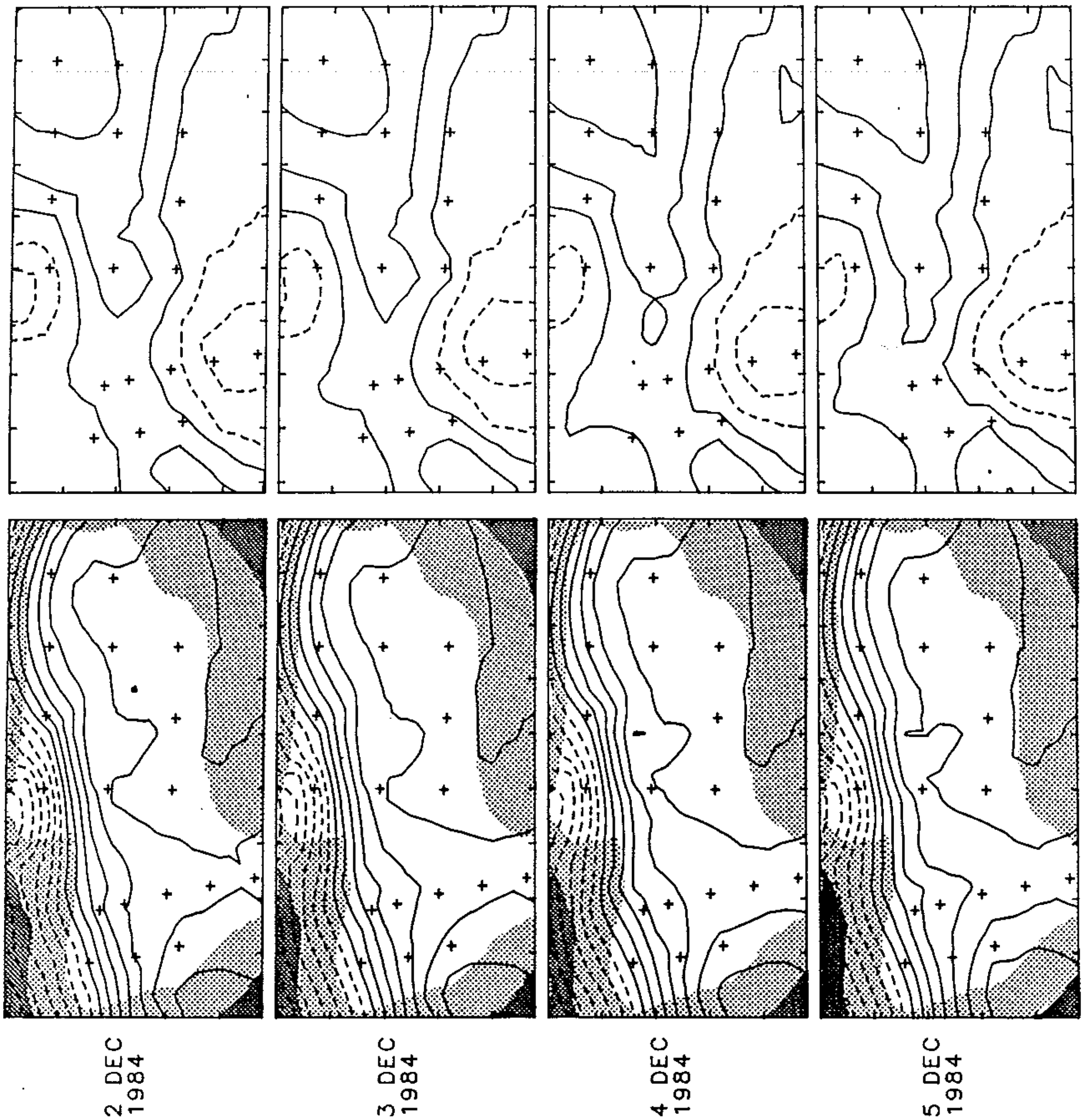
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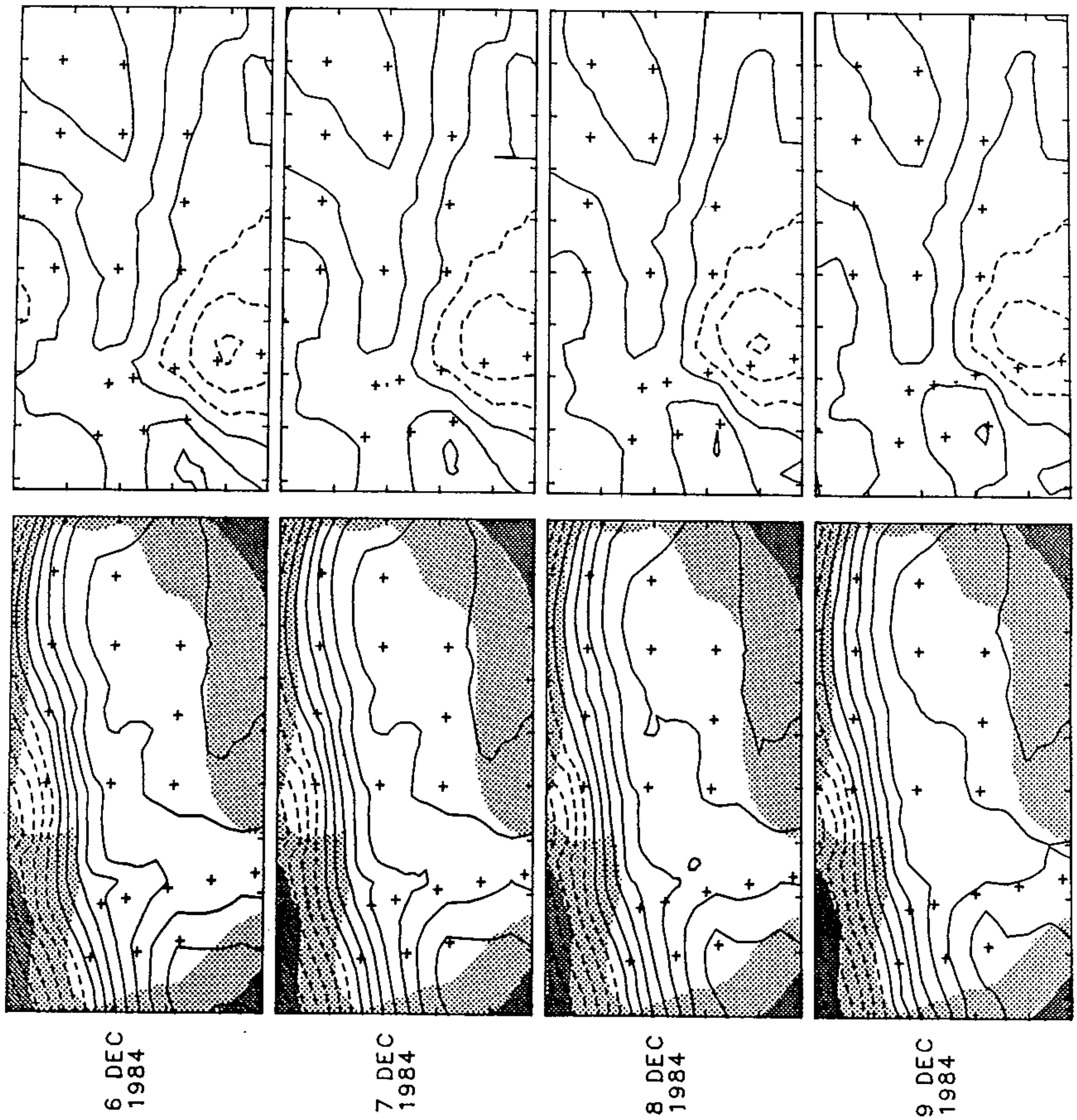
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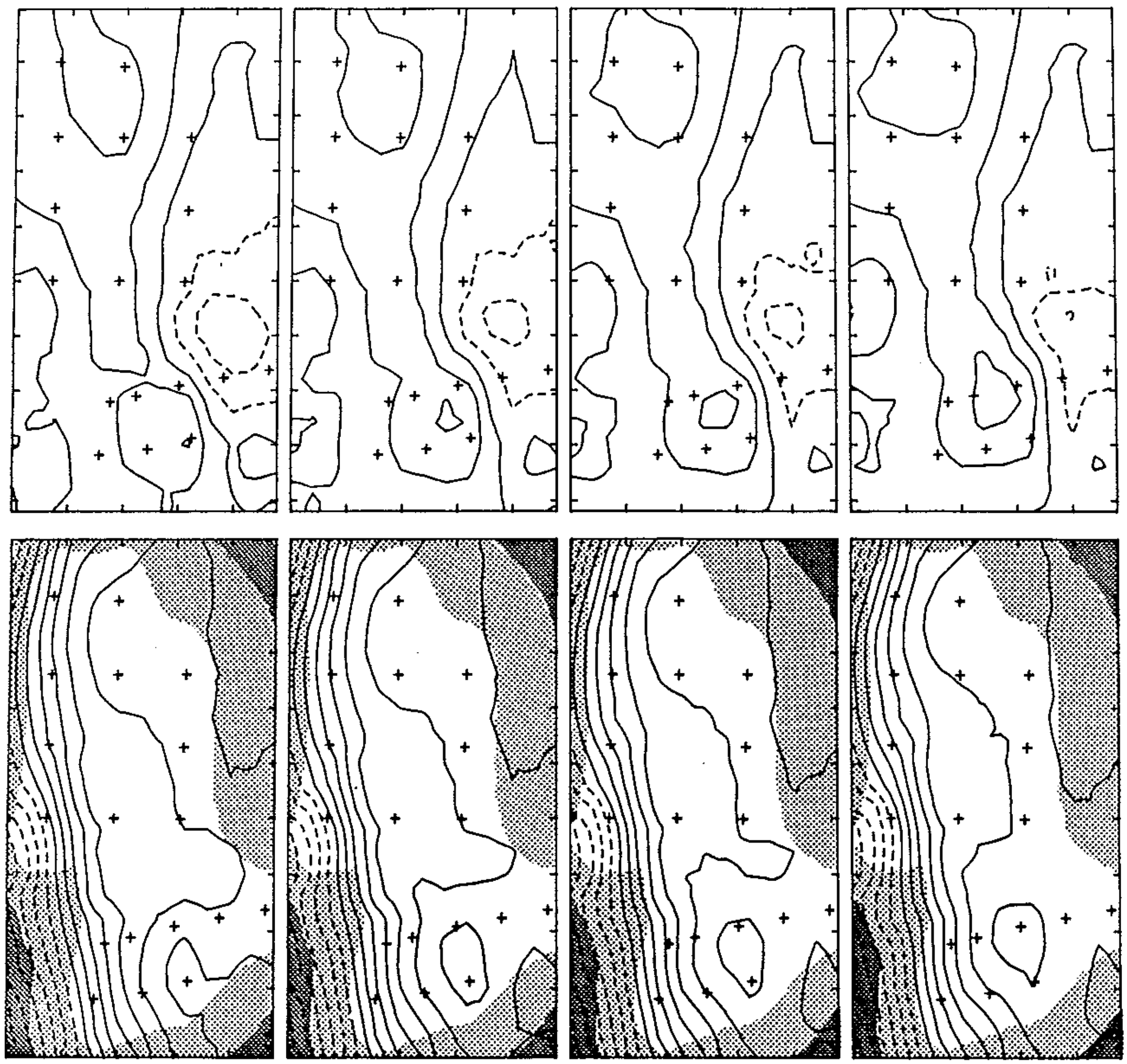

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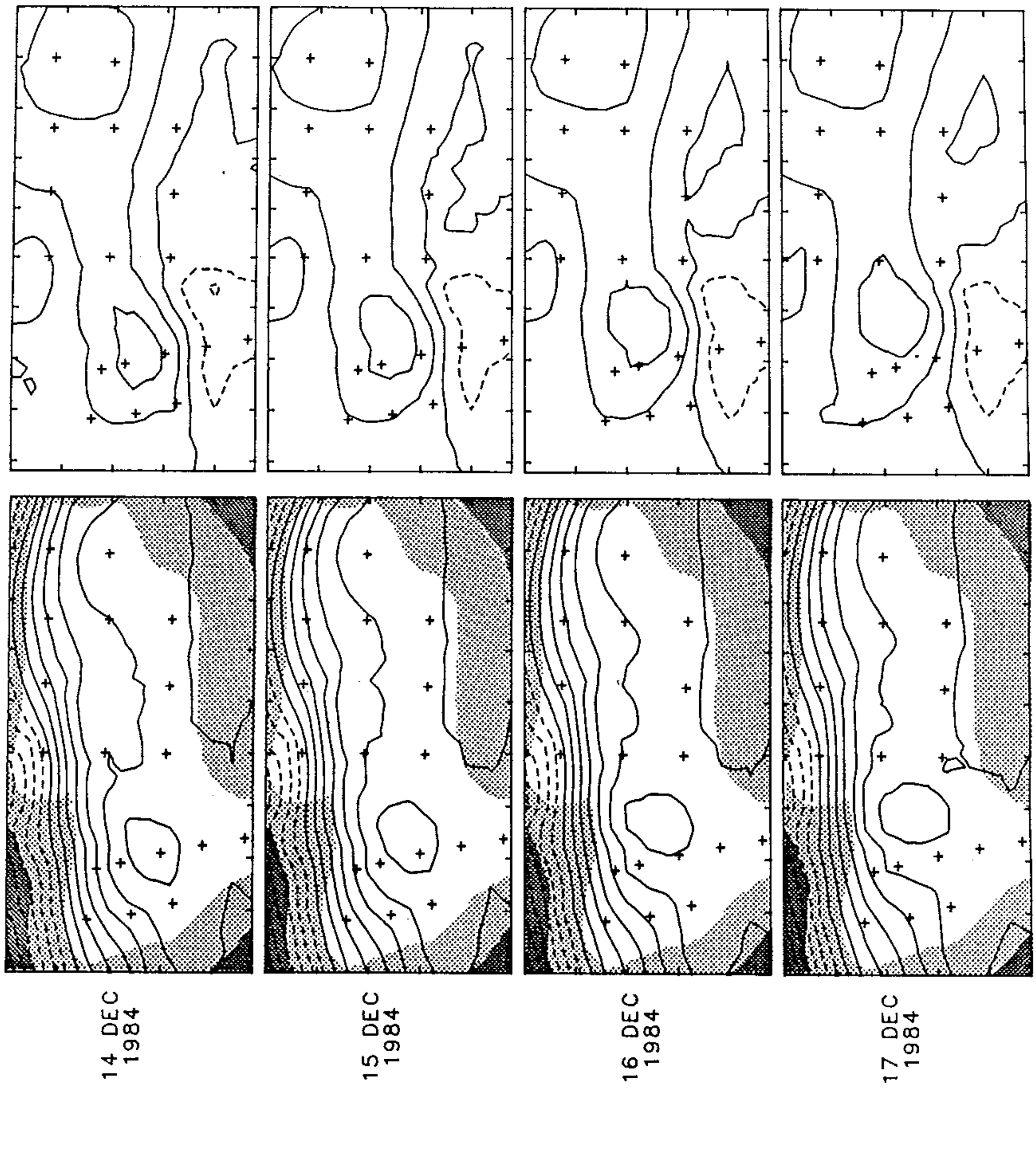
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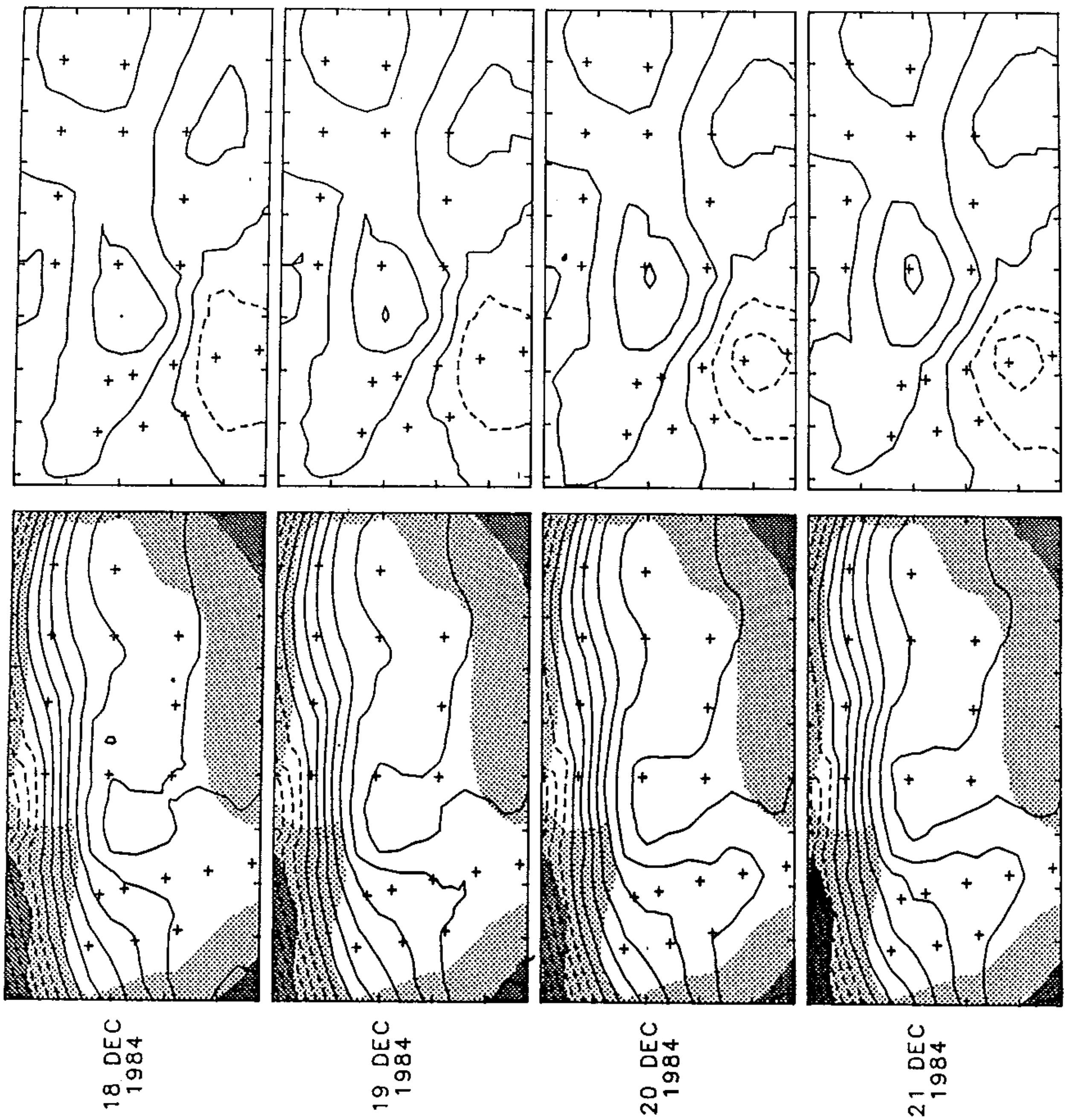
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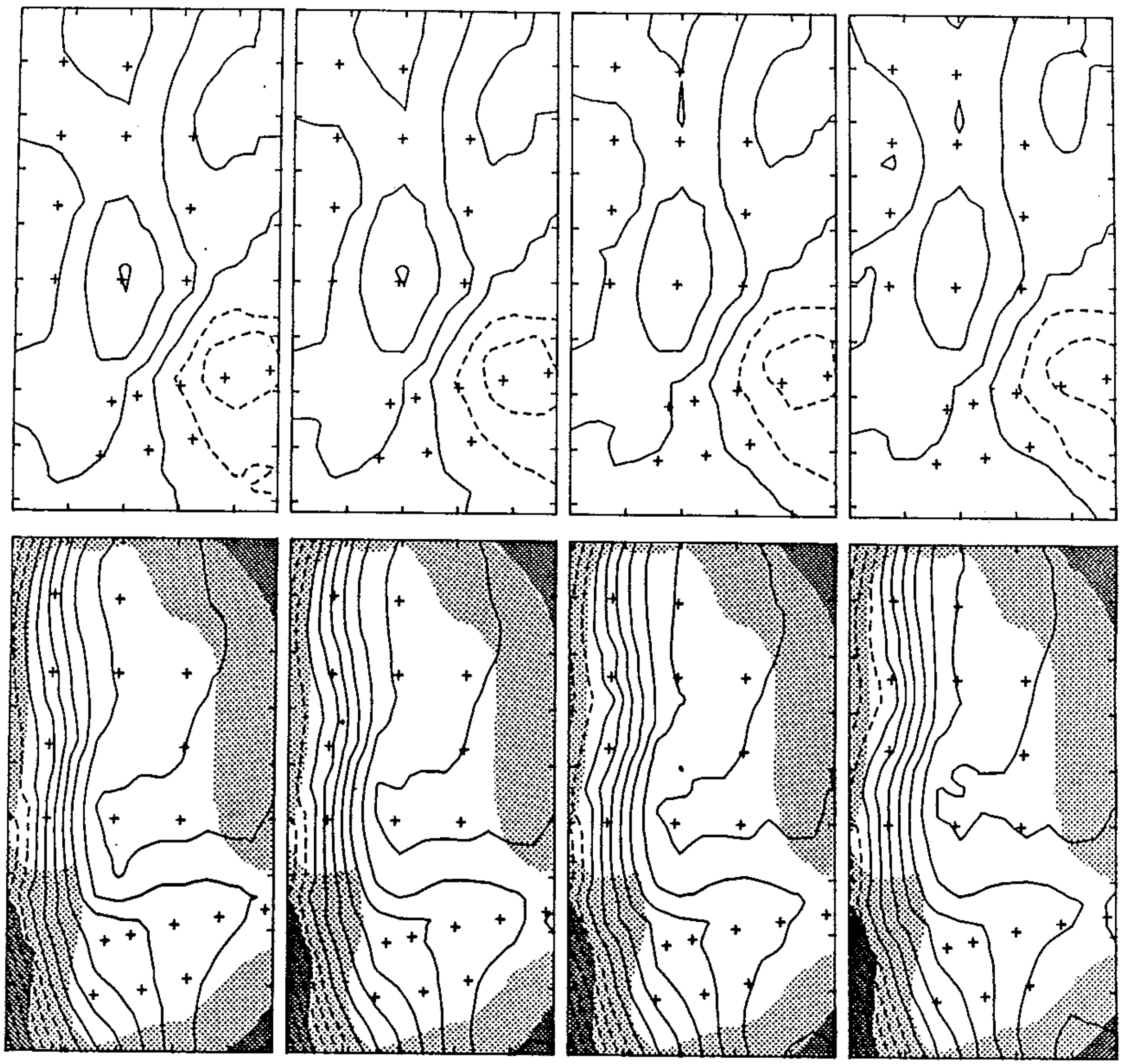

