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The SYNOP Experiment: Inverted Echo Sounder Data Report for Jun 1989 to Sep 1990

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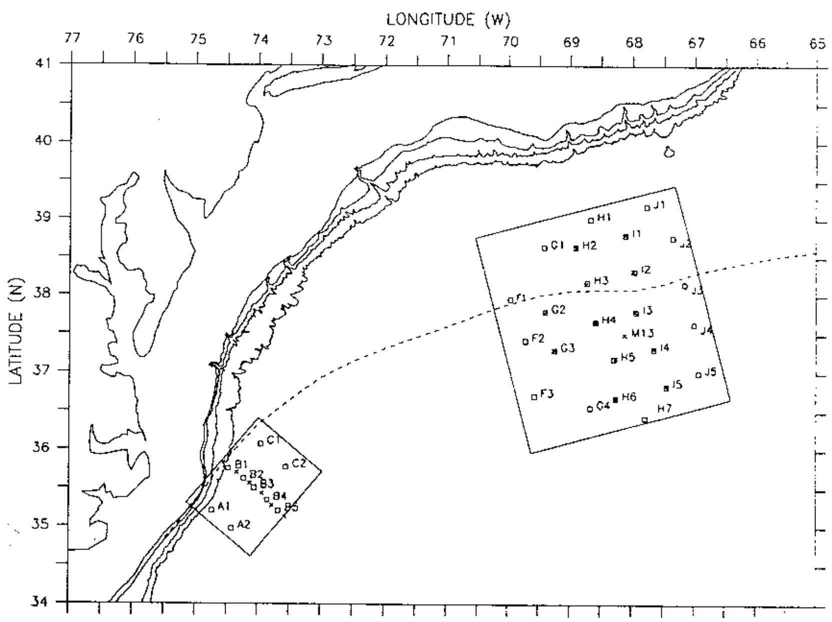
GSO Technical Report No. 91-2



by
Erik Fields and D. Randolph Watts
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Errata for GSO Technical Report 91-2

Instrument	Page	Line	Old Value	Corr Value	Remark
PIES90I2	66	8	38° 47.68	38° 19.68	wrong latitude

Some of the means and standard deviations of measured bottom pressures documented in this report are incorrect. The corrected ones are listed below.

Instrument	Page	Line	Mean	Standard Deviation
PIES90G2	40	9,10	4141.23	0.33
PIES90G3	43	9,10	4460.19	0.33
PIES90H2	48	9,10	3515.44	0.32
PIES90H3	51	9,10	4097.71	0.33
PIES90H4	54	9,10	4552.93	0.33
PIES90H5	57	9,10	4937.17	0.33
PIES90H6	60	9,10	4996.14	0.34
PIES90I1	64	9,10	3888.71	0.32
PIES90I2	67	9,10	4350.62	0.32
PIES90I3	70	9,10	4717.82	0.33
PIES90I4	73	9,10	4907.13	0.33
PIES90I5	76	9,10	5087.11	0.33

Abstract

The SYNoptic Ocean Prediction experiment (SYNOP) was undertaken with the goal that increased understanding of the Gulf Stream obtained through coordinated observations could be integrated with numerical models, including predictive models of the Gulf Stream. Our moored experiment, which began in fall of 1987, consisted of two separate arrays in the Gulf Stream as part of the SYNOP program. The "Inlet" array of inverted echo sounders (IES) and deep current meters measured key parameters that describe the variability of the Gulf Stream and deep western boundary current (DWBC) near Cape Hatteras. In this region the Gulf Stream first flows into deeper water and crosses over the DWBC. The "Central" array of IESs, in a 350 km square centered on the Gulf Stream near 68°W, monitored the thermocline structure of the Gulf Stream in the region of large meanders and frequent interactions with rings. The array also contained thirteen tall current meter moorings, that reached into the Gulf Stream core. Additionally the IESs in the interior of the array were outfitted with bottom pressure recorders (PIES).

IES data recovered during the summer of 1990, from the "Year 3" deployment period, is documented here by plots and tables of basic statistics and pertinent deployment information. Altogether 32 IES records are presented, plus pressure records at 12 sites. The echo sounders were recovered during a cruise aboard the R/V Endeavor, EN216 (4-Aug-90 to 5-Sep-90). The IESs had been deployed the previous summer during cruises on the R/V Oceanus, OC207 (26-May-89 to 21-Jun-89) and OC210 (8-Aug-89 to 1-Sep-89). One IES was exchanged in mid-October 1989 using the R/V Cape Henlopen. The plots are time series of measured travel time, pressure, temperature; the residual pressure; and low-pass filtered records of residual pressure, thermocline depth, and temperature. A brief description of the experiment is given; the standard steps of data processing are discussed along with special processing for several IES records that had different problems.

Contents

List of Tables

List of Figures

1 Experiment Description and Data Processing

1.1 Introduction

In the region northeast of Cape Hatteras, NC, the Gulf Stream has large time-varying meanders. The current shifts within an envelope that grows downstream to several times the instantaneous width of the Gulf Stream itself, and it frequently interacts with powerful currents in eddies adjacent to the Gulf Stream. Fundamental questions remain regarding the dynamics and energy balances governing the meandering. A multi-investigator research effort SYNoptic Ocean Prediction (SYNOP) is being conducted to understand the physics of, and test predictive models of these energetic processes. Our field program has now completed a three-year deployment of arrays of inverted echo sounders with bottom pressure gauges and 28-month deployment of high-performance current meter moorings, reaching into the core of the Gulf Stream. The arrays are specifically designed for our objectives to understand the structure and energy exchanges associated with Gulf Stream variability throughout an extensive region where meanders are large and frequent interactions with eddies occur.

There have been two study areas, an "Inlet Array" and "Central Array", as detailed below, in which inverted echo sounders were deployed for 34 months. The IES records of the "Year 3" deployment period for both arrays (Summer '89 – Summer '90) are the subject of this report.

Using data from current meters, inverted echo sounders (IESs) and IES/bottom pressure sensor combinations (PIESs), we intend to determine how the path and structure of the Gulf Stream evolve, both according to its internal dynamics and instabilities, and as affected by eddies in the adjacent regions. The main objective of our program is a more complete, fundamentally improved dynamical understanding of the Gulf Stream and its variability. From this understanding the longer term goal is to guide and test a predictive modeling capability for the Gulf Stream.

IES data in this report were recovered during the summer of 1990 during a cruise aboard the R/V Endeavor, EN216 (4-Aug-90 to 5-Sep-90). One IES had been exchanged in October 1989, and the record recovered at that time is included in this report. The data are presented in plots of travel times, thermocline depth measurements, and for IES's with additional sensors, bottom pressure and temperature. Basic statistics for those records and pertinent deployment information are given in tables.

In addition to the records presented here, data were received throughout the deployment from five telemetry IESs (TIESs) in the inlet array. The TIESs and associated moorings were deployed during a cruise aboard the R/V Oceanus, OC210, in Aug 1989.

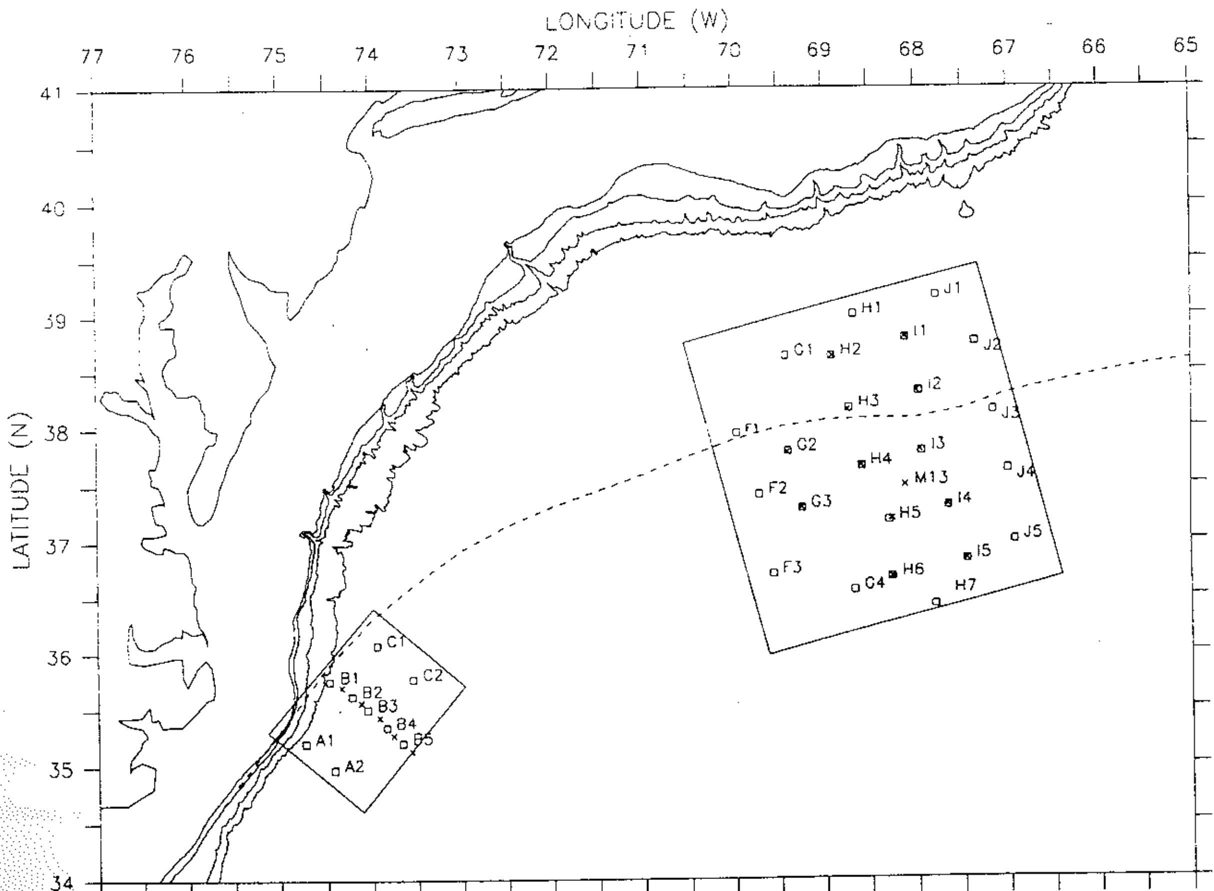


Figure 1: Mooring and IES sites. In the inlet array 'X's denote deep current meter moorings; in the central array they indicate tall current meter moorings. IES locations are marked by boxes. The dashed curve indicates the mean path of the Gulf Stream (1975 to 1986) from Gilman and Cornillon (1990).

1.2 Instrument Sites and Naming Conventions

The "Inlet Array", near Cape Hatteras, consisted of three instrumented lines designated A–C. The "Central Array" centered on the Gulf Stream about 68 W had five instrument lines, F–J. Both arrays are shown in Figure 1. The instrument naming convention is to specify the line and the relative position in the line (increasing seaward from the shelf) prefixed by the type of instrument type and year of recovery. For example PIES90H3 would refer to the third instrument, a PIES, in the H line, for the deployment year of 1990. Tables 1 and 2 list the site postions and times, and Figure 2 illustrates their respective deployment periods.

There were nine instruments in the Inlet Array. IESs there that additionally telemetered data are referred to as TIESs. The five TIESs were B2–B5 and C2. There were 24 instruments in the Central Array. Twelve of these contained bottom pressure recorders and are referred to as PIESs.

1.3 Data Recovery

Tables 1 and 2 and Figure 2 summarize the data returns from each of the IESs. 32 IESs of 34 were successfully recovered. B2 failed to drop its anchor after accepting the release code. F3 would not accept the release command (but did respond normally to the relocation signal). IES F3 was revisited for its backup time release; the four second beacon was activated on schedule, but the IES remained on the bottom.

Some travel time data were lost at sites I1 and H5. Both instruments suffered from maladjusted echo-detectors. IES I1 measured only two months of usable data; the rest was composed of entirely of "no echos" (see section 1.6.6). H5 failed to measure an echo for the first three months of its deployment, but later functioned satisfactorily.

The temperature record at G3 was degraded as a result of a set of stuck bits in a register. Temperature was counted in steps of 128, fortunately, the effect of decreased resolution on calculating of pressure was negligible(see Section 1.6.3)

1.4 Inverted Echo Sounder Description

The IES is an instrument, which is moored one meter above the ocean floor, that monitors the depth of the main thermocline acoustically (Chaplin and Watts 1984). A sample burst of acoustic pulses is transmitted every half hour. A sample burst consists of twenty-four

Site Locations and Data Returns

Table 1: Inlet Array

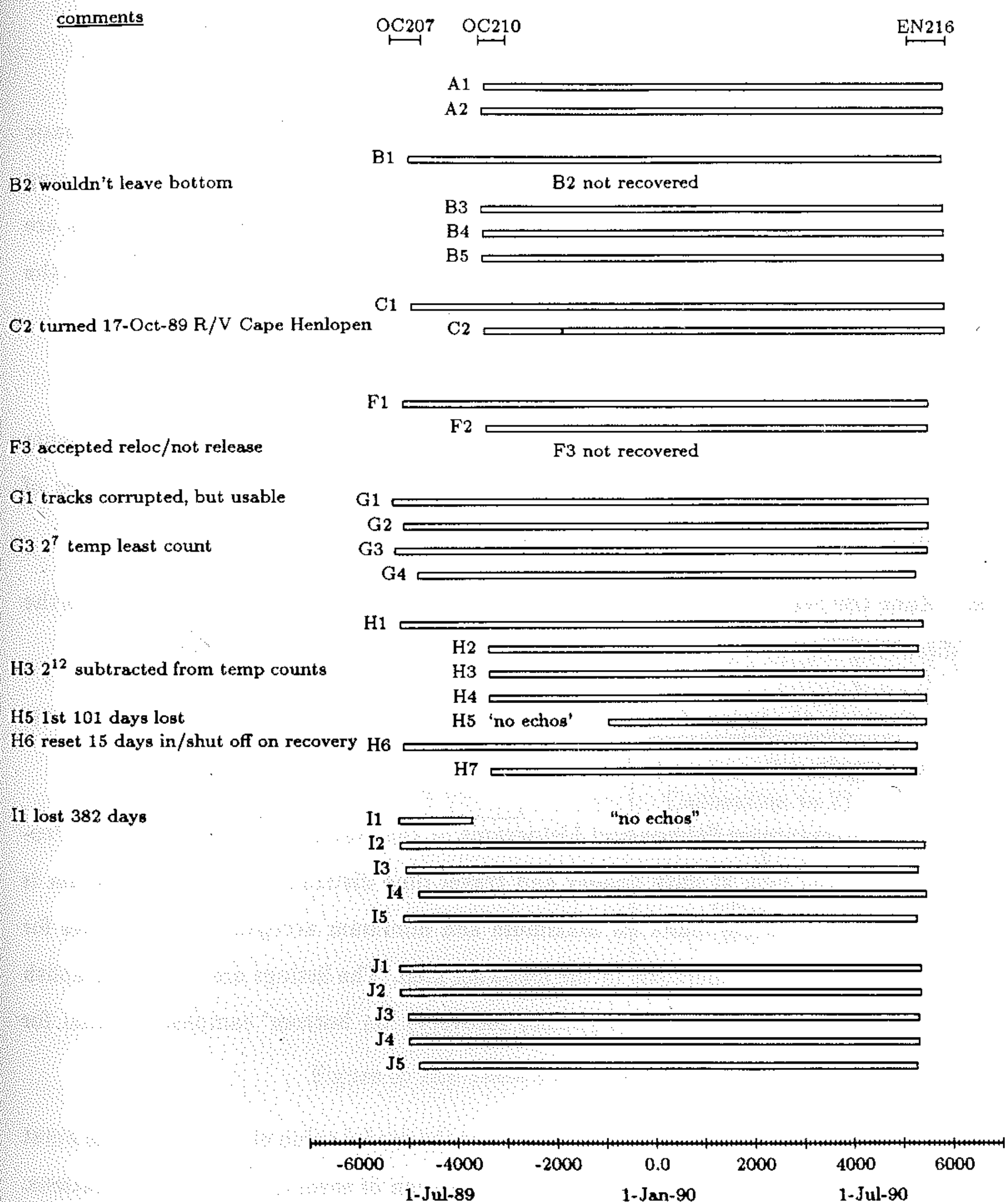
site	lat(N)	lon(W)	1st point	last point	notes
IES90A1	35° 12.32	74° 43.91	13-Aug-89	02-Sep-90	
IES90A2	34° 58.18	74° 24.53	11-Aug-89	02-Sep-90	obstruction by DSL
IES90B1	35° 45.13	74° 27.90	10-Jun-90	01-Sep-90	
TIES90B2	35° 37.01	74° 13.82	lost		stuck on bottom
TIES90B3	35° 30.07	74° 03.40	10-Aug-90	02-Sep-90	
TIES90B4	35° 20.75	73° 50.60	11-Aug-90	02-Sep-90	
TIES90B5	35° 12.13	73° 39.66	11-Aug-90	02-Sep-90	
IES90C1	36° 04.57	73° 56.84	12-Jun-90	03-Sep-90	
TIES89C2	35° 46.15	73° 33.00	12-Aug-89	17-Oct-89	Cape Henlopen turn around
TIES90C2	35° 46.22	73° 32.75	17-Oct-89	03-Sep-90	

From: cruise log EN216 Table 2 pg 18

Table 2: **Central Array**

site	lat(N)	lon(W)	1st point	last point	notes
IES90F1	37° 56.96	69° 58.19	05-Jun-89	20-Aug-90	
IES90F2	37° 24.62	69° 46.59	14-Aug-89	19-Aug-90	
IES90F3	36° 42.08	69° 33.92	lost		faulty release
IES90G1	38° 37.63	69° 25.39	27-May-89	20-Aug-90	tape errors
PIES90G2	37° 47.84	69° 24.31	05-Jun-89	20-Aug-90	
PIES90G3	37° 16.99	69° 14.71	29-May-90	19-Aug-90	
IES90G4	36° 33.00	68° 39.96	17-Jun-89	09-Aug-90	
IES90H1	38° 59.85	68° 39.92	02-Jun-89	15-Aug-90	
PIES90H2	38° 37.78	68° 54.90	15-Aug-89	11-Aug-90	
PIES90H3	38° 10.09	68° 43.65	15-Aug-89	15-Aug-90	
PIES90H4	37° 39.57	68° 35.35	15-Aug-89	18-Aug-90	high scatter
PIES90H5	37° 10.23	68° 17.83	25-Nov-89	17-Aug-90	no echos, 1st 3 months lost
PIES90H6	36° 39.35	68° 15.70	04-Jun-89	09-Aug-90	unexpected reset
IES90H7	36° 24.92	67° 47.81	16-Aug-89	09-Aug-90	
PIES90I1	38° 47.58	68° 06.25	30-May-89	30-Jul-89	no echos, only 3 months good
PIES90I2	38° 19.68	67° 58.71	01-Jun-89	16-Aug-90	
PIES90I3	37° 47.61	67° 58.85	06-Jun-89	10-Aug-90	
PIES90I4	37° 18.88	67° 39.58	16-Jun-89	16-Aug-90	
PIES90I5	36° 50.19	67° 27.36	03-Jun-89	08-Aug-90	
IES90J1	39° 10.05	67° 47.20	31-May-89	12-Aug-90	
IES90J2	38° 45.90	67° 21.03	31-May-89	11-Aug-90	
IES90J3	38° 09.69	67° 10.37	07-Jun-89	10-Aug-90	
IES90J4	37° 38.77	67° 00.65	07-Jun-89	10-Aug-90	
IES90J5	36° 00.68	66° 57.86	16-Jun-89	08-Aug-90	

Figure 2: IES deployment Chart. The deployment periods of the IESs in this report are charted as a thin rectangles. The length of each rectangle and its horizonal position on the time axis, in yearhour at the bottom, provide a calendar of data coverage, first good ping to last. Each large tick is 1000 hr and the smaller ticks denote 100 hr increments.



10 KHz pings at 10 sec intervals. The round trip travel times to the surface and back are recorded on a digital cassette tape within the instrument. For the PIESs, the measured bottom pressure and temperature are also written to tape. Pressure is an average measurement over a half-hour sampling period. For early model PIESs (URI types) the temperature is also an average measurement over a half-hour sample period. Later models (Sea Data types) average temperature for slightly less than one minute. Section 1.5.5 will explain in detail the actual times associated with the various measurements.

1.5 Data Processing

All processing steps were done on MicroVAX II and MicroVAX III computers. The basic steps include transcribing, editing, and converting into scientific units. The data processing is accomplished by a series of routines specifically developed for the IES. The steps are outlined below and schematically illustrated in Figure 3. A complete documentation of the data processing programs is in Fields, Tracey, and Watts (1991).

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.

SDR : Runs the Sea Data Reader which transfers the data from cassettes directly to the MicroVAX 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. The histogram is used to determine the limits for maximum and minimum acceptable travel times for an initial windowing operation in the following step. The listings are used to establish the first (after launch) and last (before recovery) 'on bottom' samples essential for determining the exact time base.

MEMOD : Establishes the time base. Determines the modal value of the travel time burst as the representative measurement after application of several windowing operations.

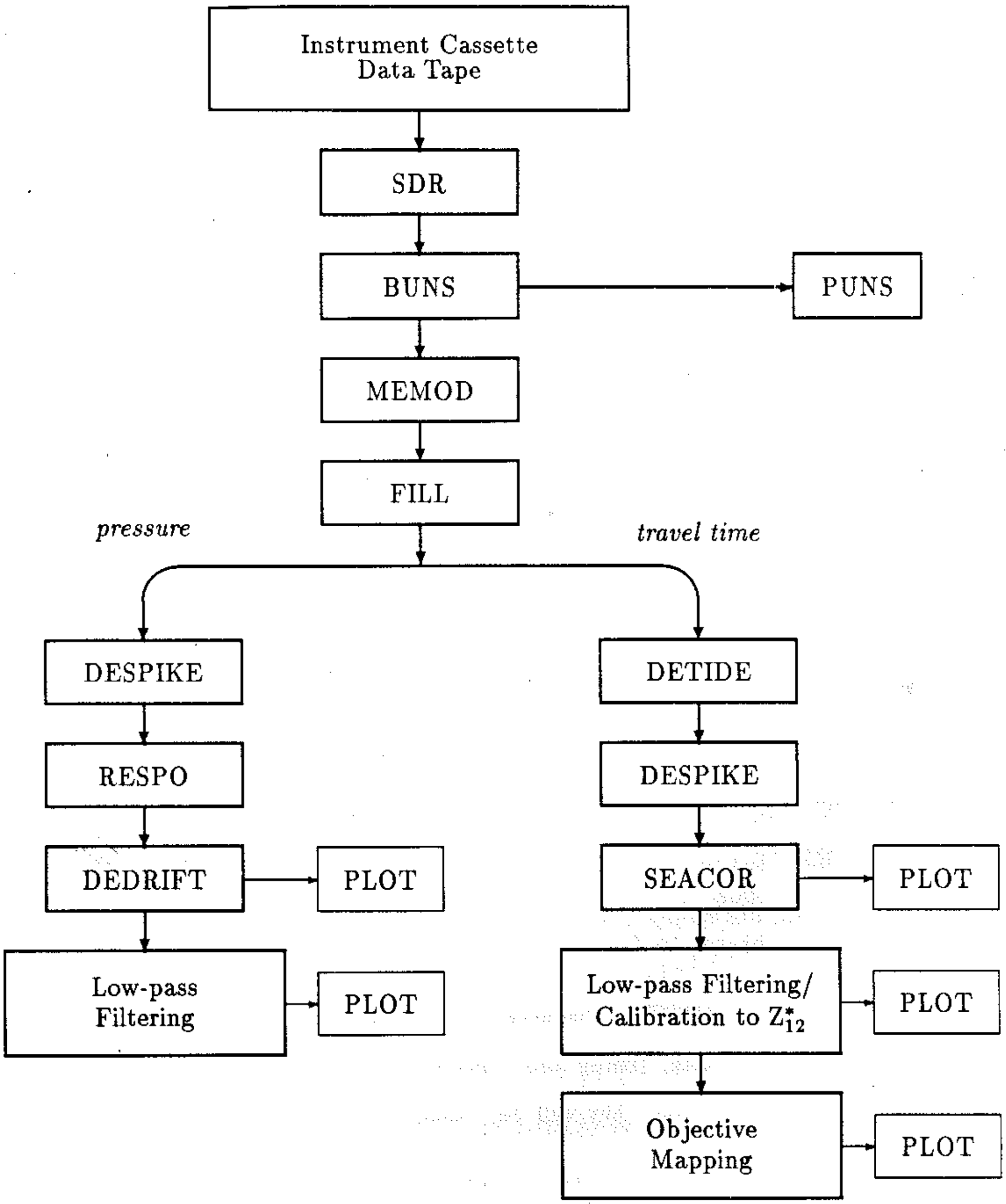


Figure 3: IES Data Processing Flowchart

Converts all travel time, pressure and temperature counts into specific units of seconds, decibars, and degrees Celsius, respectively.

FILL : Checks for proper incrementation of the time base. Missing samples are inserted using interpolated values. For PIESs the temperature and the pressure are written to separate files with the appropriate time bases.

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. At this stage, plots of the half-hourly pressure, temperature and travel time are generated.

RESPO : Removes the tides from the pressure records using tidal response analysis (Munk and Cartwright, 1977) to determine the tidal constituents for each record.

DEDRIFT : Removes long term drifts associated with the pressure sensor and slight imperfection in the IES master clock frequency.

LOW PASS FILTERING : A 2nd order 40 hr low-pass Butterworth filter is applied forward and backwards to the travel time, residual pressure, and temperature records. The smoothed series are subsampled at six hour intervals centered on 0000Z, 0600Z, 1200Z, and 1800Z (UT), and plotted. The smoothed subsampled travel time is subsequently calibrated to Z_{12}.

OBJECTIVE MAPPING : Produces daily maps of the depth of the 12°C isotherm as documented in Watts, Tracey and Friedlander, 1989. The results of this step are not presented here. Rather, they will be presented in a subsequent data report.

1.5.1 Travel Time Calibration

The acoustic travel time (τ) records will be shown in Section 3, Figures 9.1–9.32. Variations in the travel times have been shown to be proportional to variations in the thermocline depth in the Gulf Stream region (Watts and Rossby, 1977; Watts and Wimbush, 1981; Watts and Johns, 1982). For practical purposes the main thermocline depth can be represented by the depth of the 12°C isotherm, Z_{12}, as it is situated near the highest temperature gradients of the main thermocline and correlates well with τ (Rossby, 1969; Watts and Johns, 1982).

In previous studies, Z_{12} was obtained directly from the XBT cast. However, a new method has been developed which takes advantage of the integrative nature of the travel-time measurement to give a more representative measure of the thermocline depth. The new measure, $Z^{\star}_{12}$, should be less succeptible to small, transient perturbations (i.e., internal waves) in the water column than the single-point measurement, Z_{12}. This method consists of calculating Q, the 'heat content' ($\int_{250m}^{750m} T dz$) for each calibration XBT cast; then using Q to determine $Z^{\star}_{12}$ from an empirical curve relating Z_{12} and Q. The curve was established using over 5000 XBT casts in the Gulf Stream region (from NODC archives).

At each IES site, XBTs were taken in order to determine the IES's calibration coefficient, B, for converting the travel time into thermocline depth according to the relation: $Z^{\star}_{12} = M\tau + B$. M was determined from regressions of all calibration pairs $(Z^{\star}_{12}, \tau)$ from 1987 to 1990. The regressions showed that the constant value M=−19,800 m/sec was appropriate for all these Gulf Stream sites. The values of B used for each IES are listed in the tables in Section 2.

The low-pass filtered travel time records were scaled to the thermocline depths (Z_{12}, dropping the star. Hereafter Z_{12} is synonymous with $Z^{\star}_{12}$) and these records are shown in Figures 16.1–16.8. Since τ is resolved to 0.1 msec, the 40 HRLP Z_{12} scaled values are therefore resolved to ±2 m. However, the accuracy of the offset parameter B is estimated to be ±19 m for most records, 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.

1.5.2 Temperature

Temperatures (Figures 11.1–11.12, 15.1–15.3, 18.1–18.3) were measured using thermistors (Yellow Springs International Corp., model 44032) controlled by Sea Data Corp. (model DC-37B) electronics cards installed in the IESs. The thermistor's main purpose is to correct the pressure values for the temperature sensitivity of the transducer. The thermistor is inside the instrument, on the pressure transducer, rather than in the water. However, once the temperature probe has reached equilibrium with the surrounding waters, it also provides accurate measurements of the bottom temperature fluctuations (effectively low-pass filtered with a 2–4 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 measurements is about 0.1°C, and the resolution is 0.0002°C.

1.5.3 Bottom Pressure

Digiquartz pressure sensor (models 46K-017, 46K-023, 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 10.1–10.12) are dominated by the tides, however for some of the instruments, the pressures also drift, O(0.1 dbar yr^{-1}), monotonically with time. Processing of the pressure measurements includes removing the long-term drift and tides.

Tidal response analysis (Munk and Cartwright, 1977) was used to determine the tidal constituents for each instrument. The calculated tides were then removed from the pressure records. The amplitudes, H (dbar), and phases, $G°$ (Greenwich epoch), of the constituents are given in the tables in Section 2.

The pressure records were dedrifted in the manner developed by Watts and Kontoyiannis (1990) who have addressed pressure sensor drift and performance. The rate of drift decayed with time and was best approximated by an exponential function of the form,

$$Drift = Ae^{-\lambda t} + B.$$

A design matrix for the nonlinear least-squares fit would be composed of ($e^{-\lambda t_i}$, 1). The overdetermined set of equations were solved for coefficients A and B. These coefficients were found subject to the minimization of the rms error of the fit as a function of the decay rate, λ. Minimization was accomplished using the method of parabolic extrapolation and golden sections (Press et al., 1988) to optimally search for λ with a minimum of function evaluations (fits). The first 12 hours of pressure were ignored since the crystal's temperature was equilibrating. The drift curves were found from 2-hour subsampled records for computational simplicity. The time of drift was referenced from 1 hour before the first sample on the ocean bottom, i.e. at a time when the instrument was sinking to the sea floor after launch. At a later stage, comparison of geostrophic currents, calculated from adjacent dedrifted pressure sensors versus nearby current meters will be used to verify the dedrift procedure's success.

Three of the twelve PIESs showed some sign of drift. Two were identified as exponential (G3 and H6) and one was linear (I5). The linear pressure drift was estimated from the IES clock drift rather than a least-squares fit. The fitted drift parameters are listed for each instrument individually, in the site and record information tables of Section 2. 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, shown in Figures 12.1–12.12 and Figure 14.1–14.3, have an accuracy (relative to their mean pressure) of better than 0.05 dbar (Watts and Kontoyiannis, 1990). The residual bottom pressure records were low-pass filtered and the results are plotted in Figures 17.1–17.3.

1.5.4 Time Base

The date and time were assigned to each sampling period. Tables 6–37 in Section 2 report the hours, minutes, and seconds associated with the first and last sampling period. All times are given as Universal Time (UT). For processing convenience, the times were converted into yearhours. A yearhour calendar (Table 3 and 4) lists the yearhours which correspond to 0000 UT 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, 1990 at 00:00:00 UT.

Jan Day	Jan yrhr	Feb	Feb	Mar	Mar	Apr	Apr	May	May	Jun	Jun
1	0	1	744	1	1416	1	2160	1	2880	1	3624
2	24	2	768	2	1440	2	2184	2	2904	2	3648
3	48	3	792	3	1464	3	2208	3	2928	3	3672
4	72	4	816	4	1488	4	2232	4	2952	4	3696
5	96	5	840	5	1512	5	2256	5	2976	5	3720
6	120	6	864	6	1536	6	2280	6	3000	6	3744
7	144	7	888	7	1560	7	2304	7	3024	7	3768
8	168	8	912	8	1584	8	2328	8	3048	8	3792
9	192	9	936	9	1608	9	2352	9	3072	9	3816
10	216	10	960	10	1632	10	2376	10	3096	10	3840
11	240	11	984	11	1656	11	2400	11	3120	11	3864
12	264	12	1008	12	1680	12	2424	12	3144	12	3888
13	288	13	1032	13	1704	13	2448	13	3168	13	3912
14	312	14	1056	14	1728	14	2472	14	3192	14	3936
15	336	15	1080	15	1752	15	2496	15	3216	15	3960
16	360	16	1104	16	1776	16	2520	16	3240	16	3984
17	384	17	1128	17	1800	17	2544	17	3264	17	4008
18	408	18	1152	18	1824	18	2568	18	3288	18	4032
19	432	19	1176	19	1848	19	2592	19	3312	19	4056
20	456	20	1200	20	1872	20	2616	20	3336	20	4080
21	480	21	1224	21	1896	21	2640	21	3360	21	4104
22	504	22	1248	22	1920	22	2664	22	3384	22	4128
23	528	23	1272	23	1944	23	2688	23	3408	23	4152
24	552	24	1296	24	1968	24	2712	24	3432	24	4176
25	576	25	1320	25	1992	25	2736	25	3456	25	4200
26	600	26	1344	26	2016	26	2760	26	3480	26	4224
27	624	27	1368	27	2040	27	2784	27	3504	27	4248
28	648	28	1392	28	2064	28	2808	28	3528	28	4272
29	672			29	2088	29	2832	29	3552	29	4296
30	696			30	2112	30	2856	30	3576	30	4320
31	720			31	2136			31	3600		

Jul	Jul	Aug	Aug	Sep	Sep	Oct	Oct	Nov	Nov	Dec	Dec
1	4344	1	5088	1	5832	1	6552	1	7296	1	8016
2	4368	2	5112	2	5856	2	6576	2	7320	2	8040
3	4392	3	5136	3	5880	3	6600	3	7344	3	8064
4	4416	4	5160	4	5904	4	6624	4	7368	4	8088
5	4440	5	5184	5	5928	5	6648	5	7392	5	8112
6	4464	6	5208	6	5952	6	6672	6	7416	6	8136
7	4488	7	5232	7	5976	7	6696	7	7440	7	8160
8	4512	8	5256	8	6000	8	6720	8	7464	8	8184
9	4536	9	5280	9	6024	9	6744	9	7488	9	8208
10	4560	10	5304	10	6048	10	6768	10	7512	10	8232
11	4584	11	5328	11	6072	11	6792	11	7536	11	8256
12	4608	12	5352	12	6096	12	6816	12	7560	12	8280
13	4632	13	5376	13	6120	13	6840	13	7584	13	8304
14	4656	14	5400	14	6144	14	6864	14	7608	14	8328
15	4680	15	5424	15	6168	15	6888	15	7632	15	8352
16	4704	16	5448	16	6192	16	6912	16	7656	16	8376
17	4728	17	5472	17	6216	17	6936	17	7680	17	8400
18	4752	18	5496	18	6240	18	6960	18	7704	18	8424
19	4776	19	5520	19	6264	19	6984	19	7728	19	8448
20	4800	20	5544	20	6288	20	7008	20	7752	20	8472
21	4824	21	5568	21	6312	21	7032	21	7776	21	8496
22	4848	22	5592	22	6336	22	7056	22	7800	22	8520
23	4872	23	5616	23	6360	23	7080	23	7824	23	8544
24	4896	24	5640	24	6384	24	7104	24	7848	24	8568
25	4920	25	5664	25	6408	25	7128	25	7872	25	8592
26	4944	26	5688	26	6432	26	7152	26	7896	26	8616
27	4968	27	5712	27	6456	27	7176	27	7920	27	8640
28	4992	28	5736	28	6480	28	7200	28	7944	28	8664
29	5016	29	5760	29	6504	29	7224	29	7968	29	8688
30	5040	30	5784	30	6528	30	7248	30	7992	30	8712
31	5064	31	5808			31	7272			31	8736

Table 3: Yearhour Calendar for Non-Leap Years. Each yearhour listed corresponds to 00:00:00 UT on the specified day.

Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Day	yrhr																						
1	-8760	1	-8016	1	-7344	1	-6600	1	-5880	1	-5136	1	-4416	1	-3672	1	-2928	1	-2208	1	-1464	1	-744
2	-8736	2	-7992	2	-7320	2	-6576	2	-5856	2	-5112	2	-4392	2	-3648	2	-2904	2	-2184	2	-1440	2	-720
3	-8712	3	-7968	3	-7296	3	-6552	3	-5832	3	-5088	3	-4368	3	-3624	3	-2880	3	-2160	3	-1416	3	-696
4	-8688	4	-7944	4	-7272	4	-6528	4	-5808	4	-5064	4	-4344	4	-3600	4	-2856	4	-2136	4	-1392	4	-672
5	-8664	5	-7920	5	-7248	5	-6504	5	-5784	5	-5040	5	-4320	5	-3576	5	-2832	5	-2112	5	-1368	5	-648
6	-8640	6	-7896	6	-7224	6	-6480	6	-5760	6	-5016	6	-4296	6	-3552	6	-2808	6	-2088	6	-1344	6	-624
7	-8616	7	-7872	7	-7200	7	-6456	7	-5736	7	-4992	7	-4272	7	-3528	7	-2784	7	-2064	7	-1320	7	-600
8	-8592	8	-7848	8	-7176	8	-6432	8	-5712	8	-4968	8	-4248	8	-3504	8	-2760	8	-2040	8	-1296	8	-576
9	-8568	9	-7824	9	-7152	9	-6408	9	-5688	9	-4944	9	-4224	9	-3480	9	-2736	9	-2016	9	-1272	9	-552
10	-8544	10	-7800	10	-7128	10	-6384	10	-5664	10	-4920	10	-4200	10	-3456	10	-2712	10	-1992	10	-1248	10	-528
11	-8520	11	-7776	11	-7104	11	-6360	11	-5640	11	-4896	11	-4176	11	-3432	11	-2688	11	-1968	11	-1224	11	-504
12	-8496	12	-7752	12	-7080	12	-6336	12	-5616	12	-4872	12	-4152	12	-3408	12	-2664	12	-1944	12	-1200	12	-480
13	-8472	13	-7728	13	-7056	13	-6312	13	-5592	13	-4848	13	-4128	13	-3384	13	-2640	13	-1920	13	-1176	13	-456
14	-8448	14	-7704	14	-7032	14	-6288	14	-5568	14	-4824	14	-4104	14	-3360	14	-2616	14	-1896	14	-1152	14	-432
15	-8424	15	-7680	15	-7008	15	-6264	15	-5544	15	-4800	15	-4080	15	-3336	15	-2592	15	-1872	15	-1128	15	-408
16	-8400	16	-7656	16	-6984	16	-6240	16	-5520	16	-4776	16	-4056	16	-3312	16	-2568	16	-1848	16	-1104	16	-384
17	-8376	17	-7632	17	-6960	17	-6216	17	-5496	17	-4752	17	-4032	17	-3288	17	-2544	17	-1824	17	-1080	17	-360
18	-8352	18	-7608	18	-6936	18	-6192	18	-5472	18	-4728	18	-4008	18	-3264	18	-2520	18	-1800	18	-1056	18	-336
19	-8328	19	-7584	19	-6912	19	-6168	19	-5448	19	-4704	19	-3984	19	-3240	19	-2496	19	-1776	19	-1032	19	-312
20	-8304	20	-7560	20	-6888	20	-6144	20	-5424	20	-4680	20	-3960	20	-3216	20	-2472	20	-1752	20	-1008	20	-288
21	-8280	21	-7536	21	-6864	21	-6120	21	-5400	21	-4656	21	-3936	21	-3192	21	-2448	21	-1728	21	-984	21	-264
22	-8256	22	-7512	22	-6840	22	-6096	22	-5376	22	-4632	22	-3912	22	-3168	22	-2424	22	-1704	22	-960	22	-240
23	-8232	23	-7488	23	-6816	23	-6072	23	-5352	23	-4608	23	-3888	23	-3144	23	-2400	23	-1680	23	-936	23	-216
24	-8208	24	-7464	24	-6792	24	-6048	24	-5328	24	-4584	24	-3864	24	-3120	24	-2376	24	-1656	24	-912	24	-192
25	-8184	25	-7440	25	-6768	25	-6024	25	-5304	25	-4560	25	-3840	25	-3096	25	-2352	25	-1632	25	-888	25	-168
26	-8160	26	-7416	26	-6744	26	-6000	26	-5280	26	-4536	26	-3816	26	-3072	26	-2328	26	-1608	26	-864	26	-144
27	-8136	27	-7392	27	-6720	27	-5976	27	-5256	27	-4512	27	-3792	27	-3048	27	-2304	27	-1584	27	-840	27	-120
28	-8112	28	-7368	28	-6696	28	-5952	28	-5232	28	-4488	28	-3768	28	-3024	28	-2280	28	-1560	28	-816	28	-96
29	-8088			29	-6672	29	-5928	29	-5208	29	-4464	29	-3744	29	-3000	29	-2256	29	-1536	29	-792	29	-72
30	-8064			30	-6648	30	-5904	30	-5184	30	-4440	30	-3720	30	-2976	30	-2232	30	-1512	30	-768	30	-48
31	-8040			31	-6624			31	-5160			31	-3696	31	-2952			31	-1488			31	-24

Table 4: Negative-Yearhour Calendar for Non-Leap Years. Each yearhour listed corresponds to 00:00:00 UT on the specified day.

1.5.5 Note on Sample Times

Two PIES models, URI and Sea Data (hereafter SD) were used during this deployment period. The URI models were used at sites G3, H3, and H5; all others were SDs. In Section 2, the URI models are indicated in the tables by serial numbers less than 63 and SDs by serial numbers 63 or greater. The SDs were produced by Sea Data Corporation and designed after the URI model.

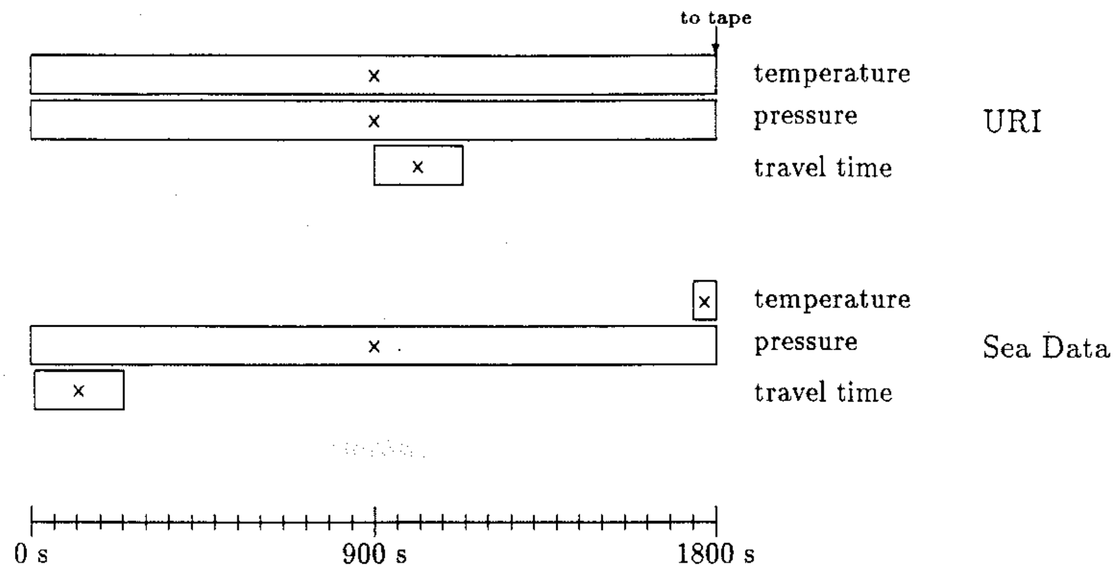


Figure 4: Sampling Sequences for URI and Sea Data Model IESs. The horizontal length and position of the boxes represent the duration and relative temporal location of the sampling periods, respectively. The center of each box is indicated by a ×. Each tick mark on the time axis represents a minute.

Although both models measure three variables, travel time, bottom pressure, and temperature, their sampling schemes are different. These are illustrated in Figure 4. Consider a typical 1800 s (0.5 hr) sampling interval. For comparison, it is useful to assign the time 0 s to the instant the previous sample is written to the tape. Then the time 1800 s corresponds to the instant the sample of interest is recorded. For both the URI and SD models, the travel time measurement consists of a burst of 24 pings at 10 s intervals and pressure is measured for the full 1800 s sampling interval. The URI models also measure temperature for the full 1800 s, whereas the temperature interval is reduced to only 56.25 s (a sixty-forth of an hour) in the SD models. The durations and relative temporal positioning of the three types of measurements are illustrated in Figure 4 for both models. The time base assigned to each variable coincides with the center of its measuring interval.

In the URI model, since both pressure and temperature are measured for 1800 s, their centers occur at 900 s. The travel time burst actually begins at that time, and thus its center is offset by 115 s.

The SD model PIES does its internal bookkeeping and storage to tape in the first 11.25 s of the 1800 s sampling interval. The travel time burst begins after this processing, so its center is located at 126.25 s (i.e. 115 + 11.25 s). The center of the half-hourly pressure measurement will occur at 900 s. The shorter temperature measurement occurs at the end of the 1800 s sampling interval, with its center at 1771.875 s (1800 - 56.25/2 sec).

In order to prevent time-basing errors related to these offsets, the travel time, pressure, and temperature were segregated at the FILL step: each variable was written to a separate file with the appropriate time base. In the past, the PIES's variables were separated after the SEACOR step.

1.6 Special Processing

1.6.1 IES90B1

The travel time record at site B1 was degraded by the presence of a deep scattering layer (DSL), which often obscured the surface throughout the deployment (Fig 5). The DSL migrated daily, up to the surface in the evenings (~1900 local) and back down below 285 m at dawn (~0600 local). This instrument was set to lock out any return echos prior to 2.25 s in order to focus upon the sea-surface echoes at about 2.60 to 2.65 s. Hence, if the DSL migrated too deep, its echos were locked out. During the night, the DSL's movements indicated passive sinking followed by a rapid re-ascent to the surface before the morning's downward migration.

Data quality oscillated between extremes, good data and no data, on a regular daily pattern. Often, during the day, the DSL traveled below the lockout depth, and the IES was able to sound the surface with little obstruction. The surface returns also tended to be better when the DSL was near the surface; this was likely because DSL was at it's furthest from the IES. Winter seemed to bring a better record, possibly in accordance with decreased biological density in that season. The travel time record required much

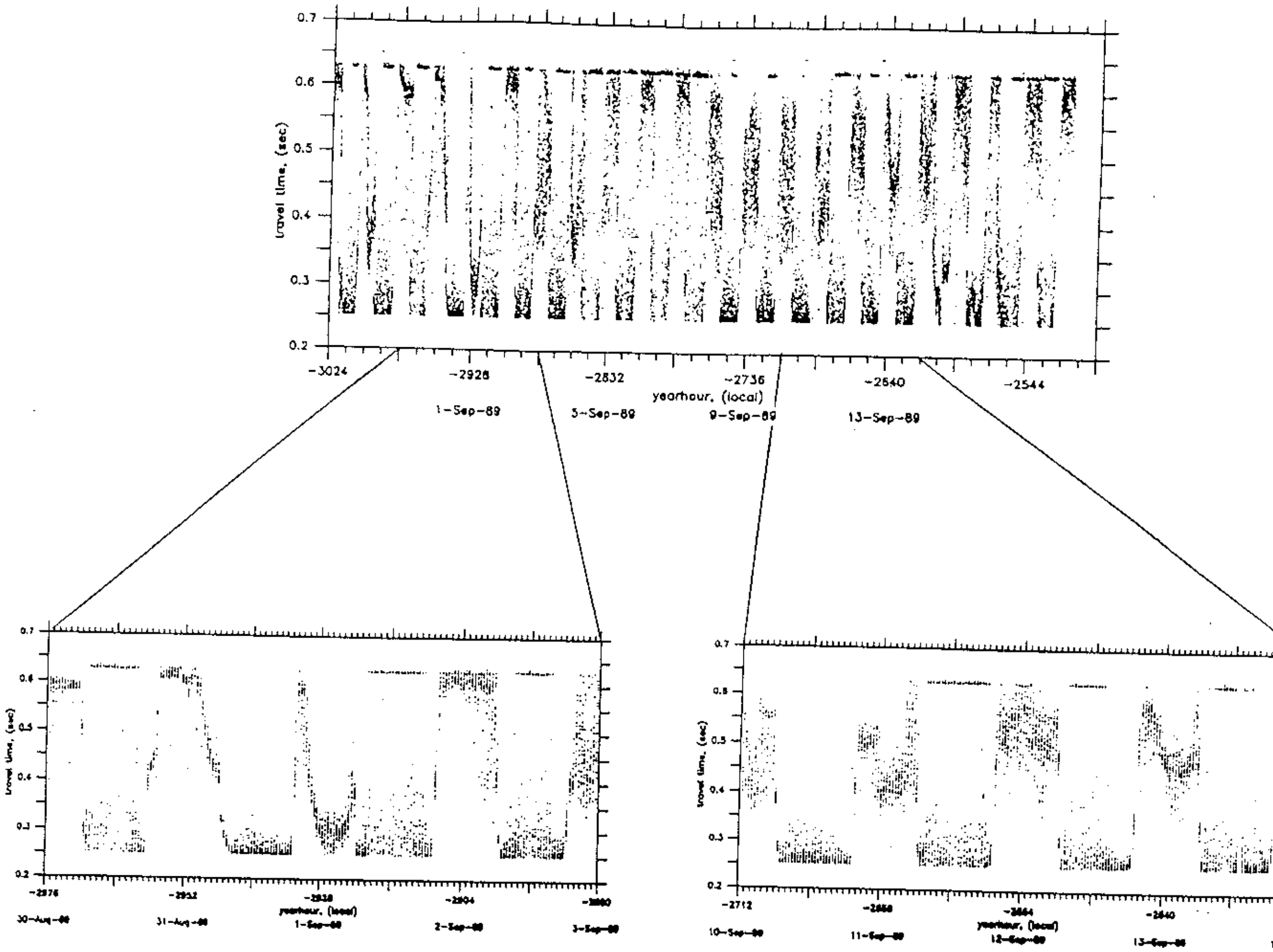


Figure 5: A subrecord from IES90B1 illustrates the deep scattering layer. Two sections of the upper plot are expanded to show the diel vertical migration. Date labels are centered at 0000 local time, and ticks are spaced 12 hours apart in the top plot, and 1 hour apart in the lower plots. The lockout depth and the surface are apparent at 0.225 s and 0.650 s, respectively.

interpolation, because nearly half of each day was dominated by spurious DSL echos, and 44% of the travel times were replaced.

The acoustic wavelength of the IES is about 15 cm (1500 ms^{-1}/ 10khz), so the scatterers must have been larger nekton or a very dense lamina (~15cm thick) of zooplankton. From the IES record, the DSL thickness was typically over 70 m, which supports the notion of an aggregation of fish rather than zooplankton. The sharp density contrast of a fish's swim bladder makes for a good acoustic scatterer. A DSL composed of mid-water fish was likely what the IES saw (K.Wishner personal communications).

In previous deployments, either the detection threshold was lower or the DSL sparser. The daily pattern was not as apparent and the high scatter was attributed to an overly sensitive echo detector. IES89B1 was reexamined more closely and the DSL's migration was recognized.

On the bright side, a valuable time series of long-term diel vertical migration was inadvertently collected. Acoustic studies of vertical migration have been of relatively short duration and typically in shallow waters. Prof. K. Wishner intends to use the IES record to calculate useful statistics about vertical migration.

1.6.2 IES90G1

The IES at G1 required special processing because the tape recording system did not work properly. All four tracks of the data cassette had been corrupted. The tape contained 391 overrun flags, 2221 short records, 2475 weak signals, and 5472 parity errors. Only eighty percent of the records were successfully read from tape (99-100% is the norm). The sequence number failed to increment monotonically and got progressively more disordered with time (Fig. 6). Good sequence numbers could usually be distinguished from bad (Table 5), because good sequence numbers incremented by multiples of two and were odd valued (URI model IESs have odd sequence number; SD, even). Though, late in the record the good sequence numbers changed from odd to even.

In addition to incrementing by multiples two, the "good" sequence numbers were assumed to be numerically correct: the sequence number increased by two each half hour from "final reset" to "off" without fail (with the one exception of the parity change). So "good" sequence numbers maintained the time base even with large groups of records absent. Consider Table 5, between the good sequence numbers in relative positions 2 and 9

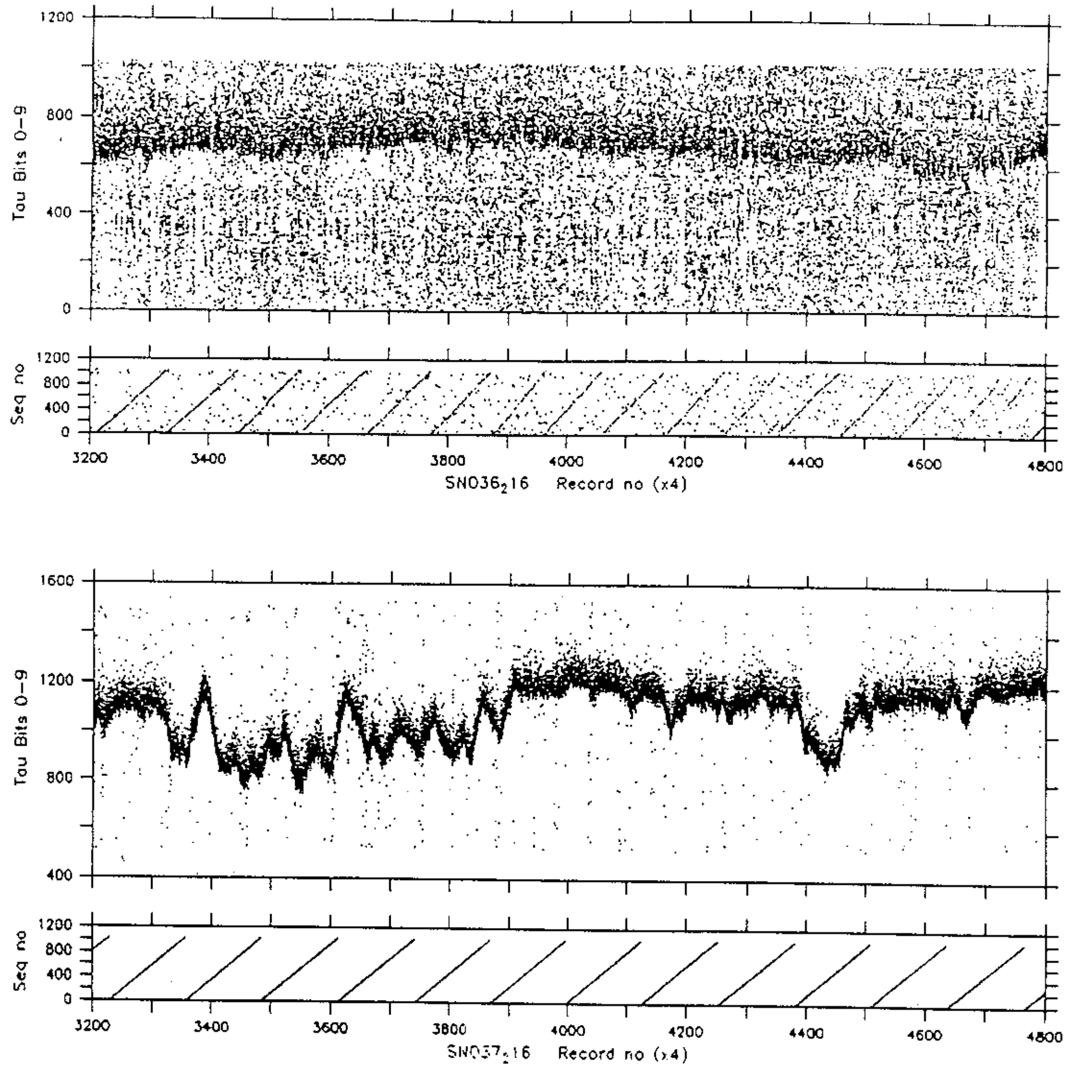


Figure 6: BUNS plot of G1 and F1. F1 was included here to illustrate a healthy record.

1	**36415**	good
2	**36417**	good
3	4403	
4	59957	
5	**36427**	good
6	5619	
7	26962	
8	35497	
9	**36439**	good
10	**36441**	good
11	**36443**	good
12	**36445**	good
13	35340	

Table 5: A group of consecutive sequence numbers for IES G1.

(in the table) ten records would be expected rather than just six. The assumption that was described above would imply that four records were missing, not recovered from the tape. The sequence number was converted to time at the MEMOD step using the time of final reset as a reference.

The FILL program checks for proper incrementation of time and inserts missing records by interpolation. FILL ran successfully, but first it was necessary to attend to many problem areas of the record. The problem areas resulted from sample times that were determined from bad, but properly spaced sequence number pairs. Such problem areas crashed the FILL routine. One of two problems would occur: 1) the number of missing records would exceed an acceptable limit or 2) the bad sample times would correspond to times earlier than those FILL had already processed. These sample times that FILL failed to recognize as bad were "hand-edited": the bad records where FILL failed were corrected by hand (in the text editor) to be consistent with surrounding good ones.

The change from odd to even sequence numbers posed another problem area, since it violated of the assumption that the sequence number increased properly through out the record. The question of what happened at that point was entwined in the problem of establishing the time base.

Fortunately, the ping burst documenting the last good record and the release were not missed. These events marked important time references which in addition to their "good' sequence numbers, indicated that five "garbage" records had been inserted into the record. These "garbage" records were conspicuous because they contained only zeros and separated two consecutive "good" records.

After these zeros-records were removed, a time history was established which was entirely consistent (all events at the proper time, launch and release, first and last good, and reset and off times). For consistency of the time base, an offset of three-quarters of an hour was required after the time of the even/odd change.

Arrays within the FILL program were redimensioned to accommodate the large gaps in the record. Several gaps were over a hundred records, however typically hiatuses were less than ten records. A great many records were filled by interpolation; so when plotted, a second trace was visible (Fig. 7) which resulted from interpolating between good data and bad-flag value of of 1.0 sec. The time base was corrected for clock drift after FILL

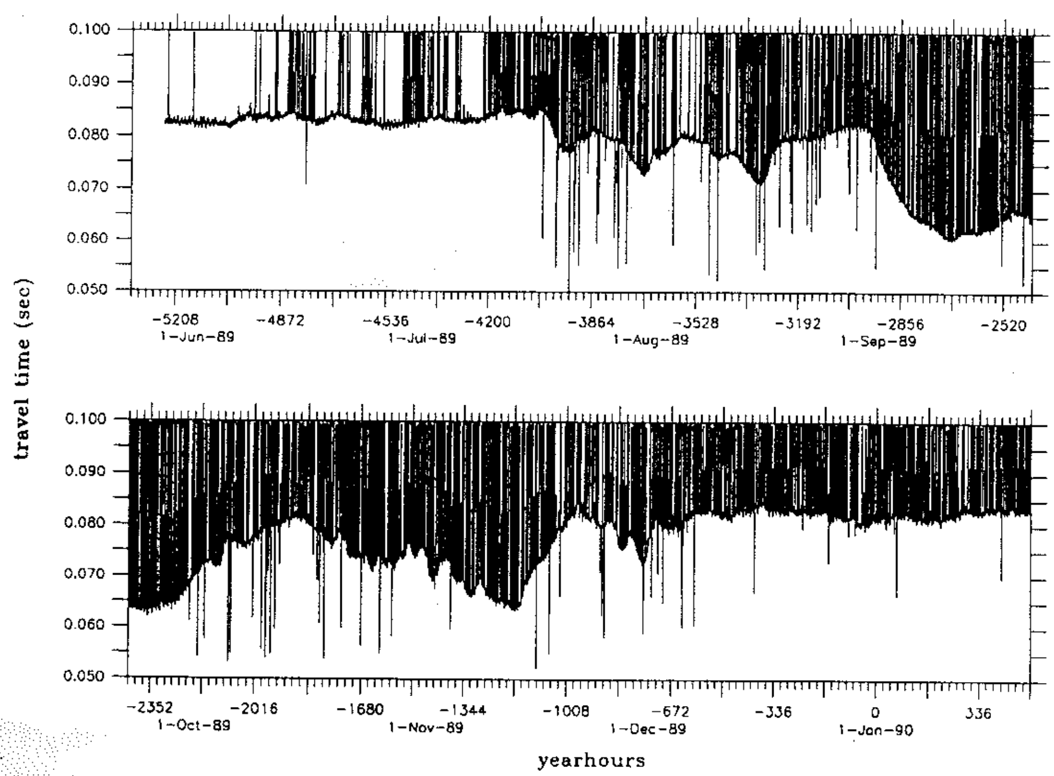


Figure 7: Plot of the resulting FILL record. The slightly higher trace results from interpolation between the main trace and the upper bound of 1.0 seconds

(this correction is usually incorporated into the time base at MEMOD), and bad data were replaced at the DESPIKE step. The final record shown in Section 3, Figure 9.12, was remarkably clean considering the original quality of the data.

1.6.3 PIES90G3

The PIES at G3 had a faulty temperature counter. The first seven bits were stuck, so it counted by 128 (Fig. 11.2). For the type of sensor used, pressure is calculated from the temperature and frequency of a quartz crystal; because the least count of G3 temperature was 128 rather than 1, the pressure was affected.

The effect on pressure caused by decreased temperature resolution was investigated using a healthy temperature record (PIES90I1). The healthy record was degraded to a steppy one: the counts were integer divided by 128 and then multiplied by 128. The pressure record calculated from the steppy temperature record was compared with the pressure record calculated from the normal smooth temperature record.

The difference between the two I1 pressure records indicated that no special processing was necessary. The degradation only introduced a small-amplitude noise of 0.0028 dbar (rms). The resolution appeared to matter little since the temperature was nearly constant near the ocean bottom (for the PIES in the Central Array, standard deviations typically varied between 0.01–0.02°C).

Since I1 required no special processing, G3 would not be expected to require any either (additionally, G3's temperature resolution was twice that of I1's; the different resolutions resulted from two different temperature calibrations: one for the URI model IESs and the other for SD models.)

1.6.4 PIES90H3

The temperature record for the H3 PIES was about 1°C higher than expected. At the other sites and at H3 in previous years, the temperature at the bottom has typically been around 2.5°C. PIES90H3's mean temperature was greater than the highest maximum bottom-temperature found in the Central Array. The one degree difference is larger than the accuracy of the thermistor (0.1°C).

A bit was assumed to be set that shouldn't have been. For the calibration of H3, 1°C corresponded to 4608 counts, so it seemed possible that the thirteenth bit (4096) had stuck "on". After the counts were reduced by 4096 the temperatures agreed with expected bottom temperatures. Though, when the IES was examined in the lab, the thirteenth bit functioned normally. Nevertheless, the 4096 count offset was retained in the final processing.

1.6.5 PIES90H6

The IES at H6 required special attention due to a unexpected reset fifteen days after it was launched. The "deadman" (also called the "watchdog") sequence must have activated. (The deadman sequence prevents the IES's cpu from latching up indefinitely. The cpu must reset a counter in the deadman circuit on a regular schedule; if it fails to do so the circuit reboots and resets the IES.)

The reset in PIES90H6 would have caused a hiccup in the sampling. Sea Data IESs, like H6, record to tape a half hour after sampling. A reset completely restarts the IES, and the previous sample, to be written to tape, is lost. The size of the gap was investigated by considering PIES90H6 to be composed to two records: a 15 day record with samples on the hour and half hour (which was the sample time at launch), and a 416 day record with samples at 19 min 42 sec and 49 min 42 sec after the hour (the sample time at recovery).

Since the clock drift (estimated from the difference in the master clock frequency at launch and recovery) was less than two minutes, the sampling intervals were taken to be exactly 0.5 hr. The time base for the subrecord before the reset was established from the time of *final reset*, the other subrecord was assigned a time base from the last good ping before the *off time*.

The sample times at launch and recovery were different by 19 minutes 42 seconds. The hiatus at the reset was an additional half hour longer than the expected 19 minutes 42 seconds. This suggested that the IES had reset twice: the first reset was unsuccessful and the second one was required before the half-hour sample time elapsed.

The short subrecord was interpolated to a sample time consistent with the long subrecord (XX:19:42,XX:49:42). Two samples were inserted to reconcile the two subrecords and form a single continuous record. For temperature and travel time, the inserted records were linearly interpolated. A quadratic form was used for pressure, since the parabola represented the trough-shape of low tide much better than a line.

The patch job appeared to be very good. Tidal analysis of the H6 bottom-pressure record gave a phase and amplitude for each of eight major tidal constituents that agreed with those of neighboring pressure records, thus confirming that the time base was correct.

Contour maps of phase and amplitude (for the major tidal constituents) across the array were plotted, and the maps were smooth and without aberration at H6.

1.6.6 PIES90H5, PIES90H6, PIES90I1, and PIES90I4

Although no special processing was required for these IESs, they are included in this section to document why they should be used with some caution. After low-pass filtering, these records appeared healthy but were not completely so. Figure 8 illustrates how the final product may not reflect the poor quality of the original raw data. These IESs' travel time measurements were degraded as a result of maladjustment of echo detectors relative to their smaller pinger transducers. Overly sensitive detectors triggered on ambient noise as well as, or instead of, the echo returning from the surface, which caused unusually high scatter.

The detection threshold is variable and depends on the ratio of the narrow- to broad-band signal (200 Hz vs. 1000 Hz centered on the out-going 10.24 KHz ping). While this guards against false triggering, it may also exclude good echoes in the presence of intense noise. If the detector fails to receive a suitable echo, a constant value is recorded as a "no echo" flag (the flags were 4351 for URI and 4352 for SD).

Travel time measurements at I1, I4, H5, and H6 were of notably lower quality characterized by high scatter and long periods of "no echos". IES I1 had only two months of usable travel-time record, the rest was composed entirely of "no echos". H5 failed to measure an echo for the first three months of its deployment, but afterwards gave a usable record.

At the MEMOD step, much of this bad data was identified: the 24 travel time measurements of each burst were "PUNS" windowed, "bin" windowed, and any "no echos" excluded, if less than four echos remained, the mode could not be properly estimated and was taken to be one of the "PUNS" window bounds. These bounds were easily distinguished from good data and removed in the DESPIKE step.

Large portions of each of these four records were replaced in the DESPIKE processing step (eg. 42% for I4).

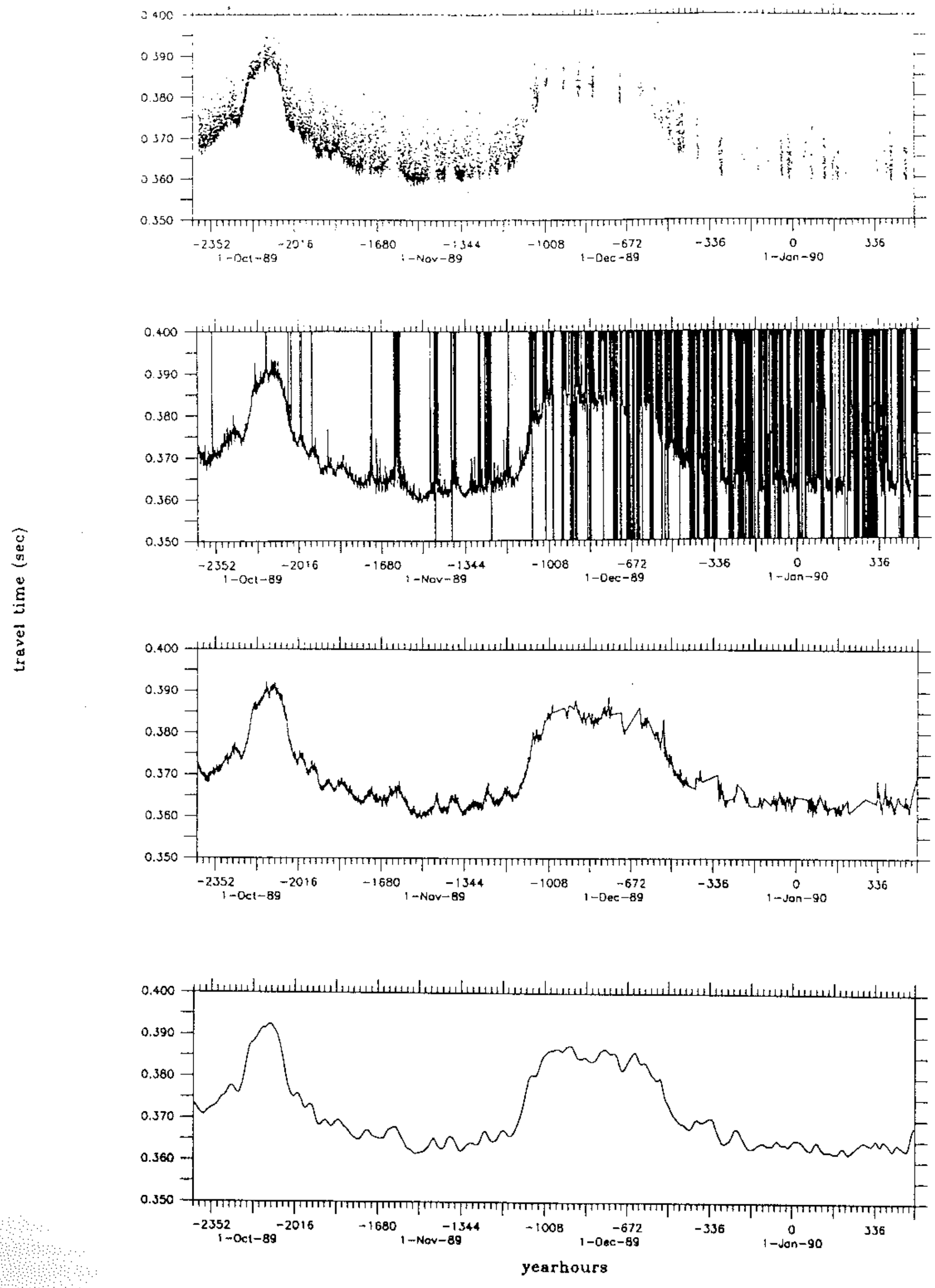


Figure 8: These plots show a subrecord (PIES90I4) at several processing stages. The quality of the data after low-pass filtering (bottom panel) does not reflect the poor quality of the original record (top).

2 Individual Site and Record Information Tables

The tables that follow provide information about the location, dates, and basic statistics of the data records. Each table documents a single instrument deployment. General site information, such as position, bottom depth, and launch and recovery times, is given first. Subsequently, details about the travel time, bottom pressure, temperature and thermocline depth records plotted in Sections 3–5 are tabulated. Tables supply the times associated with the first and last data point of each plot. All yearhours are referenced to January 1, 1990 at 0000 UT. Measurements made during the calendar year prior to the reference date are given as negative yearhours.

The first order statistics (minimum, maximum, mean, and standard deviation) are tabulated for the half-hourly and six-hourly low-passed records (40 HRLP) for each variable of standard IES and PIESs.

Note that the travel time displayed should not be interpreted as the absolute time required for a signal to make the round trip in 3000 – 5000m of water. The full round-trip time takes approximately 6 seconds and requires that a minimum of 18 bits be recorded on the internal cassette tape. For storage economy, only the 13 least significant bits are recorded. So, the full-scale range of the variation is approximately 200 msec. If wrapping occurs, it is only at the high or the low end of the window, never more than once around because the full scale variation of the signal is only 50 msec, and consequently it an unambiguous matter to unwrap the record. The variation in travel time is all that is required for subsequent interpretation and calibration against XBTs. After calibration to thermocline depth, the records from all IESs can easily be compared.