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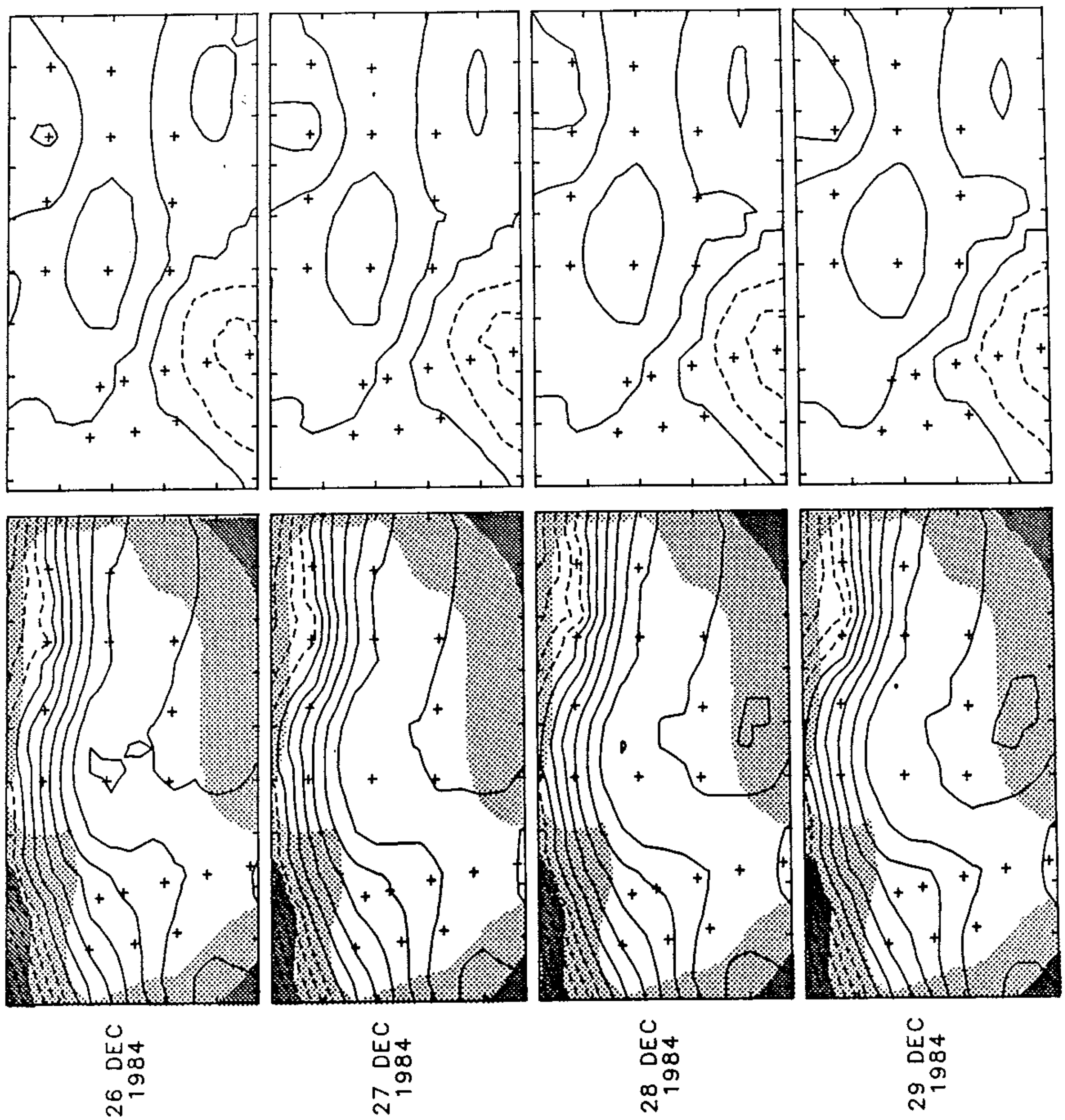
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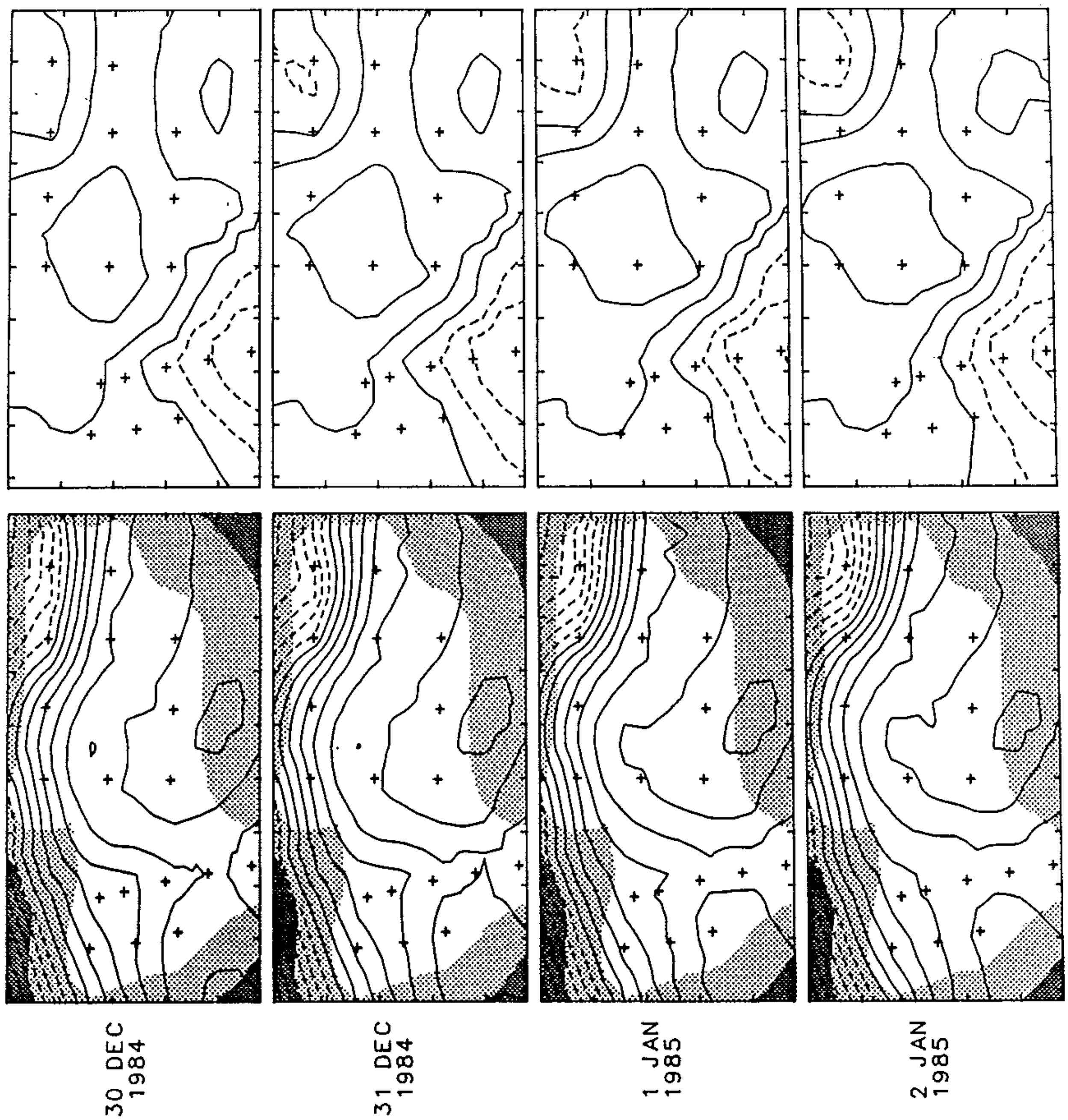

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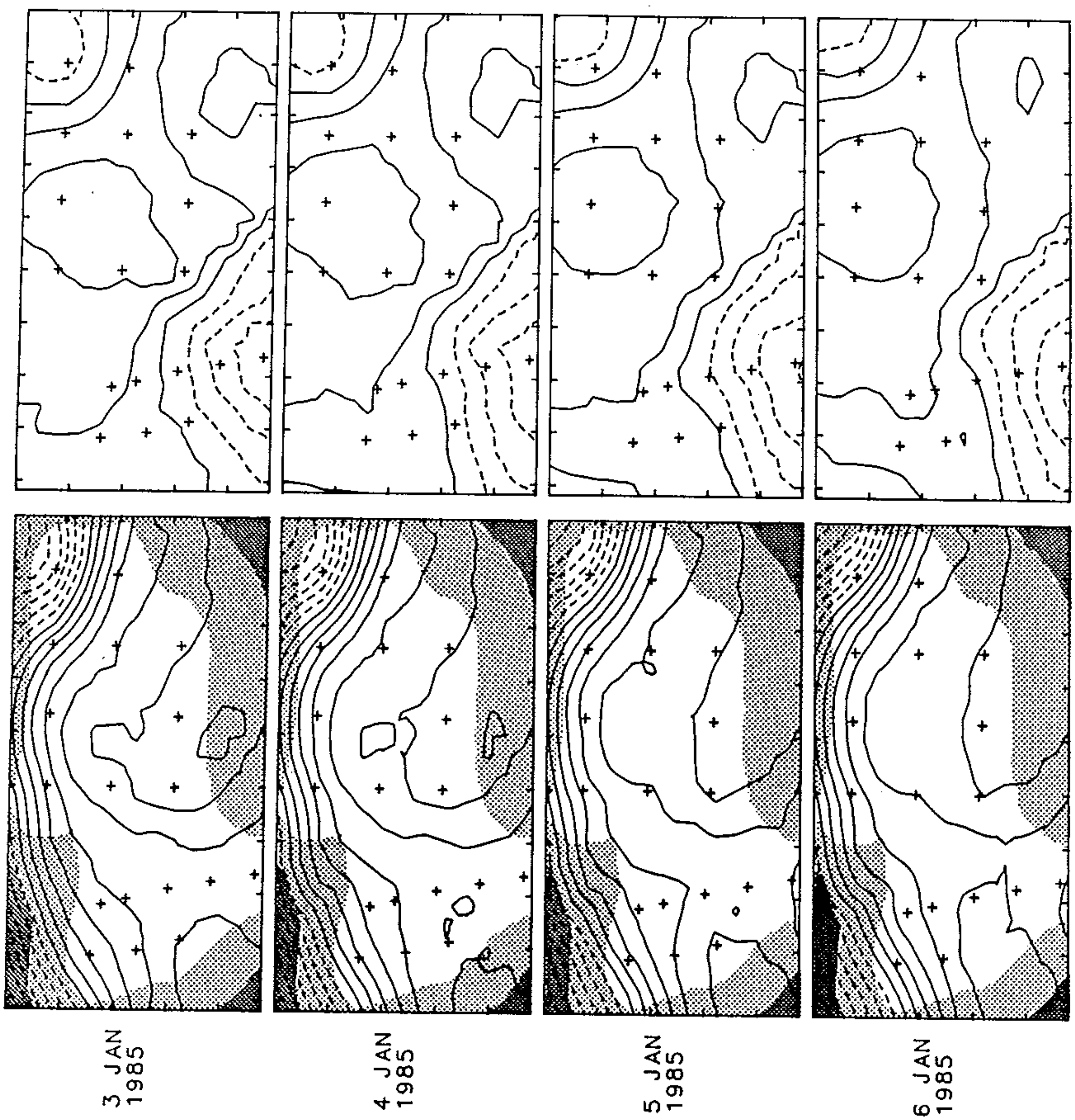
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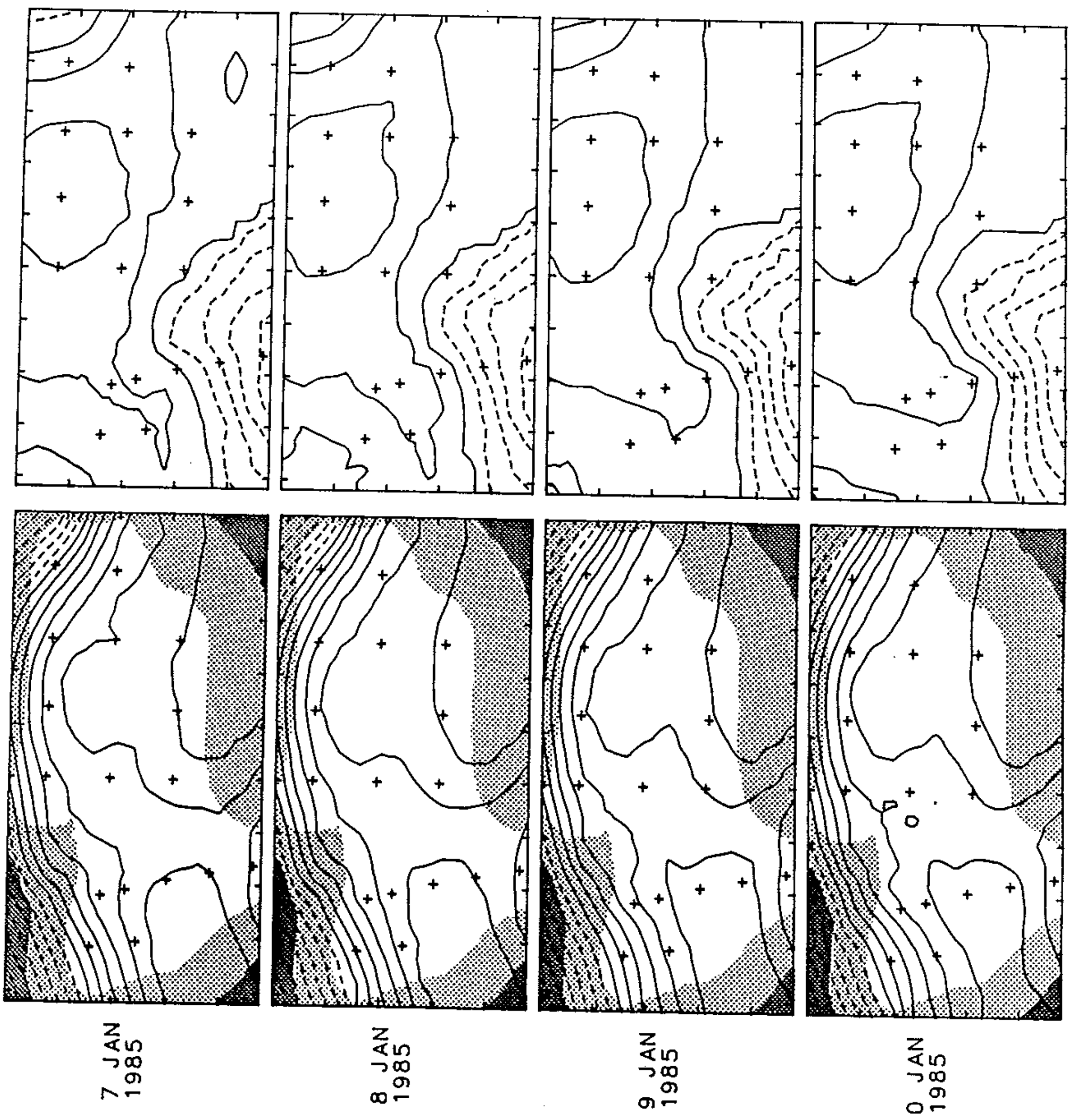
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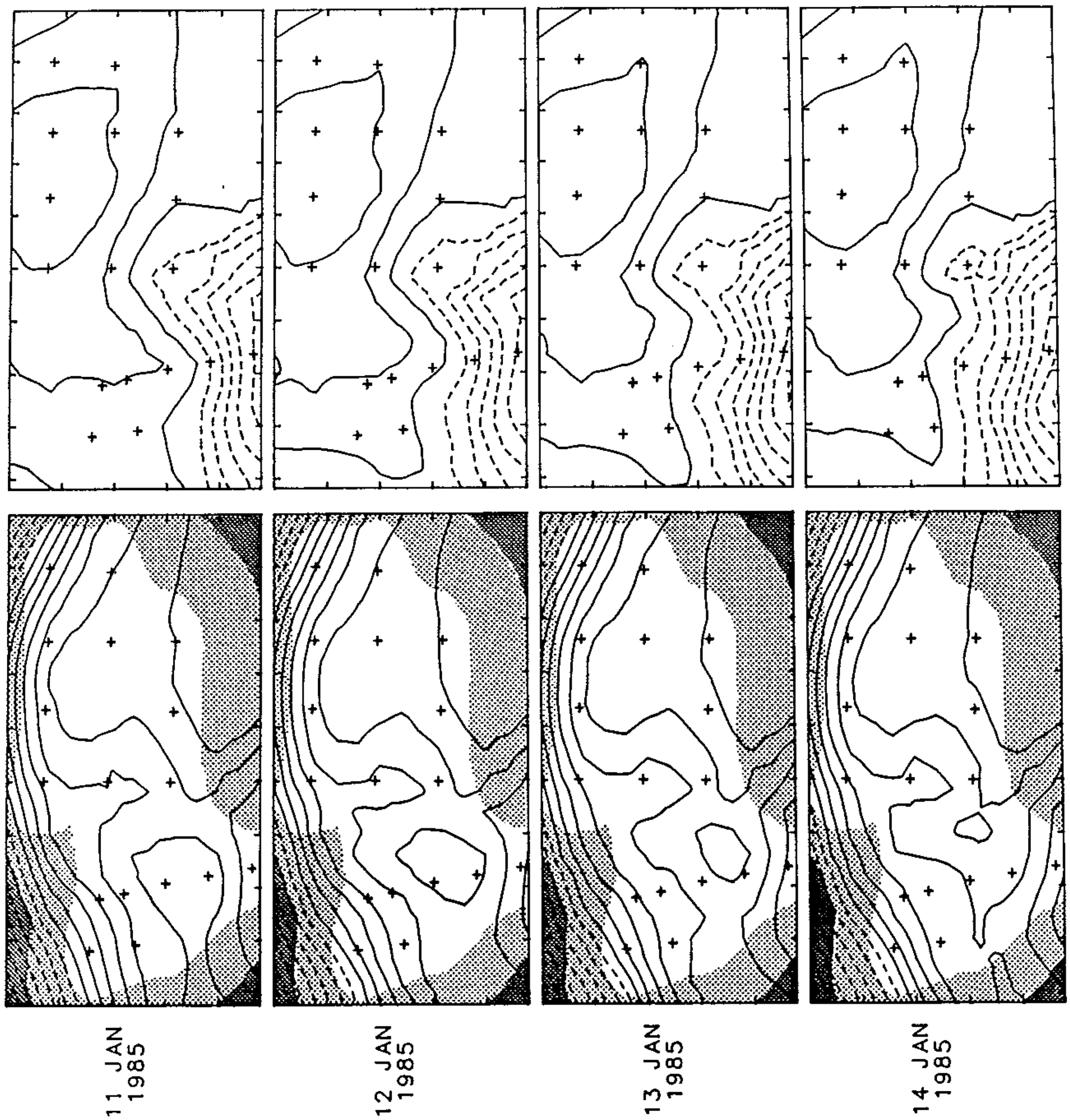
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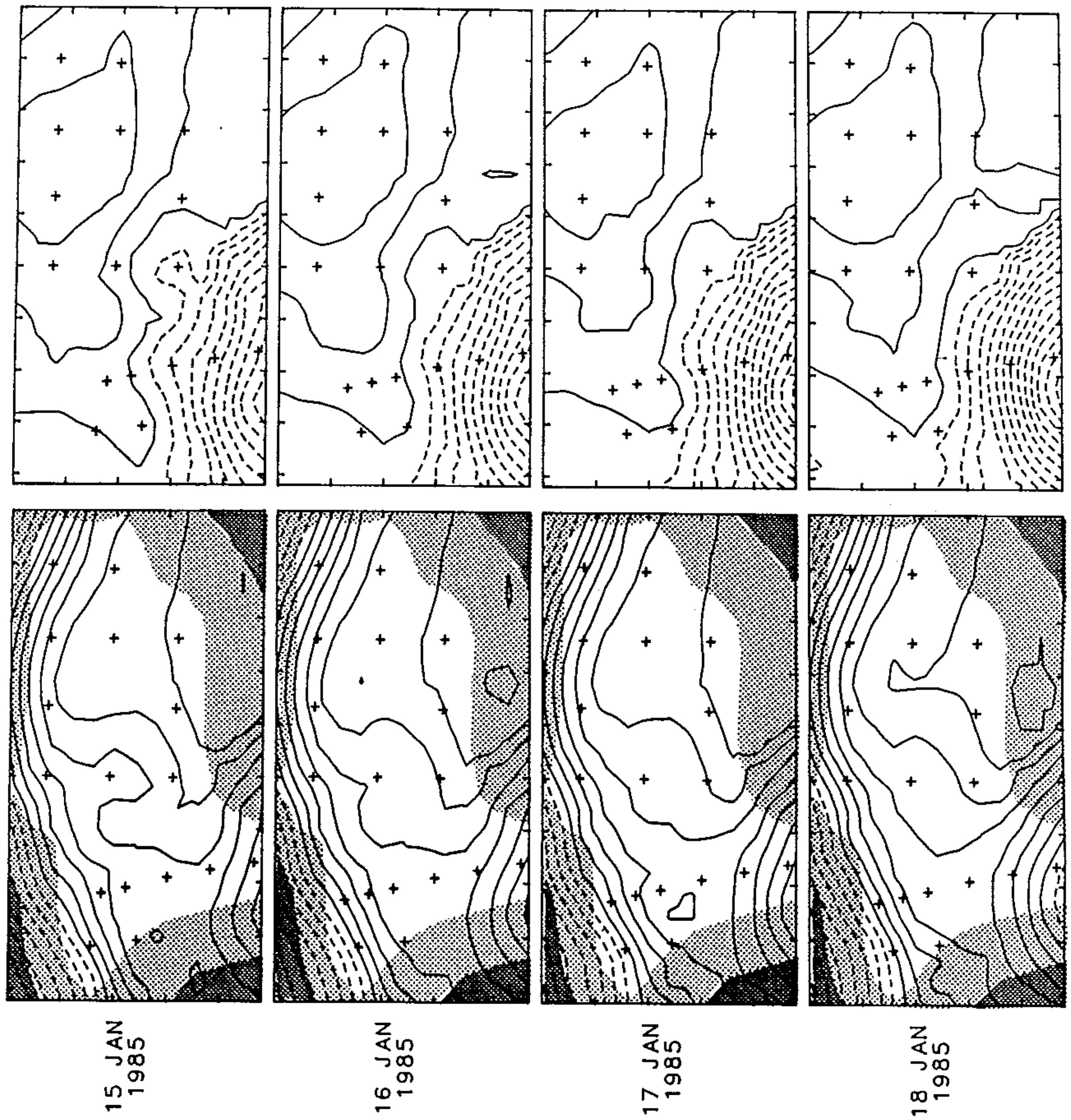
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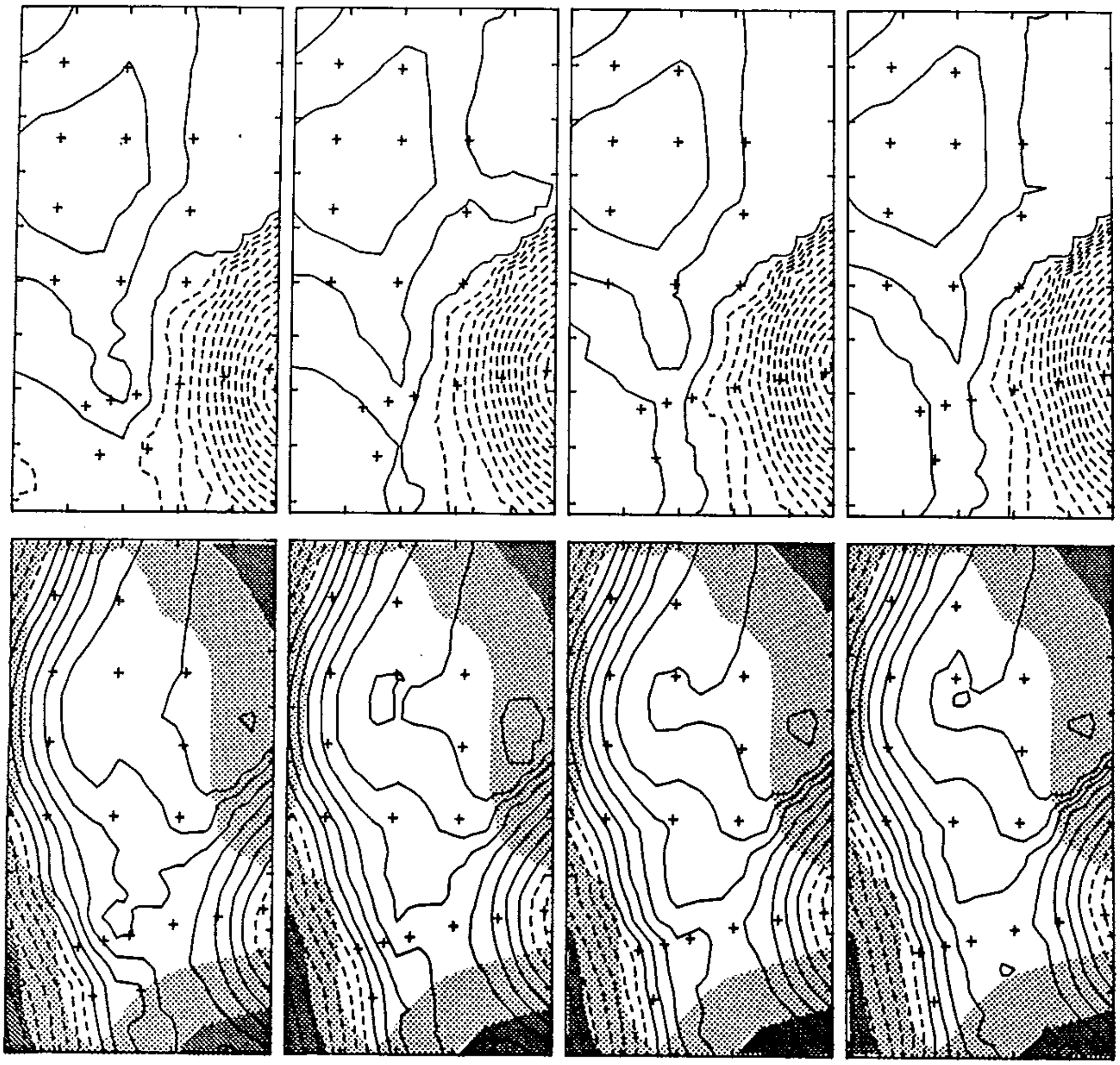

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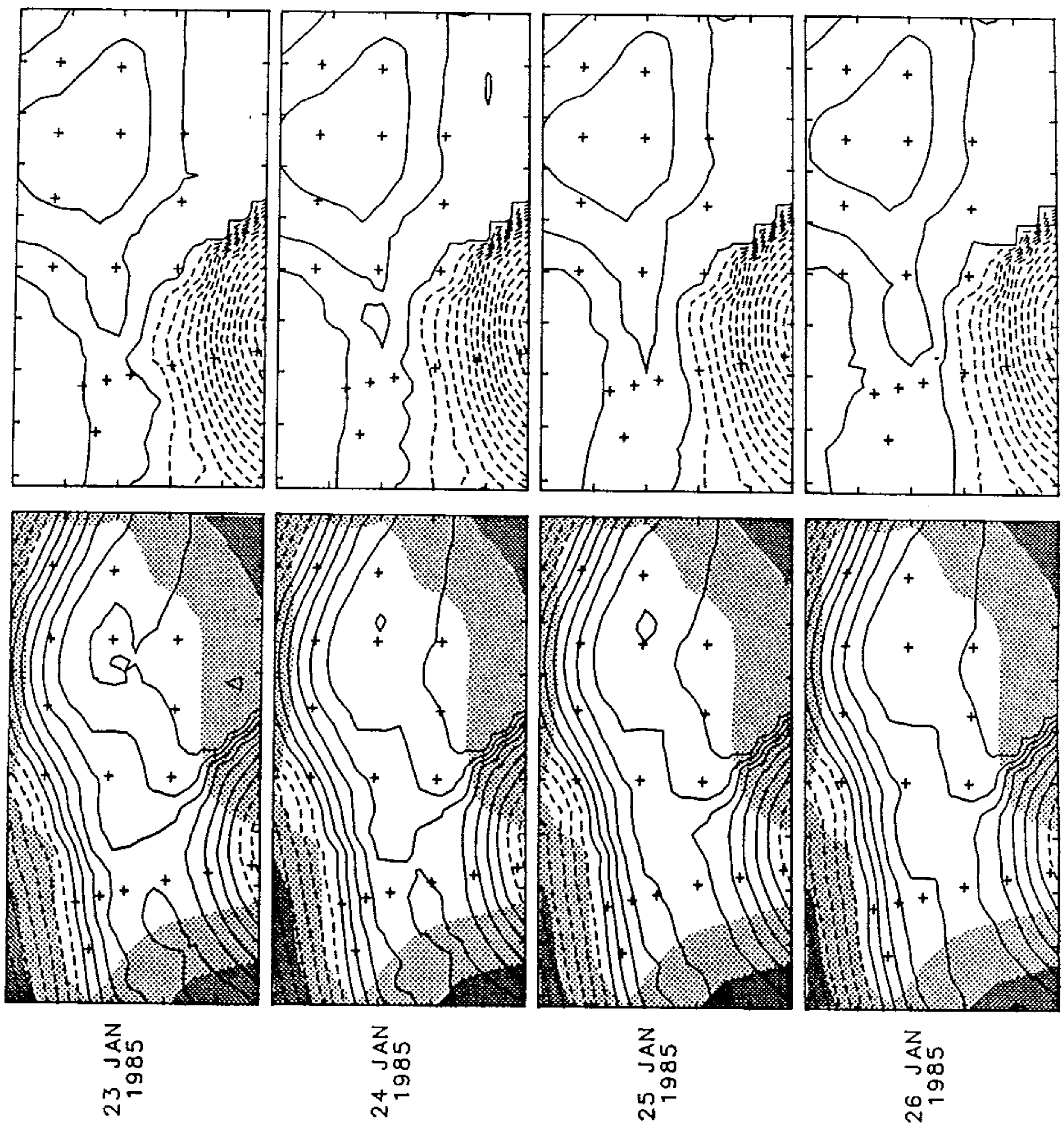

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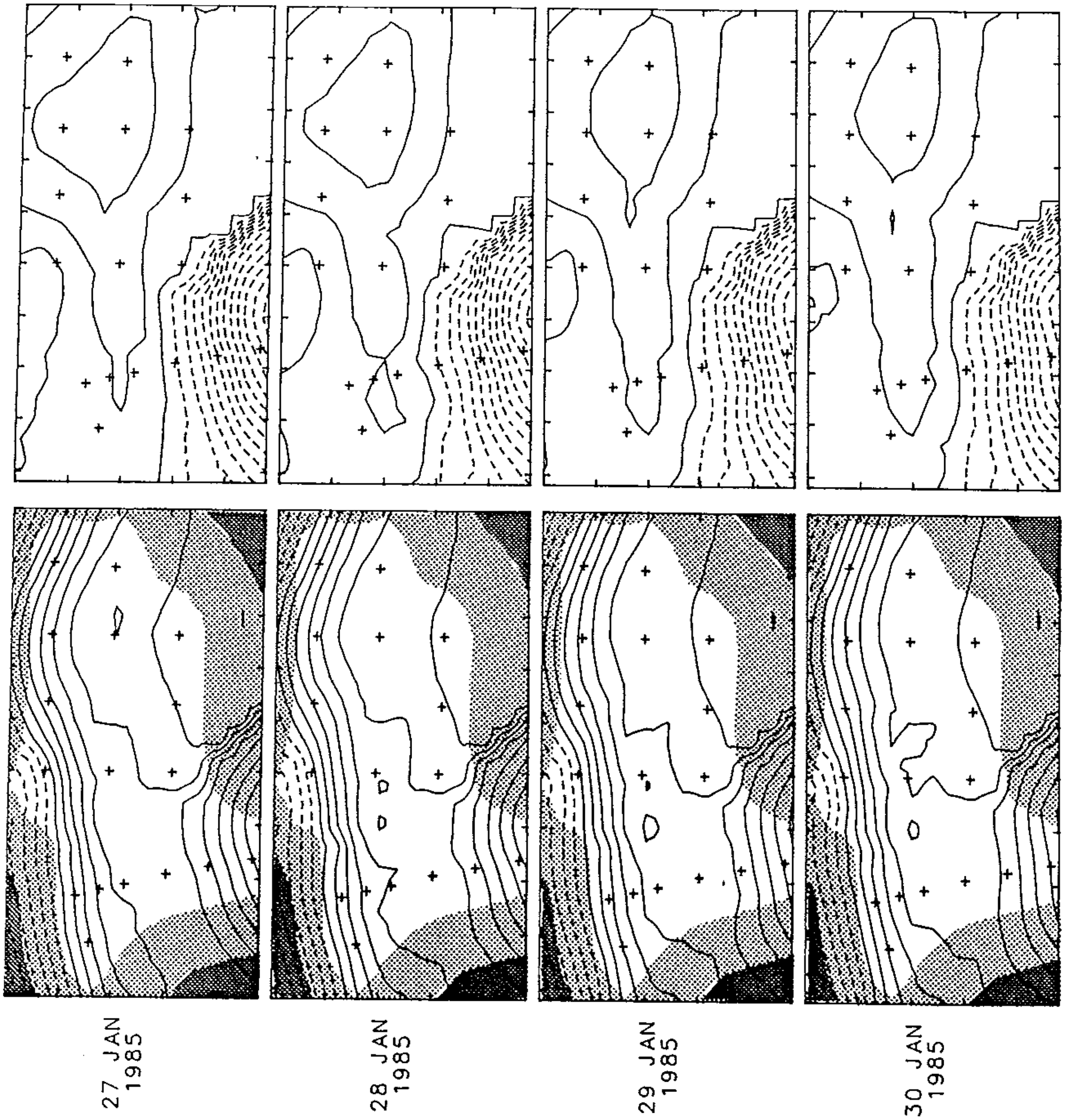
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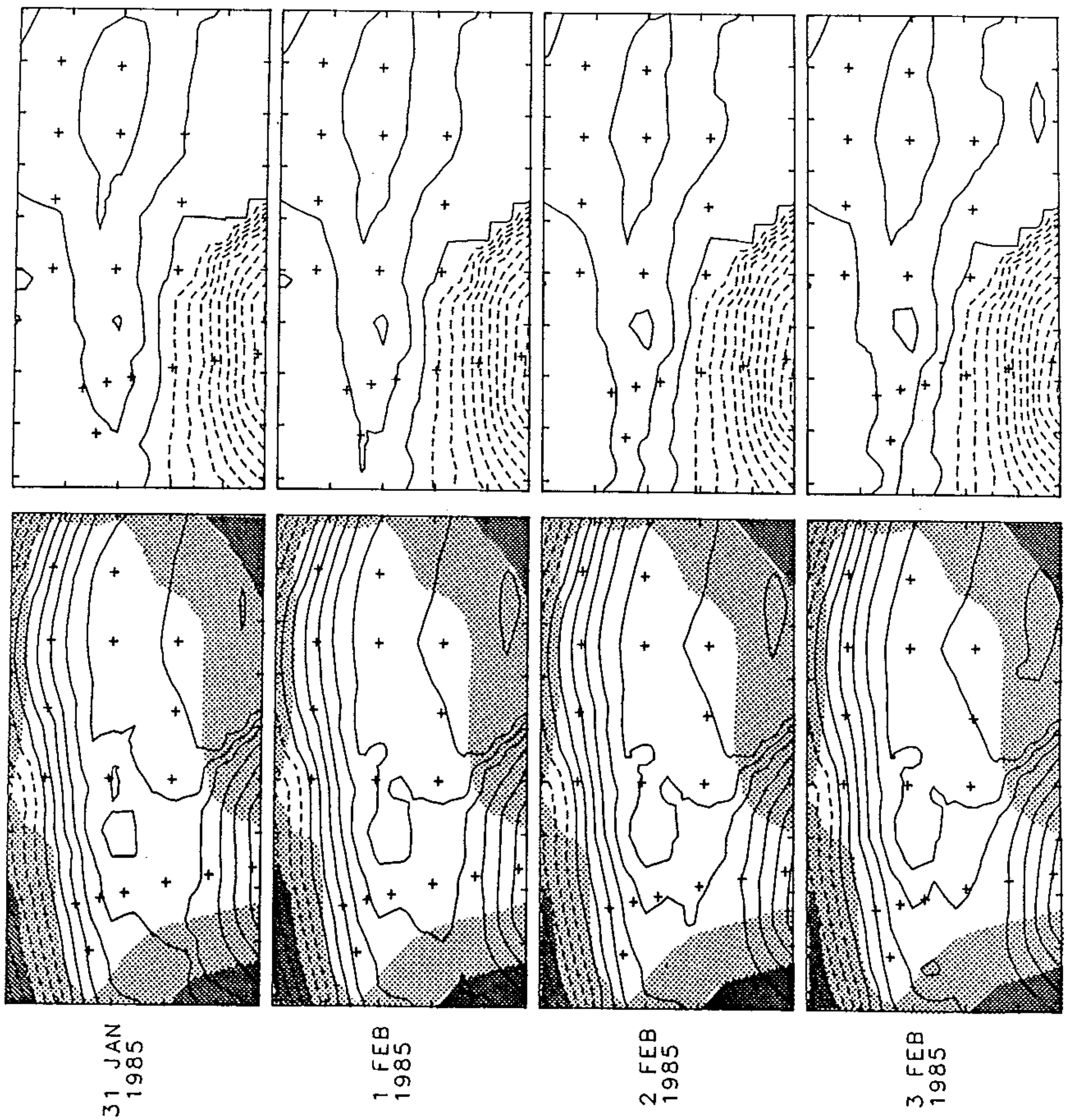
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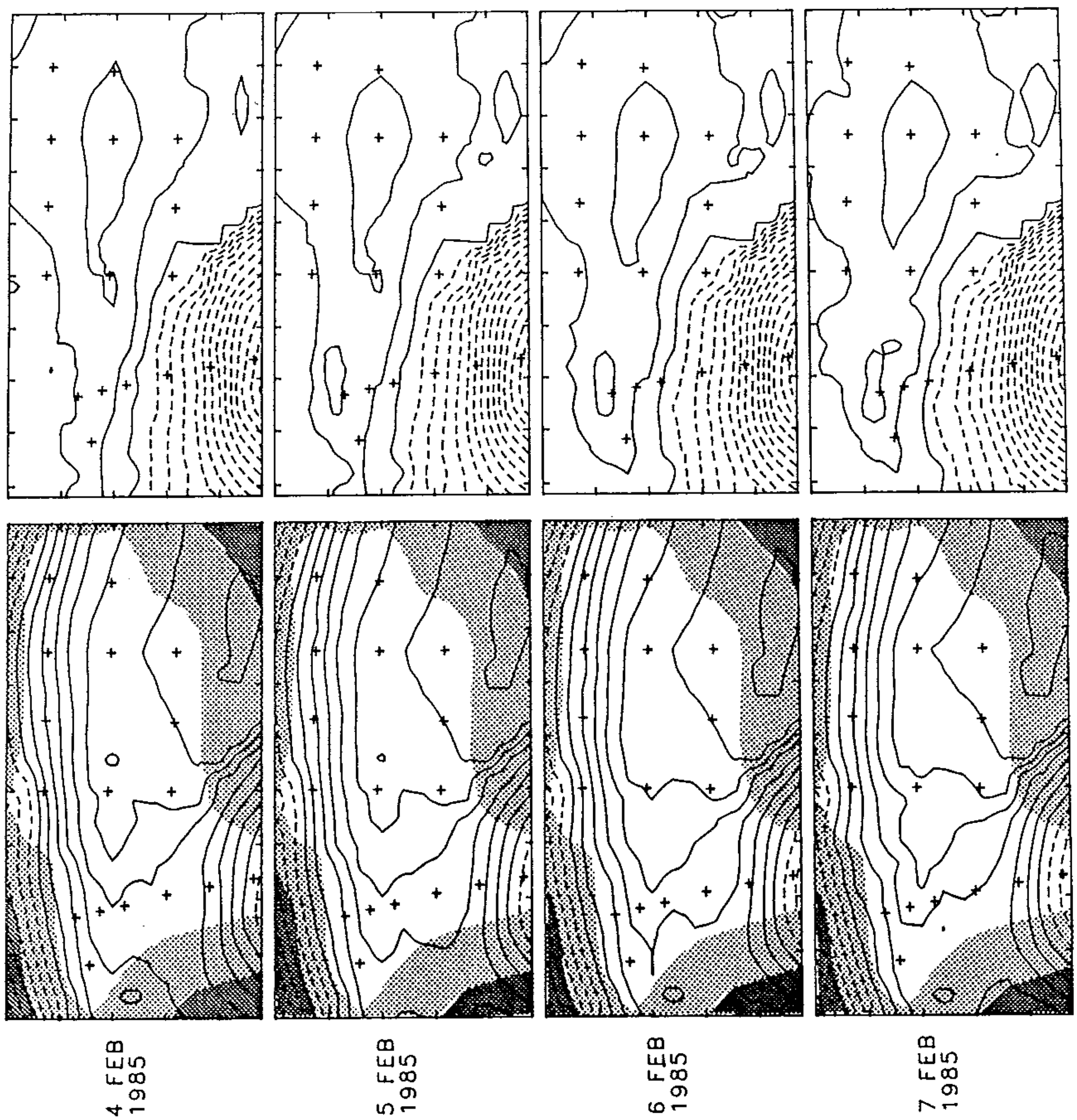