Table 6: **Site and Record Information for**

IES90A1

Serial Number: 080
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°12.32 N DEPTH: 2500 m
74°43.91 W

	DATE	UT	CRUISE
LAUNCH:	Aug 13, 1989	1008	OC210
RELEASE:	Sep 2, 1990	0337	EN216

TRAVEL TIME RECORDS

Figure 9.1 and 13.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 13, 1989	06:30:54	-3377.4851
LAST DATA POINT:	Sep 2, 1990	03:30:54	5859.5151

Number of Points: 18475
Sampling Interval: 0.50 hrs

Minimum τ = 0.145160 s Mean = 0.153347 s
Maximum τ = 0.162660 s Standard Deviation = 0.003472 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.1)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 3404.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 14, 1989	06:00:00	-3354.0000
LAST DATA POINT:	Sep 1, 1990	06:00:00	5838.0000

Number of Points: 1533
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 208.01 m Mean = 367.73 m
Maximum Z_{12} = 501.60 m Standard Deviation = 66.82 m

Table 7: **Site and Record Information for**

IES90A2

Serial Number: 057
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 34°58.18 N DEPTH: 3070 m
74°24.94 W

	DATE	UT	CRUISE
LAUNCH:	Aug 10, 1989	1830	OC210
RELEASE:	Sep 2, 1990	0718	EN216

TRAVEL TIME RECORDS

Figure 9.2 and 13.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 11, 1989	02:01:56	-3429.9680
LAST DATA POINT:	Sep 2, 1990	06:54:21	5862.9058

Number of Points: 18587
Sampling Interval: 0.50 hrs

Minimum τ = 0.086544 s Mean = 0.093061 s
Maximum τ = 0.104735 s Standard Deviation = 0.002826 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.1)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 2505.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 12, 1989	00:00:00	-3408.0000
LAST DATA POINT:	Sep 1, 1990	06:00:00	5838.0000

Number of Points: 1542
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 450.56 m Mean = 662.24 m
Maximum Z_{12} = 762.19 m Standard Deviation = 54.72 m

Table 8: **Site and Record Information for**

IES90B1

Serial Number: 035
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°45.13 N DEPTH:1975 m
74°27.90 W

	DATE	UT	CRUISE
LAUNCH:	Jun 10, 1989	1008	OC207
RELEASE:	Sep 1, 1990	0456	EN216

TRAVEL TIME RECORDS
Figure 9.3 and 13.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 10, 1989	11:01:56	-4908.9678
LAST DATA POINT:	Sep 1, 1990	04:23:02	5836.3838

Number of Points: 21492
Sampling Interval: 0.50 hrs

Minimum τ = 0.216606 s Mean = 0.224727 s
Maximum τ = 0.230038 s Standard Deviation = 0.002427 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.2)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4670.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 11, 1989	12:00:00	-4884.0000
LAST DATA POINT:	Aug 31, 1990	06:00:00	5814.0000

Number of Points: 1784
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 129.03 m Mean = 220.61 m
Maximum Z_{12} = 354.24 m Standard Deviation = 46.14 m

Table 9: **Site and Record Information for**

TIES90B3

Serial Number: 082
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°30.07 N DEPTH:2960 m
74°03.40 W

	DATE	UT	CRUISE
LAUNCH:	Aug 10, 1989	0932	OC210
RELEASE:	Sep 2, 1990	1250	EN216

TRAVEL TIME RECORDS

Figure 9.4 and 13.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 10, 1989	10:16:26	-3445.7261
LAST DATA POINT:	Sep 2, 1990	12:46:26	5868.7739

Number of Points: 18630
Sampling Interval: 0.50 hrs

Minimum τ = 0.342946 s   Mean = 0.352156 s
Maximum τ = 0.369696 s   Standard Deviation = 0.005141 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.2)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 7533.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 11, 1989	12:00:00	-3420.0000
LAST DATA POINT:	Sep 1, 1990	12:00:00	5844.0000

Number of Points: 1545
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 236.75 m   Mean = 560.57 m
Maximum Z_{12} = 722.87 m   Standard Deviation = 101.04 m

Table 10: **Site and Record Information for**

TIES90B4

Serial Number: 078
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°20.75 N DEPTH:3325 m
74°50.60 W

	DATE	UT	CRUISE
LAUNCH:	Aug 11, 1989	1859	OC210
RELEASE:	Sep 2, 1990	1551	EN216

TRAVEL TIME RECORDS
Figure 9.5 and 13.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 11, 1989	19:47:31	-3412.2080
LAST DATA POINT:	Sep 2, 1990	15:47:31	5871.7920

Number of Points: 18569
Sampling Interval: 0.50 hrs

Minimum τ = 0.046479 s Mean = 0.054428 s
Maximum τ = 0.067147 s Standard Deviation = 0.003803 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.2)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 1794.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 12, 1989	18:00:00	-3390.0000
LAST DATA POINT:	Sep 1, 1990	18:00:00	5850.0000

Number of Points: 1541
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 488.53 m Mean = 716.30 m
Maximum Z_{12} = 839.24 m Standard Deviation = 74.61 m

Table 11: **Site and Record Information for**

TIES90B5

Serial Number: 077
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°12.13 N   DEPTH:3675 m
73°39.66 W

	DATE	UT	CRUISE
LAUNCH:	Aug 11, 1989	1515	OC210
RELEASE:	Sep 2, 1990	1835	EN216

TRAVEL TIME RECORDS

Figure 9.6 and 13.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 11, 1989	16:17:51	-3415.7029
LAST DATA POINT:	Sep 2, 1990	18:17:49	5874.2969

Number of Points: 18581
Sampling Interval: 0.50 hrs

Minimum τ = 0.044367 s   Mean = 0.052144 s
Maximum τ = 0.059789 s   Standard Deviation = 0.002750 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.2)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 1808.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 12, 1989	18:00:00	-3390.0000
LAST DATA POINT:	Sep 1, 1990	18:00:00	5850.0000

Number of Points: 1541
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 644.83 m   Mean = 775.48 m
Maximum Z_{12} = 898.07 m   Standard Deviation = 53.28 m

Table 12: **Site and Record Information for**

IES90C1

Serial Number: 050
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 36°04.57 N DEPTH:3325 m
75°56.84 W

	DATE	UT	CRUISE
LAUNCH:	Jun 12, 1989	1015	OC207
RELEASE:	Sep 3, 1990	0637	EN216

TRAVEL TIME RECORDS
Figure 9.7 and 13.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 12, 1989	11:31:56	-4860.4678
LAST DATA POINT:	Sep 3, 1990	06:29:32	5886.4922

Number of Points: 21495
Sampling Interval: 0.50 hrs

Minimum τ = 0.189959 s   Mean = 0.204540 s
Maximum τ = 0.214809 s   Standard Deviation = 0.005093 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.3)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4314.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 13, 1989	12:00:00	-4836.0000
LAST DATA POINT:	Sep 2, 1990	06:00:00	5862.0000

Number of Points: 1784
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 84.68 m   Mean = 264.37 m
Maximum Z_{12} = 538.27 m   Standard Deviation = 99.91 m

Table 13: **Site and Record Information for**

TIES89C2

Serial Number: 074
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°46.15 N DEPTH:3450 m
73°33.00 W

	DATE	UT	CRUISE
LAUNCH:	Aug 12, 1989	1717	OC210
RELEASE:	Oct 17, 1989	0721	CH

TRAVEL TIME RECORDS

Figure 9.8 and 13.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 12, 1989	18:16:49	-3389.7200
LAST DATA POINT:	Oct 17, 1989	07:16:49	-1816.7200

Number of Points: 3147
Sampling Interval: 0.50 hrs

Minimum τ = 0.221453 s   Mean = 0.232955 s
Maximum τ = 0.242347 s   Standard Deviation = 0.004939 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.3)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4931.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 13, 1989	18:00:00	-3366.0000
LAST DATA POINT:	Oct 16, 1989	06:00:00	-1842.0000

Number of Points: 255
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 149.51 m   Mean = 313.70 m
Maximum Z_{12} = 522.32 m   Standard Deviation = 93.42 m

Table 14: **Site and Record Information for**

TIES90C2

Serial Number: 063
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 35°46.22 N 73°32.75 W DEPTH: ~3353 m

	DATE	UT	CRUISE
LAUNCH:	Oct 17, 1989	1015	CH
RELEASE:	Sep 3, 1990	0225	EN216

TRAVEL TIME RECORDS

Figure 9.9 and 13.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Oct 17, 1989	10:47:42	-1813.2050
LAST DATA POINT:	Sep 2, 1990	22:17:42	5878.2949

Number of Points: 15384
Sampling Interval: 0.50 hrs

Minimum τ = 0.195413 s Mean = 0.204293 s
Maximum τ = 0.216236 s Standard Deviation = 0.003630 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.3)

Z_{12} Conversion equation: $Z_{12} = -19800\text{m s}^{-1} \cdot \tau_d + B$
where B = 4732.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Oct 18, 1989	12:00:00	-1788.0000
LAST DATA POINT:	Sep 2, 1990	00:00:00	5856.0000

Number of Points: 1275
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 477.03 m Mean = 686.33 m
Maximum Z_{12} = 834.09 m Standard Deviation = 70.63 m

Table 15: **Site and Record Information for**

IES90F1

Serial Number: 037
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 37°56.96 N DEPTH: 3900 m
69°58.19 W

	DATE	UT	CRUISE
LAUNCH:	Jun 5, 1989	0906	OC207
RELEASE:	Aug 20, 1990	1023	EN216

TRAVEL TIME RECORDS

Figure 9.10 and 13.4

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	10:16:56	-5029.7178
LAST DATA POINT:	Aug 20, 1990	10:09:00	5554.1499

Number of Points: 21169
Sampling Interval: 0.50 hrs

Minimum τ = 0.377775 s Mean = 0.399626 s
Maximum τ = 0.413182 s Standard Deviation = 0.007633 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.4)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 8226.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	12:00:00	-5004.0000
LAST DATA POINT:	Aug 19, 1990	12:00:00	5532.0000

Number of Points: 1757
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 76.88 m Mean = 314.08 m
Maximum Z_{12} = 715.71 m Standard Deviation = 150.25 m

Table 16: **Site and Record Information for**

IES90F2

Serial Number: 062
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 37°24.62 N 69°46.59 W DEPTH: 4245 m

	DATE	UT	CRUISE
LAUNCH:	Aug 14, 1989	0415	OC210
RELEASE:	Aug 20, 1990	0006	EN216

TRAVEL TIME RECORDS

Figure 9.11 and 13.4

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 14, 1989	05:32:00	-3354.4670
LAST DATA POINT:	Aug 19, 1990	23:59:49	5543.9971

Number of Points: 17798
Sampling Interval: 0.50 hrs

Minimum τ = 0.030221 s Mean = 0.041120 s
Maximum τ = 0.067455 s Standard Deviation = 0.006076 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.4)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 1532.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	06:00:00	-3330.0000
LAST DATA POINT:	Aug 19, 1990	00:00:00	5520.0000

Number of Points: 1476
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 247.36 m Mean = 718.03 m
Maximum Z_{12} = 901.56 m Standard Deviation = 119.94 m

Table 17: **Site and Record Information for**

IES90G1

Serial Number: 036
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 38°37.63 N 69°25.39 W DEPTH: 4245 m

	DATE	UT	CRUISE
LAUNCH:	May 27, 1989	0811	OC207
RELEASE:	Aug 20, 1990	1622	EN216

TRAVEL TIME RECORDS

Figure 9.12 and 13.5

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 27, 1989	09:01:56	-5246.9678
LAST DATA POINT:	Aug 20, 1990	15:58:30	5559.9751

Number of Points: 21615
Sampling Interval: 0.50 hrs

Minimum τ = 0.061845 s Mean = 0.081119 s
Maximum τ = 0.089505 s Standard Deviation = 0.005441 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.5)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 1819.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 28, 1989	06:00:00	-5226.0000
LAST DATA POINT:	Aug 19, 1990	18:00:00	5538.0000

Number of Points: 1795
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 84.98 m Mean = 213.09 m
Maximum Z_{12} = 581.99 m Standard Deviation = 107.20 m

Table 18: **Site and Record Information for**

PIES90G2

Serial Number: 067
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33824

POSITION: 37°47.80 N   DEPTH: 4088 m
69°24.23 W

	DATE	UT	CRUISE
LAUNCH:	Jun 5, 1989	2000	OC207
RELEASE:	Aug 20, 1990	0415	EN216

TRAVEL TIME RECORDS

Figure 9.13 and 13.5

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	21:16:56	-5018.7178
LAST DATA POINT:	Aug 20, 1990	04:19:01	5548.3169

Number of Points: 21135
Sampling Interval: 0.50 hrs

Minimum τ = 0.187813 s   Mean = 0.205926 s
Maximum τ = 0.227940 s   Standard Deviation = 0.010969 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.5)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4553.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	18:00:00	-4998.0000
LAST DATA POINT:	Aug 19, 1990	06:00:00	5526.0000

Number of Points: 1755
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 67.26 m   Mean = 476.16 m
Maximum Z_{12} = 804.49 m   Standard Deviation = 216.61 m

PIES90G2 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	21:29:49	-5018.5029
LAST DATA POINT:	Aug 20, 1990	04:01:56	5548.0322

Number of Points: 21134
Sampling Interval: 0.50 hrs

Minimum P = 4140.46 dbar   Mean = 4141.43 dbar
Maximum P = 4142.08 dbar   Standard Deviation = 0.39 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.1 and 14.1

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

DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42838	0.09871	0.09290	0.02197	0.08285	0.06433	0.02733	0.01379
G° :	352.382	331.741	20.558	21.956	177.199	182.775	177.755	183.096

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	09:29:49	-5006.5029
LAST DATA POINT:	Aug 20, 1990	04:01:56	5548.0322

Number of Points: 21110
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.1439 dbar   Mean = -0.0001 dbar
Maximum P_{res} = 0.1597 dbar   Standard Deviation = 0.0514 dbar

PIES90G2 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	06:00:00	-4986.0000
LAST DATA POINT:	Aug 19, 1990	06:00:00	5526.0000

Number of Points: 1753
Sampling Interval: 6.0 hrs

Minimum P = -0.1150 dbar   Mean = -0.0002 dbar
Maximum P = 0.1405 dbar   Standard Deviation = 0.0495 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.1 and 15.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	21:44:20	-5018.2612
LAST DATA POINT:	Aug 20, 1990	04:16:26	5548.2739

Number of Points: 21134
Sampling Interval: 0.50 hrs

Minimum T = 2.40°C   Mean = 2.44 °C
Maximum T = 2.55°C   Standard Deviation = 0.01 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	06:00:00	-4986.0000
LAST DATA POINT:	Aug 19, 1990	06:00:00	5526.0000

Number of Points: 1753
Sampling Interval: 6.0 hrs

Minimum T = 2.407°C   Mean = 2.437 °C
Maximum T = 2.522°C   Standard Deviation = 0.012°C

Table 19: **Site and Record Information for**

PIES90G3

Serial Number: 055
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 36873

POSITION: 37°16.99 N DEPTH: 4358 m
69°14.71 W

	DATE	UT	CRUISE
LAUNCH:	May 29, 1989	0454	OC207
RELEASE:	Aug 19, 1990	0558	EN216

TRAVEL TIME RECORDS

Figure 9.14 and 13.5

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 29, 1989	06:01:51	-5201.9692
LAST DATA POINT:	Aug 19, 1990	08:28:23	5528.4731

Number of Points: 21462
Sampling Interval: 0.50 hrs

Minimum τ = 0.189146 s   Mean = 0.201227 s
Maximum τ = 0.231113 s   Standard Deviation = 0.009407 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.5)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4664.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 30, 1989	06:00:00	-5178.0000
LAST DATA POINT:	Aug 18, 1990	12:00:00	5508.0000

Number of Points: 1782
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 132.06 m   Mean = 679.79 m
Maximum Z_{12} = 900.36 m   Standard Deviation = 185.95 m

PIES90G3 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 29, 1989	05:59:56	-5202.0010
LAST DATA POINT:	Aug 19, 1990	08:26:27	5528.4409

Number of Points: 21462
Sampling Interval: 0.50 hrs

Minimum P = 4459.33 dbar   Mean = 4460.35 dbar
Maximum P = 4461.25 dbar   Standard Deviation = 0.37 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.2 and 14.1

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

DRIFT = $Ae^{-\lambda t} + B$

where t = Time of sample in hours, starting with t = 13.0 hrs for the first data point

A = 0.201600 dbar

λ = $+0.000732$ hr^{-1}

B = -0.025723 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42800	0.09889	0.09261	0.02189	0.08155	0.06409	0.02687	0.01399
G° :	353.004	332.323	21.187	22.543	177.997	183.404	178.489	184.059

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 29, 1989	17:59:56	-5190.0010
LAST DATA POINT:	Aug 19, 1990	08:26:27	5528.4409

Number of Points: 21438
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.1982 dbar   Mean = 0.0000 dbar
Maximum P_{res} = 0.2007 dbar   Standard Deviation = 0.0553 dbar

PIES90G3 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 30, 1989	18:00:00	-5166.0000
LAST DATA POINT:	Aug 18, 1990	12:00:00	5508.0000

Number of Points: 1780
Sampling Interval: 6.0 hrs

Minimum P = -0.1778 dbar   Mean = -0.0003 dbar
Maximum P = 0.1788 dbar   Standard Deviation = 0.0536 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.2 and 15.1

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 29, 1989	06:00:00	-5202.0000
LAST DATA POINT:	Aug 19, 1990	08:26:34	5528.4429

Number of Points: 21462
Sampling Interval: 0.50 hrs

Minimum T = 2.31°C   Mean = 2.36 °C
Maximum T = 7.58°C   Standard Deviation = 0.04 °C

Table 20: **Site and Record Information for**

IES90G4

Serial Number: 076
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 36°33.00 N 68°39.96 W DEPTH: 4680 m

	DATE	UT	CRUISE
LAUNCH:	Jun 17, 1989	1108	OC207
RELEASE:	Aug 9, 1990	0705	EN216

TRAVEL TIME RECORDS

Figure 9.15 and 13.5

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 17, 1989	12:12:18	-4739.7949
LAST DATA POINT:	Aug 9, 1990	06:42:18	5286.7051

Number of Points: 20054
Sampling Interval: 0.50 hrs

Minimum τ = 0.237753 s   Mean = 0.250853 s
Maximum τ = 0.278210 s   Standard Deviation = 0.007649 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.5)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 5727.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 18, 1989	12:00:00	-4716.0000
LAST DATA POINT:	Aug 8, 1990	06:00:00	5262.0000

Number of Points: 1664
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 245.96 m   Mean = 759.87 m
Maximum Z_{12} = 992.26 m   Standard Deviation = 150.90 m

Table 21: **Site and Record Information for**

IES90H1

Serial Number: 044
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 38°59.85 N 68°39.92 W DEPTH: 3255 m

	DATE	UT	CRUISE
LAUNCH:	Jun 2, 1989	0513	OC207
RELEASE:	Aug 15, 1990	0810	EN216

TRAVEL TIME RECORDS

Figure 9.16 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 2, 1989	06:02:00	-5105.9668
LAST DATA POINT:	Aug 15, 1990	07:58:30	5431.9751

Number of Points: 21077
Sampling Interval: 0.50 hrs

Minimum τ = 0.321447 s Mean = 0.341838 s
Maximum τ = 0.351372 s Standard Deviation = 0.006499 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 7020.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 3, 1989	06:00:00	-5082.0000
LAST DATA POINT:	Aug 14, 1990	06:00:00	5406.0000

Number of Points: 1749
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 92.06 m Mean = 251.90 m
Maximum Z_{12} = 625.19 m Standard Deviation = 128.41 m

Table 22: **Site and Record Information for**

PIES90H2

Serial Number: 071
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31724

POSITION: 38°37.78 N DEPTH: 3458 m
68°54.90 W

	DATE	UT	CRUISE
LAUNCH:	Aug 15, 1989	1217	OC210
RELEASE:	Aug 11, 1990	0709	EN216

TRAVEL TIME RECORDS
Figure 9.17 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	13:32:21	-3322.4609
LAST DATA POINT:	Aug 11, 1990	07:02:21	5335.0391

Number of Points: 17316
Sampling Interval: 0.50 hrs

Minimum τ = 0.193065 s Mean = 0.214549 s
Maximum τ = 0.225445 s Standard Deviation = 0.006998 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4453.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	12:00:00	-3300.0000
LAST DATA POINT:	Aug 10, 1990	06:00:00	5310.0000

Number of Points: 1436
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 1.80 m Mean = 204.38 m
Maximum Z_{12} = 601.39 m Standard Deviation = 137.62 m

PIES90H2 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	13:45:14	-3322.2461
LAST DATA POINT:	Aug 11, 1990	06:45:14	5334.7539

Number of Points: 17315
Sampling Interval: 0.50 hrs

Minimum P = 3514.75 dbar   Mean = 3515.81 dbar
Maximum P = 3516.38 dbar   Standard Deviation = 0.49 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.3 and 14.2

$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$
DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42338	0.09771	0.09392	0.02234	0.08233	0.06376	0.02717	0.01356
G° :	352.406	331.618	19.942	21.067	176.062	181.702	176.696	181.465

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	01:45:14	-3310.2461
LAST DATA POINT:	Aug 11, 1990	06:45:14	5334.7539

Number of Points: 17291
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.1332 dbar   Mean = -0.0001 dbar
Maximum P_{res} = 0.1678 dbar   Standard Deviation = 0.0437 dbar

PIES90H2 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	00:00:00	-3288.0000
LAST DATA POINT:	Aug 10, 1990	06:00:00	5310.0000

Number of Points: 1434
Sampling Interval: 6.0 hrs

Minimum P = -0.1035 dbar Mean = -0.0001 dbar
Maximum P = 0.1489 dbar Standard Deviation = 0.0417 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.3 and 15.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	13:59:46	-3322.0039
LAST DATA POINT:	Aug 11, 1990	06:59:46	5334.9961

Number of Points: 17315
Sampling Interval: 0.50 hrs

Minimum T = 2.28°C Mean = 2.38 °C
Maximum T = 2.60°C Standard Deviation = 0.05 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	00:00:00	-3288.0000
LAST DATA POINT:	Aug 10, 1990	06:00:00	5310.0000

Number of Points: 1434
Sampling Interval: 6.0 hrs

Minimum T = 2.279°C Mean = 2.378 °C
Maximum T = 2.542°C Standard Deviation = 0.049°C

Table 23: **Site and Record Information for**

PIES90H3

Serial Number: 053
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 19327

POSITION: 38°10.09 N DEPTH: 4025 m
68°43.65 W

	DATE	UT	CRUISE
LAUNCH:	Aug 15, 1989	1632	OC210
RELEASE:	Aug 15, 1990	2018	EN216

TRAVEL TIME RECORDS

Figure 9.18 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	17:31:30	-3318.4751
LAST DATA POINT:	Aug 15, 1990	20:01:30	5444.0249

Number of Points: 17526
Sampling Interval: 0.50 hrs

Minimum τ = 0.137551 s Mean = 0.158885 s
Maximum τ = 0.175709 s Standard Deviation = 0.011610 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 3549.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	18:00:00	-3294.0000
LAST DATA POINT:	Aug 15, 1990	00:00:00	5424.0000

Number of Points: 1454
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 93.85 m Mean = 403.45 m
Maximum Z_{12} = 797.77 m Standard Deviation = 229.79 m

PIES90H3 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.4

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	17:29:35	-3318.5071
LAST DATA POINT:	Aug 15, 1990	19:59:35	5443.9932

Number of Points: 17526
Sampling Interval: 0.50 hrs

Minimum P = 4096.90 dbar   Mean = 4097.36 dbar
Maximum P = 4098.58 dbar   Standard Deviation = 0.48 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.4 and 14.2

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

DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42509	0.09856	0.09409	0.02238	0.08186	0.06349	0.02701	0.01354
G° :	352.763	331.883	20.636	21.775	176.398	182.127	177.095	181.441

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	05:29:35	-3306.5071
LAST DATA POINT:	Aug 15, 1990	19:59:35	5443.9932

Number of Points: 17502
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.2073 dbar   Mean = 0.0001 dbar
Maximum P_{res} = 0.1719 dbar   Standard Deviation = 0.0701 dbar

PIES90H3 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	06:00:00	-3282.0000
LAST DATA POINT:	Aug 14, 1990	18:00:00	5418.0000

Number of Points: 1451
Sampling Interval: 6.0 hrs

Minimum P = -0.1829 dbar   Mean = 0.0001 dbar
Maximum P = 0.1545 dbar   Standard Deviation = 0.0685 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.4 and 15.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	17:29:35	-3318.5071
LAST DATA POINT:	Aug 15, 1990	19:59:35	5443.9932

Number of Points: 17526
Sampling Interval: 0.50 hrs

Minimum T = 2.15°C   Mean = 2.18 °C
Maximum T = 2.34°C   Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	06:00:00	-3282.0000
LAST DATA POINT:	Aug 14, 1990	18:00:00	5418.0000

Number of Points: 1451
Sampling Interval: 6.0 hrs

Minimum T = 2.149°C   Mean = 2.183 °C
Maximum T = 2.321°C   Standard Deviation = 0.022°C

Table 24: **Site and Record Information for**

PIES90H4

Serial Number: 065
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 28197

POSITION: 37°39.57 N DEPTH: 4445 m
68°35.35 W

	DATE	UT	CRUISE
LAUNCH:	Aug 15, 1989	2021	OC210
RELEASE:	Aug 18, 1990	0426	EN216

TRAVEL TIME RECORDS
Figure 9.19 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	21:32:10	-3314.4641
LAST DATA POINT:	Aug 18, 1990	04:02:10	5500.0361

Number of Points: 17630
Sampling Interval: 0.50 hrs

Minimum τ = 0.303573 s Mean = 0.319818 s
Maximum τ = 0.346525 s Standard Deviation = 0.012155 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 6947.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	18:00:00	-3294.0000
LAST DATA POINT:	Aug 17, 1990	06:00:00	5478.0000

Number of Points: 1463
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 107.79 m Mean = 615.00 m
Maximum Z_{12} = 913.28 m Standard Deviation = 239.96 m

PIES90H4 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.5

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	21:45:04	-3314.2490
LAST DATA POINT:	Aug 18, 1990	04:15:04	5500.2510

Number of Points: 17630
Sampling Interval: 0.50 hrs

Minimum P = 4552.16 dbar   Mean = 4552.39 dbar
Maximum P = 4553.91 dbar   Standard Deviation = 0.63 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.5 and 14.2

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

DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42565	0.09851	0.09421	0.02241	0.08102	0.06296	0.02673	0.01344
G° :	352.826	331.998	20.985	22.243	177.061	182.963	177.736	182.615

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	09:45:04	-3302.2490
LAST DATA POINT:	Aug 18, 1990	04:15:04	5500.2510

Number of Points: 17606
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.2227 dbar   Mean = 0.0001 dbar
Maximum P_{res} = 0.2597 dbar   Standard Deviation = 0.0600 dbar

PIES90H4 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	06:00:00	-3282.0000
LAST DATA POINT:	Aug 17, 1990	06:00:00	5478.0000

Number of Points: 1461
Sampling Interval: 6.0 hrs

Minimum P = -0.2101 dbar Mean = 0.0003 dbar
Maximum P = 0.2090 dbar Standard Deviation = 0.0584 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.5 and 15.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	21:59:35	-3314.0071
LAST DATA POINT:	Aug 18, 1990	04:29:35	5500.4932

Number of Points: 17630
Sampling Interval: 0.50 hrs

Minimum T = 2.26°C Mean = 2.33 °C
Maximum T = 2.46°C Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	06:00:00	-3282.0000
LAST DATA POINT:	Aug 17, 1990	06:00:00	5478.0000

Number of Points: 1461
Sampling Interval: 6.0 hrs

Minimum T = 2.257°C Mean = 2.326 °C
Maximum T = 2.376°C Standard Deviation = 0.014°C

Table 25: **Site and Record Information for**

PIES90H5

Serial Number: 054
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 17849

POSITION: 37°10.23 N 68°17.83 W DEPTH: 4800 m

	DATE	UT	CRUISE
LAUNCH:	Aug 14, 1989	1954	OC210
RELEASE:	Aug 17, 1990	2330	EN216

TRAVEL TIME RECORDS

Figure 9.20 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Nov 25, 1989	04:31:12	-883.4800
LAST DATA POINT:	Aug 17, 1990	22:29:20	5494.4888

Number of Points: 12757
Sampling Interval: 0.50 hrs

Minimum τ = 0.390364 s Mean = 0.401428 s
Maximum τ = 0.431109 s Standard Deviation = 0.008534 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 8654.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Nov 26, 1989	06:00:00	-858.0000
LAST DATA POINT:	Aug 17, 1990	00:00:00	5472.0000

Number of Points: 1056
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 156.41 m Mean = 704.94 m
Maximum Z_{12} = 896.81 m Standard Deviation = 168.33 m

PIES90H5 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 14, 1989	21:30:00	-3338.5000
LAST DATA POINT:	Aug 17, 1990	23:27:25	5495.4570

Number of Points: 17669
Sampling Interval: 0.50 hrs

Minimum P = 4936.24 dbar Mean = 4936.49 dbar
Maximum P = 4938.11 dbar Standard Deviation = 0.76 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.6 and 14.2

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$
DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42305	0.09753	0.09398	0.02236	0.07963	0.06204	0.02626	0.01333
G° :	353.125	332.212	21.364	22.676	177.468	183.397	178.104	183.380

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 15, 1989	09:30:00	-3326.5000
LAST DATA POINT:	Aug 17, 1990	23:27:25	5495.4570

Number of Points: 17645
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.3459 dbar Mean = 0.0002 dbar
Maximum P_{res} = 0.2349 dbar Standard Deviation = 0.0942 dbar

PIES90H5 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	06:00:00	-3306.0000
LAST DATA POINT:	Aug 17, 1990	00:00:00	5472.0000

Number of Points: 1464
Sampling Interval: 6.0 hrs

Minimum P = -0.3359 dbar Mean = 0.0002 dbar
Maximum P = 0.1818 dbar Standard Deviation = 0.0930 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.6 and 15.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 14, 1989	21:30:00	-3338.5000
LAST DATA POINT:	Aug 17, 1990	23:27:25	5495.4570

Number of Points: 17669
Sampling Interval: 0.50 hrs

Minimum T = 2.27°C Mean = 2.32 °C
Maximum T = 2.40°C Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	06:00:00	-3306.0000
LAST DATA POINT:	Aug 17, 1990	00:00:00	5472.0000

Number of Points: 1464
Sampling Interval: 6.0 hrs

Minimum T = 2.275°C Mean = 2.323 °C
Maximum T = 2.368°C Standard Deviation = 0.016°C

Table 26: **Site and Record Information for**

PIES90H6

Serial Number: 066
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31162

POSITION: 36°39.35 N DEPTH: 4840 m
68°15.~~10~~ 70 W

	DATE	UT	CRUISE
LAUNCH:	Jun 4, 1989	0110	OC207
RELEASE:	Aug 9, 1990	1130	EN216

TRAVEL TIME RECORDS

Figure 9.21 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	02:51:36	-5061.1401
LAST DATA POINT:	Aug 9, 1990	11:21:36	5291.3599

Number of Points: 20706
Sampling Interval: 0.50 hrs

Minimum τ = 0.060276 s Mean = 0.078516 s
Maximum τ = 0.110328 s Standard Deviation = 0.011145 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 2190.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	00:00:00	-5040.0000
LAST DATA POINT:	Aug 8, 1990	12:00:00	5268.0000

Number of Points: 1719
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 58.30 m Mean = 635.06 m
Maximum Z_{12} = 955.40 m Standard Deviation = 219.98 m

PIES90H6 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	03:04:31	-5060.9248
LAST DATA POINT:	Aug 9, 1990	11:04:31	5291.0752

Number of Points: 20705
Sampling Interval: 0.50 hrs

Minimum P = 4995.03 dbar Mean = 4996.47 dbar
Maximum P = 4997.08 dbar Standard Deviation = 0.47 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.7 and 14.2

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

DRIFT = $Ae^{-\lambda t} + B$

where t = Time of sample in hours, starting with t = 13.0 hrs for the first data point

$A =$ −0.445700 dbar

$\lambda =$ +0.000573 hr^{-1}

$B =$ 0.075302 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42197	0.09695	0.09312	0.02209	0.07906	0.06199	0.02606	0.01348
G° :	352.959	332.030	21.280	22.672	177.679	183.525	178.274	183.730

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	15:04:31	-5048.9248
LAST DATA POINT:	Aug 9, 1990	11:04:31	5291.0752

Number of Points: 20681
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.2270 dbar Mean = 0.0000 dbar
Maximum P_{res} = 0.2173 dbar Standard Deviation = 0.0807 dbar

PIES90H6 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	12:00:00	-5028.0000
LAST DATA POINT:	Aug 8, 1990	12:00:00	5268.0000

Number of Points: 1717
Sampling Interval: 6.0 hrs

Minimum P = -0.2123 dbar Mean = -0.0001 dbar
Maximum P = 0.1952 dbar Standard Deviation = 0.0798 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.7 and 15.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	03:19:01	-5060.6831
LAST DATA POINT:	Aug 9, 1990	11:49:01	5291.8169

Number of Points: 20706
Sampling Interval: 0.50 hrs

Minimum T = 2.52°C Mean = 2.58 °C
Maximum T = 2.70°C Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.2

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	12:00:00	-5028.0000
LAST DATA POINT:	Aug 8, 1990	12:00:00	5268.0000

Number of Points: 1717
Sampling Interval: 6.0 hrs

Minimum T = 2.527°C Mean = 2.583 °C
Maximum T = 2.624°C Standard Deviation = 0.016°C

Table 27: **Site and Record Information for**

IES90H7

Serial Number: 058
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 36°24.92 N DEPTH: 4910 m
68°47.81 W

	DATE	UT	CRUISE
LAUNCH:	Aug 16, 1989	1503	OC210
RELEASE:	Aug 9, 1990	0038	EN216

TRAVEL TIME RECORDS

Figure 9.22 and 13.6

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 16, 1989	16:01:45	-3295.9709
LAST DATA POINT:	Aug 9, 1990	00:01:44	5280.0288

Number of Points: 17153
Sampling Interval: 0.50 hrs

Minimum τ = 0.109349 s Mean = 0.122997 s
Maximum τ = 0.151765 s Standard Deviation = 0.009359 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.6)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 3173.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Aug 17, 1989	18:00:00	-3270.0000
LAST DATA POINT:	Aug 8, 1990	00:00:00	5256.0000

Number of Points: 1422
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 184.38 m Mean = 738.88 m
Maximum Z_{12} = 982.62 m Standard Deviation = 183.18 m

Table 28: **Site and Record Information for**

PIES90I1

Serial Number: 081
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 36883

POSITION: 38°47.58 N DEPTH: 3828 m
68°06.25 W

	DATE	UT	CRUISE
LAUNCH:	May 30, 1989	1954	OC207
RELEASE:	Aug 17, 1990	0732	EN216

TRAVEL TIME RECORDS
Figure 9.23 and 13.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 30, 1989	21:01:56	-5162.9678
LAST DATA POINT:	Jul 30, 1989	23:31:30	-3696.4751

Number of Points: 2934
Sampling Interval: 0.50 hrs

Minimum τ = 0.277595 s Mean = 0.296853 s
Maximum τ = 0.307861 s Standard Deviation = 0.007941 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.7)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 6127.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 31, 1989	18:00:00	-5142.0000
LAST DATA POINT:	Jul 30, 1989	00:00:00	-3720.0000

Number of Points: 238
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 69.46 m Mean = 250.08 m
Maximum Z_{12} = 601.15 m Standard Deviation = 157.98 m

PIES90I1 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 30, 1989	21:14:49	-5162.7529
LAST DATA POINT:	Aug 17, 1990	07:41:38	5479.6938

Number of Points: 21286
Sampling Interval: 0.50 hrs

Minimum P = 3887.99 dbar   Mean = 3888.26 dbar
Maximum P = 3889.67 dbar   Standard Deviation = 0.55 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.8 and 14.3

$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$
DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42348	0.09758	0.09411	0.02241	0.08123	0.06264	0.02676	0.01348
G° :	352.533	331.873	20.573	21.886	175.024	181.058	175.592	181.644

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 31, 1989	09:14:49	-5150.7529
LAST DATA POINT:	Aug 17, 1990	07:41:38	5479.6938

Number of Points: 21262
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.1615 dbar   Mean = -0.0002 dbar
Maximum P_{res} = 0.1838 dbar   Standard Deviation = 0.0602 dbar

PIES90I1 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS
Figure 17.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	06:00:00	-5130.0000
LAST DATA POINT:	Aug 16, 1990	06:00:00	5454.0000

Number of Points: 1765
Sampling Interval: 6.0 hrs

Minimum P = -0.1368 dbar   Mean = -0.0004 dbar
Maximum P = 0.1615 dbar   Standard Deviation = 0.0585 dbar

MEASURED BOTTOM TEMPERATURE RECORDS
Figure 11.8 and 15.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 30, 1989	21:29:20	-5162.5112
LAST DATA POINT:	Aug 17, 1990	07:56:10	5479.9360

Number of Points: 21286
Sampling Interval: 0.50 hrs

Minimum T = 2.34°C   Mean = 2.40 °C
Maximum T = 2.60°C   Standard Deviation = 0.03 °C

40HRLP BOTTOM TEMPERATURE RECORDS
Figure 18.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	06:00:00	-5130.0000
LAST DATA POINT:	Aug 16, 1990	06:00:00	5454.0000

Number of Points: 1765
Sampling Interval: 6.0 hrs

Minimum T = 2.349°C   Mean = 2.395 °C
Maximum T = 2.543°C   Standard Deviation = 0.026°C

Table 29: **Site and Record Information for**

PIES90I2

Serial Number: 069
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33816

POSITION: 38°~~47.68~~ 12.68 N DEPTH: 4270 m
67°58.71 W

	DATE	UT	CRUISE
LAUNCH:	Jun 1, 1989	0256	OC207
RELEASE:	Aug 16, 1990	0052	EN216

TRAVEL TIME RECORDS

Figure 9.24 and 13.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	04:17:21	-5131.7109
LAST DATA POINT:	Aug 16, 1990	00:47:21	5448.7891

Number of Points: 21162
Sampling Interval: 0.50 hrs

Minimum τ = 0.054405 s Mean = 0.079046 s
Maximum τ = 0.093998 s Standard Deviation = 0.010661 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.7)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 1900.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 2, 1989	06:00:00	-5106.0000
LAST DATA POINT:	Aug 15, 1990	00:00:00	5424.0000

Number of Points: 1756
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 78.68 m Mean = 334.86 m
Maximum Z_{12} = 799.37 m Standard Deviation = 210.46 m

PIES90I2 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.9

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	04:30:14	-5131.4961
LAST DATA POINT:	Aug 16, 1990	01:00:14	5449.0039

Number of Points: 21162
Sampling Interval: 0.50 hrs

Minimum P = 4349.92 dbar   Mean = 4351.43 dbar
Maximum P = 4351.52 dbar   Standard Deviation = 0.87 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.9 and 14.3

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

DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42412	0.09766	0.09436	0.02243	0.08028	0.06215	0.02647	0.01332
G° :	353.181	332.054	21.272	22.512	175.887	181.844	176.407	182.789

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	16:30:14	-5119.4961
LAST DATA POINT:	Aug 16, 1990	01:00:14	5449.0039

Number of Points: 21138
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.1413 dbar   Mean = -0.0002 dbar
Maximum P_{res} = 0.1275 dbar   Standard Deviation = 0.0393 dbar

PIES90I2 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 2, 1989	18:00:00	-5094.0000
LAST DATA POINT:	Aug 15, 1990	00:00:00	5424.0000

Number of Points: 1754
Sampling Interval: 6.0 hrs

Minimum P = -0.0910 dbar   Mean = -0.0003 dbar
Maximum P = 0.1102 dbar   Standard Deviation = 0.0371 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.9 and 15.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	04:44:49	-5131.2529
LAST DATA POINT:	Aug 16, 1990	01:14:49	5449.2471

Number of Points: 21162
Sampling Interval: 0.50 hrs

Minimum T = 2.54°C   Mean = 2.60 °C
Maximum T = 2.70°C   Standard Deviation = 0.01 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 2, 1989	18:00:00	-5094.0000
LAST DATA POINT:	Aug 15, 1990	00:00:00	5424.0000

Number of Points: 1754
Sampling Interval: 6.0 hrs

Minimum T = 2.550°C   Mean = 2.596 °C
Maximum T = 2.643°C   Standard Deviation = 0.012°C

Table 30: **Site and Record Information for**

PIES90I3

Serial Number: 073
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 31694

POSITION: 37°47.61 N 67°58.85 W   DEPTH: 4610 m

	DATE	UT	CRUISE
LAUNCH:	Jun 6, 1989	0410	OC207
RELEASE:	Aug 10, 1990	2042	EN216

TRAVEL TIME RECORDS

Figure 9.25 and 13.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	05:22:30	-5010.6250
LAST DATA POINT:	Aug 10, 1990	19:52:30	5323.8750

Number of Points: 20670
Sampling Interval: 0.50 hrs

Minimum τ = 0.115788 s   Mean = 0.137739 s
Maximum τ = 0.158726 s   Standard Deviation = 0.013645 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.7)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 3176.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	06:00:00	-4986.0000
LAST DATA POINT:	Aug 9, 1990	18:00:00	5298.0000

Number of Points: 1715
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 72.98 m   Mean = 448.59 m
Maximum Z_{12} = 861.44 m   Standard Deviation = 269.37 m

PIES90I3 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.10

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	05:35:23	-5010.4102
LAST DATA POINT:	Aug 10, 1990	20:35:23	5324.5898

Number of Points: 20671
Sampling Interval: 0.50 hrs

Minimum P = 4716.96 dbar Mean = 4718.36 dbar
Maximum P = 4718.83 dbar Standard Deviation = 0.63 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.10 and 14.3

$$P_{residual} = P_{measured} - MEAN - DRIFT - TIDE$$
DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42437	0.09759	0.09419	0.02240	0.07966	0.06223	0.02623	0.01356
G° :	353.113	332.352	21.534	22.965	176.641	182.724	177.361	182.095

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	17:35:23	-4998.4102
LAST DATA POINT:	Aug 10, 1990	20:35:23	5324.5898

Number of Points: 20647
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.2696 dbar Mean = 0.0001 dbar
Maximum P_{res} = 0.2223 dbar Standard Deviation = 0.0786 dbar

PIES90I3 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	18:00:00	-4974.0000
LAST DATA POINT:	Aug 10, 1990	00:00:00	5304.0000

Number of Points: 1714
Sampling Interval: 6.0 hrs

Minimum P = -0.2514 dbar — Mean = 0.0002 dbar
Maximum P = 0.2019 dbar — Standard Deviation = 0.0776 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.10 and 15.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 6, 1989	05:49:59	-5010.1670
LAST DATA POINT:	Aug 10, 1990	20:49:59	5324.8330

Number of Points: 20671
Sampling Interval: 0.50 hrs

Minimum T = 2.40°C — Mean = 2.46 °C
Maximum T = 2.55°C — Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	18:00:00	-4974.0000
LAST DATA POINT:	Aug 10, 1990	00:00:00	5304.0000

Number of Points: 1714
Sampling Interval: 6.0 hrs

Minimum T = 2.401°C — Mean = 2.457 °C
Maximum T = 2.515°C — Standard Deviation = 0.015°C

Table 31: **Site and Record Information for**

PIES90I4

Serial Number: 075
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 36884

POSITION: 37°18.88 N DEPTH: 4765 m
67°39.58 W

	DATE	UT	CRUISE
LAUNCH:	Jun 16, 1989	1013	OC210
RELEASE:	Aug 16, 1990	2036	EN216

TRAVEL TIME RECORDS
Figure 9.26 and 13.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 16, 1989	11:32:14	-4764.4629
LAST DATA POINT:	Aug 16, 1990	20:32:14	5468.5371

Number of Points: 20467
Sampling Interval: 0.50 hrs

Minimum $\tau = 0.353622$ s Mean = 0.374016 s
Maximum $\tau = 0.397889$ s Standard Deviation = 0.012177 s

40-HRLP THERMOCLINE DEPTH RECORDS
(Figure 16.7)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 7941.00 m
$\tau_d =$ Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 17, 1989	12:00:00	-4740.0000
LAST DATA POINT:	Aug 16, 1990	00:00:00	5448.0000

Number of Points: 1699
Sampling Interval: 6.0 hrs

Minimum $Z_{12} = 101.14$ m Mean = 535.40 m
Maximum $Z_{12} = 903.75$ m Standard Deviation = 240.24 m

PIES90I4 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.11

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 16, 1989	11:45:07	-4764.2480
LAST DATA POINT:	Aug 16, 1990	20:45:07	5468.7520

Number of Points: 20467
Sampling Interval: 0.50 hrs

Minimum P = 4906.13 dbar   Mean = 4906.42 dbar
Maximum P = 4908.15 dbar   Standard Deviation = 0.79 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.11 and 14.3

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

DRIFT = 0.0 dbar

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.41827	0.09613	0.09358	0.02228	0.07726	0.06041	0.02543	0.01326
G° :	353.459	332.396	21.952	23.336	176.943	183.013	177.535	183.376

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 16, 1989	23:45:07	-4752.2480
LAST DATA POINT:	Aug 16, 1990	20:45:07	5468.7520

Number of Points: 20443
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.4189 dbar   Mean = -0.0001 dbar
Maximum P_{res} = 0.2815 dbar   Standard Deviation = 0.1120 dbar

PIES90I4 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 18, 1989	00:00:00	-4728.0000
LAST DATA POINT:	Aug 16, 1990	00:00:00	5448.0000

Number of Points: 1697
Sampling Interval: 6.0 hrs

Minimum P = -0.4009 dbar
Maximum P = 0.2348 dbar
Mean = -0.0004 dbar
Standard Deviation = 0.1113 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.11 and 15.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 16, 1989	11:59:39	-4764.0059
LAST DATA POINT:	Aug 16, 1990	20:59:39	5468.9941

Number of Points: 20467
Sampling Interval: 0.50 hrs

Minimum T = 2.39°C
Maximum T = 2.60°C
Mean = 2.46 °C
Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 18, 1989	00:00:00	-4728.0000
LAST DATA POINT:	Aug 16, 1990	00:00:00	5448.0000

Number of Points: 1697
Sampling Interval: 6.0 hrs

Minimum T = 2.396°C
Maximum T = 2.511°C
Mean = 2.464 °C
Standard Deviation = 0.018°C

Table 32: **Site and Record Information for**

PIES90I5

Serial Number: 072
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: Pressure and Temperature
Pressure Sensor Serial Number: 33822

POSITION: 36°50.19 N 67°27.36 W DEPTH: 4975 m

	DATE	UT	CRUISE
LAUNCH:	Jun 3, 1989	1054	OC207
RELEASE:	Aug 8, 1990	1859	EN216

TRAVEL TIME RECORDS

Figure 9.27 and 13.7

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 3, 1989	12:31:56	-5075.4678
LAST DATA POINT:	Aug 8, 1990	18:36:58	5274.6162

Number of Points: 20701
Sampling Interval: 0.50 hrs

Minimum τ = 0.177081 s   Mean = 0.191169 s
Maximum τ = 0.219416 s   Standard Deviation = 0.010848 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.7)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4443.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	12:00:00	-5052.0000
LAST DATA POINT:	Aug 7, 1990	18:00:00	5250.0000

Number of Points: 1718
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 122.70 m   Mean = 658.37 m
Maximum Z_{12} = 914.87 m   Standard Deviation = 213.40 m

PIES90I5 (continue)

MEASURED BOTTOM PRESSURE RECORDS

Figure 10.12

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 3, 1989	12:44:49	-5075.2529
LAST DATA POINT:	Aug 8, 1990	18:49:52	5274.8311

Number of Points: 20701
Sampling Interval: 0.50 hrs

Minimum P = 5086.22 dbar   Mean = 5087.70 dbar
Maximum P = 5088.10 dbar   Standard Deviation = 0.67 dbar

RESIDUAL BOTTOM PRESSURE RECORDS

Figure 12.12 and 14.3

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

$$\text{DRIFT} = A \cdot t + B$$

$$A = 0.000014 \text{ dbar hr}^{-1}$$

$$B = 0.001403 \text{ dbar}$$

TIDE were calculated from the following constituents:

	M2	N2	S2	K2	K1	O1	P1	Q1
H (dbar):	0.42049	0.09622	0.09400	0.02235	0.07679	0.06014	0.02532	0.01299
G° :	353.777	332.699	22.203	23.627	177.665	183.916	178.333	183.918

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 4, 1989	00:44:49	-5063.2529
LAST DATA POINT:	Aug 8, 1990	18:49:52	5274.8311

Number of Points: 20677
Sampling Interval: 0.50 hrs

Minimum P_{res} = -0.3731 dbar   Mean = 0.0003 dbar
Maximum P_{res} = 0.2395 dbar   Standard Deviation = 0.1018 dbar

PIES90I5 (continue)

40HRLP RESIDUAL BOTTOM PRESSURE RECORDS

Figure 17.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	00:00:00	-5040.0000
LAST DATA POINT:	Aug 7, 1990	18:00:00	5250.0000

Number of Points: 1716
Sampling Interval: 6.0 hrs

Minimum P = -0.3603 dbar   Mean = 0.0006 dbar
Maximum P = 0.2145 dbar   Standard Deviation = 0.1010 dbar

MEASURED BOTTOM TEMPERATURE RECORDS

Figure 11.12 and 15.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 3, 1989	12:59:20	-5075.0112
LAST DATA POINT:	Aug 8, 1990	19:04:24	5275.0732

Number of Points: 20701
Sampling Interval: 0.50 hrs

Minimum T = 2.60°C   Mean = 2.65 °C
Maximum T = 2.73°C   Standard Deviation = 0.02 °C

40HRLP BOTTOM TEMPERATURE RECORDS

Figure 18.3

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 5, 1989	00:00:00	-5040.0000
LAST DATA POINT:	Aug 7, 1990	18:00:00	5250.0000

Number of Points: 1716
Sampling Interval: 6.0 hrs

Minimum T = 2.603°C   Mean = 2.648 °C
Maximum T = 2.711°C   Standard Deviation = 0.015°C

Table 33: **Site and Record Information for**

IES90J1

Serial Number: 045
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 39°10.05 N DEPTH: 3480 m
67°47.20 W

	DATE	UT	CRUISE
LAUNCH:	May 31, 1989	0123	OC207
RELEASE:	Aug 12, 1990	0307	EN216

TRAVEL TIME RECORDS

Figure 9.28 and 13.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 31, 1989	02:31:56	-5157.4678
LAST DATA POINT:	Aug 12, 1990	02:57:18	5354.9551

Number of Points: 21026
Sampling Interval: 0.50 hrs

Minimum τ = 0.229048 s Mean = 0.249371 s
Maximum τ = 0.257556 s Standard Deviation = 0.005441 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.8)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 5160.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	00:00:00	-5136.0000
LAST DATA POINT:	Aug 11, 1990	06:00:00	5334.0000

Number of Points: 1746
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 82.39 m Mean = 222.68 m
Maximum Z_{12} = 594.19 m Standard Deviation = 107.17 m

Table 34: **Site and Record Information for**

IES90J2

Serial Number: 043
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 38°45.90 N DEPTH: 4270 m
67°21.03 W

	DATE	UT	CRUISE
LAUNCH:	May 31, 1989	0700	OC207
RELEASE:	Aug 11, 1990	2205	EN216

TRAVEL TIME RECORDS

Figure 9.29 and 13.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	May 31, 1989	08:02:10	-5151.9639
LAST DATA POINT:	Aug 11, 1990	21:58:04	5349.9678

Number of Points: 21005
Sampling Interval: 0.50 hrs

Minimum τ = 0.073001 s Mean = 0.094565 s
Maximum τ = 0.107382 s Standard Deviation = 0.007816 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.8)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 2146.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 1, 1989	06:00:00	-5130.0000
LAST DATA POINT:	Aug 11, 1990	00:00:00	5328.0000

Number of Points: 1744
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 74.98 m Mean = 273.81 m
Maximum Z_{12} = 681.40 m Standard Deviation = 154.15 m

Table 35: **Site and Record Information for**

IES90J3

Serial Number: 030
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 38°09.69 N 67°10.37 W DEPTH: 4635 m

	DATE	UT	CRUISE
LAUNCH:	Jun 7, 1989	0100	OC207
RELEASE:	Aug 10, 1990	0818	EN216

TRAVEL TIME RECORDS

Figure 9.30 and 13.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	02:31:56	-4989.4678
LAST DATA POINT:	Aug 10, 1990	07:56:45	5311.9458

Number of Points: 20604
Sampling Interval: 0.50 hrs

Minimum τ = 0.131934 s Mean = 0.153761 s
Maximum τ = 0.171173 s Standard Deviation = 0.012487 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.8)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 3468.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 8, 1989	00:00:00	-4968.0000
LAST DATA POINT:	Aug 9, 1990	06:00:00	5286.0000

Number of Points: 1710
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 101.72 m Mean = 423.42 m
Maximum Z_{12} = 832.92 m Standard Deviation = 247.43 m

Table 36: **Site and Record Information for**

IES90J4

Serial Number: 047
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 37°38.77 N DEPTH: 4875 m
67°01.65 W

	DATE	UT	CRUISE
LAUNCH:	Jun 7, 1989	0934	OC207
RELEASE:	Aug 10, 1990	0208	EN216

TRAVEL TIME RECORDS

Figure 9.31 and 13.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 7, 1989	11:02:00	-4980.9668
LAST DATA POINT:	Aug 10, 1990	01:58:04	5305.9678

Number of Points: 20575
Sampling Interval: 0.50 hrs

Minimum τ = 0.062288 s Mean = 0.080319 s
Maximum τ = 0.103684 s Standard Deviation = 0.011436 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.8)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 2217.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 8, 1989	12:00:00	-4956.0000
LAST DATA POINT:	Aug 9, 1990	00:00:00	5280.0000

Number of Points: 1707
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 181.35 m Mean = 627.06 m
Maximum Z_{12} = 958.69 m Standard Deviation = 226.16 m

Table 37: **Site and Record Information for**

IES90J5

Serial Number: 040
Type of Travel Time Detector: TTC
Number of Pings per Sampling: 24
Additional Sensors: None

POSITION: 37°00.68 N 66°57.86 W   DEPTH: 4955 m

	DATE	UT	CRUISE
LAUNCH:	Jun 16, 1989	0307	OC207
RELEASE:	Aug 8, 1990	0939	EN216

TRAVEL TIME RECORDS

Figure 9.32 and 13.8

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 16, 1989	04:31:56	-4771.4678
LAST DATA POINT:	Aug 8, 1990	09:28:55	5265.4819

Number of Points: 20075
Sampling Interval: 0.50 hrs

Minimum τ = 0.203925 s   Mean = 0.214223 s
Maximum τ = 0.243490 s   Standard Deviation = 0.008039 s

40-HRLP THERMOCLINE DEPTH RECORDS

(Figure 16.8)

Z_{12} Conversion equation: $Z_{12} = -19800\text{ms}^{-1} \cdot \tau_d + B$
where B = 4947.00 m
τ_d = Travel Time (sec) with tide removed

	DATE	UT	YEARHOUR
FIRST DATA POINT:	Jun 17, 1989	06:00:00	-4746.0000
LAST DATA POINT:	Aug 7, 1990	12:00:00	5244.0000

Number of Points: 1666
Sampling Interval: 6.0 hrs

Minimum Z_{12} = 149.83 m   Mean = 706.00 m
Maximum Z_{12} = 888.88 m   Standard Deviation = 158.78 m

3 Half-Hourly Individual Plots

Plots are presented for the individual time series of travel time, bottom pressure, residual bottom pressure (detided and dedrifted), and temperature. A nominal half-hourly sampling interval applies to all measurements.

The plots for each sensor are displayed in a standardized window. All sensors have a common time axis which starts at –5352 (23-May-1989 referenced to 1-Jan-1990) and extends to 6360 (23-Sep-1990 referenced to 1-Jan-1990). This time period is displayed in four panels, two per page. Each panel covers 2928 hr (one third of a leap year). A small tick is placed at each day (0000 UT) and larger ticks denote weeks (168 hr). All IES records in this report were encompassed by this period. For comparison, labels indicating specific dates are centered about their yearhour equivalents (for example a label associates "1-Jan-90" with 0.0 yearhour).

Vertical axes for each sensor will be either common or have a common increment. Travel time is plotted within a 50–msec window in increments of 5 msec. Pressure is plotted in a 2–dbar window centered about zero. The mean pressure was removed from the series for the purpose of plotting and its value is indicated in the y-axis label. After detiding and dedrifting, the residual bottom pressures are plotted within a 0.8 dbar window centered about zero. A 0.30° C window, adjusted vertically to enclose all the record's variation, is used for each temperature record.

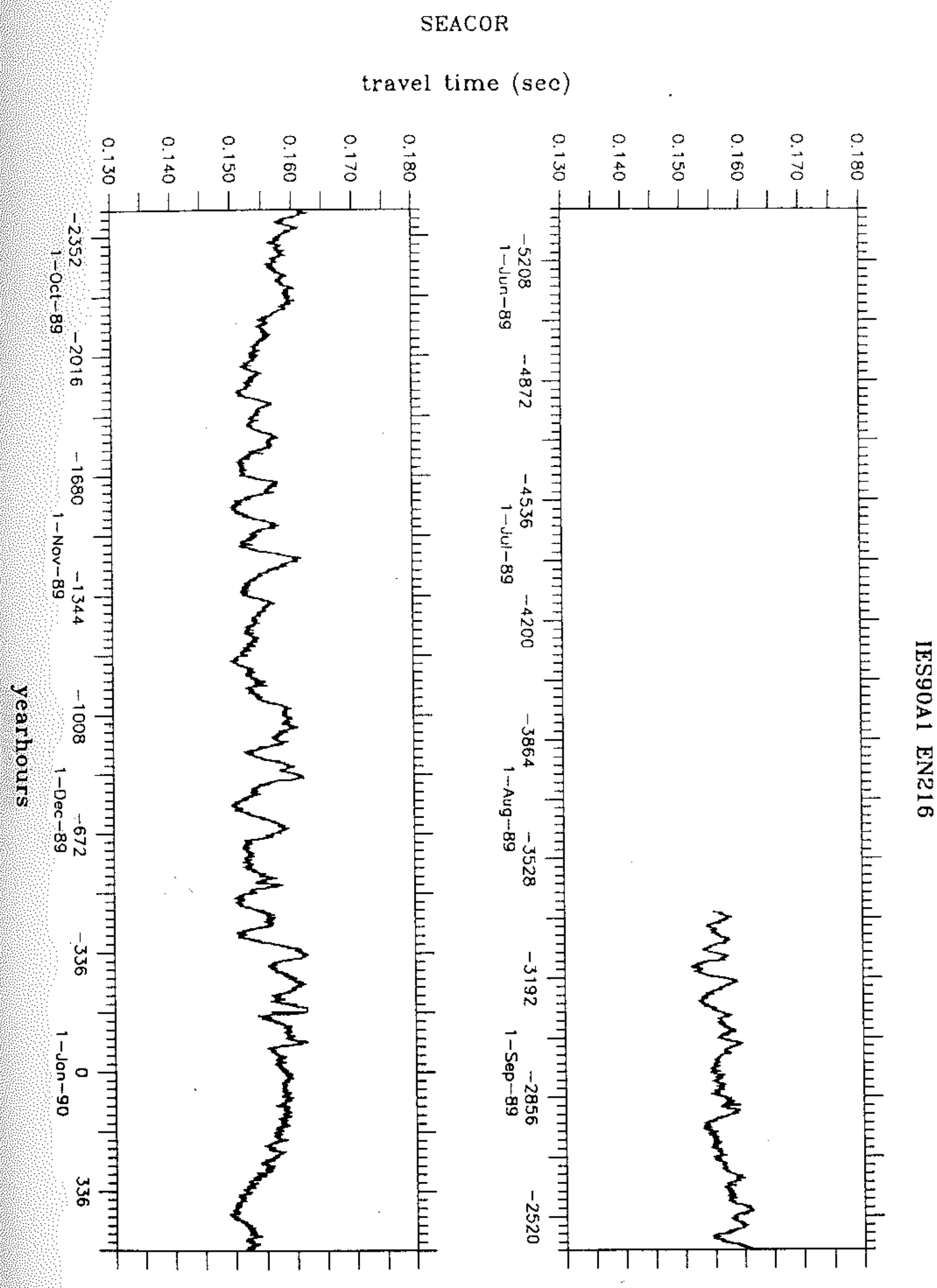
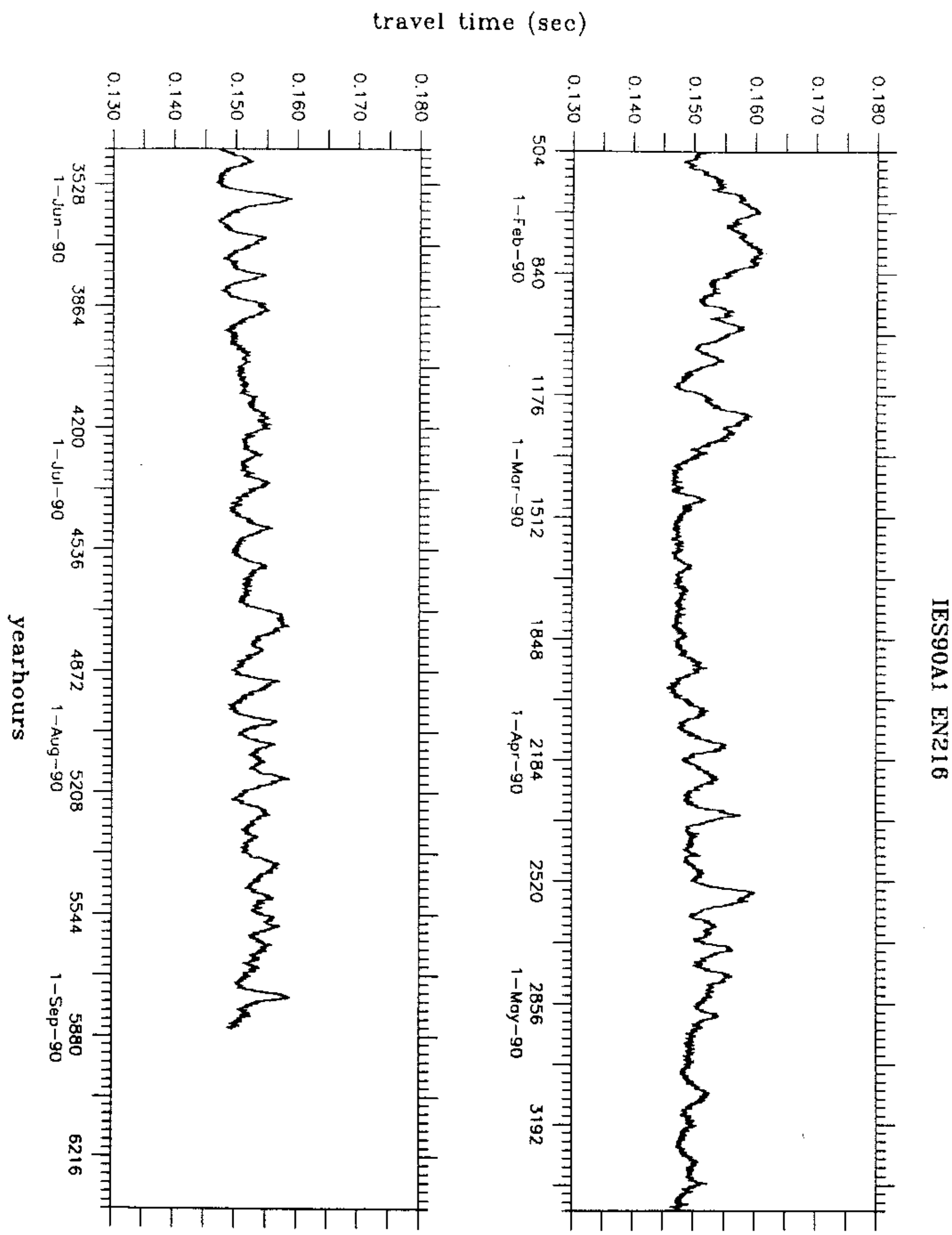


Figure 9.1: Half-Hourly Travel Times. IES90A1

SEACOR


IES90A1 EN216
travel time (sec)
0.130
0.140
0.150
0.160
0.170
0.180
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

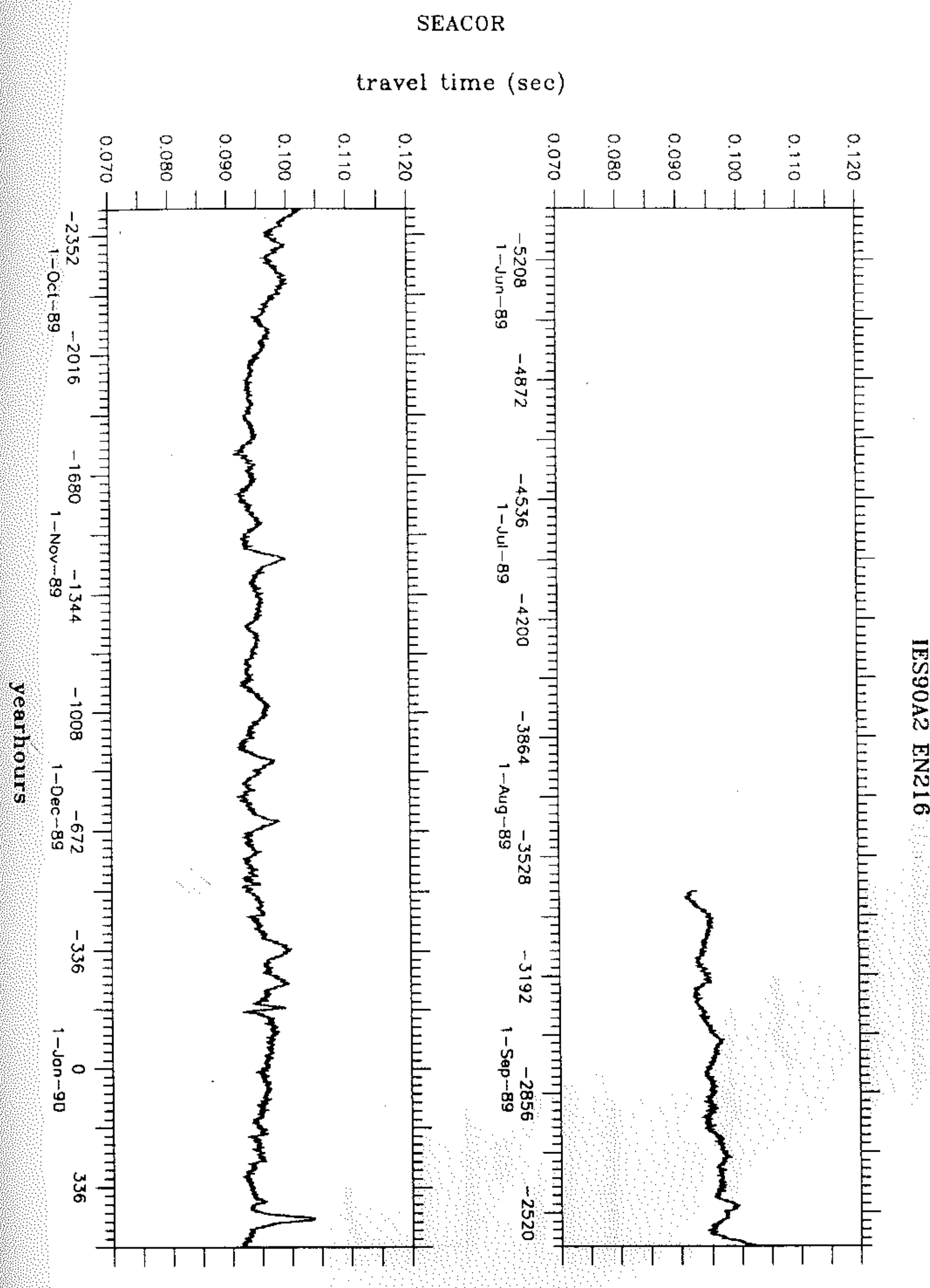
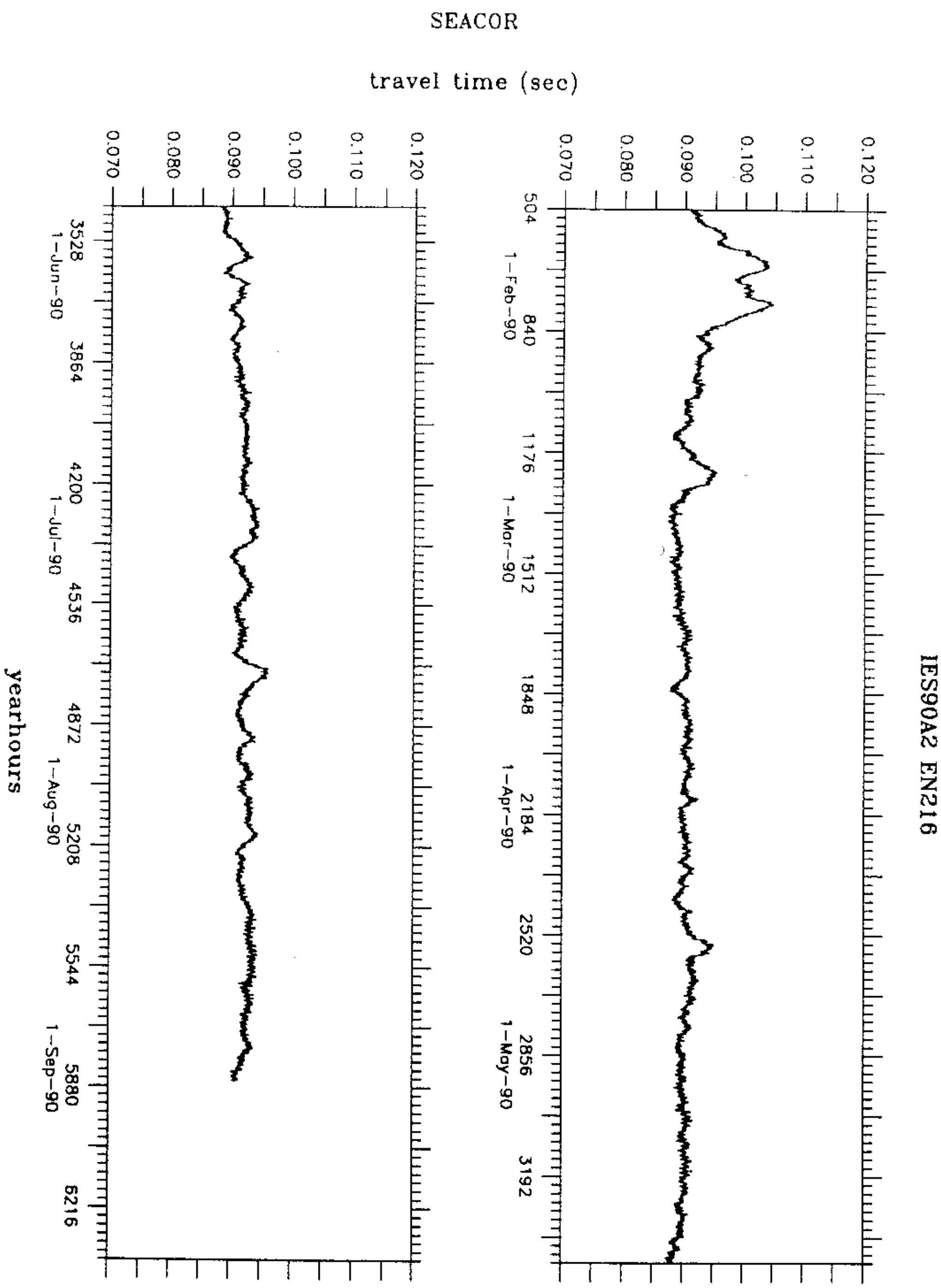


Figure 9.2: Half-Hourly Travel Times. IES90A2


SEACOR
travel time (sec)
IES90A2 EN216
0.070
0.080
0.090
0.100
0.110
0.120
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

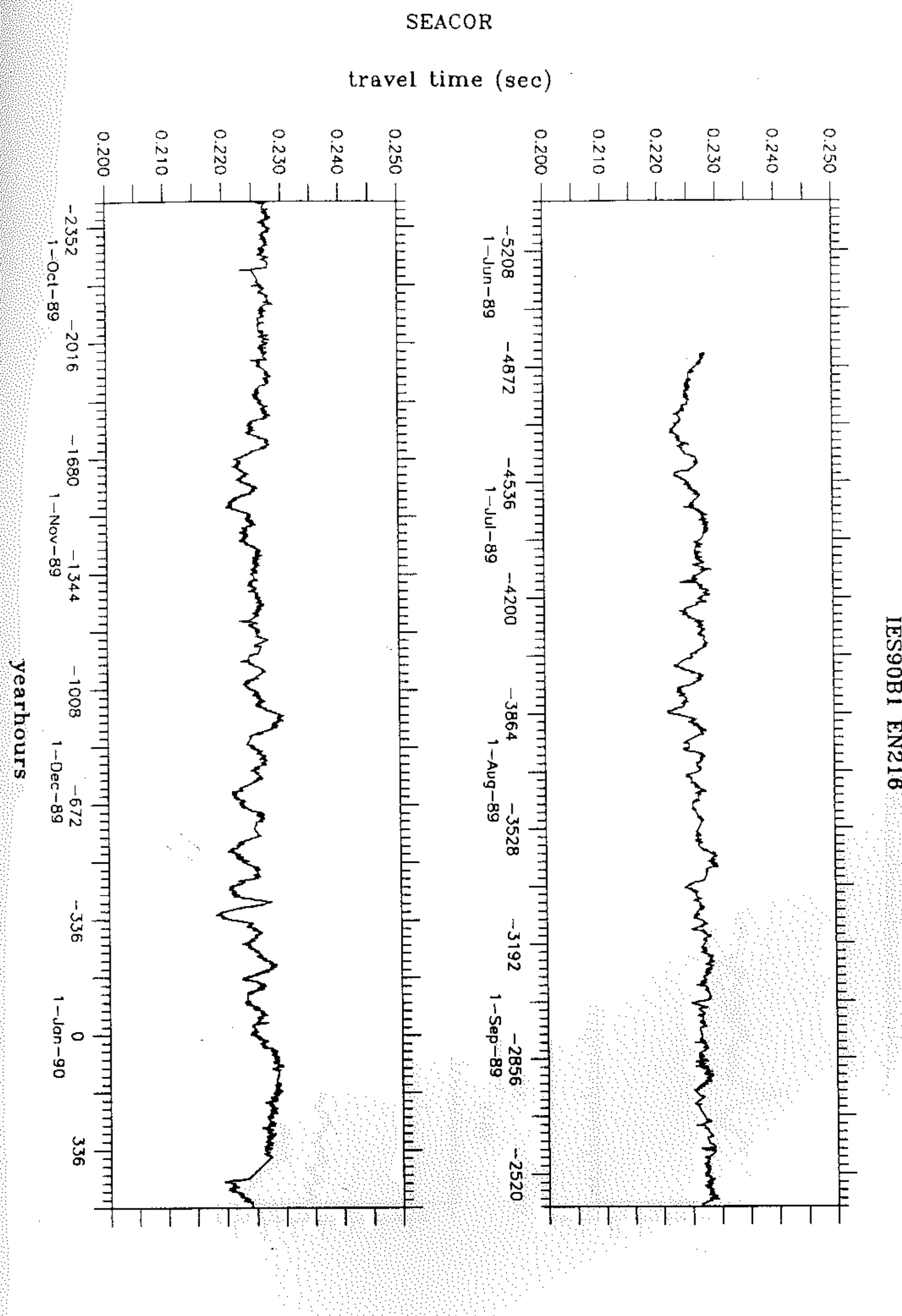
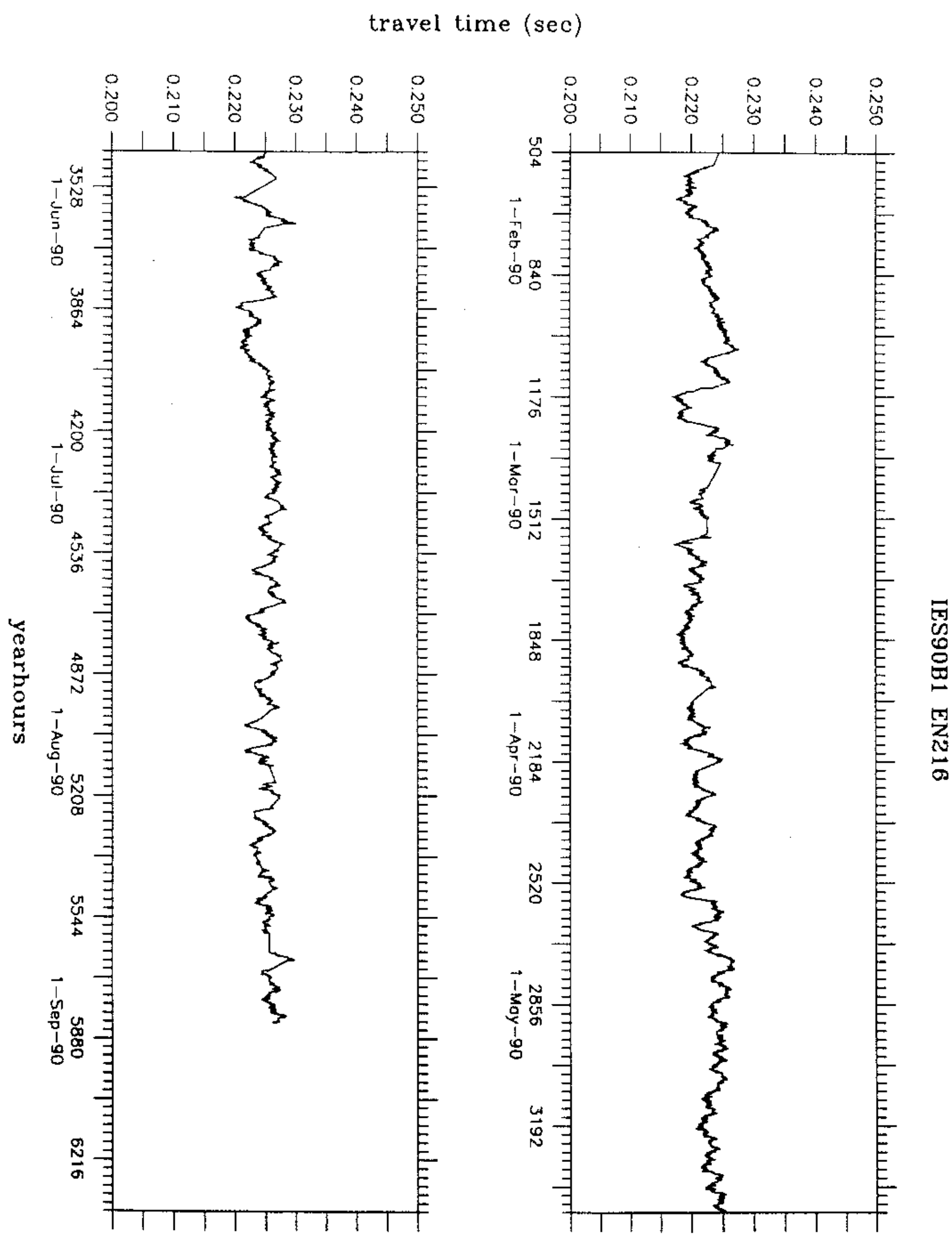