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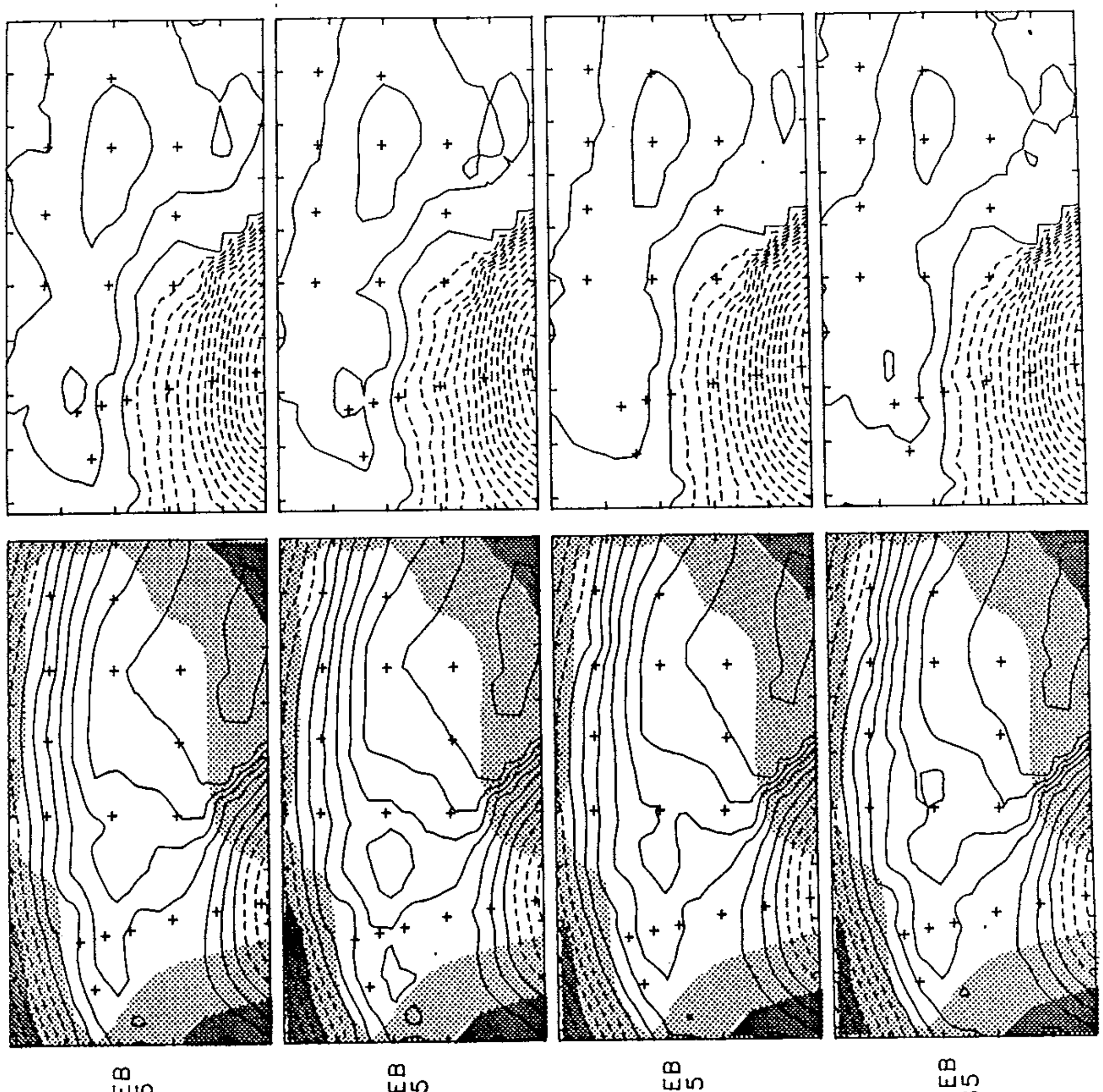

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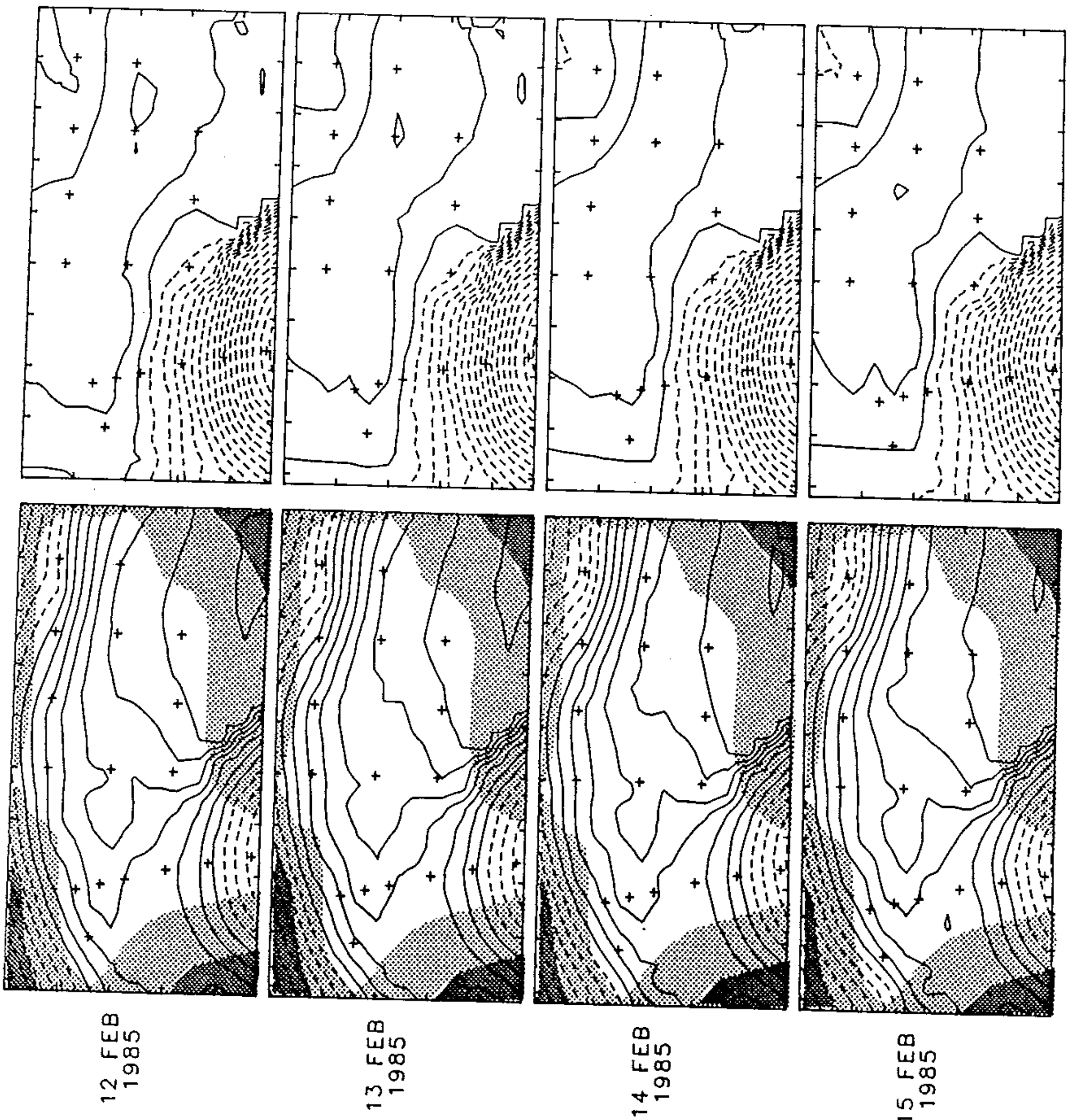
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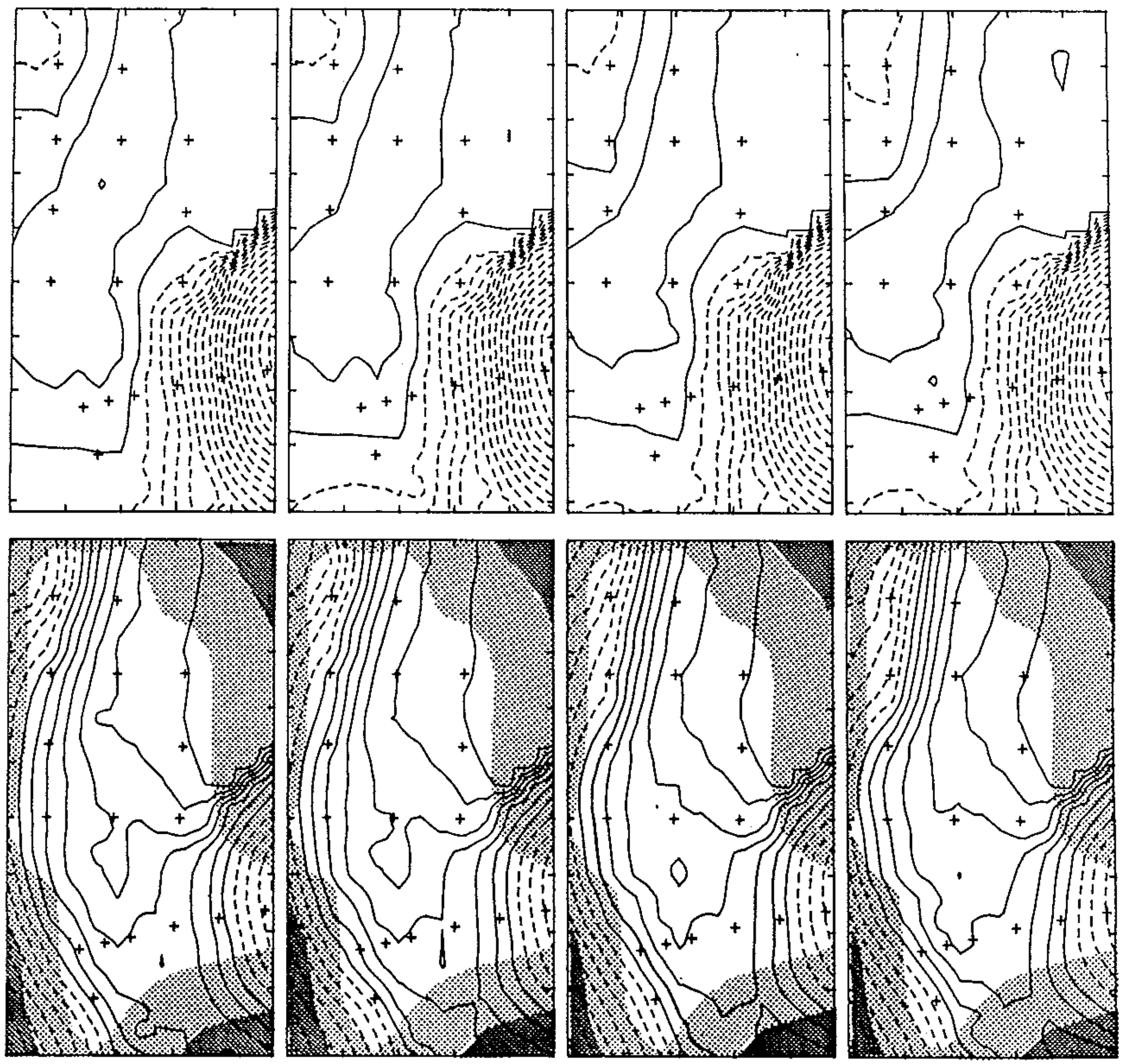

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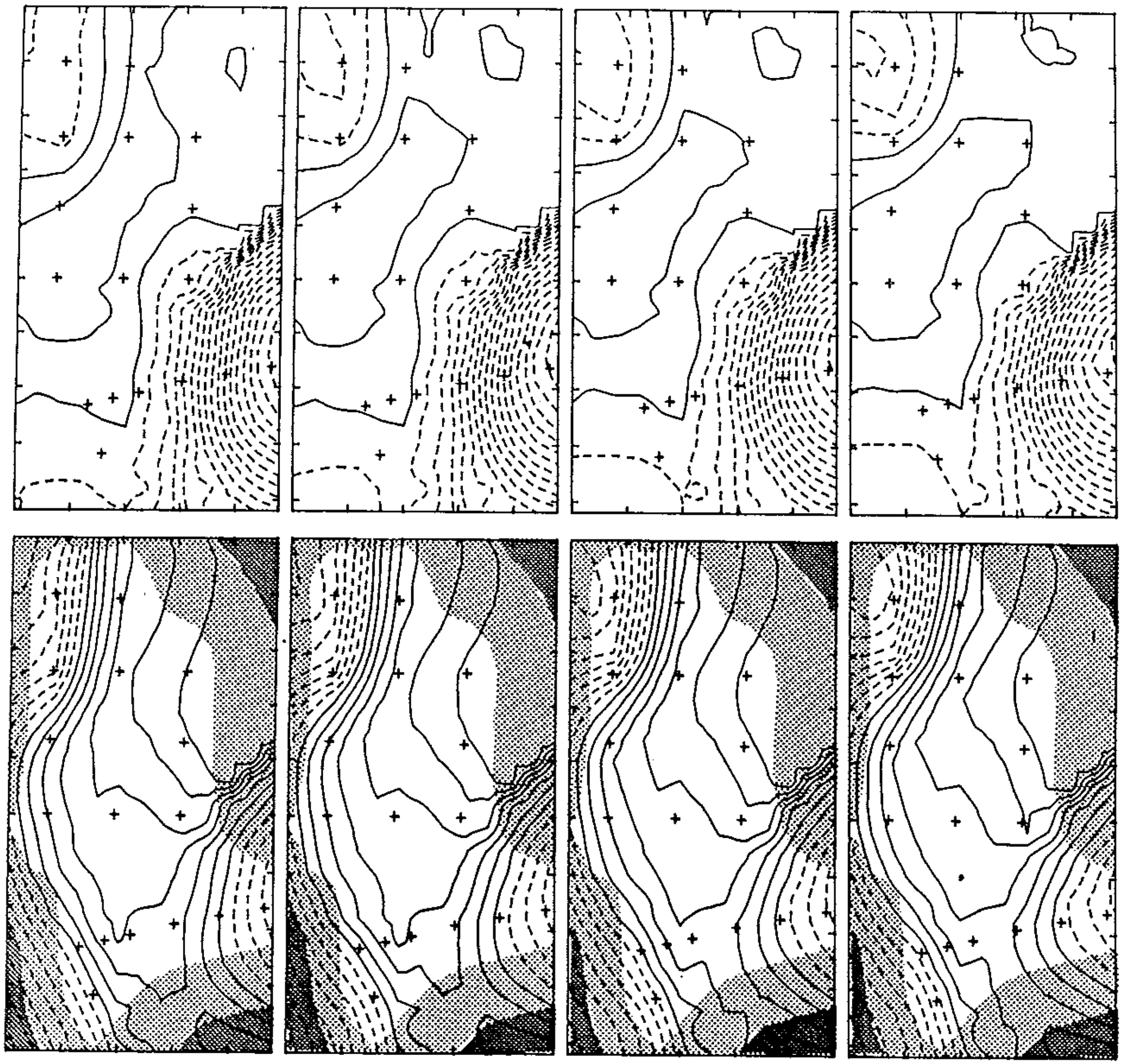

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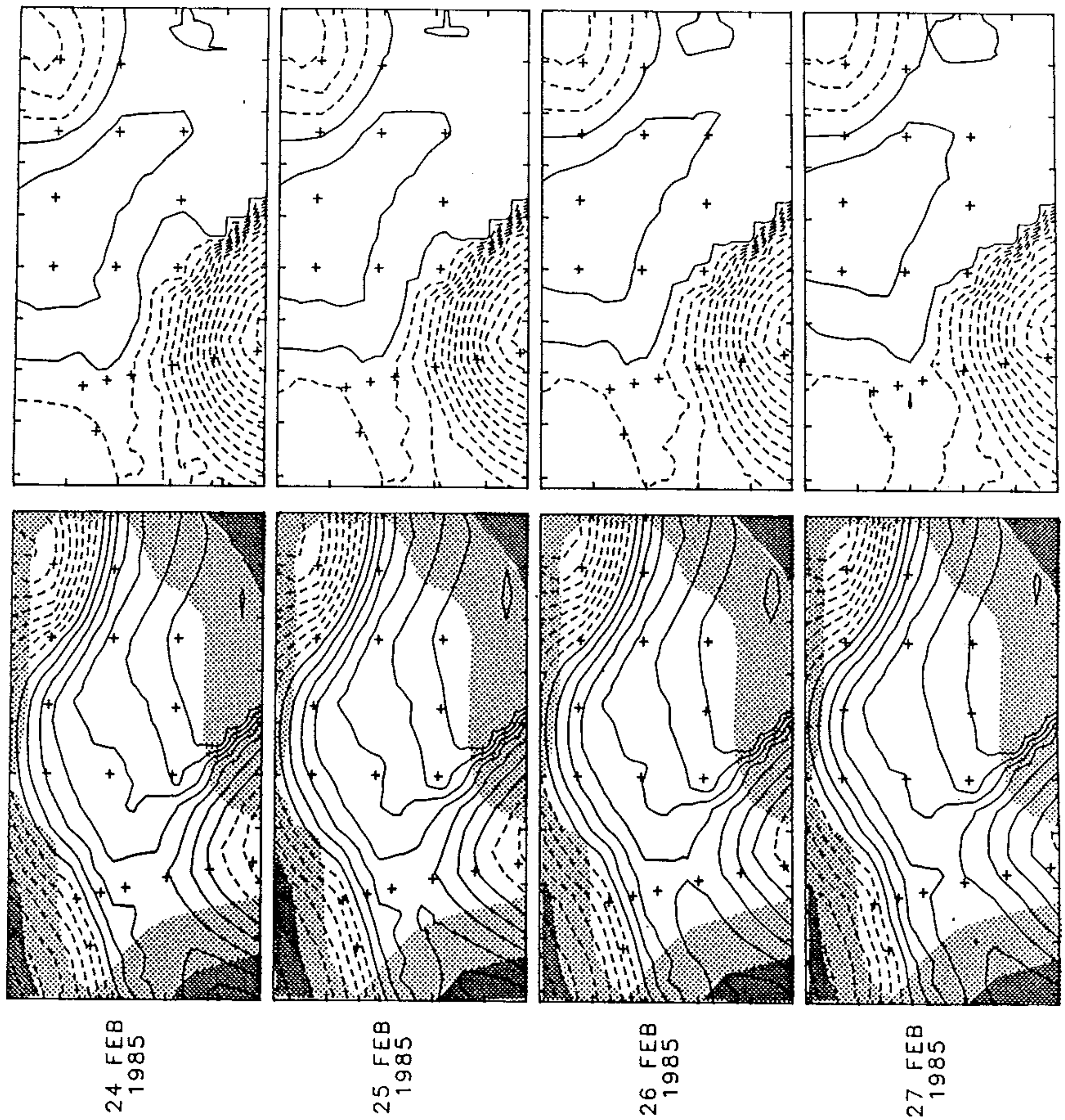
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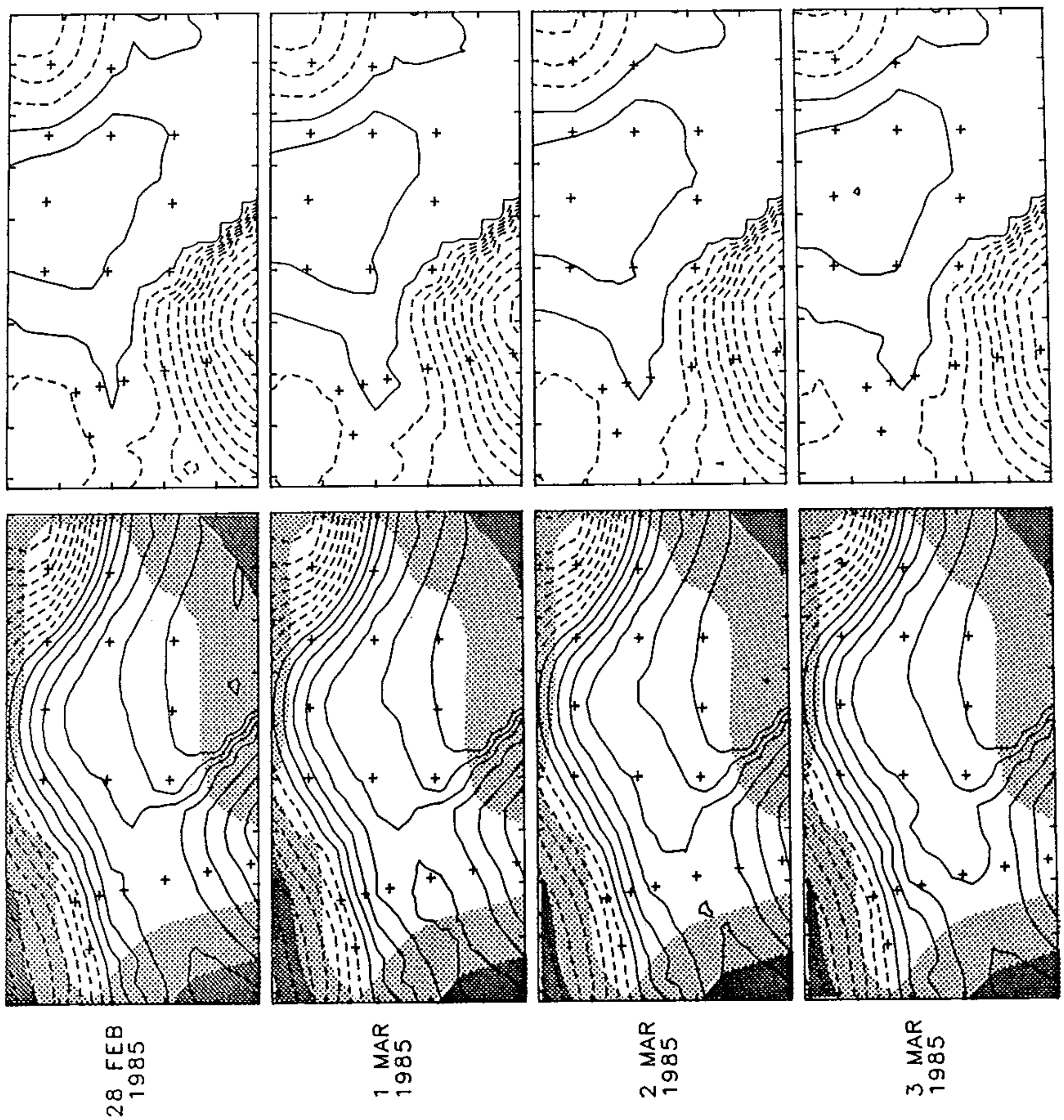