Figure 9.3: Half-Hourly Travel Times. IES90B1

SEACOR


travel time (sec)
IES90B1 EN216
0.200
0.210
0.220
0.230
0.240
0.250
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

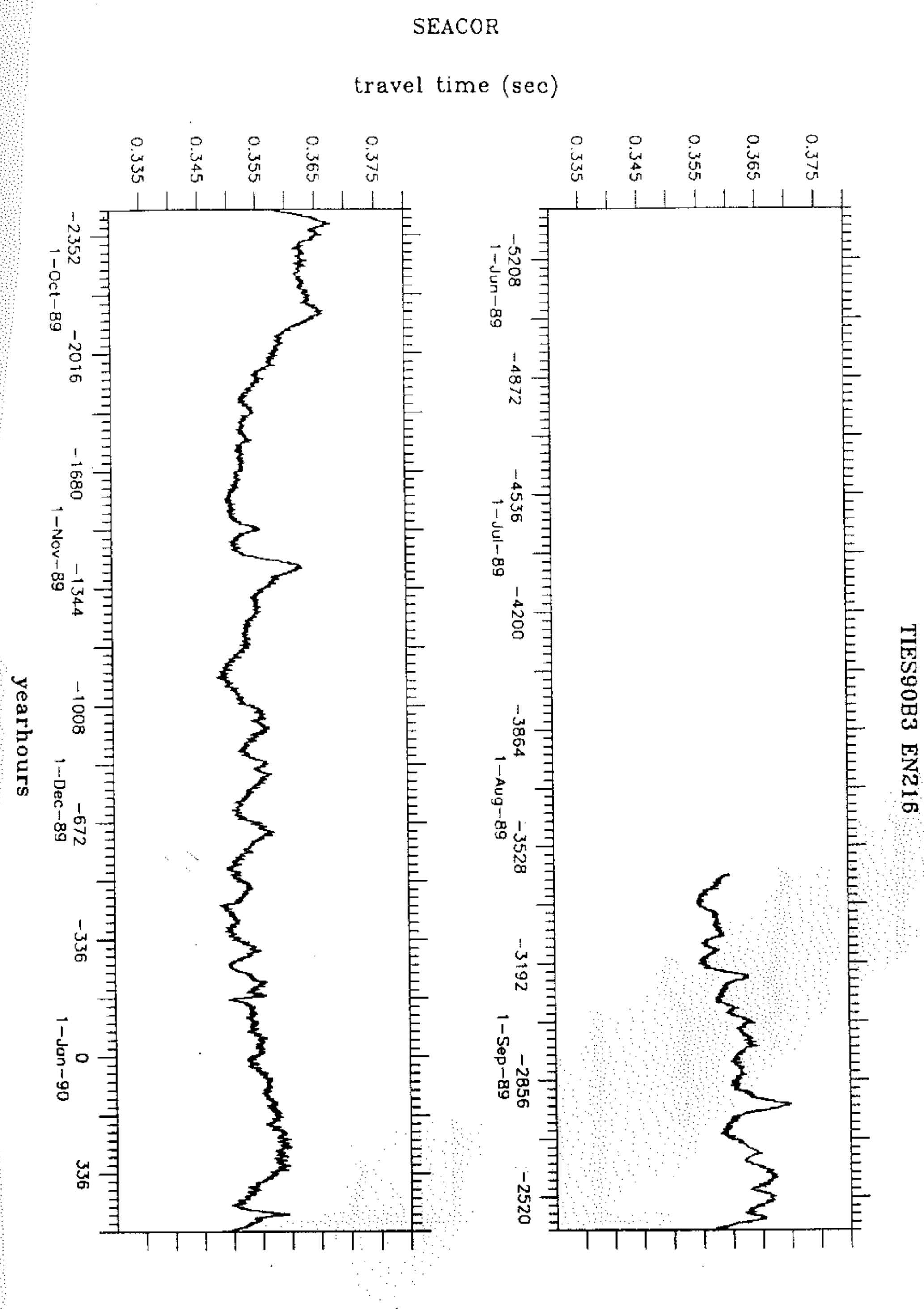
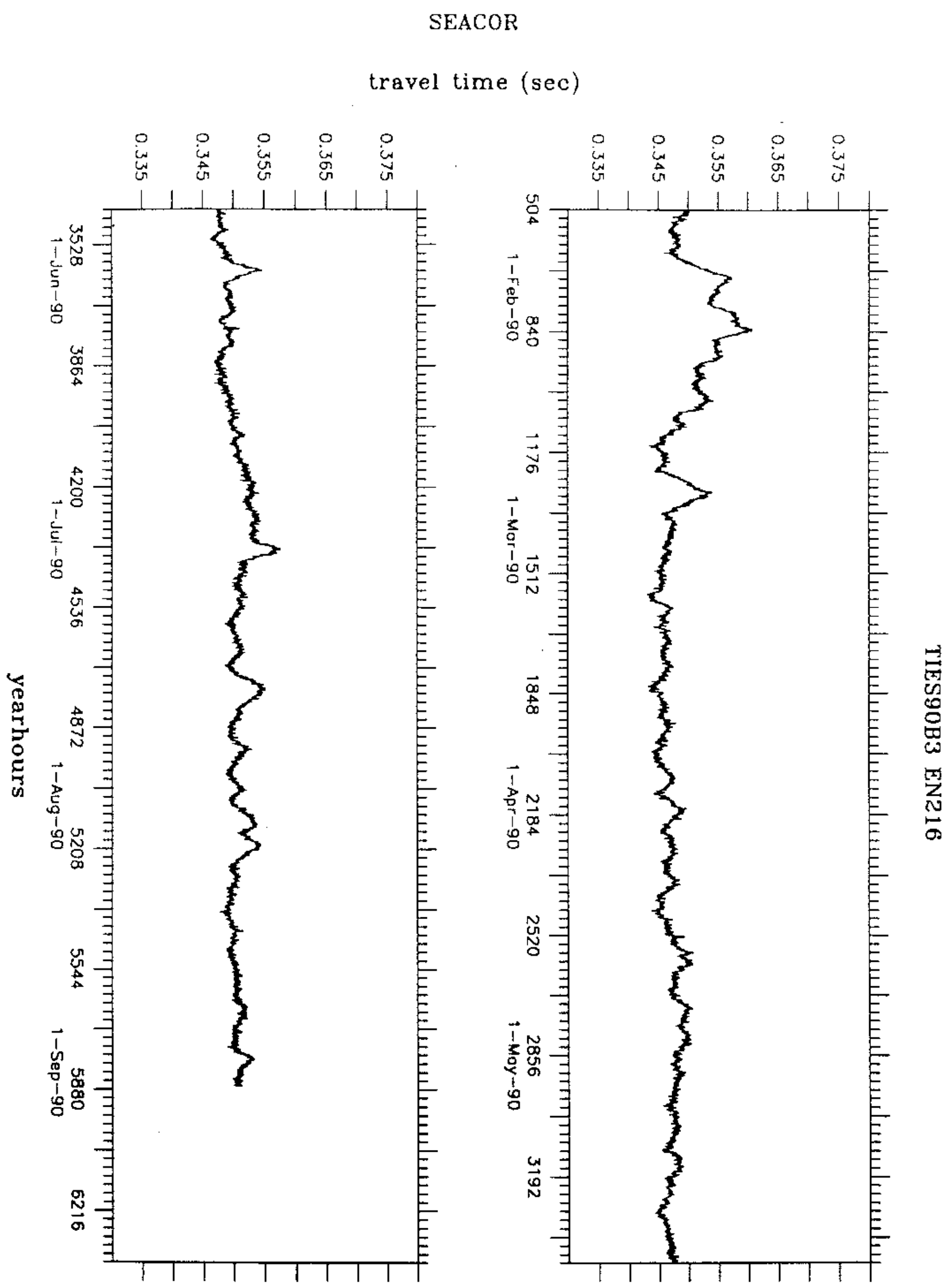


Figure 9.4: Half-Hourly Travel Times. TIES90B3


SEACOR
travel time (sec)
TIES90B3 EN216
0.335
0.345
0.355
0.365
0.375
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

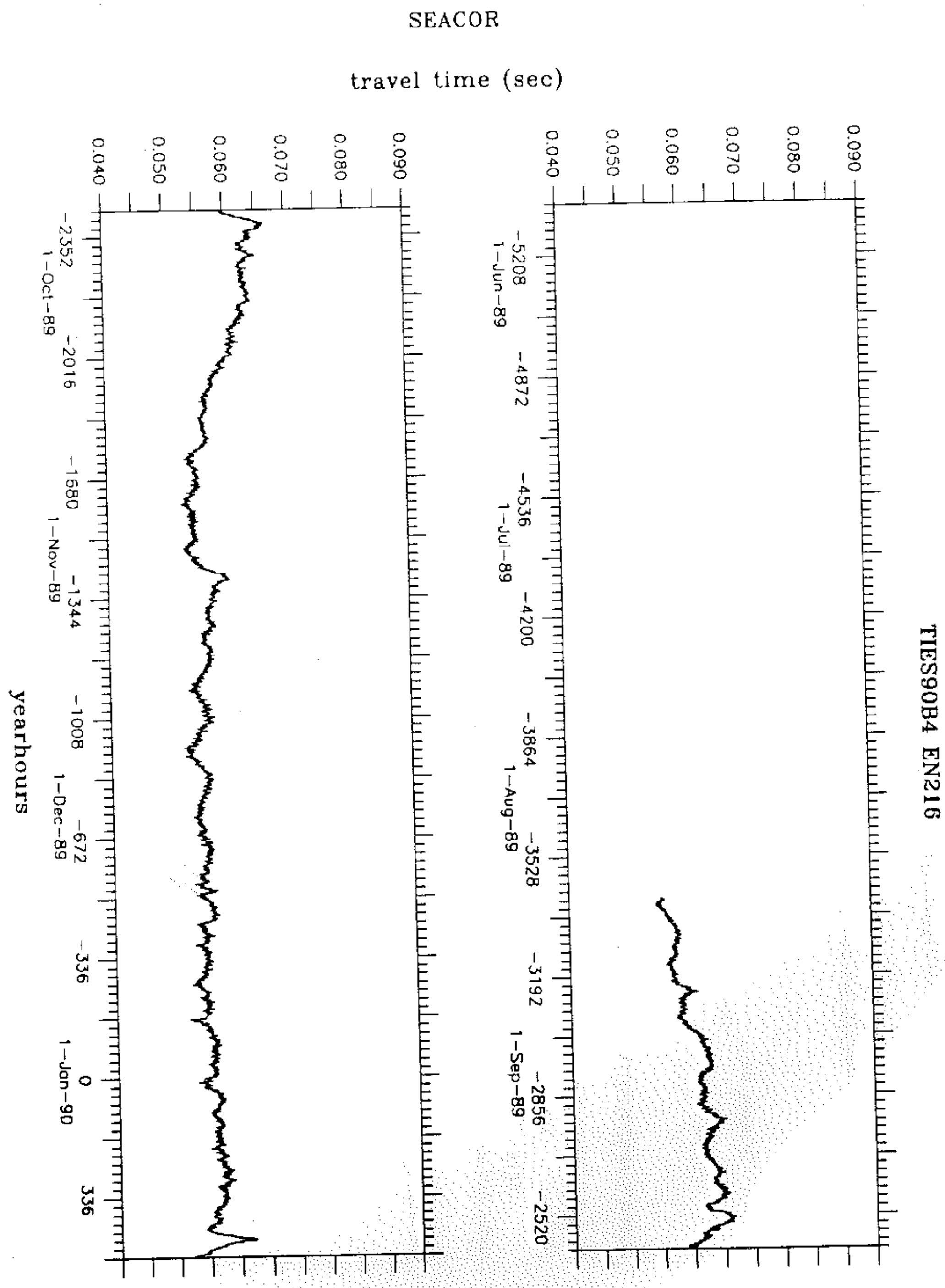
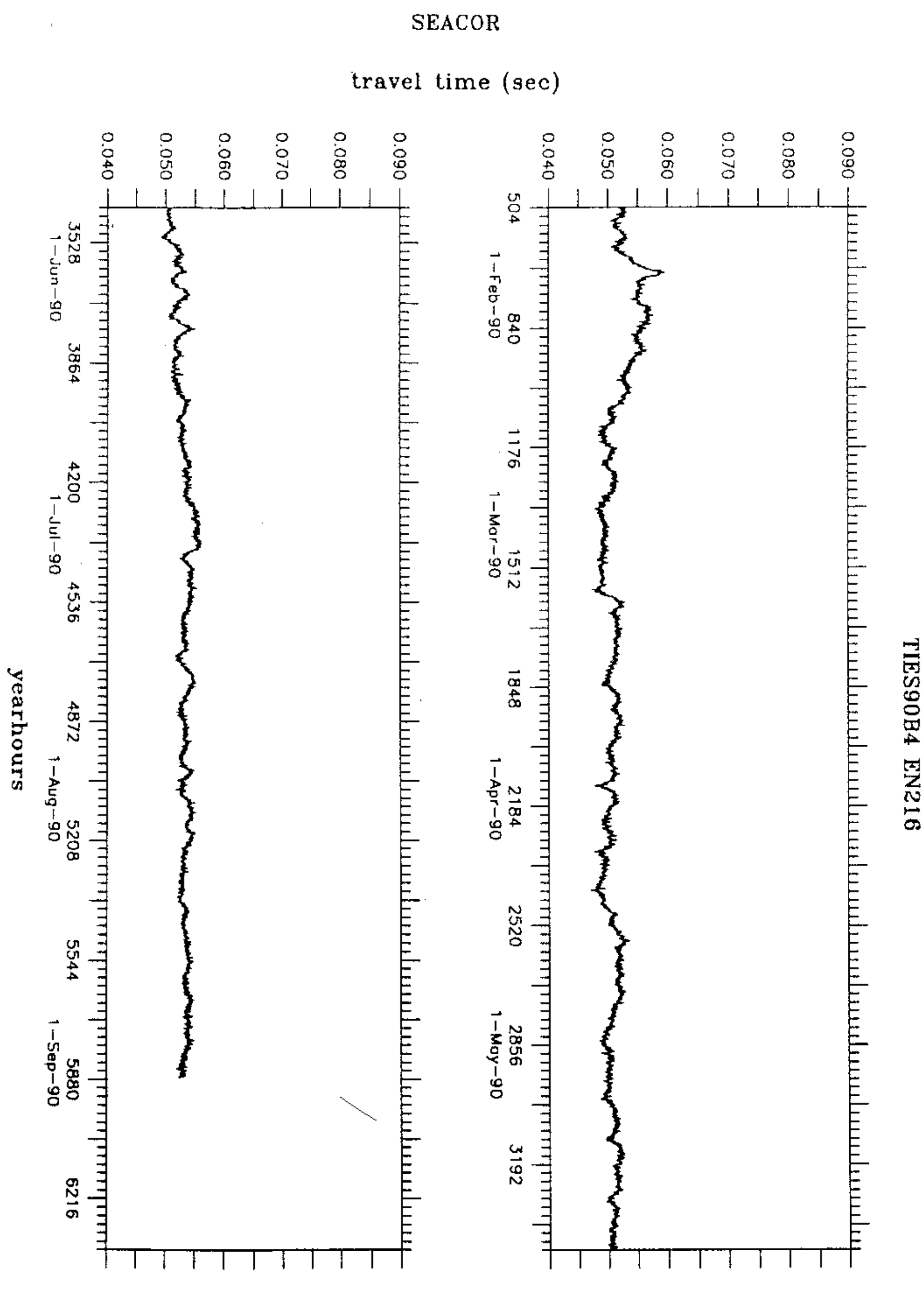


Figure 9.5: Half-Hourly Travel Times. TIES90B4


SEACOR
travel time (sec)
TIES90B4 EN216
0.040
0.050
0.060
0.070
0.080
0.090
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

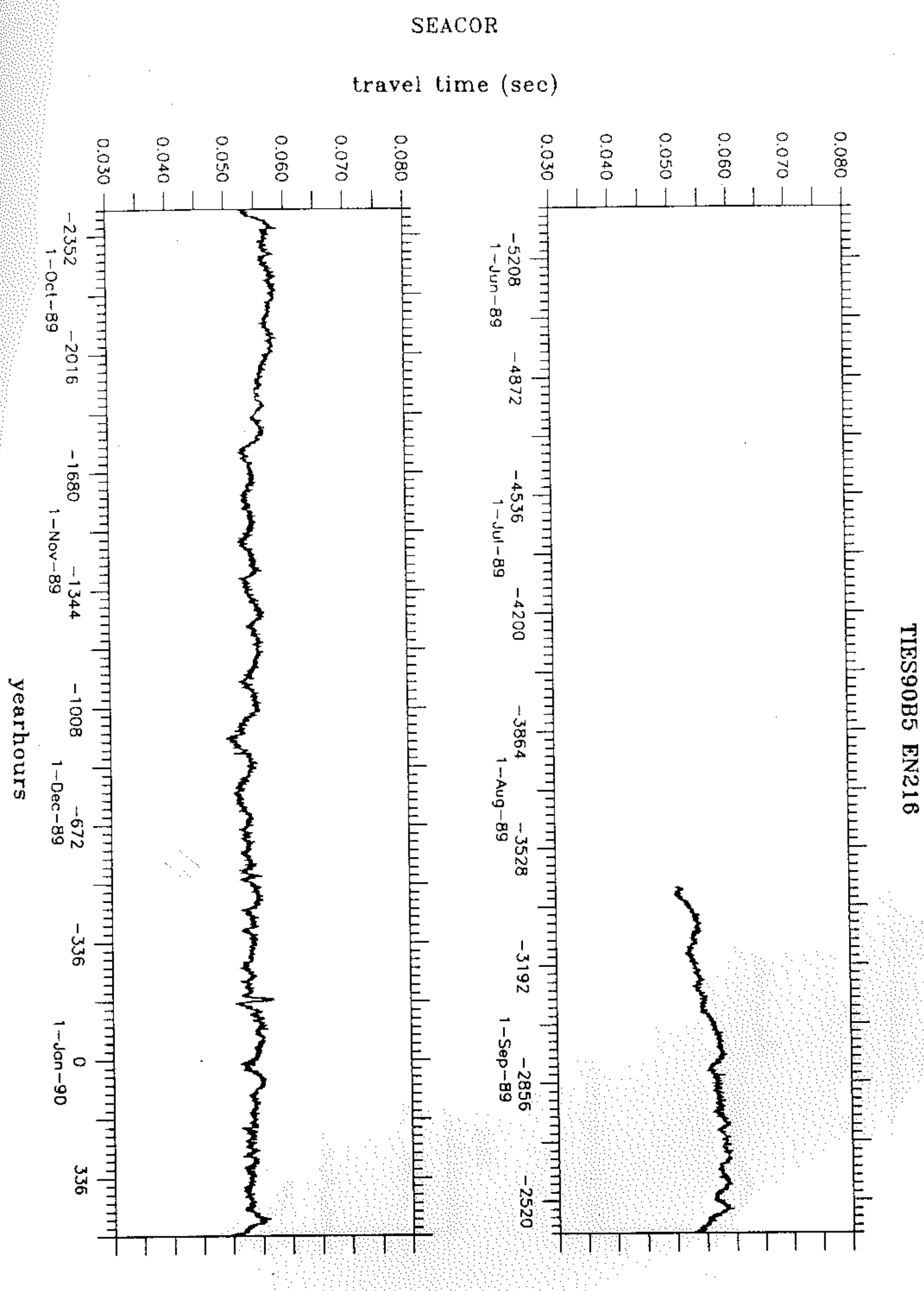
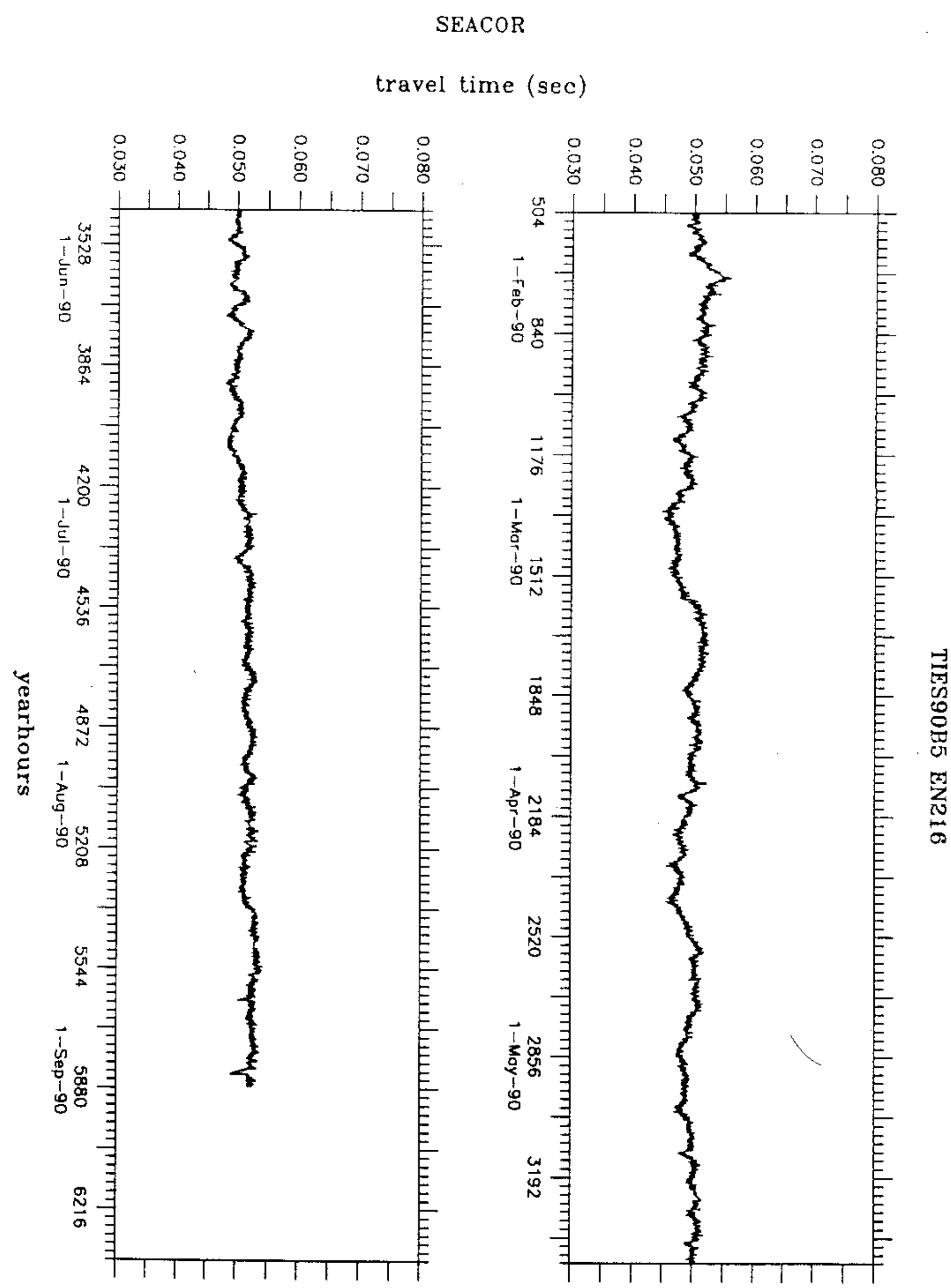


Figure 9.6: Half-Hourly Travel Times. TIES90B5


SEACOR
travel time (sec)
TIES90B5 EN216
0.030
0.040
0.050
0.060
0.070
0.080
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

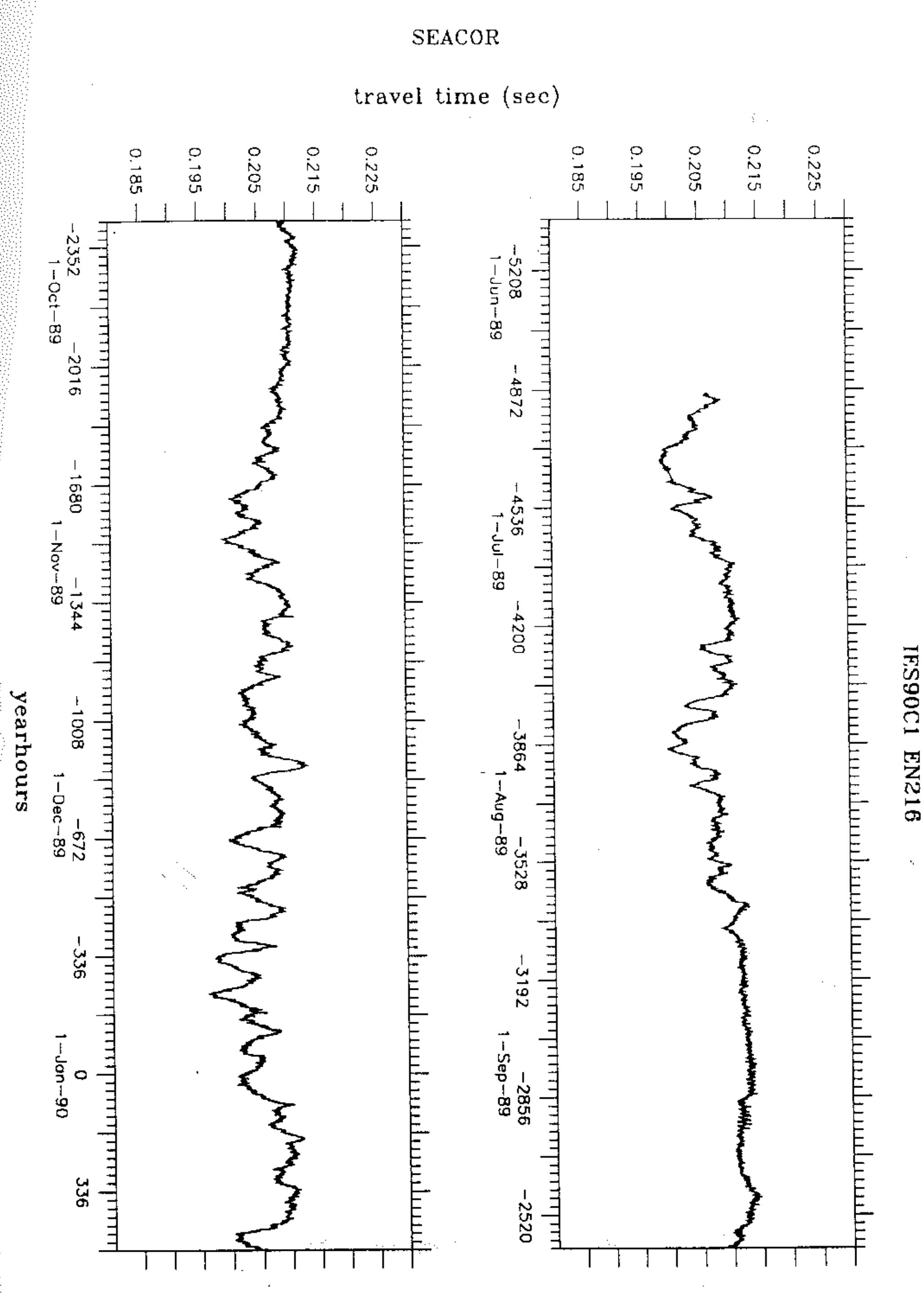
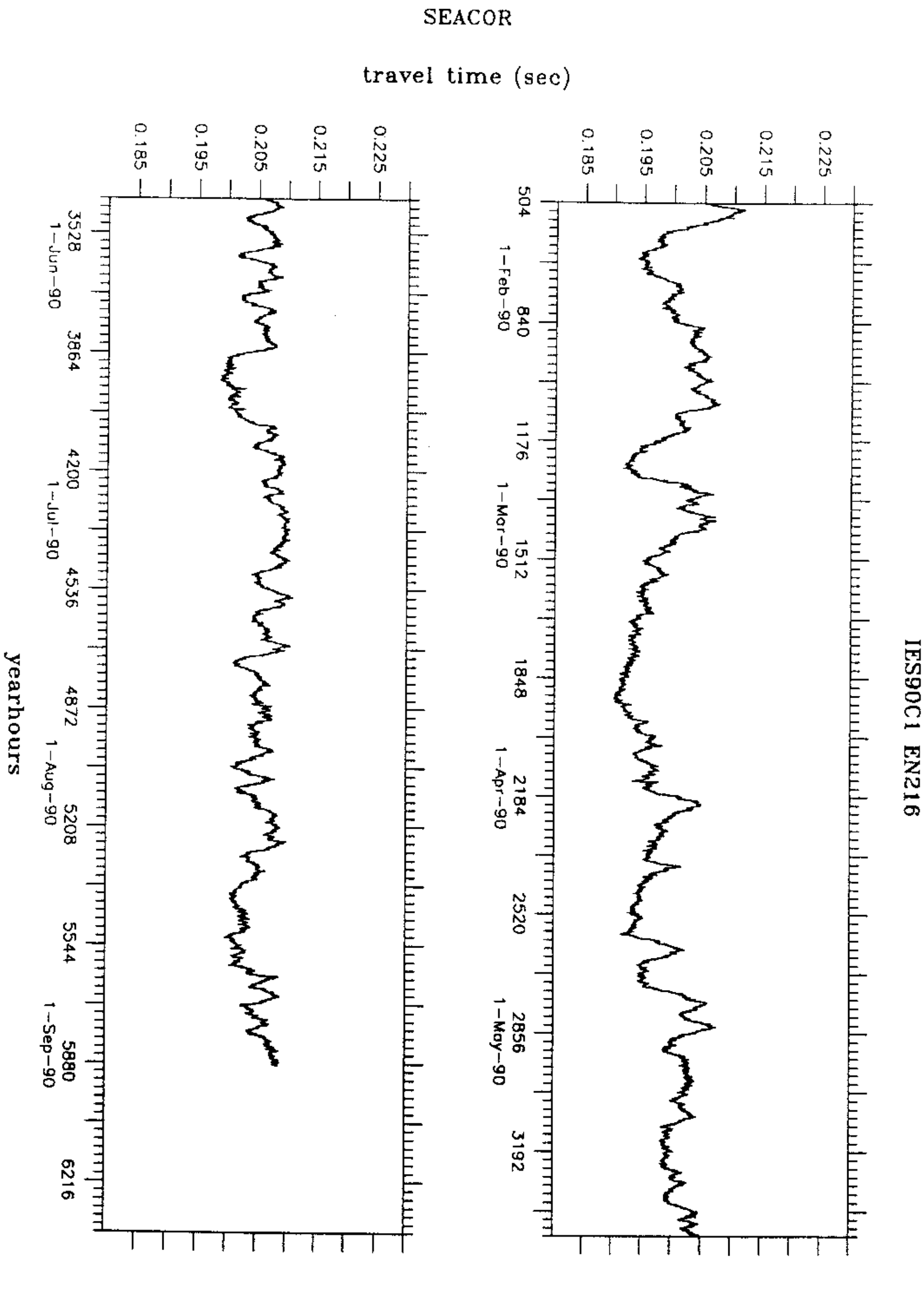


Figure 9.7: Half-Hourly Travel Times. IES90C1


SEACOR
IES90C1 EN216
travel time (sec)
0.185
0.195
0.205
0.215
0.225
504
1-Feb-90
840
1176
1-Mar-90
1512
1848
1-Apr-90
2184
2520
1-May-90
2856
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
1-Sep-90
5880
6216
yearhours

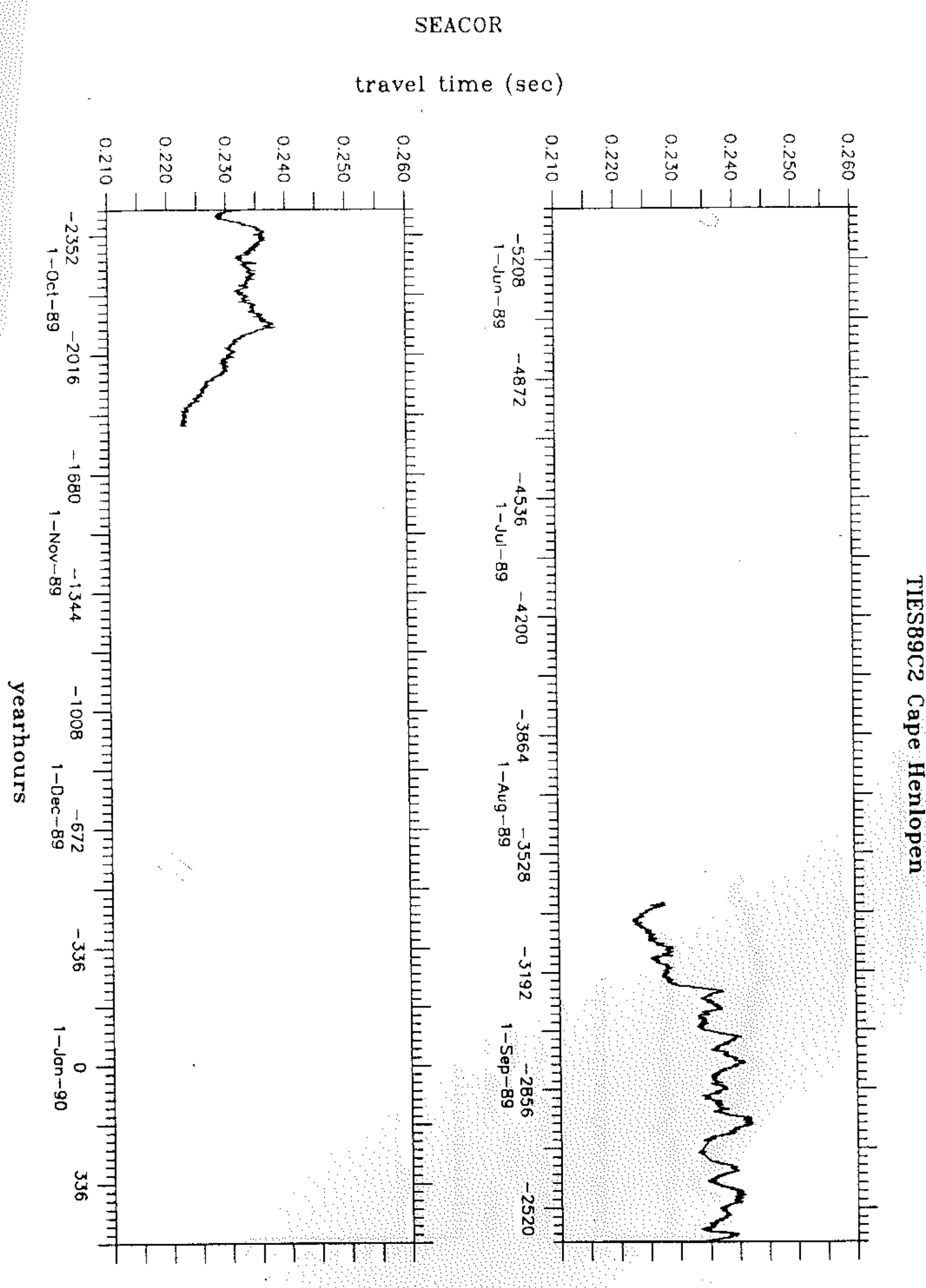


Figure 9.8: Half-Hourly Travel Times. TIES89C2

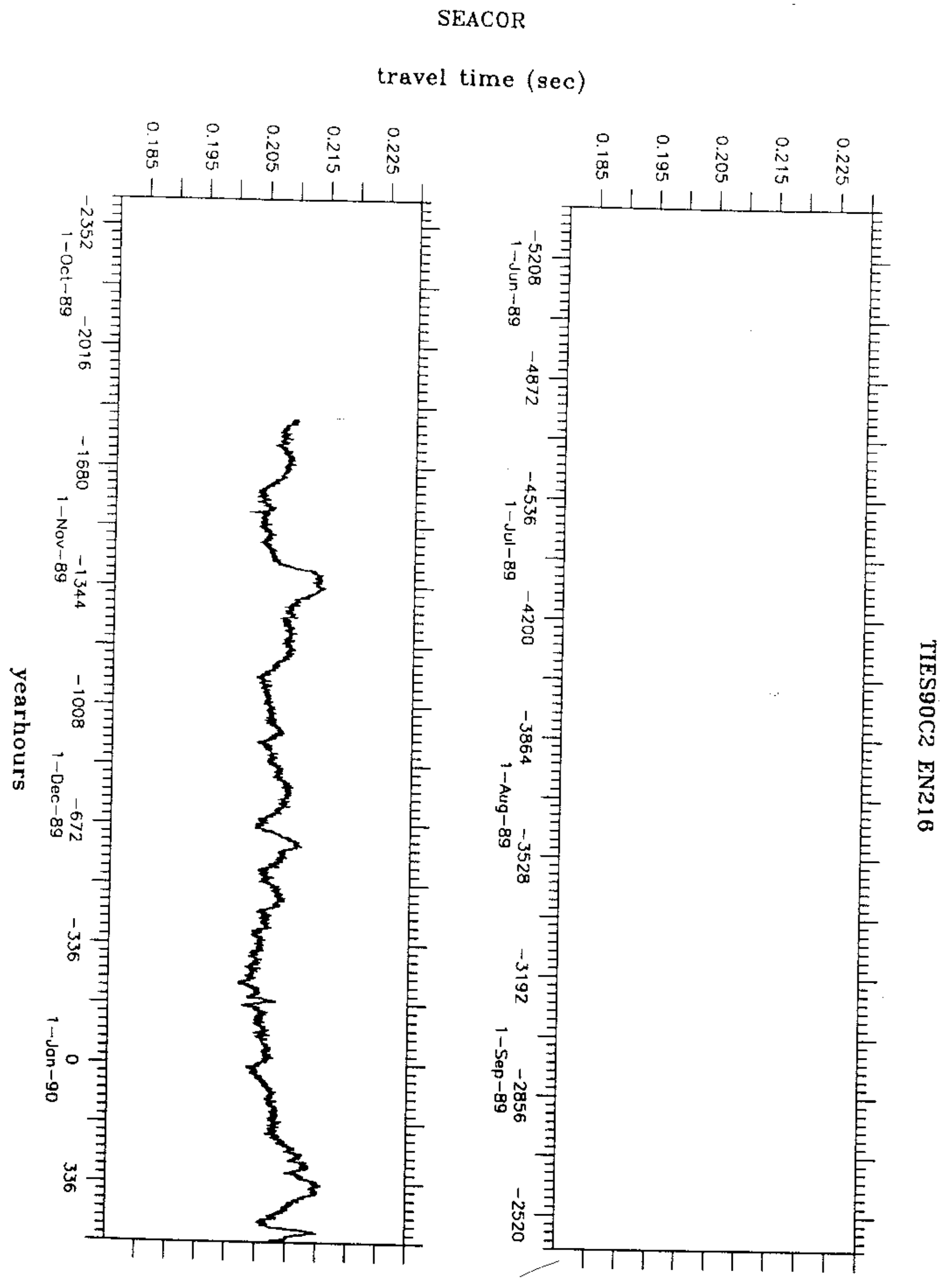
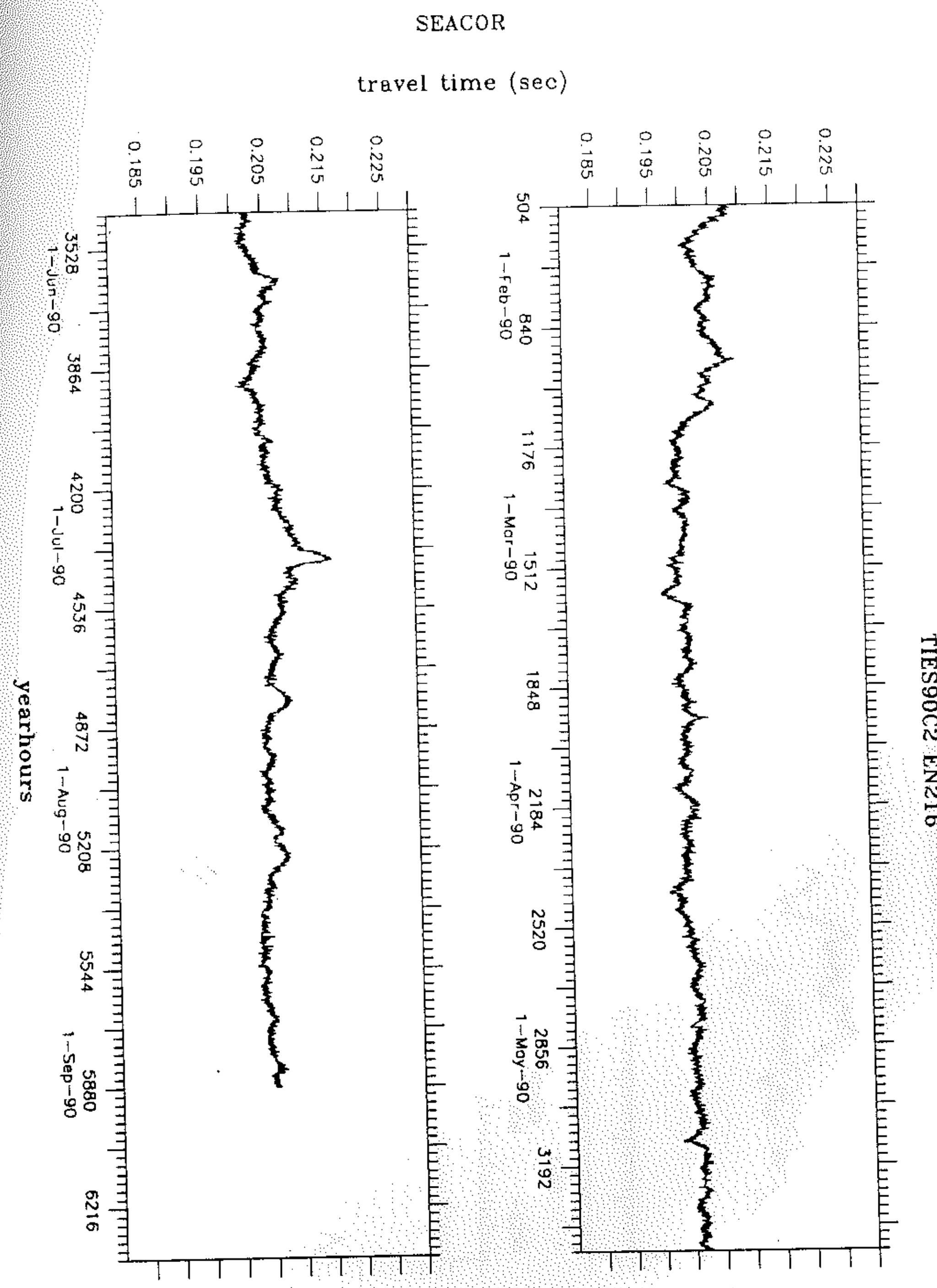


Figure 9.9: Half-Hourly Travel Times. TIES90C2


TIES90C2 EN216
SEACOR
travel time (sec)
0.185
0.195
0.205
0.215
0.225
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

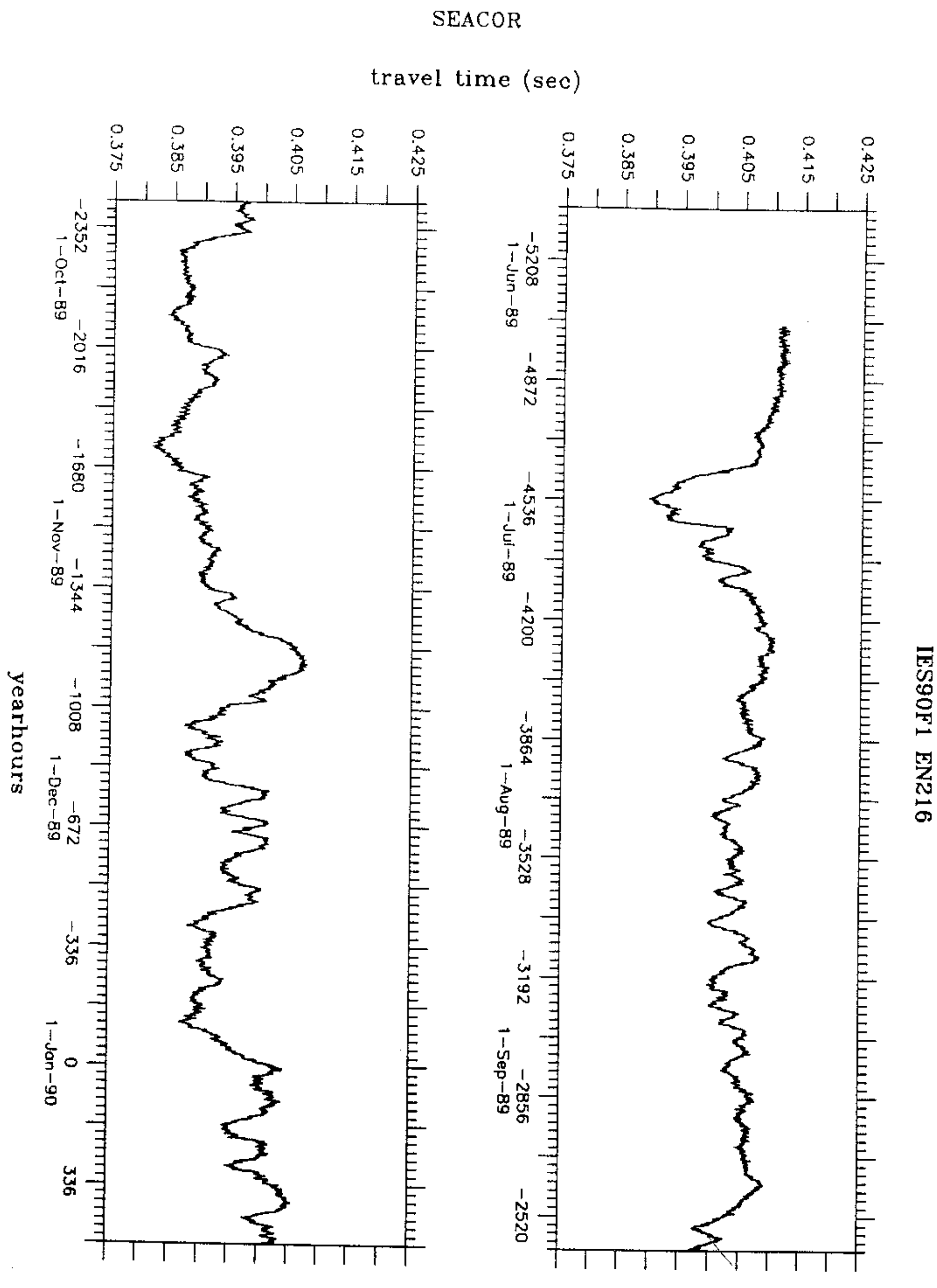
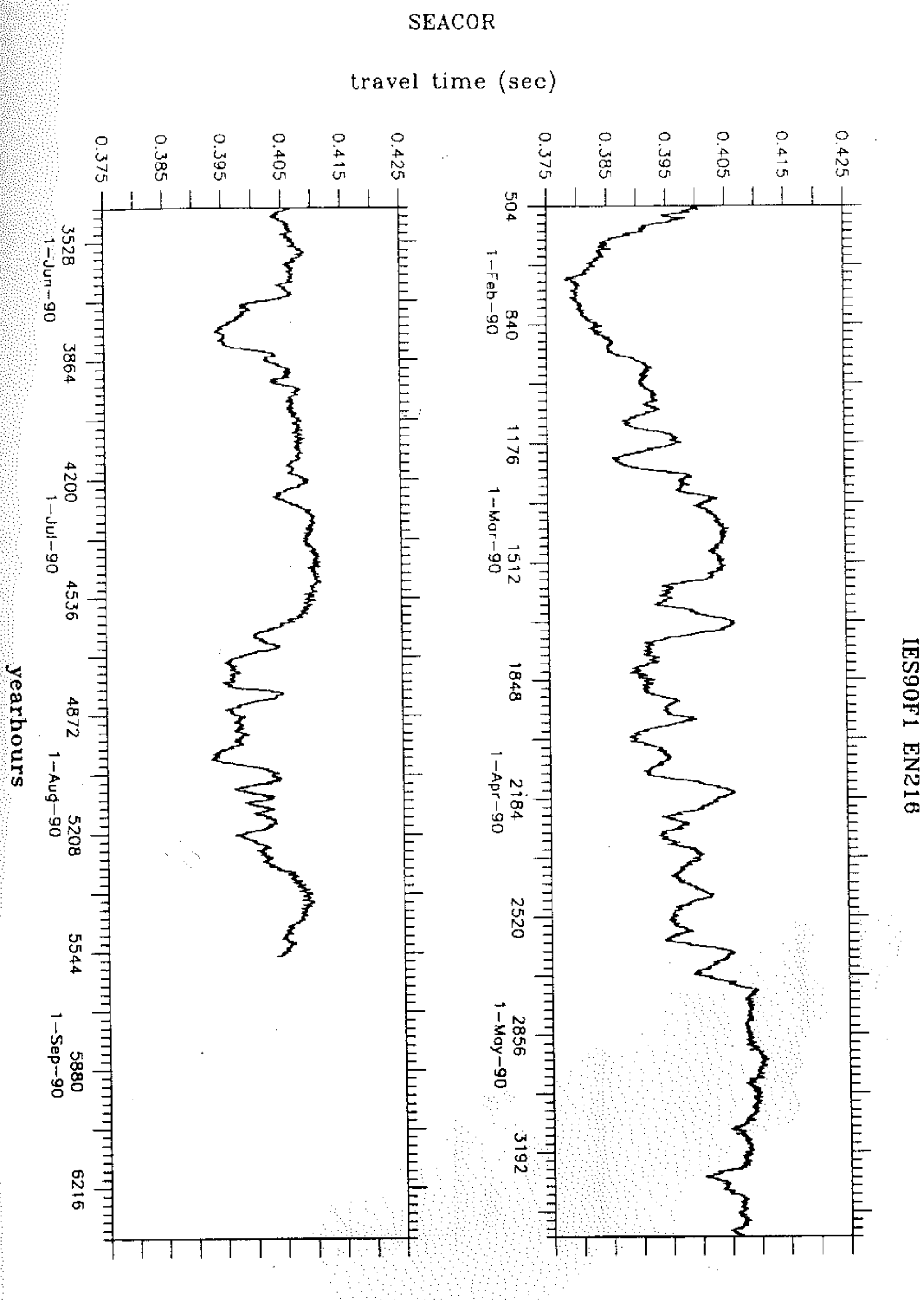


Figure 9.10: Half-Hourly Travel Times. IES90F1


SEACOR
IES90F1 EN216
travel time (sec)
0.375
0.385
0.395
0.405
0.415
0.425
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

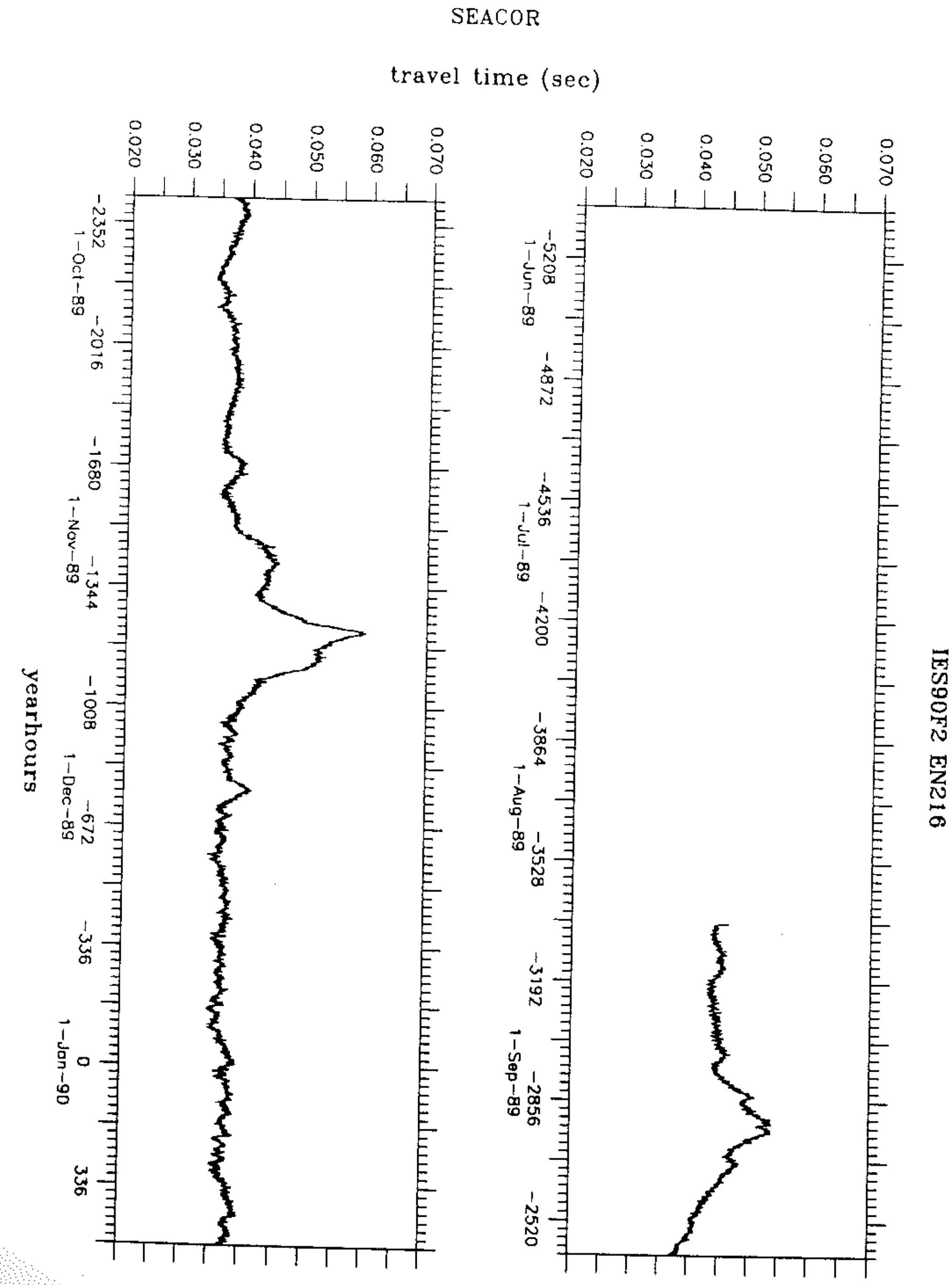
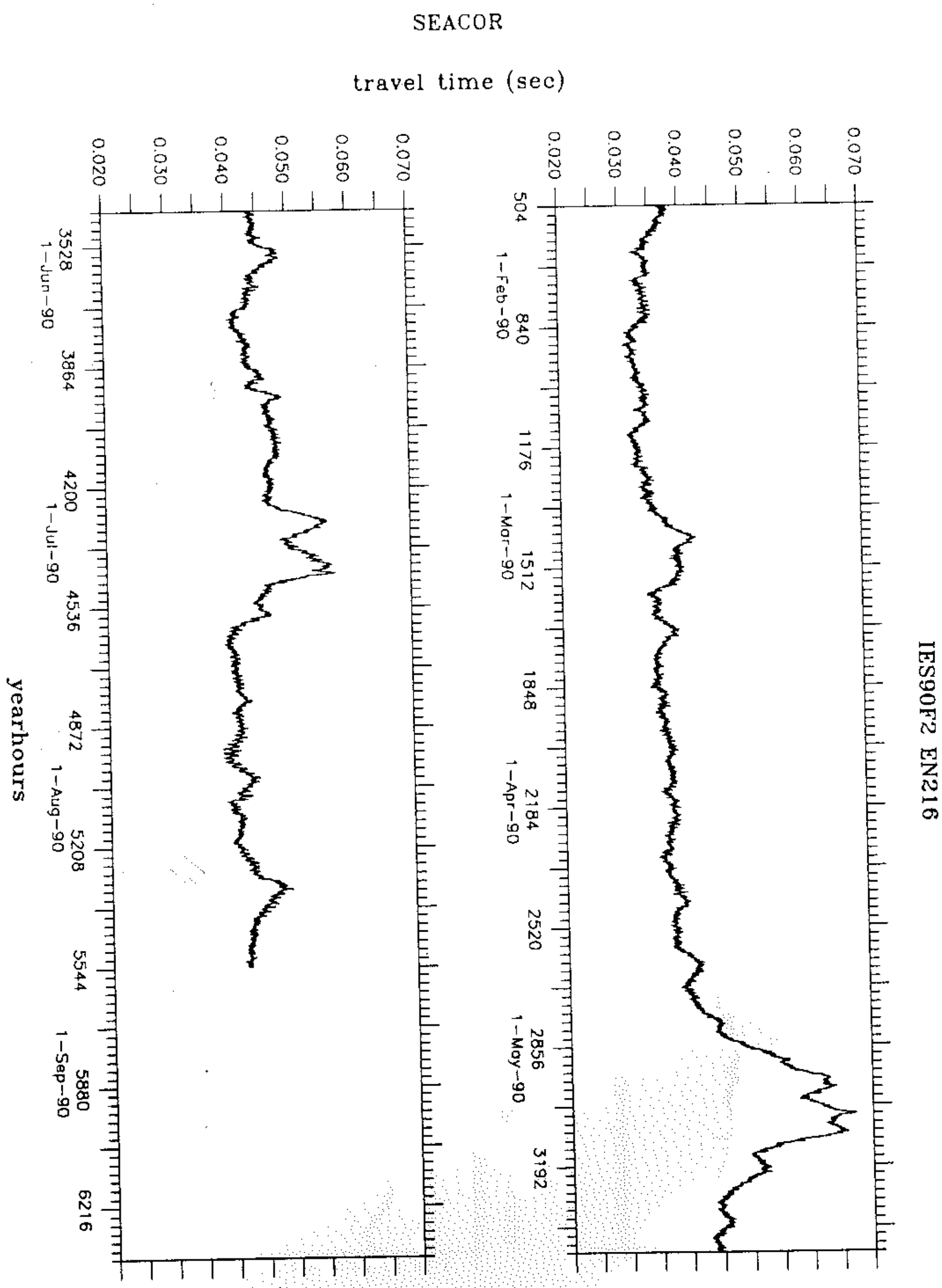


Figure 9.11: Half-Hourly Travel Times. IES90F2


SEACOR
travel time (sec)
IES90F2 EN216
0.020
0.030
0.040
0.050
0.060
0.070
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

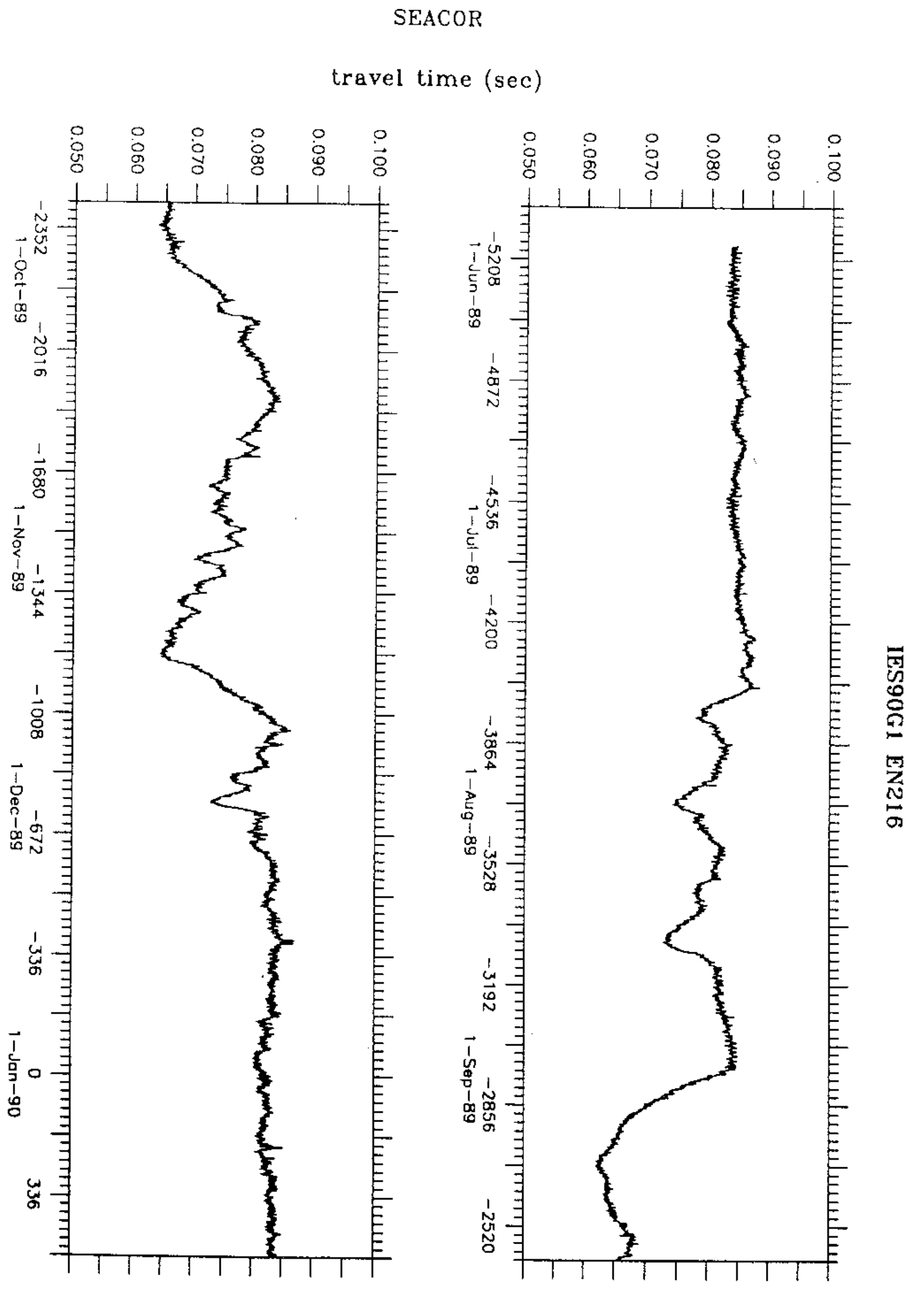
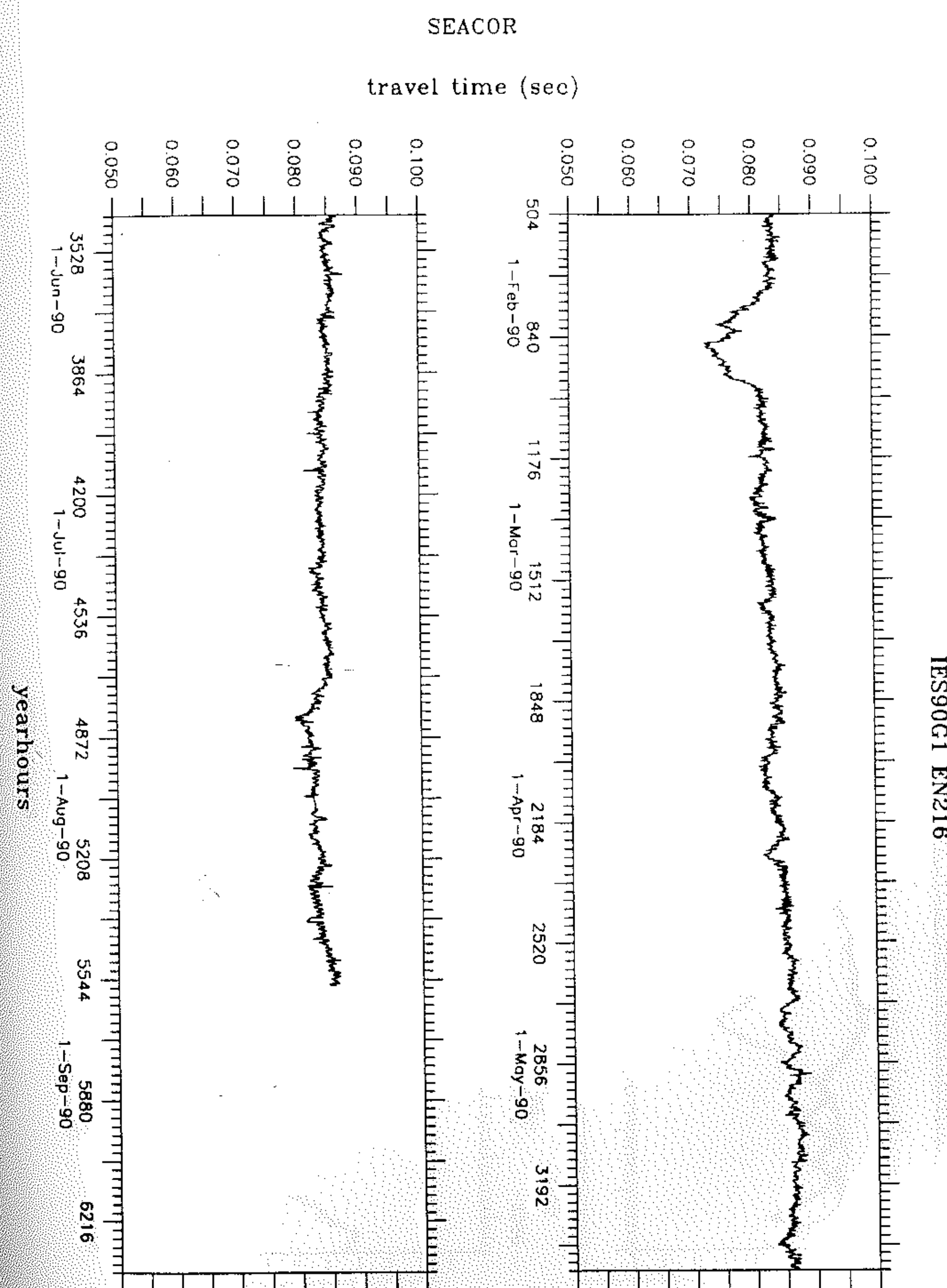


Figure 9.12: Half-Hourly Travel Times. IES90G1


IES90G1 EN216
SEACOR
travel time (sec)
0.050
0.060
0.070
0.080
0.090
0.100
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

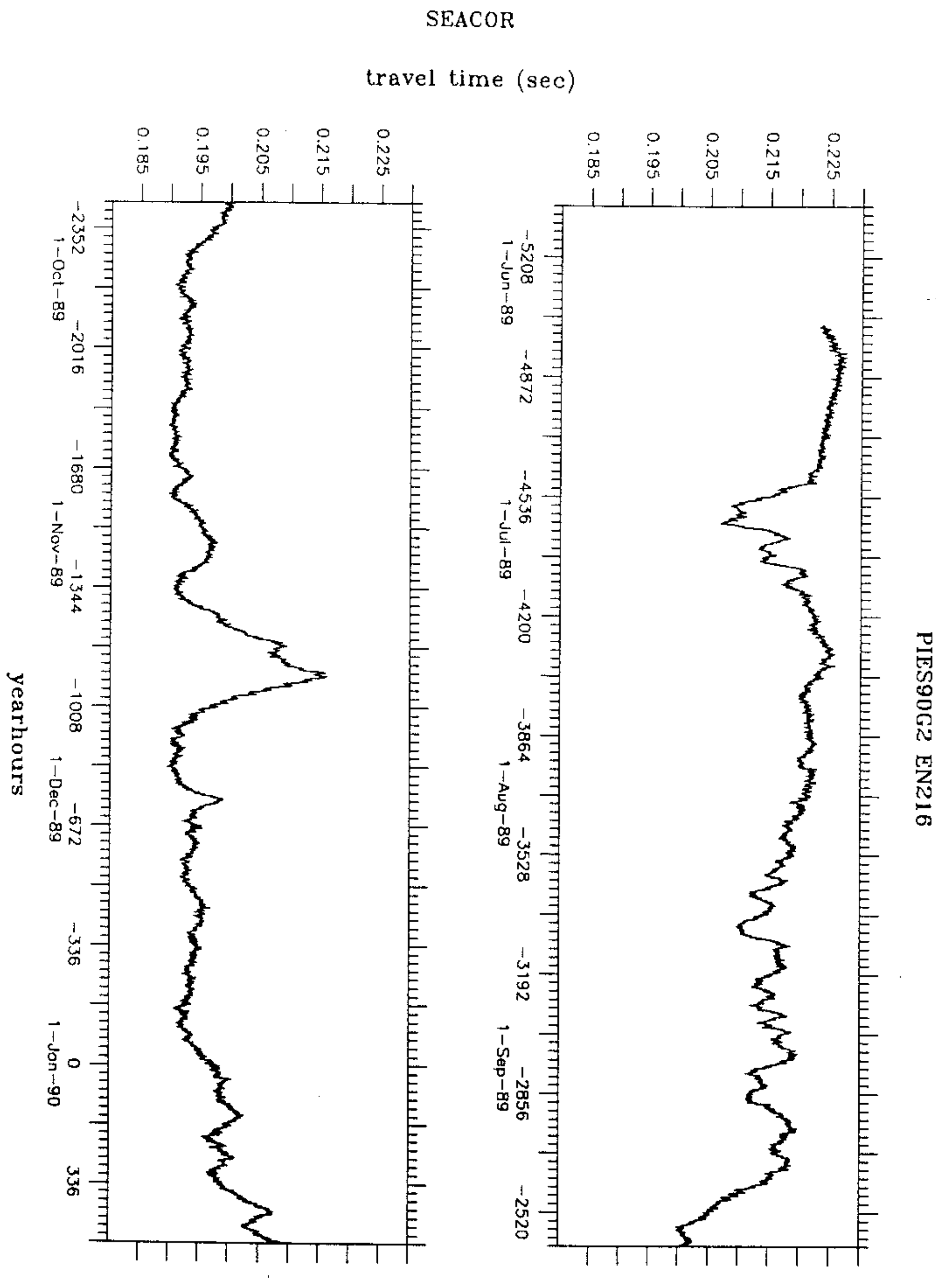
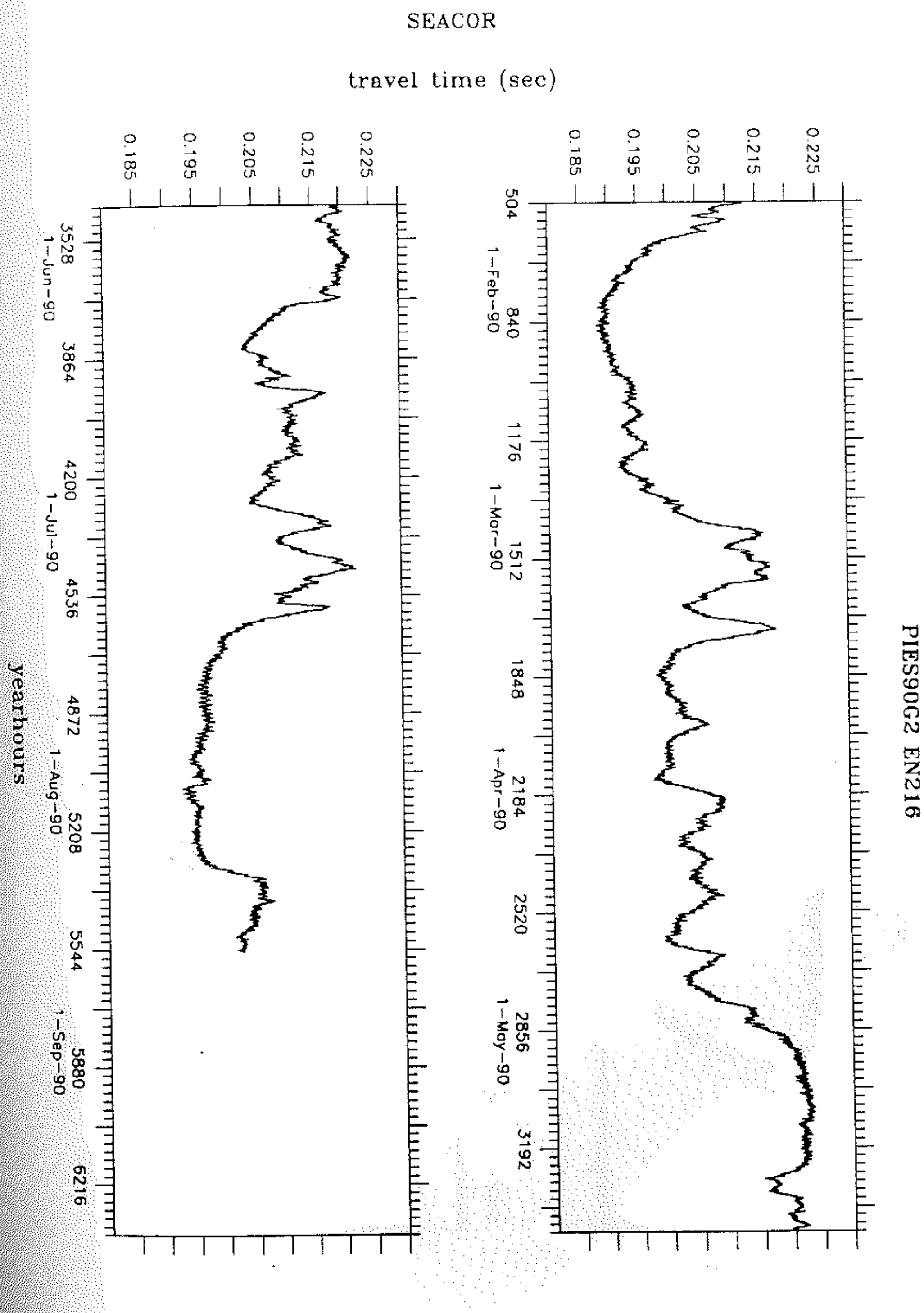