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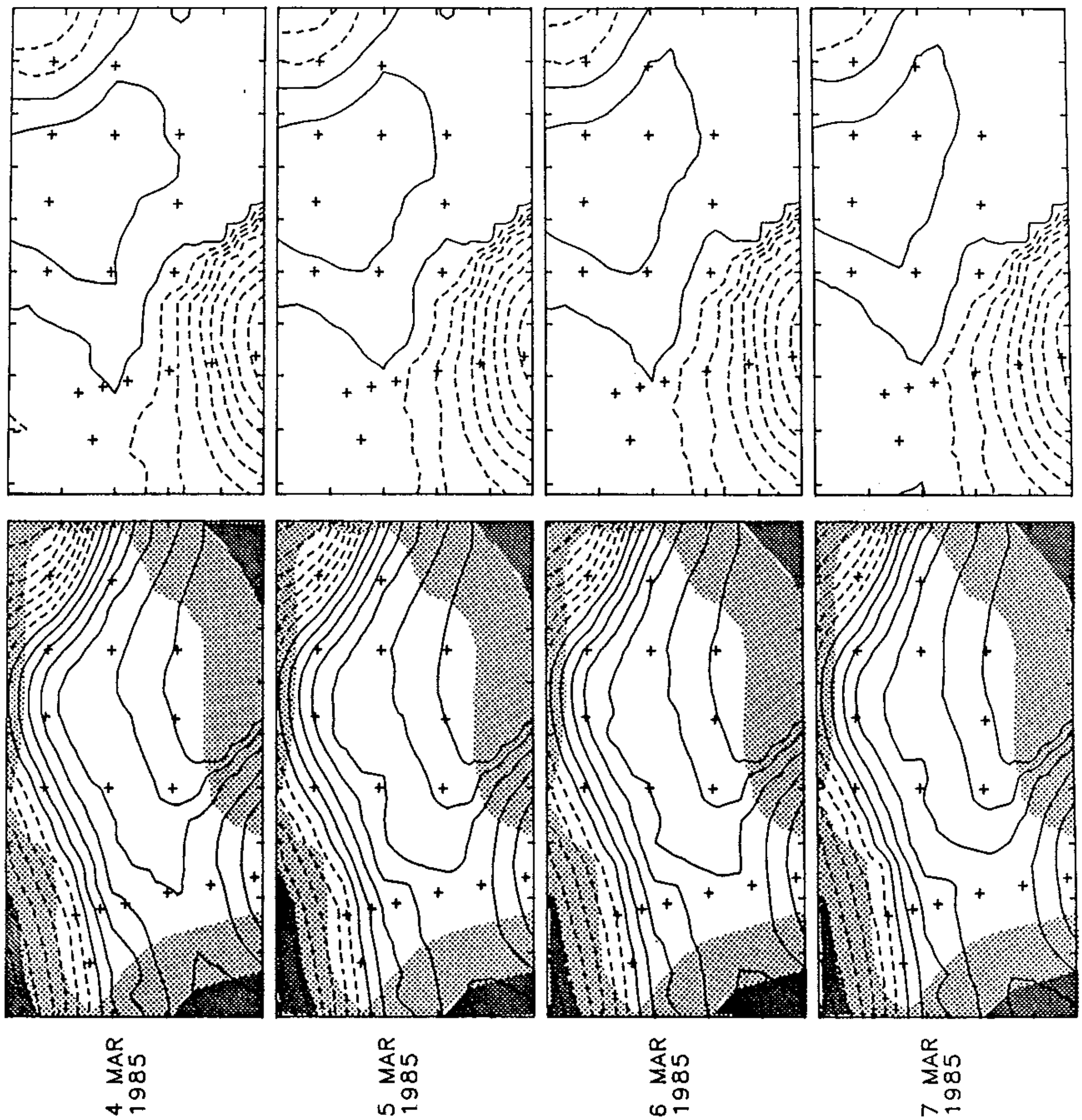
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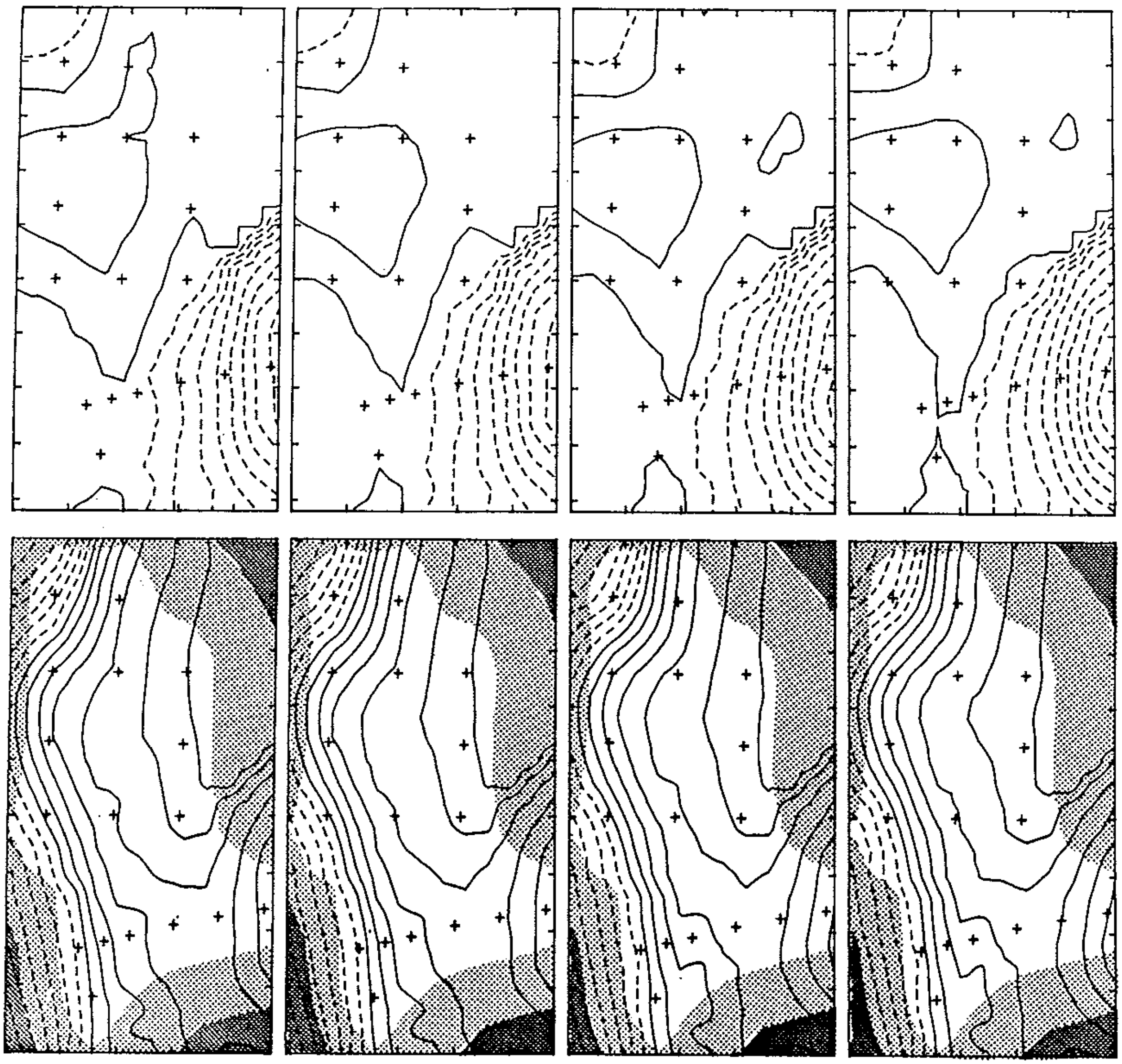

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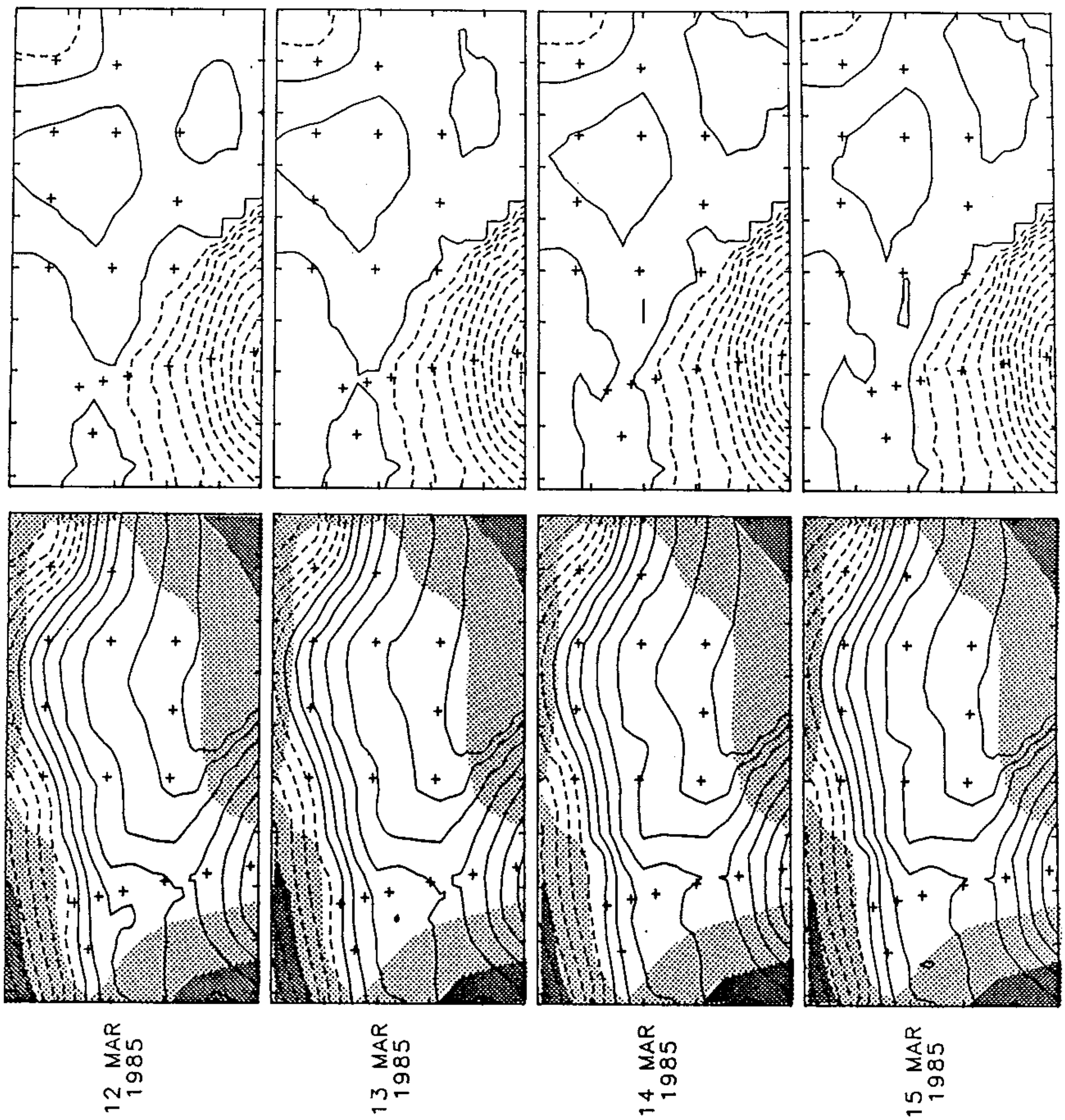
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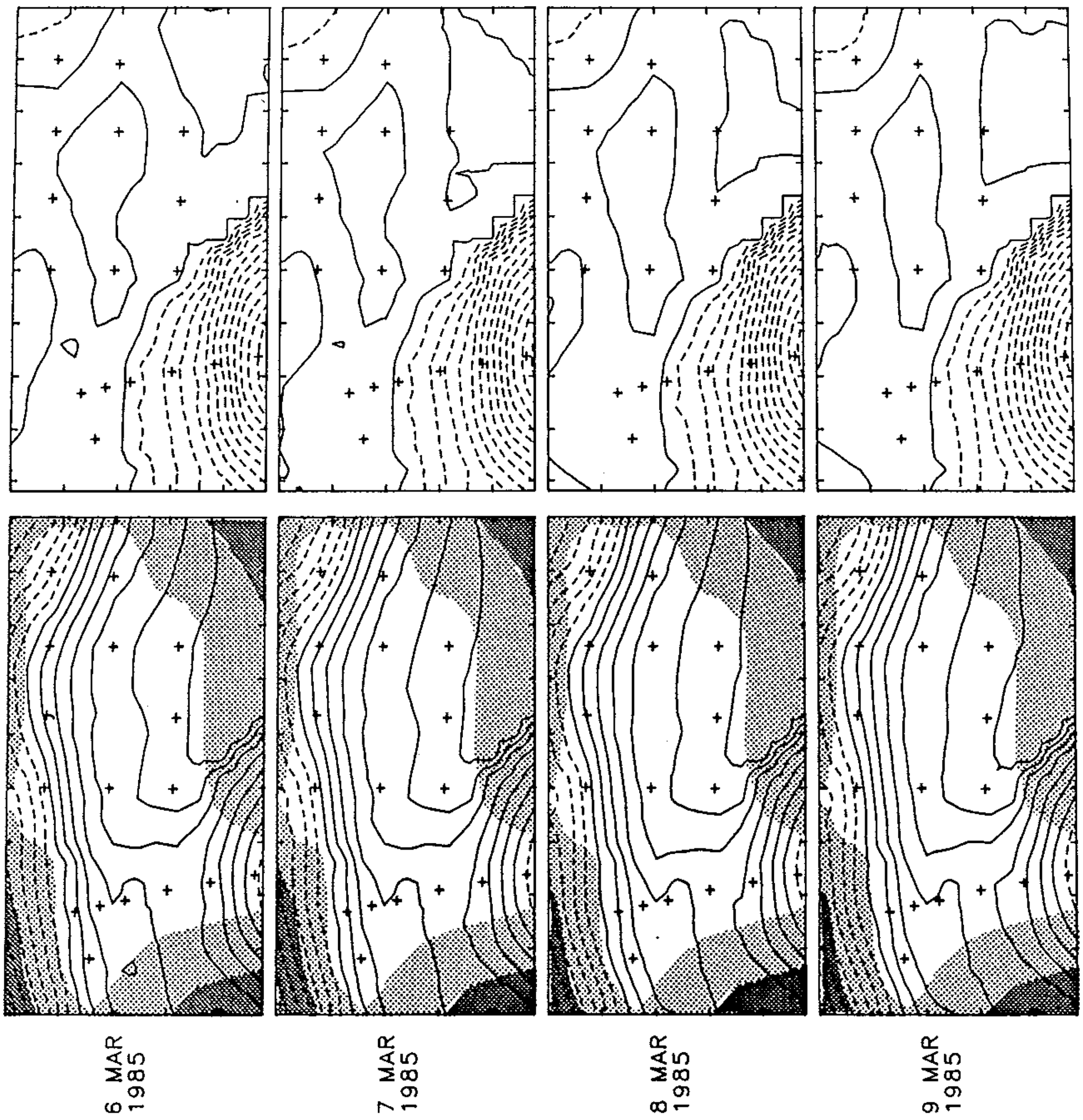
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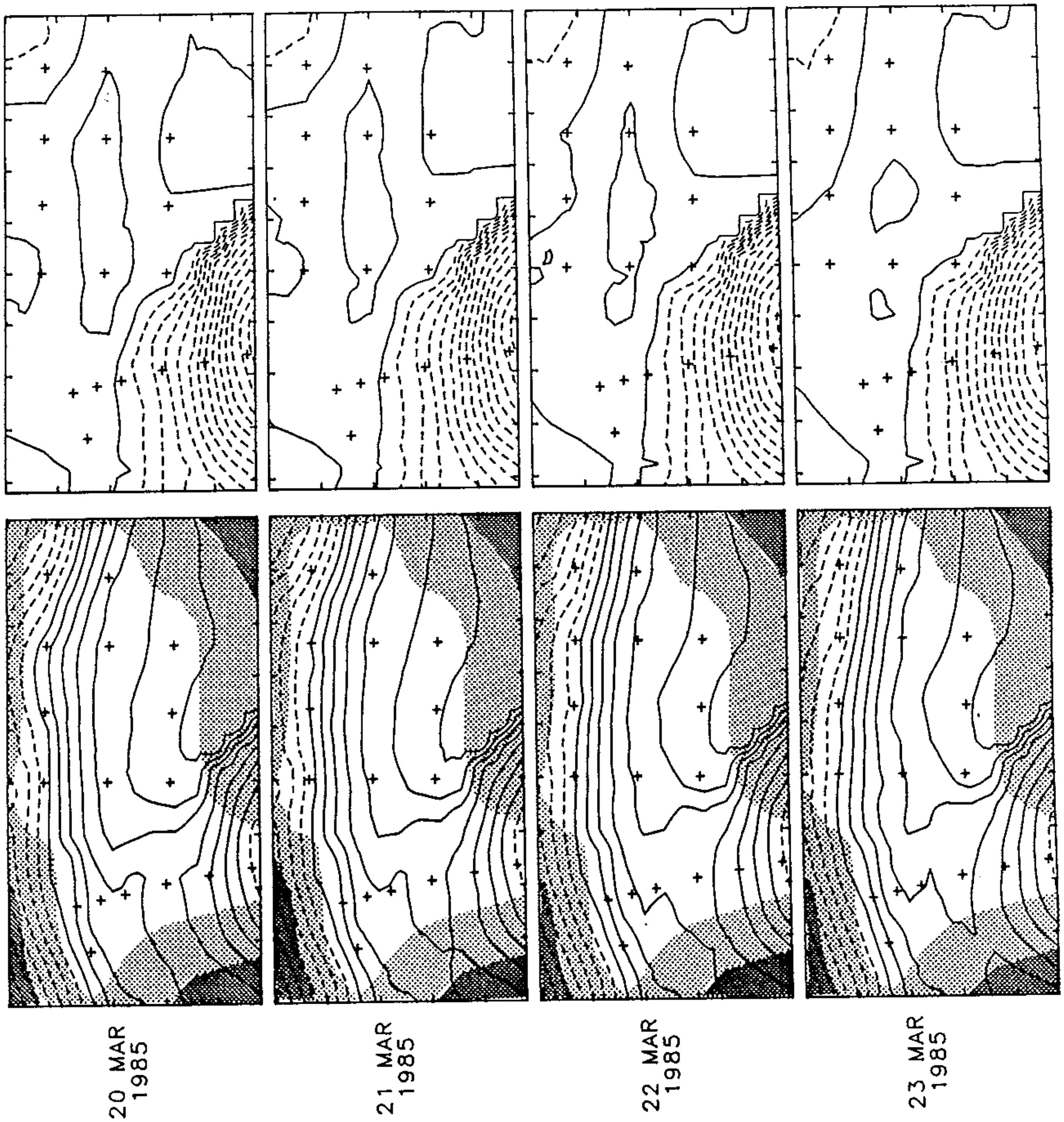
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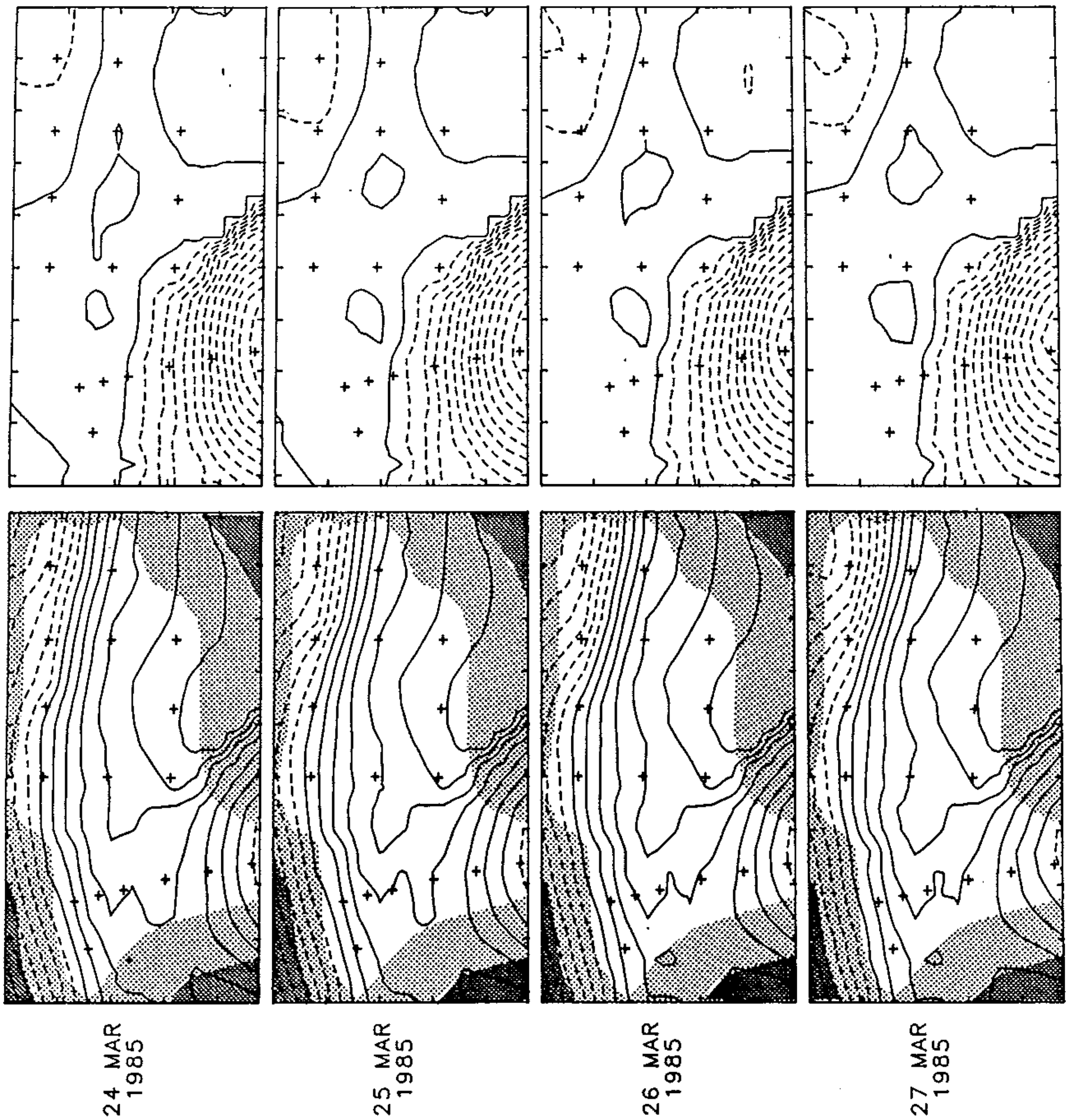