Figure 9.13: Half-Hourly Travel Times. PIES90G2



SEACOR
travel time (sec)
PIES90G2 EN216
0.185
0.195
0.205
0.215
0.225
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

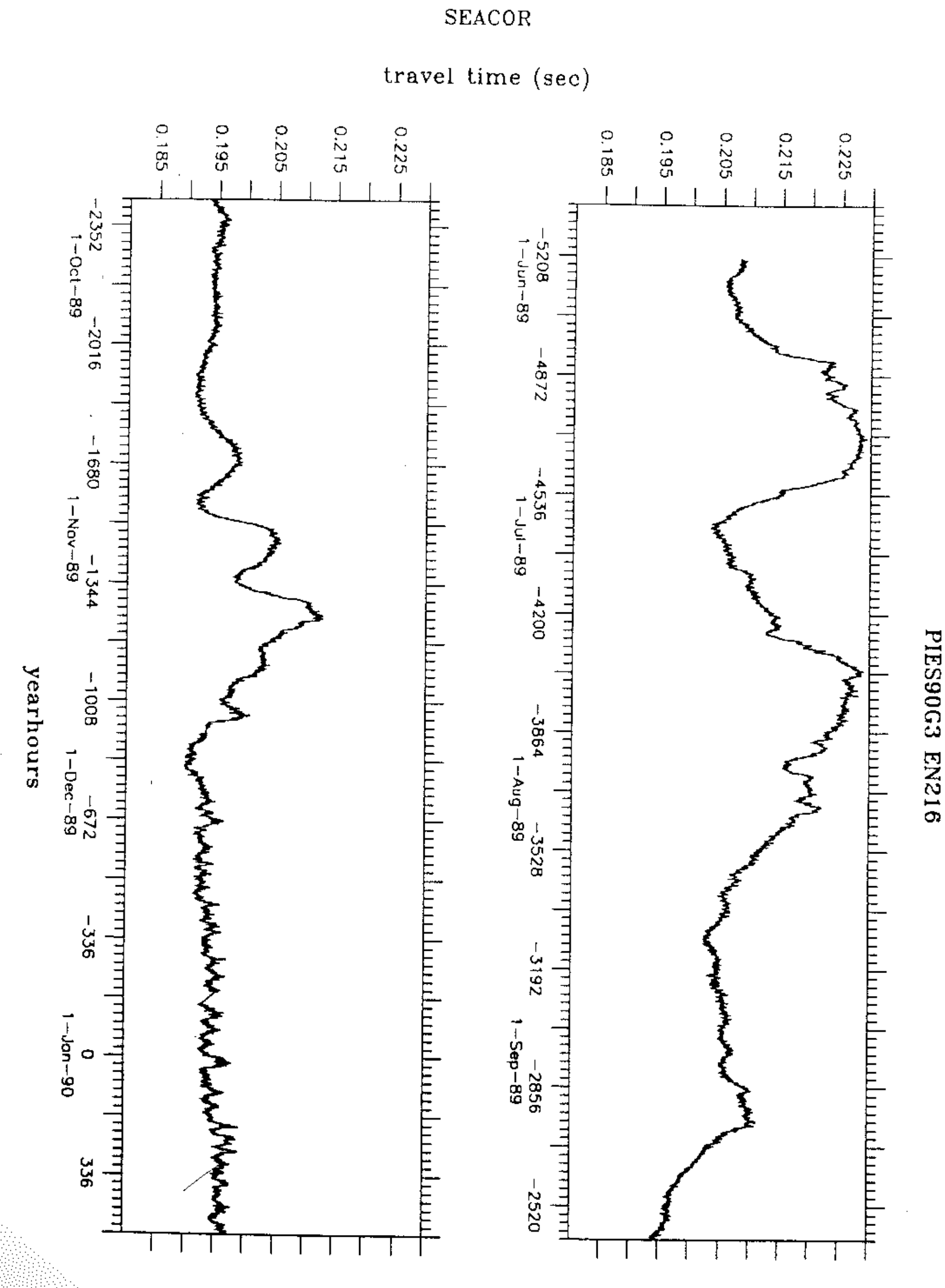
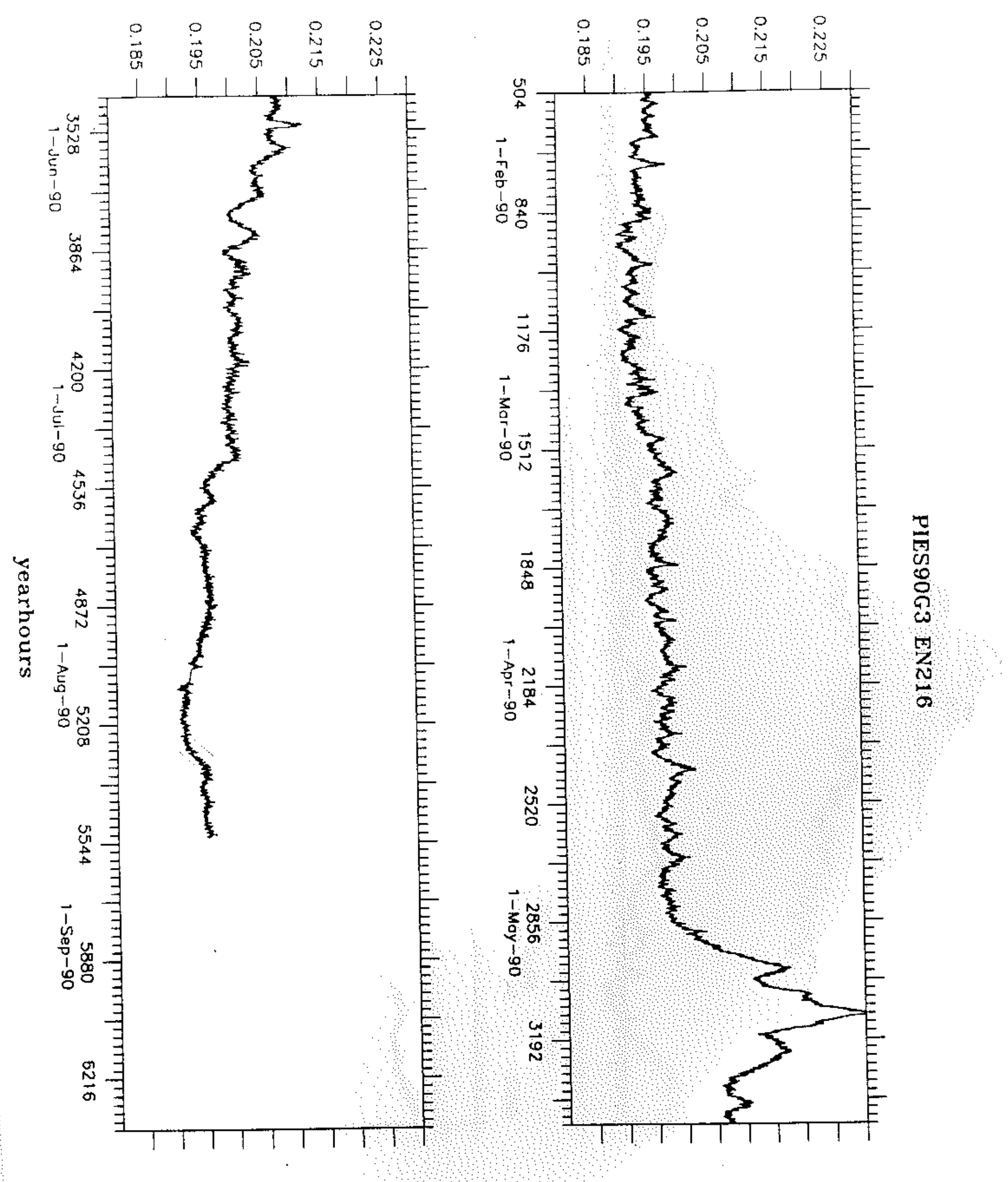


Figure 9.14: Half-Hourly Travel Times. PIES90G3

SEACOR

travel time (sec)



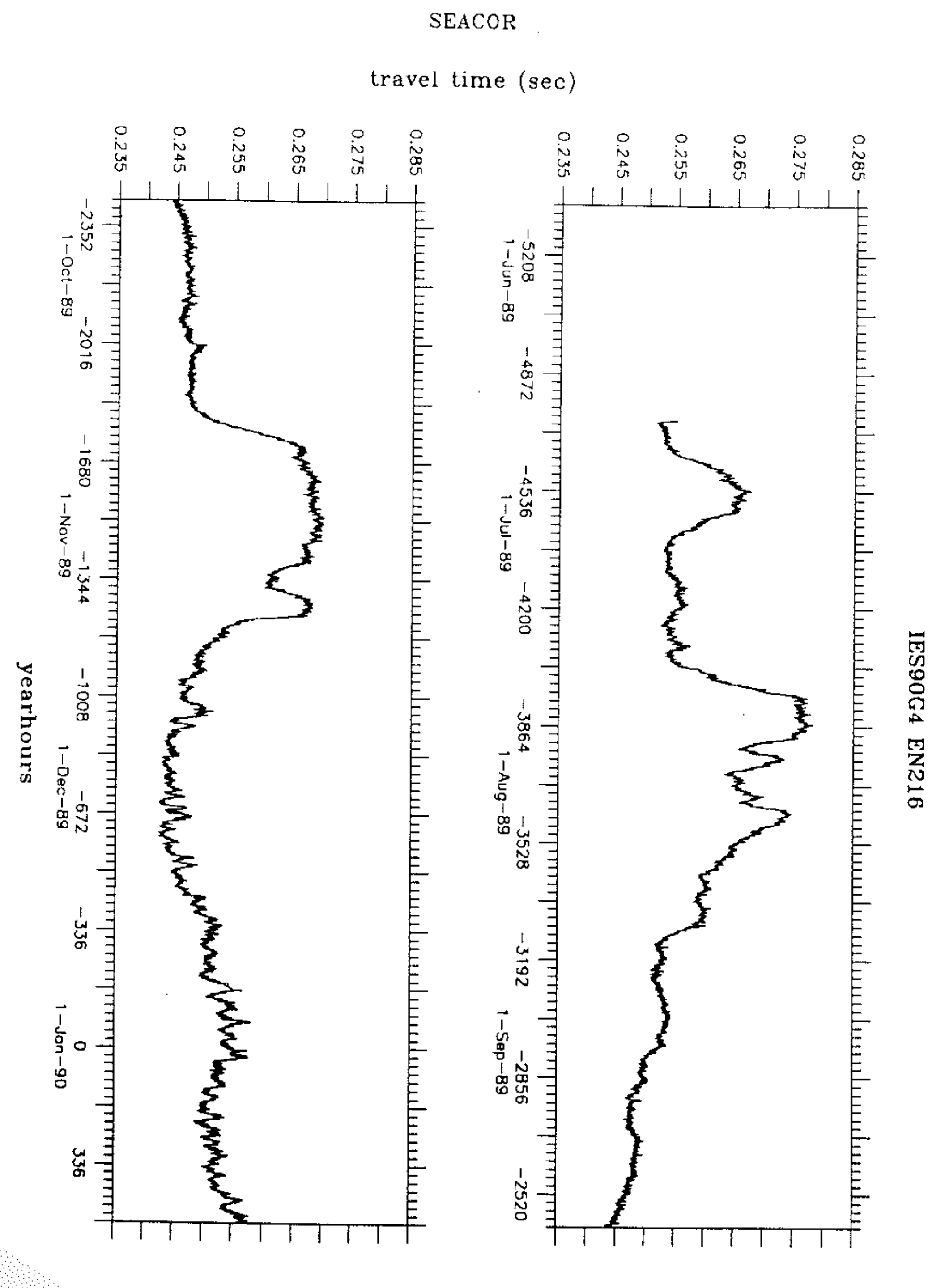
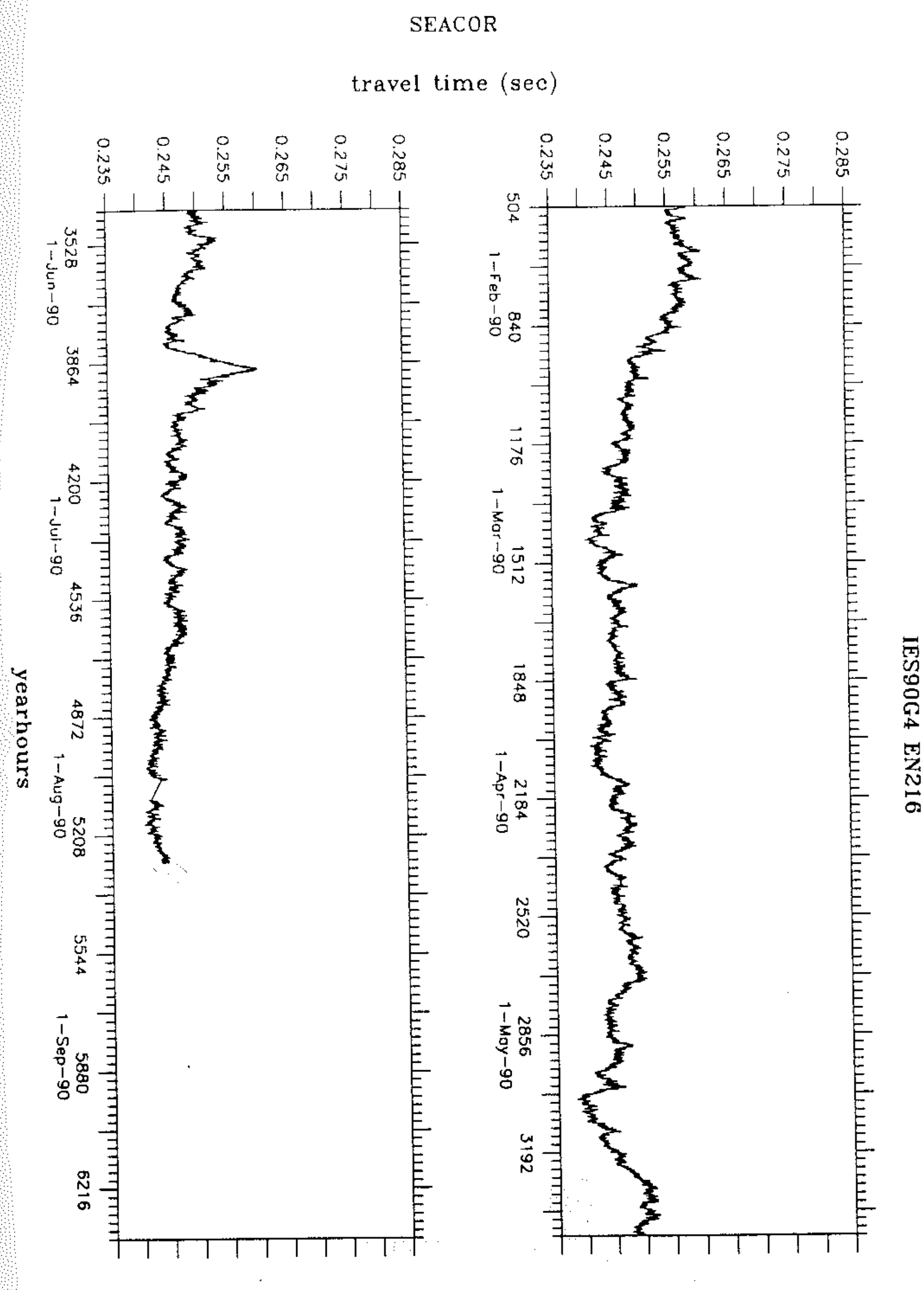


Figure 9.15: Half-Hourly Travel Times. IES90G4


IES90G4 EN216
SEACOR
travel time (sec)
0.235
0.245
0.255
0.265
0.275
0.285
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

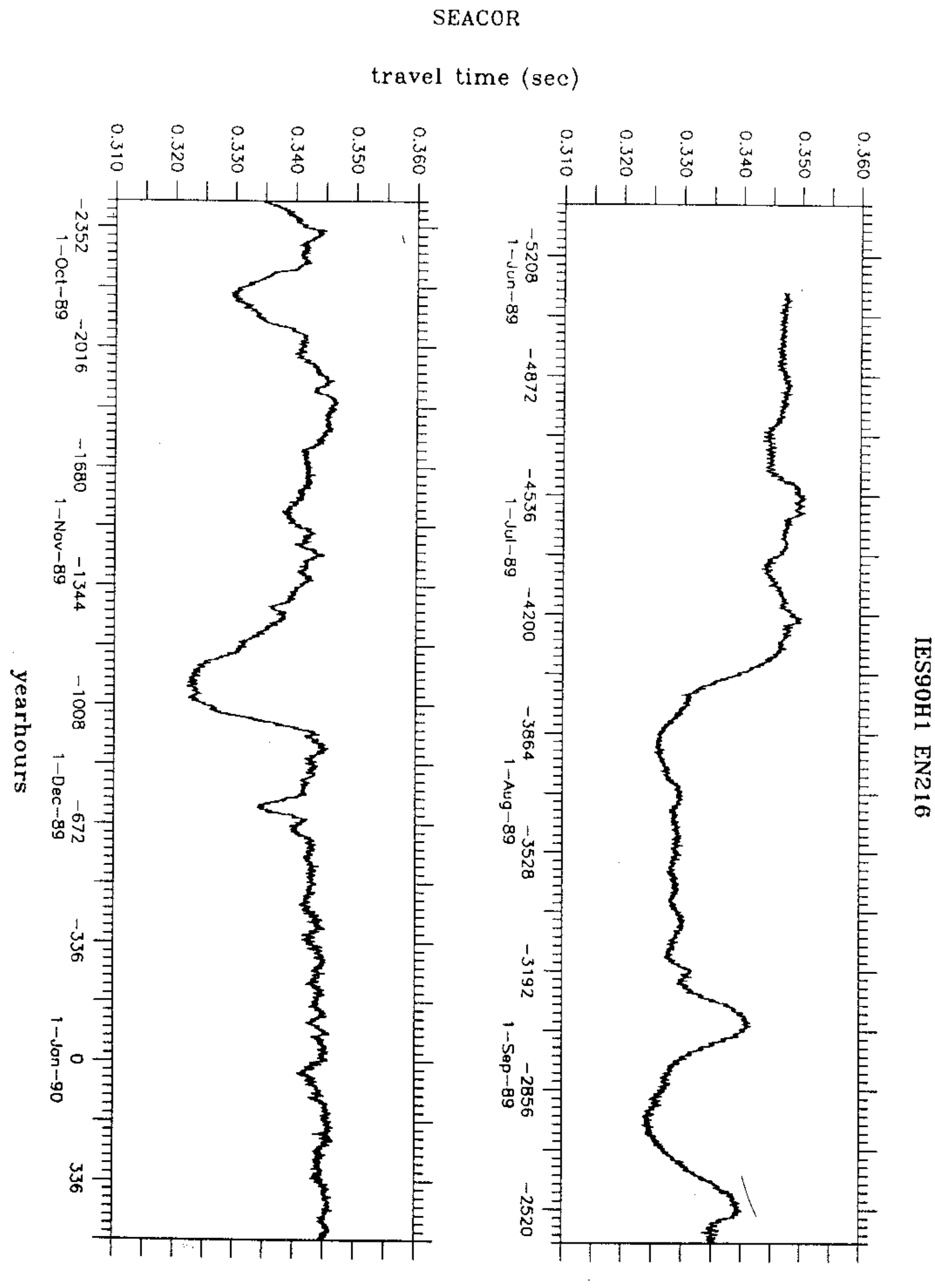
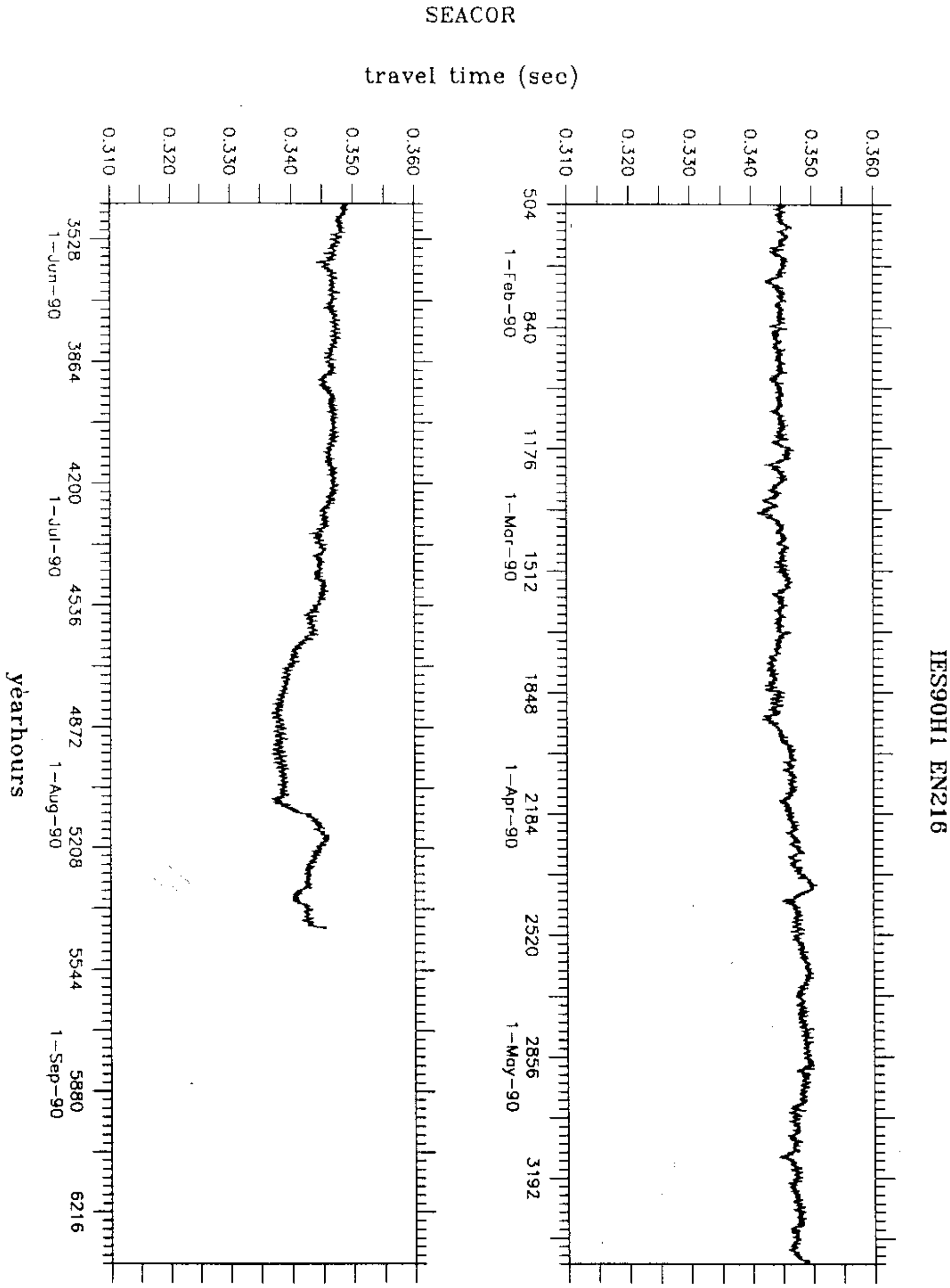


Figure 9.16: Half-Hourly Travel Times. IES90H1


SEACOR
travel time (sec)
IES90H1 EN216
0.310
0.320
0.330
0.340
0.350
0.360
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

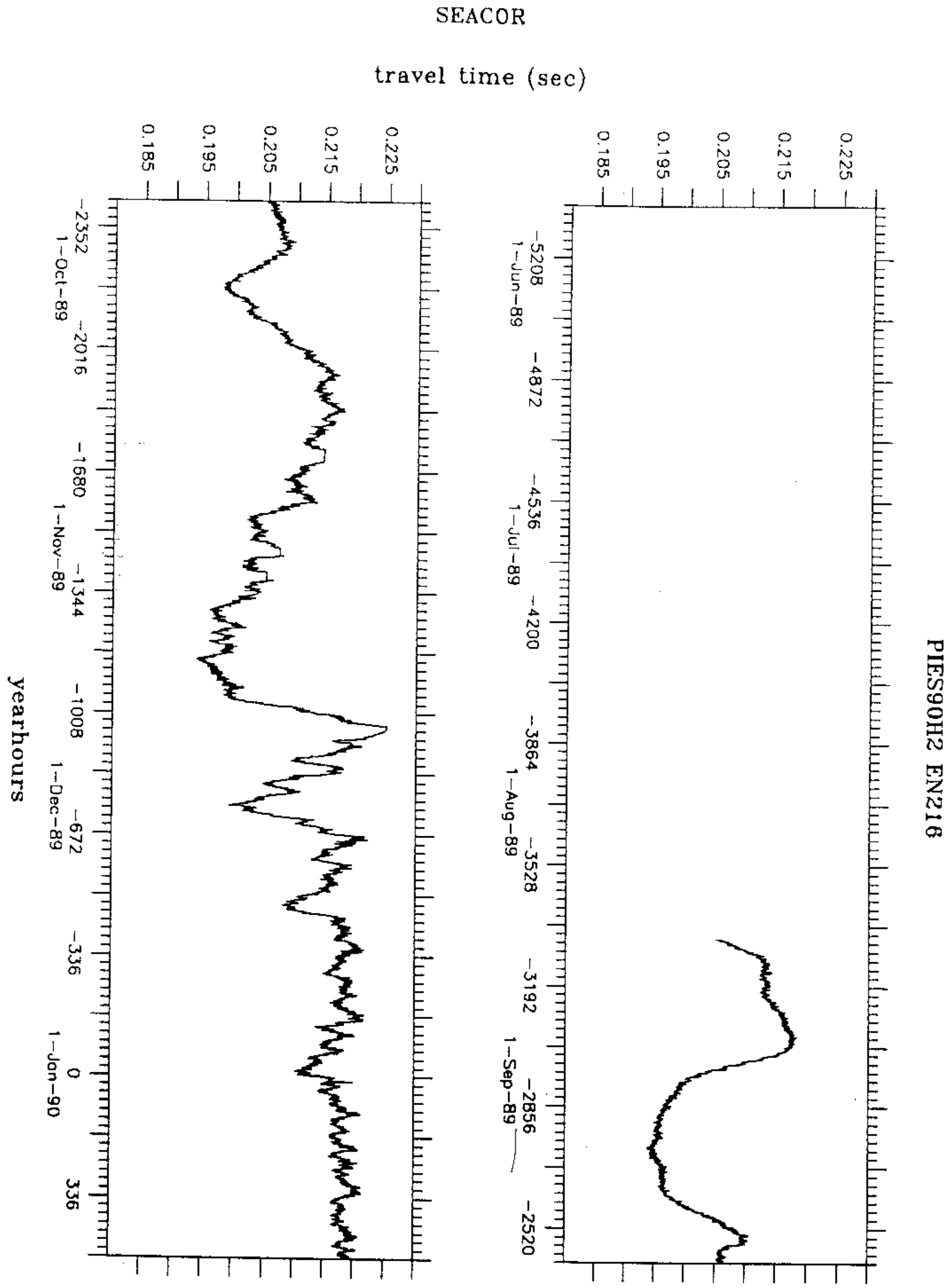
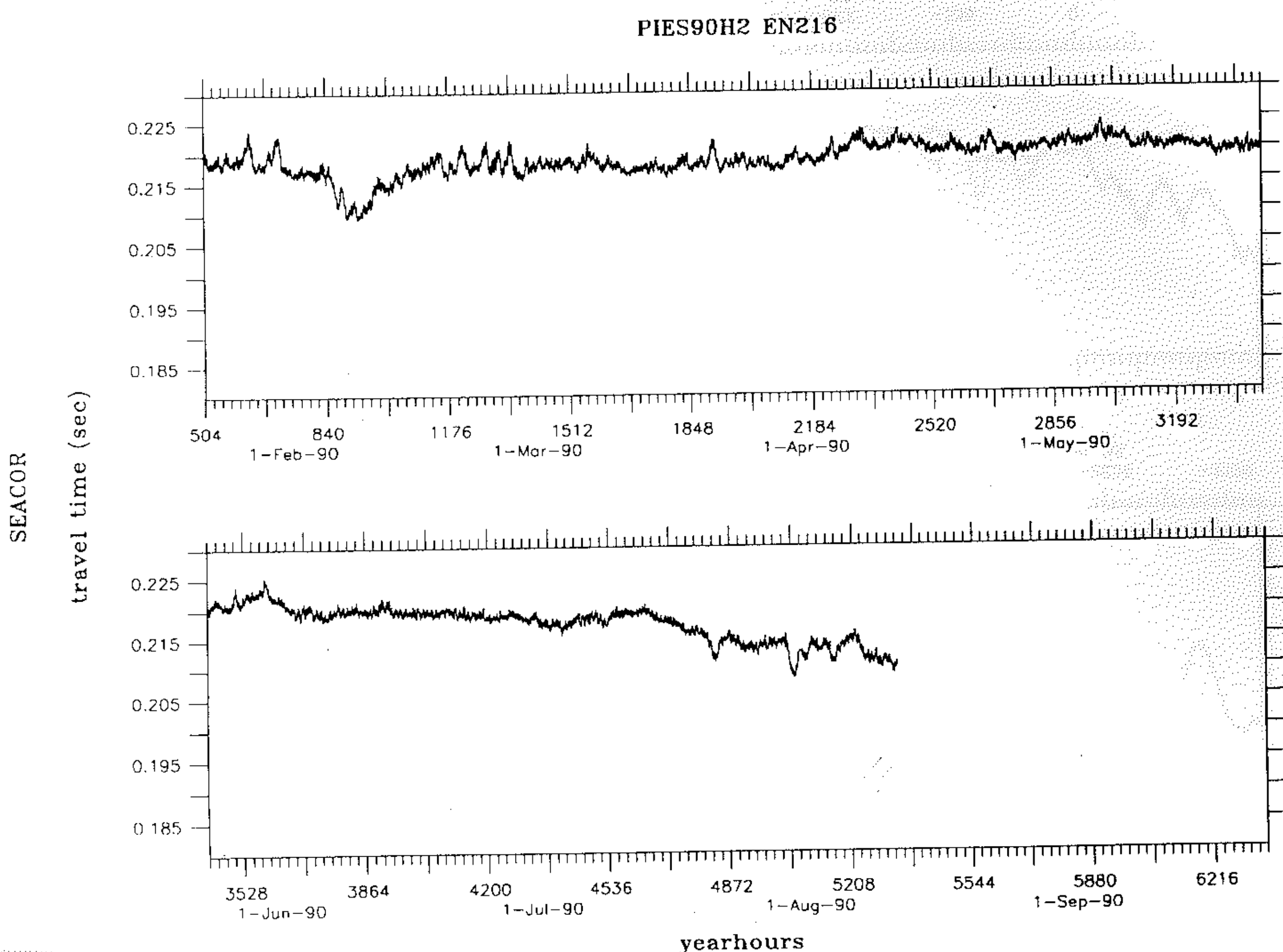


Figure 9.17: Half-Hourly Travel Times. PIES90H2


PIES90H2 EN216
SEACOR
travel time (sec)
0.225
0.215
0.205
0.195
0.185
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

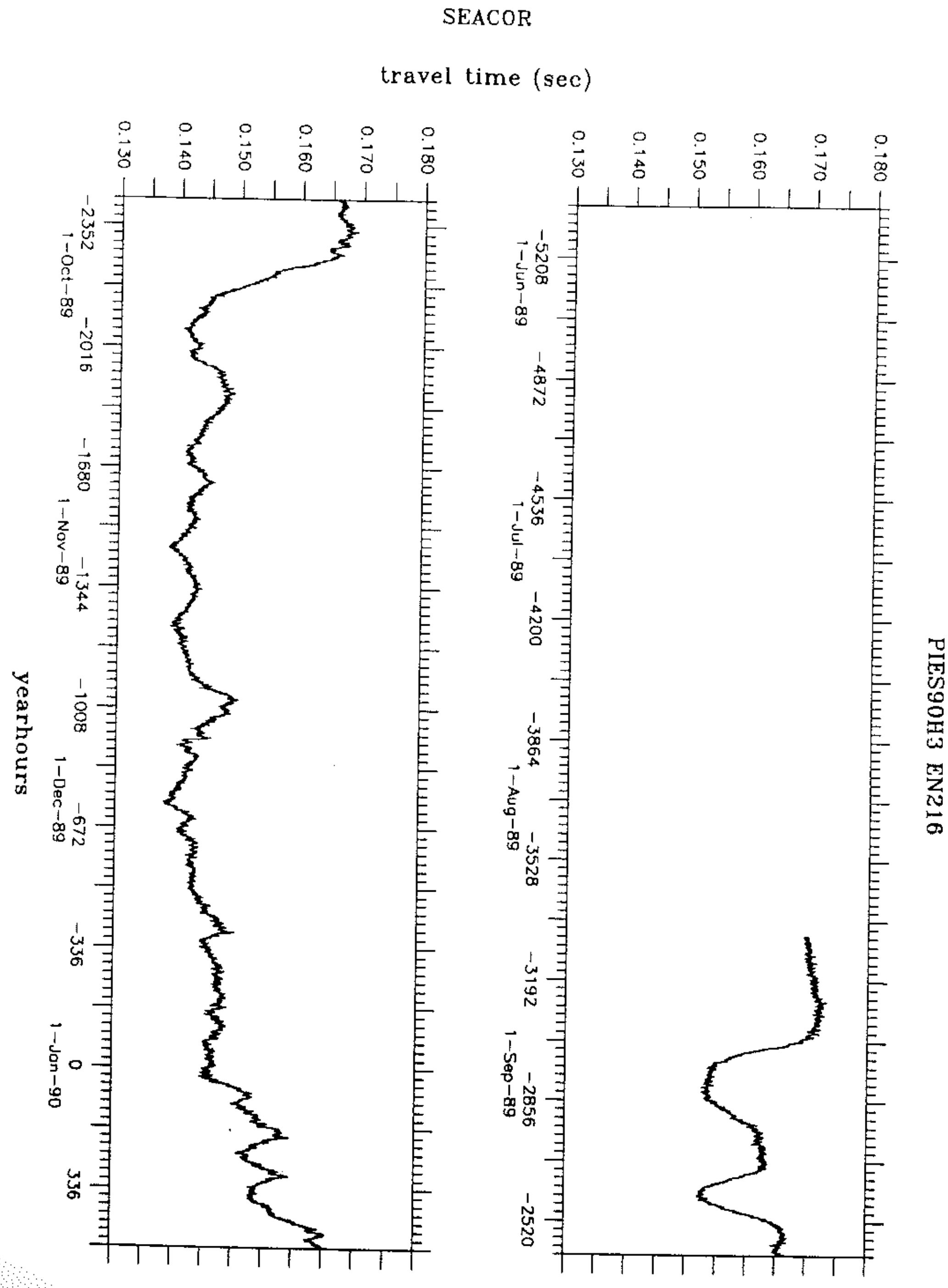
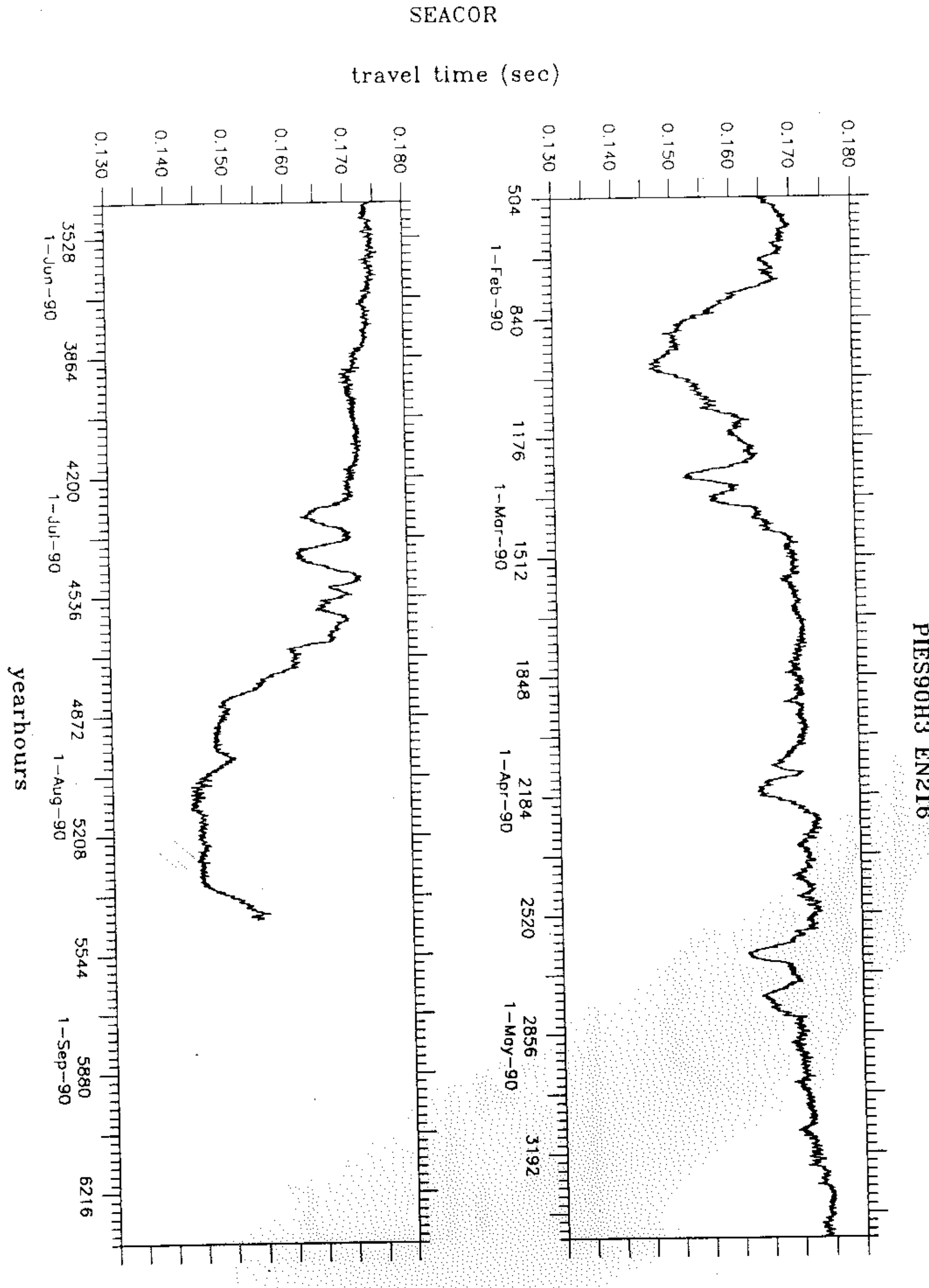