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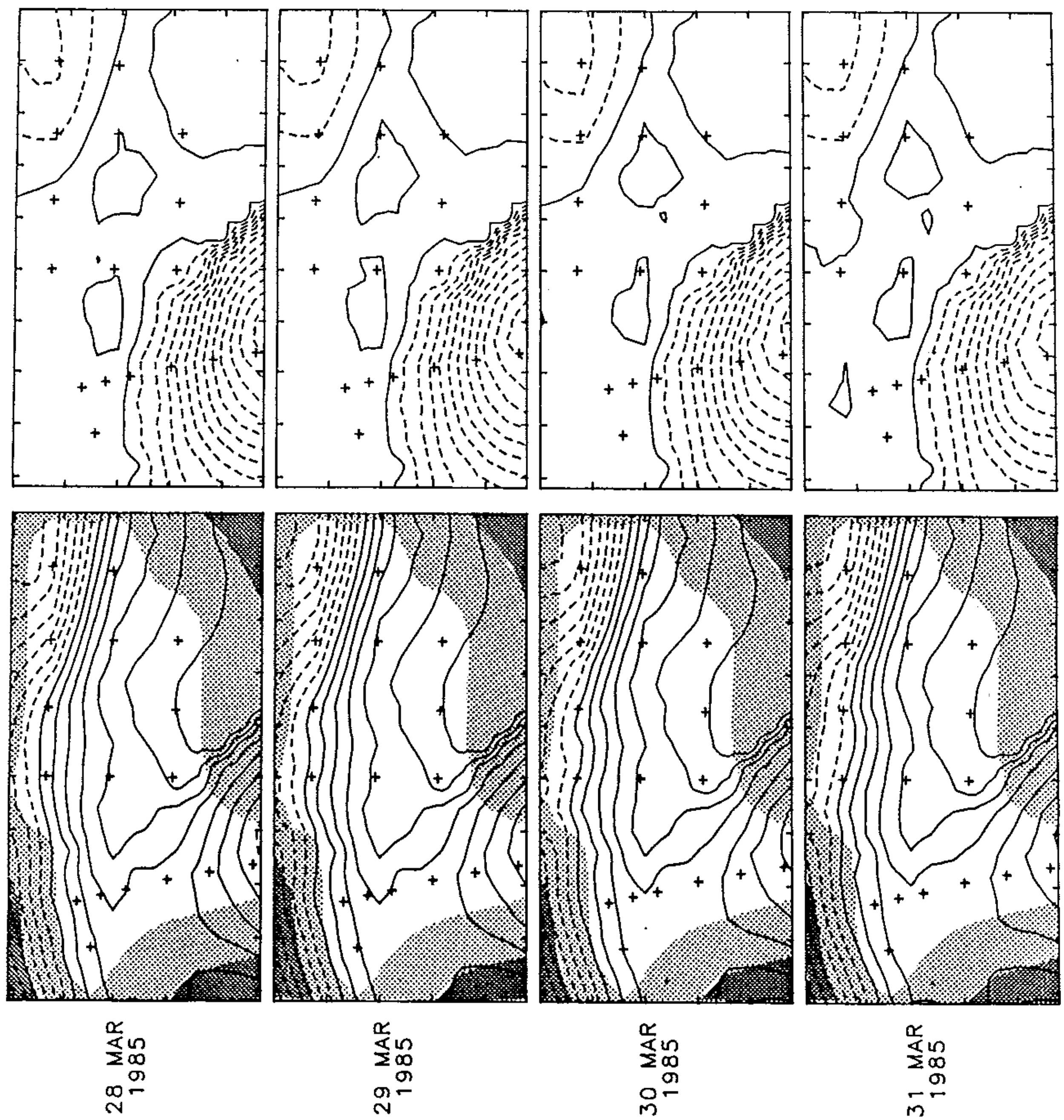
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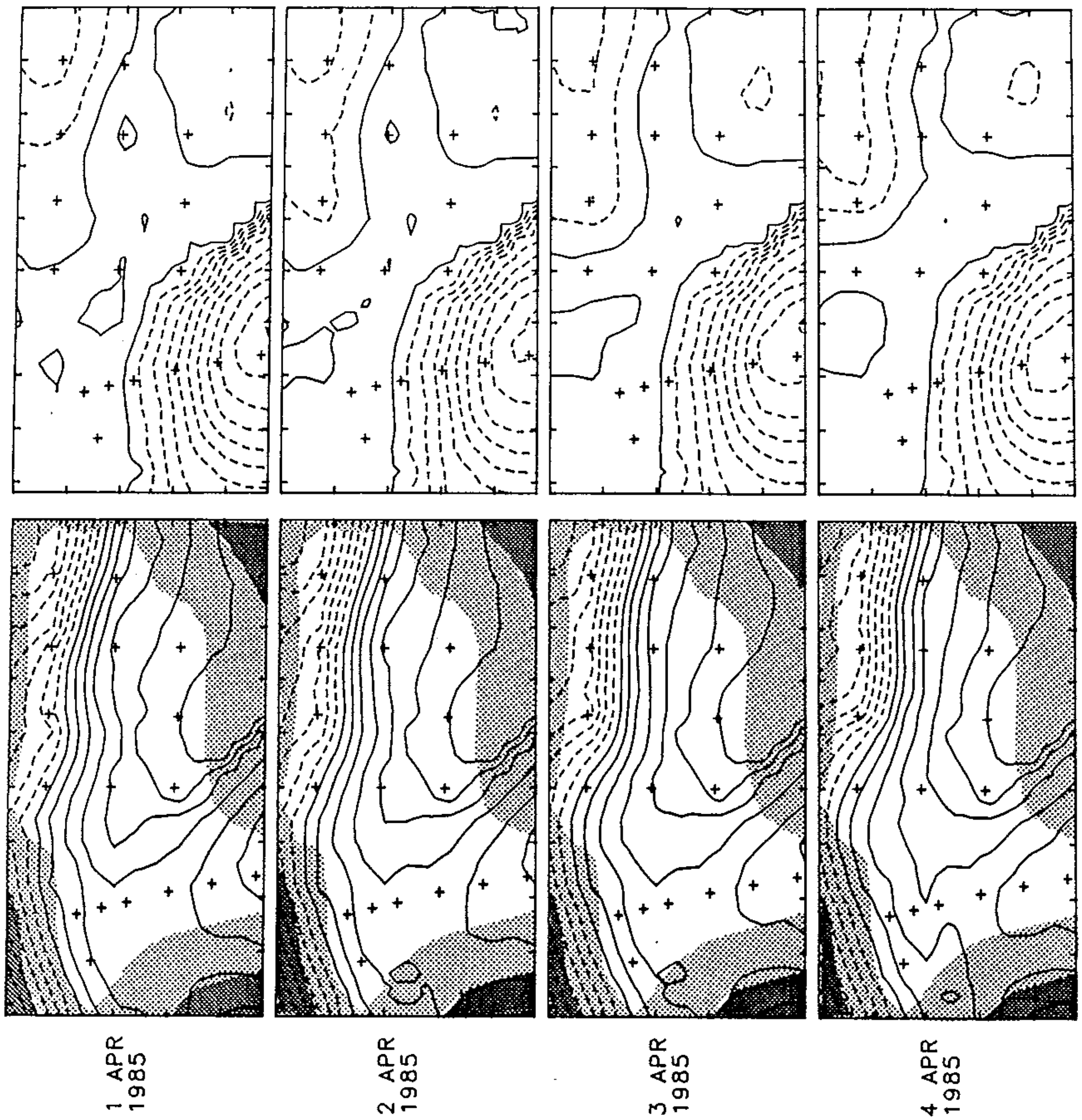
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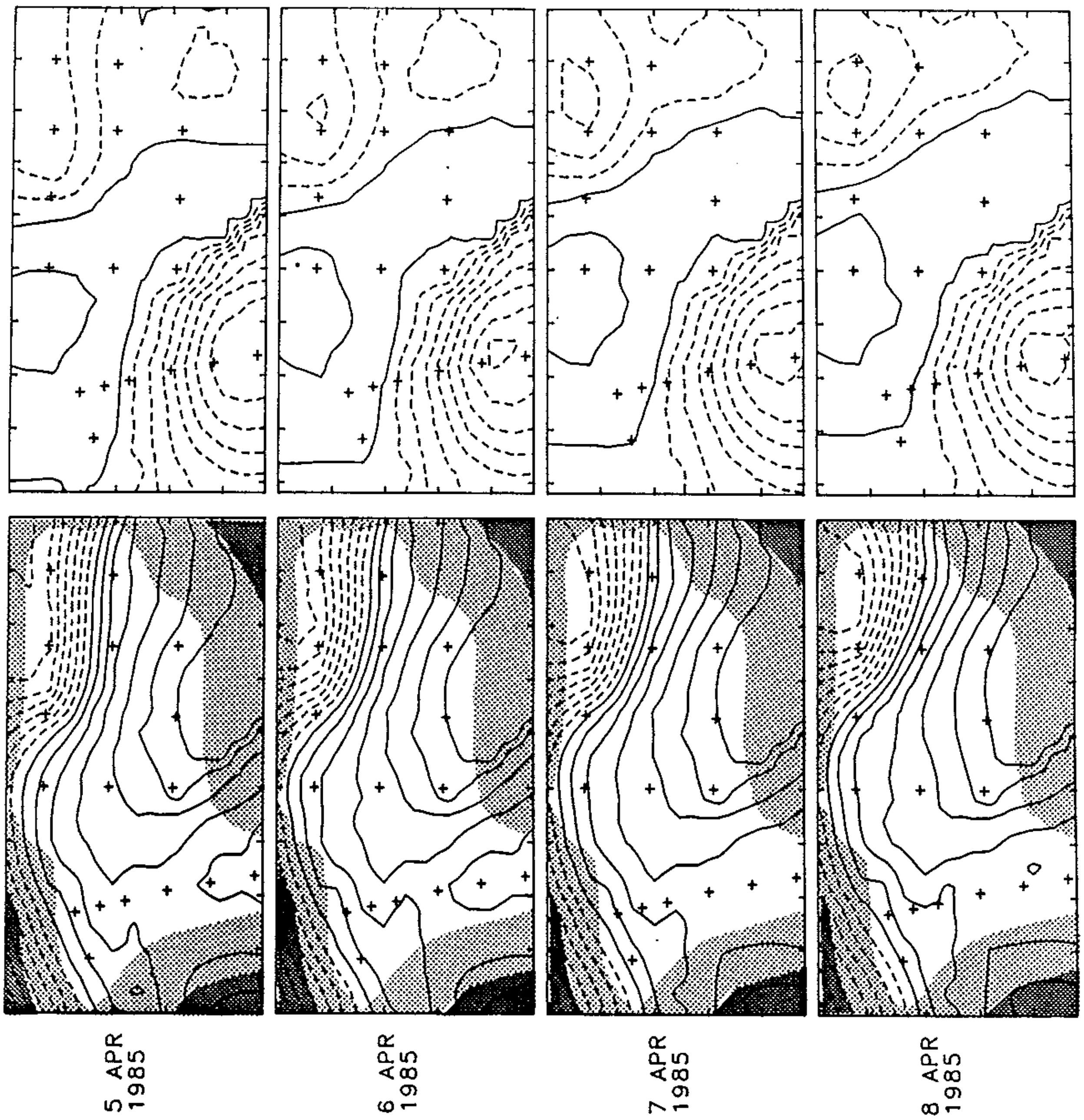

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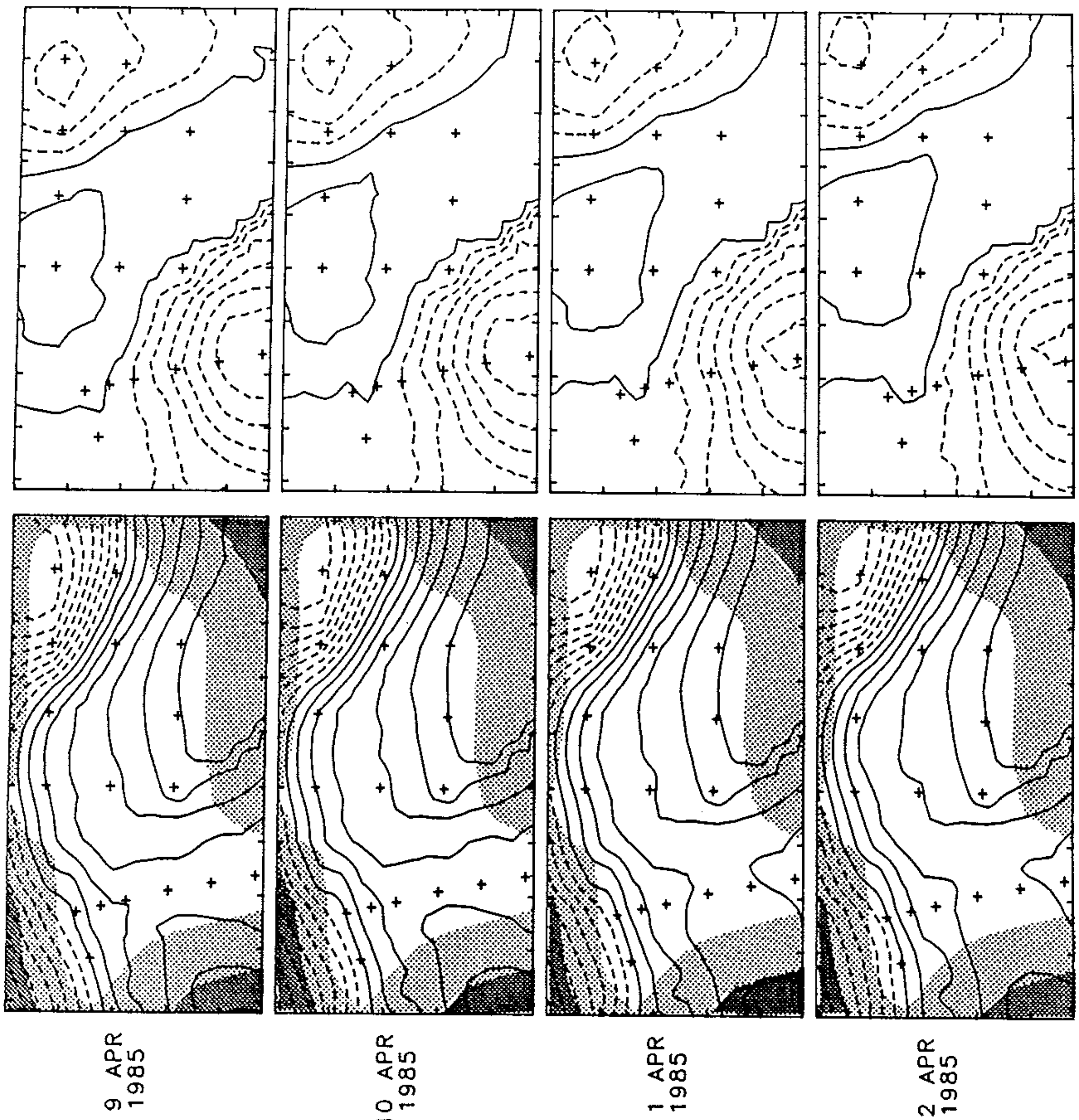
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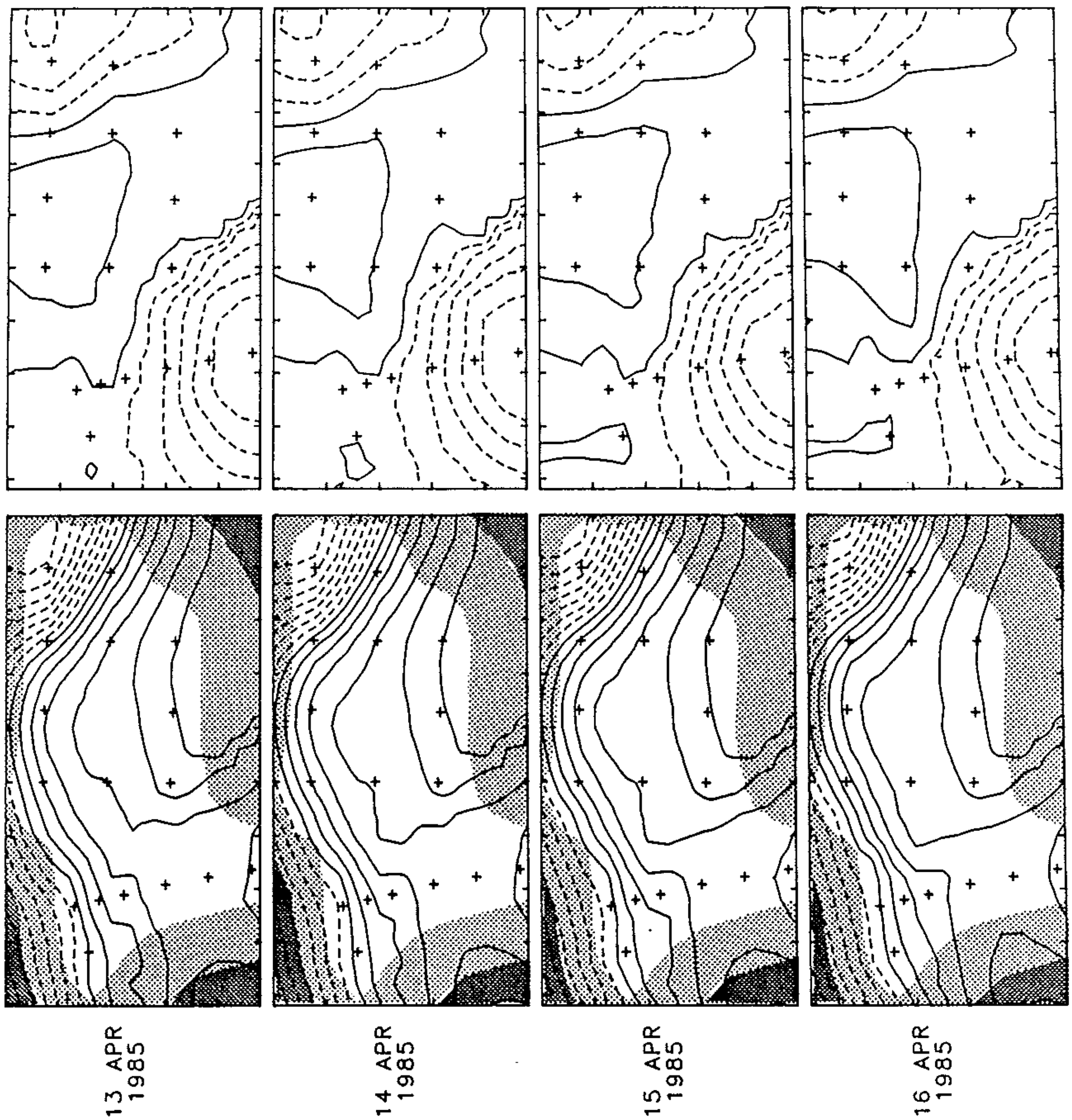
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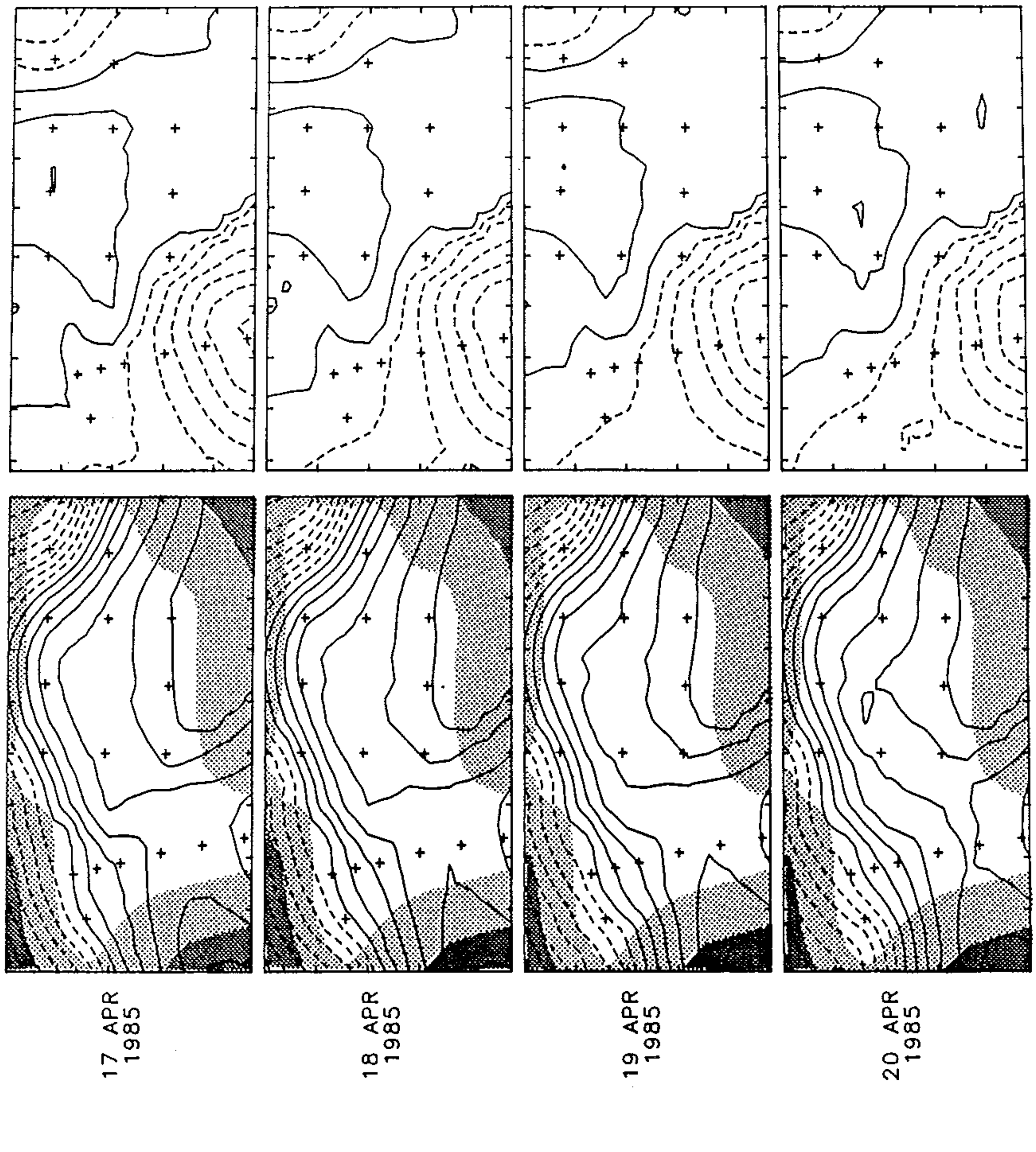
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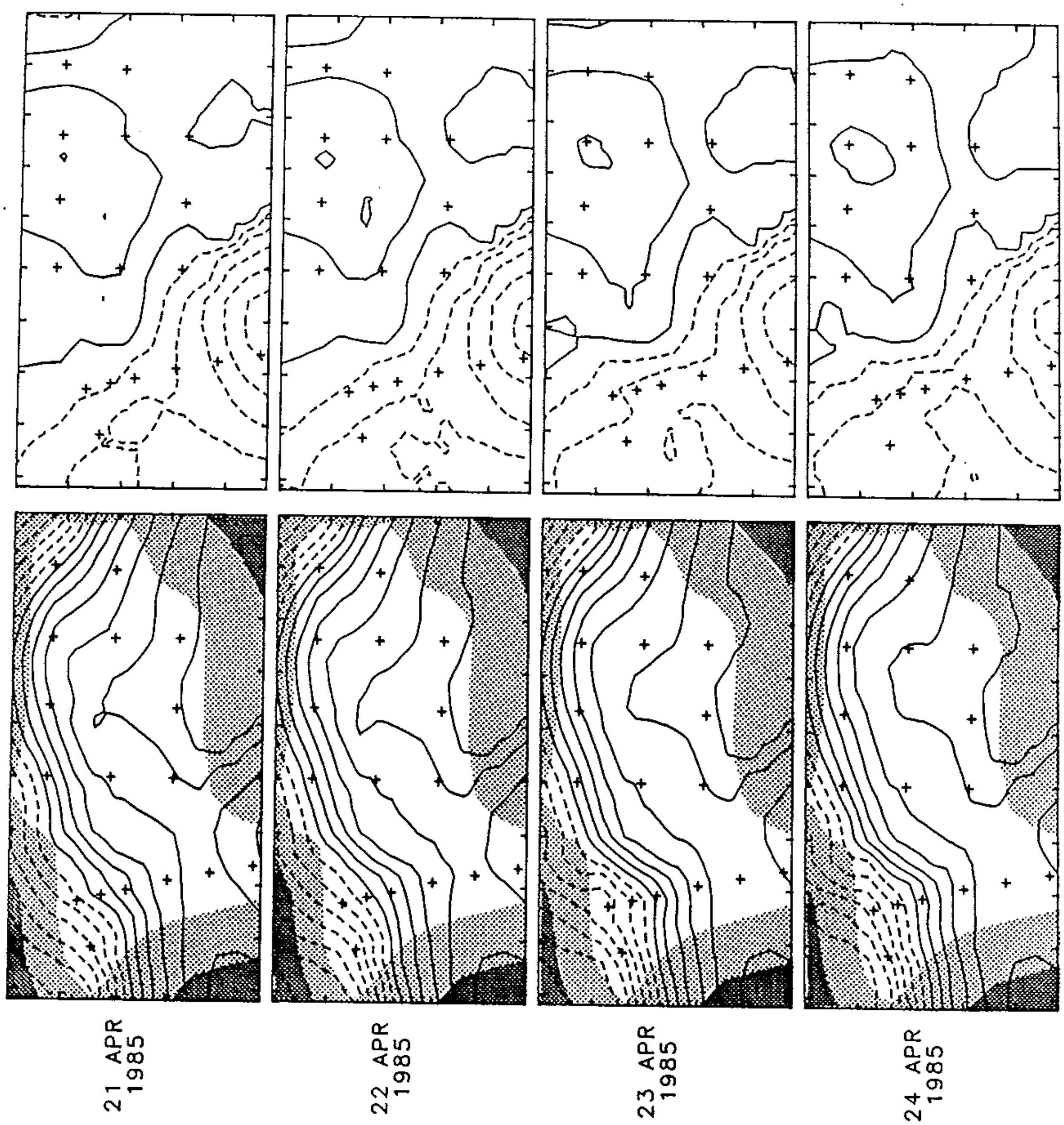
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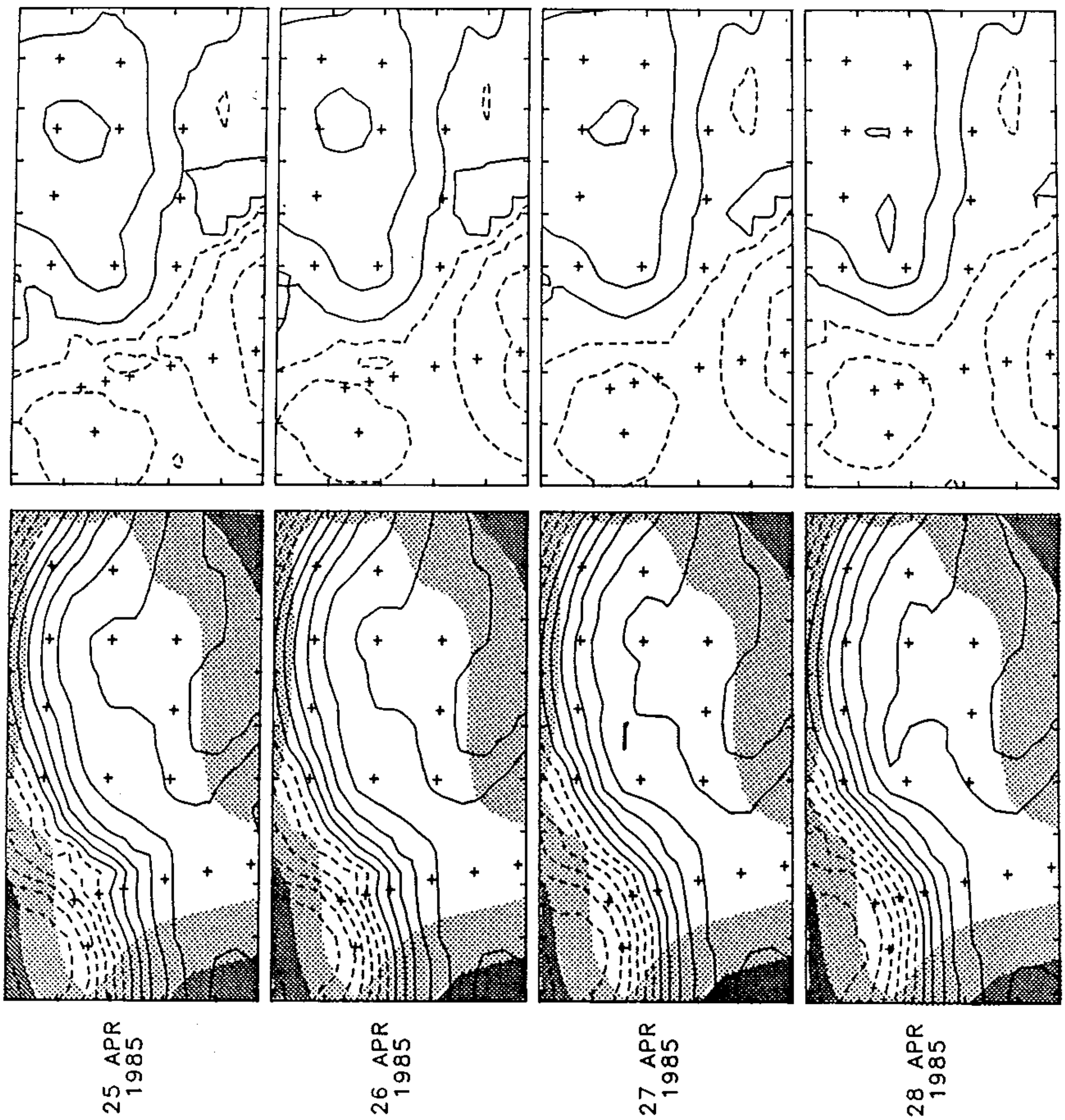
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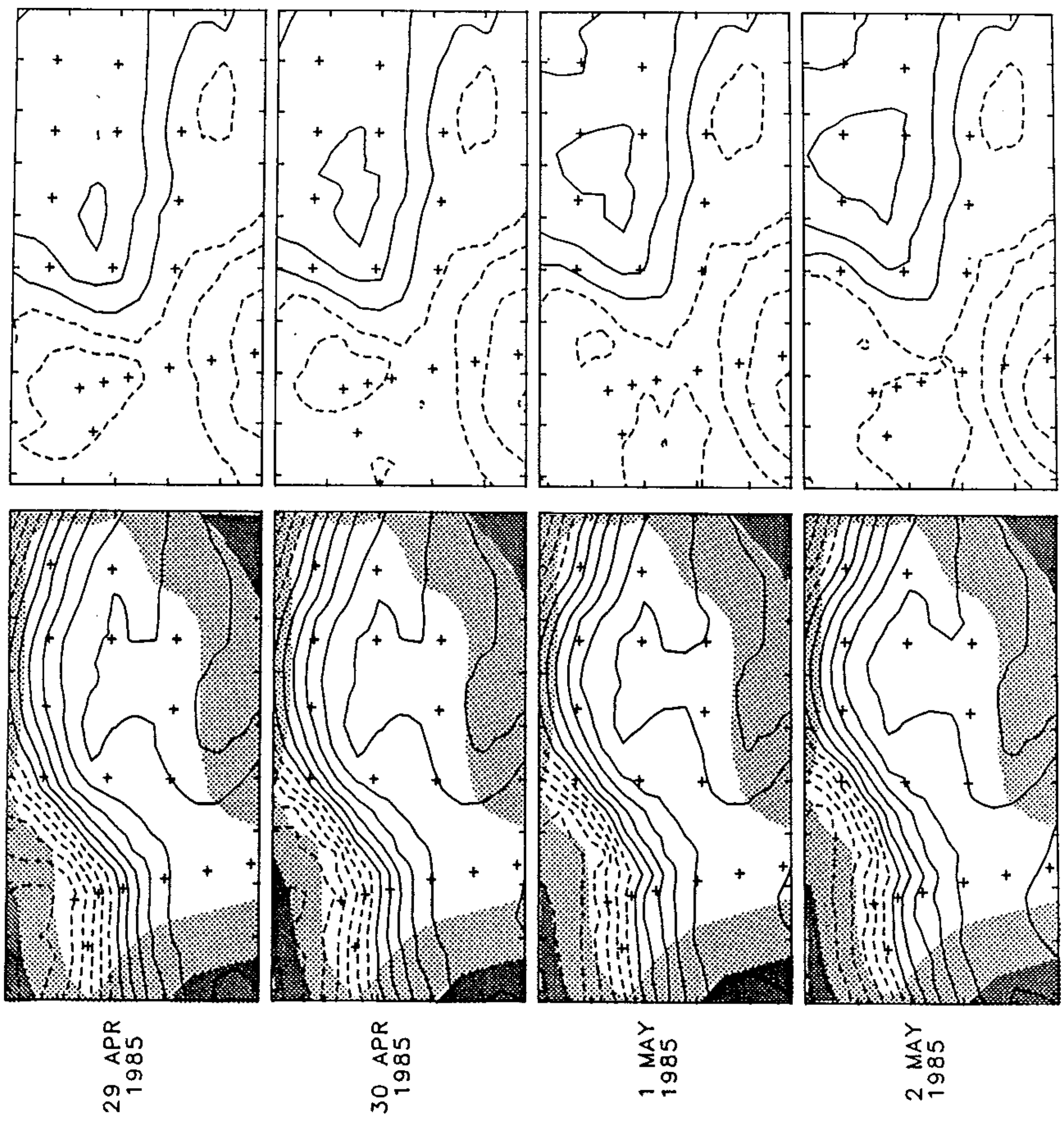

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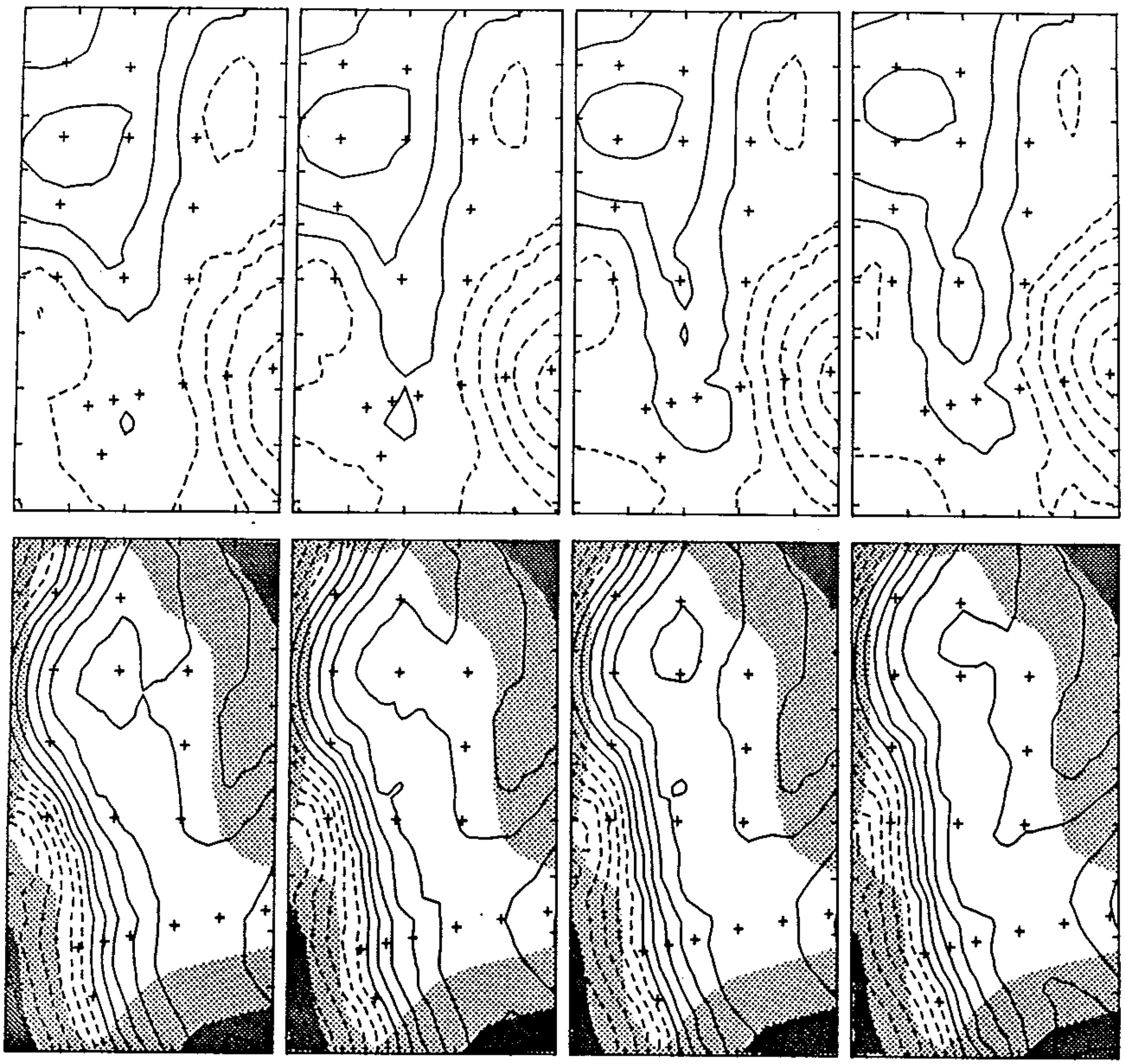
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ACKNOWLEDGMENTS

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The Gulf Stream Dynamics Experiment was conducted in the region just northeast of Cape Hatteras from April 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 June 1984 to May 1985. Time series plots of the half-hourly travel time and low-pass filtered thermocline depth measurements are presented for eighteen instruments. Bottom pressure and temperature, measured at four 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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