Figure 9.18: Half-Hourly Travel Times. PIES90H3



SEACOR
travel time (sec)
PIES90H3 EN216
0.130
0.140
0.150
0.160
0.170
0.180
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

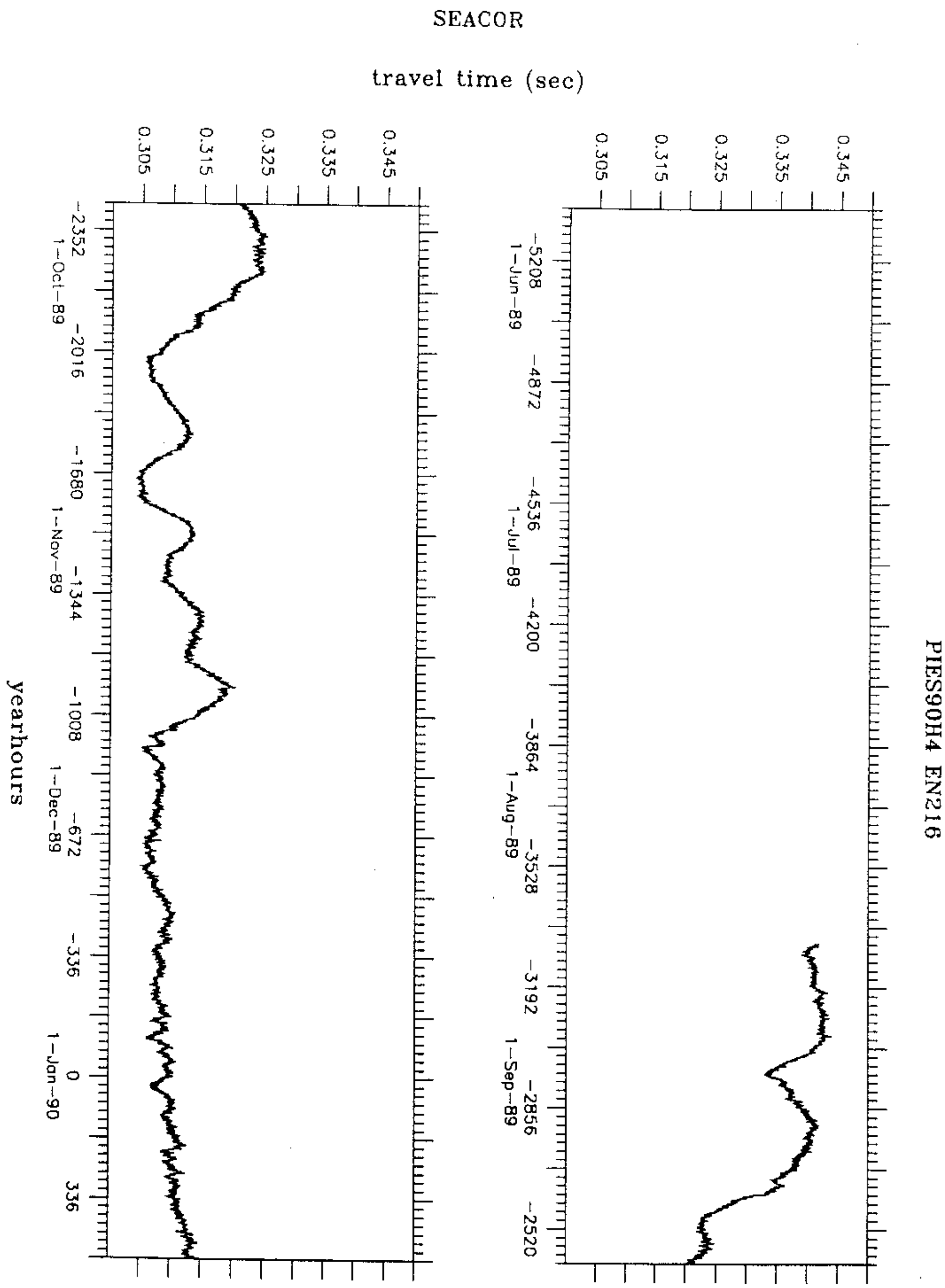
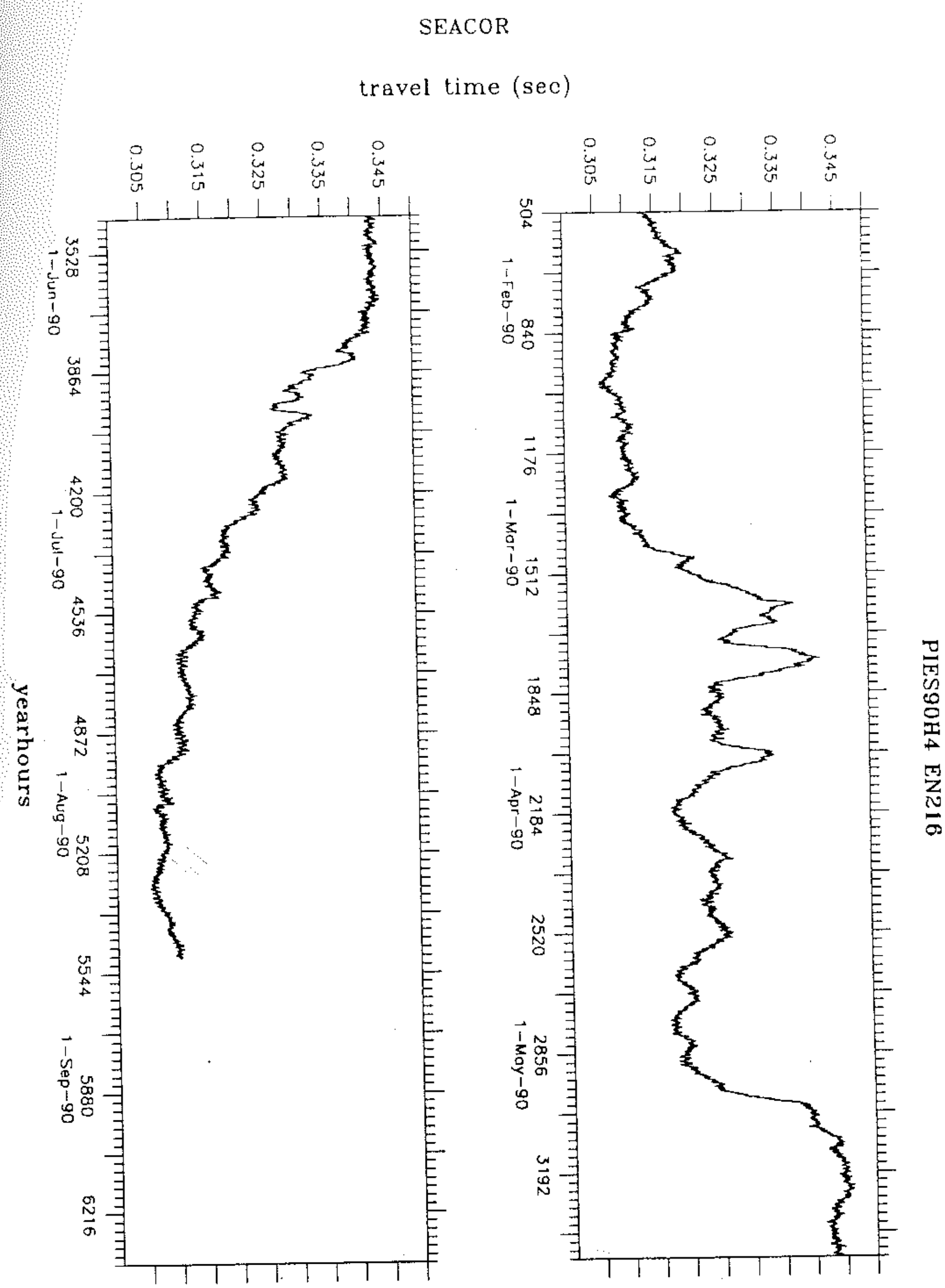


Figure 9.19: Half-Hourly Travel Times. PIES90H4


PIES90H4 EN216
SEACOR
travel time (sec)
0.305
0.315
0.325
0.335
0.345
504
1-Feb-90
840
1176
1-Mar-90
1512
1848
1-Apr-90
2184
2520
1-May-90
2856
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
1-Sep-90
5880
6216
yearhours

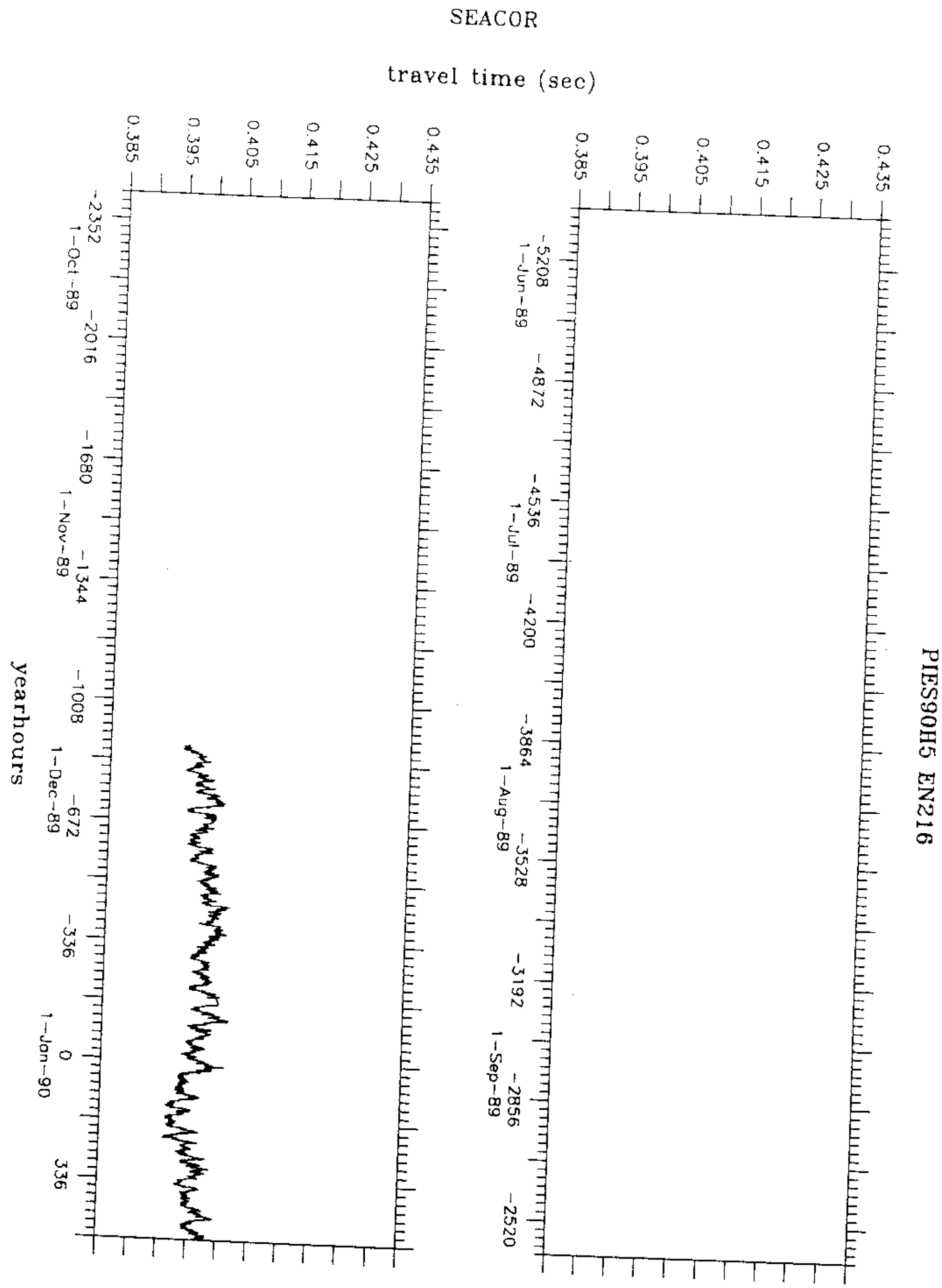
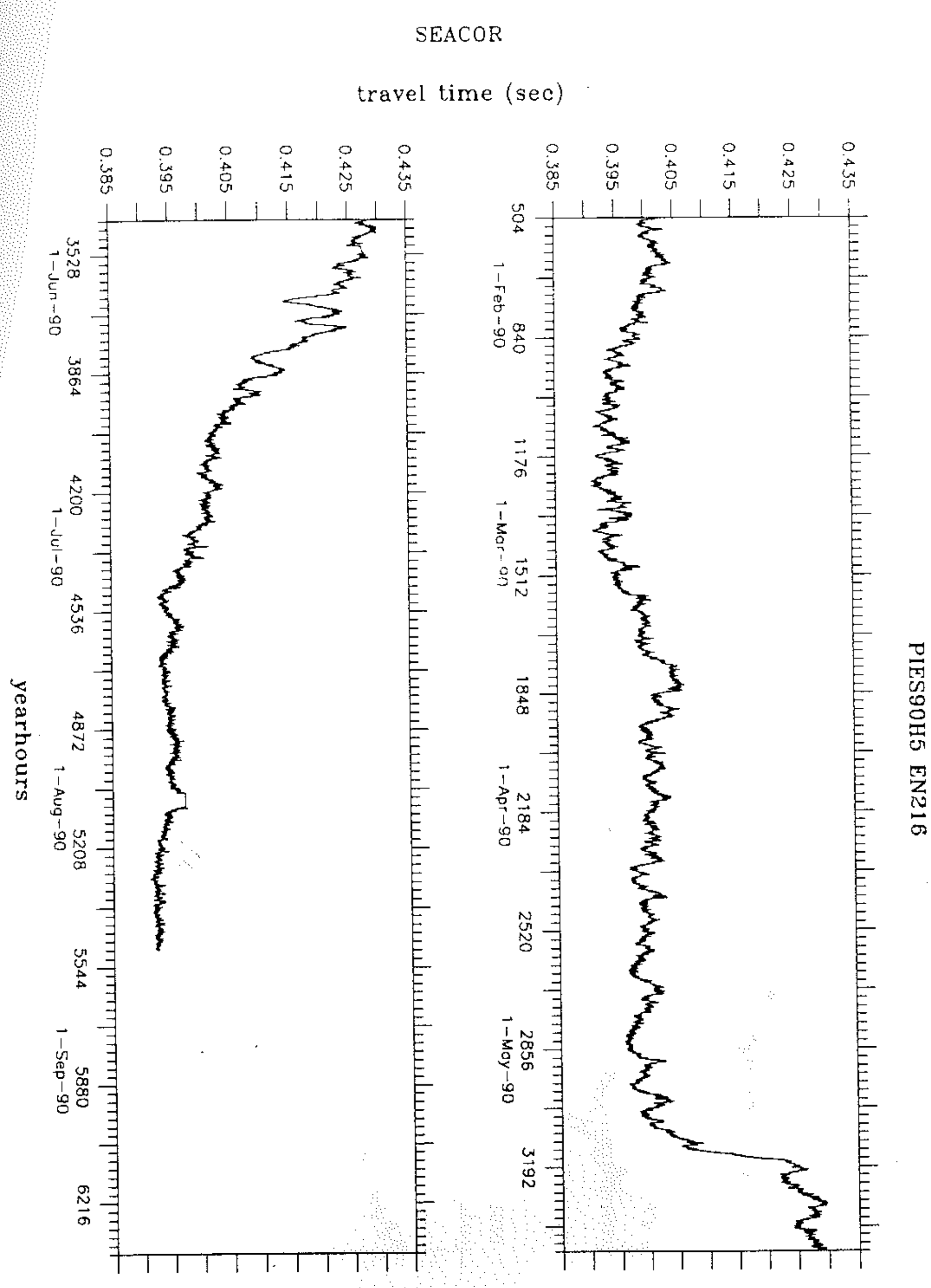


Figure 9.20: Half-Hourly Travel Times. PIES90H5


PIES90H5 EN216
SEACOR
travel time (sec)
0.385
0.395
0.405
0.415
0.425
0.435
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

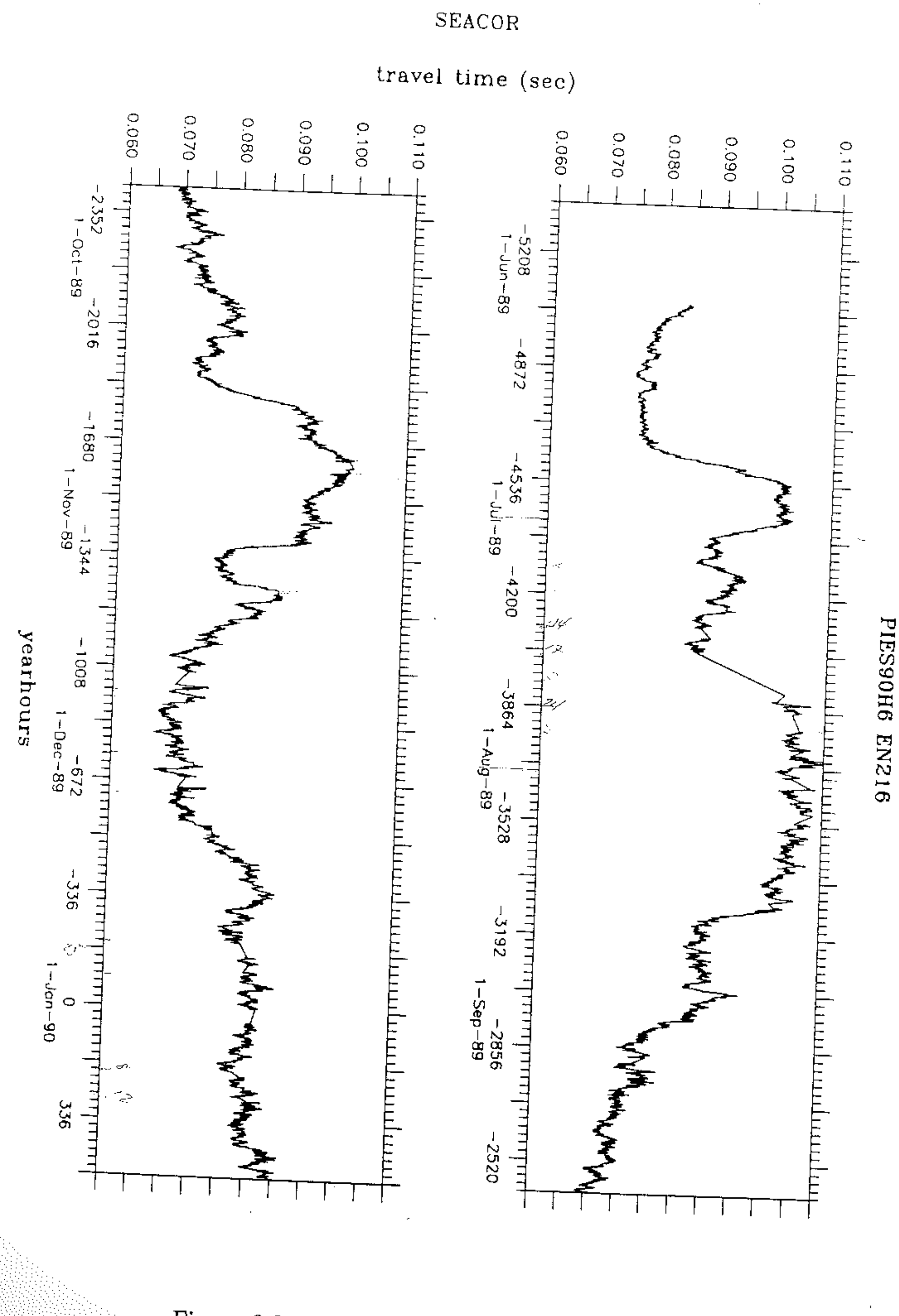
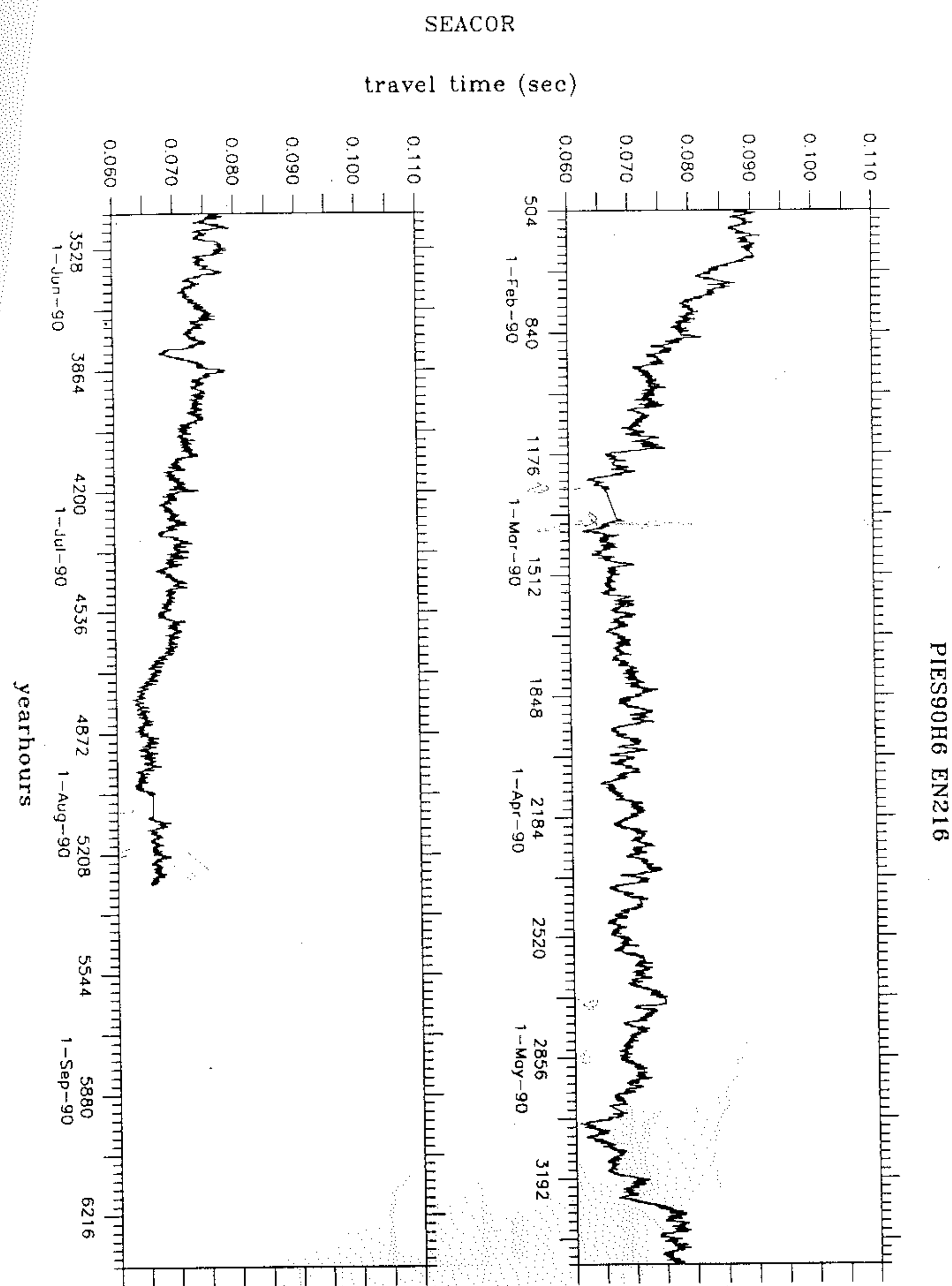


Figure 9.21: Half-Hourly Travel Times. PIES90H6


PIES90H6 EN216
SEACOR
travel time (sec)
0.060
0.070
0.080
0.090
0.100
0.110
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

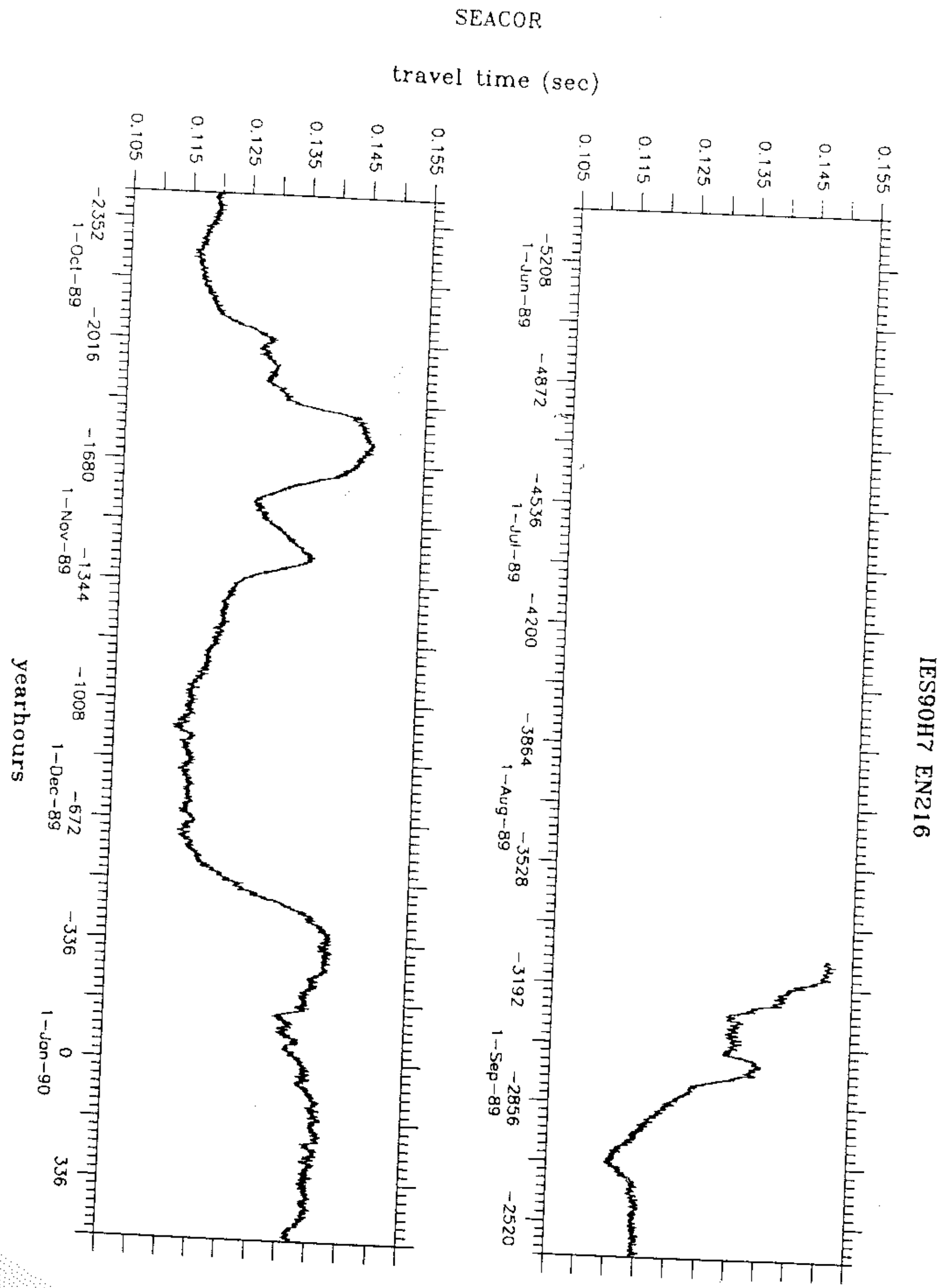
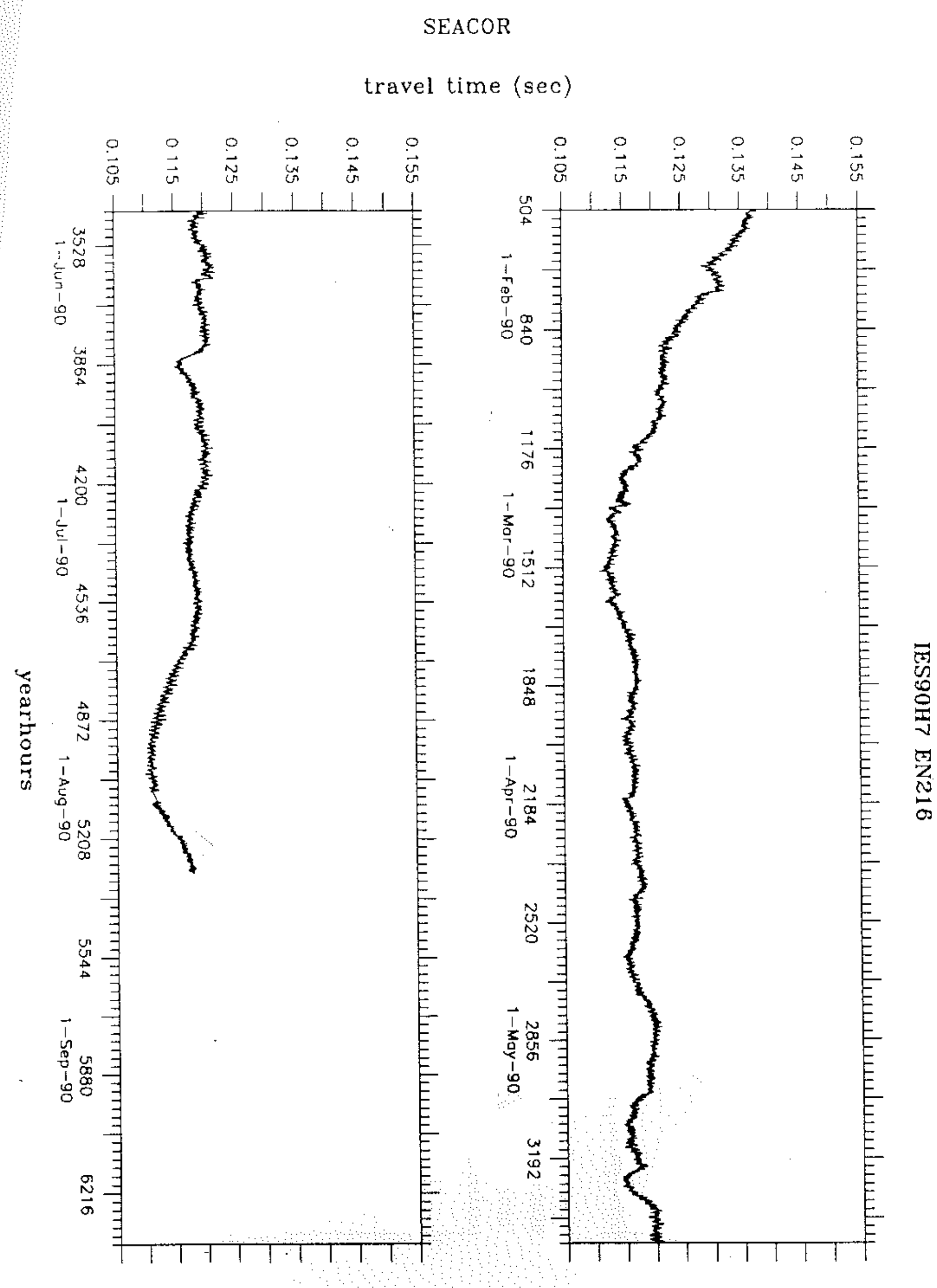


Figure 9.22: Half-Hourly Travel Times. IES90H7


IES90H7 EN216
SEACOR
travel time (sec)
yearhours
0.105
0.115
0.125
0.135
0.145
0.155
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90

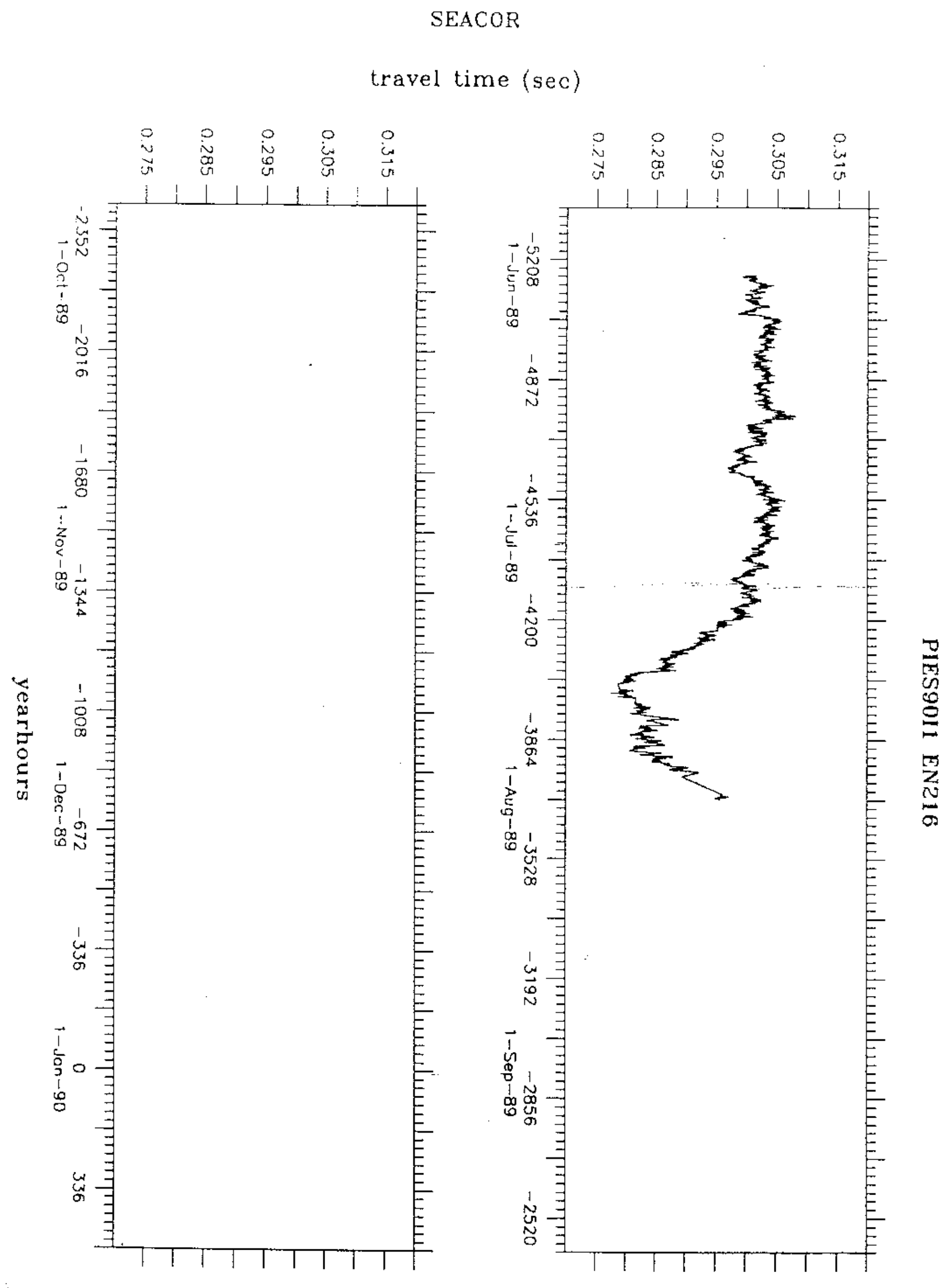


Figure 9.23: Half-Hourly Travel Times. PIES90I1

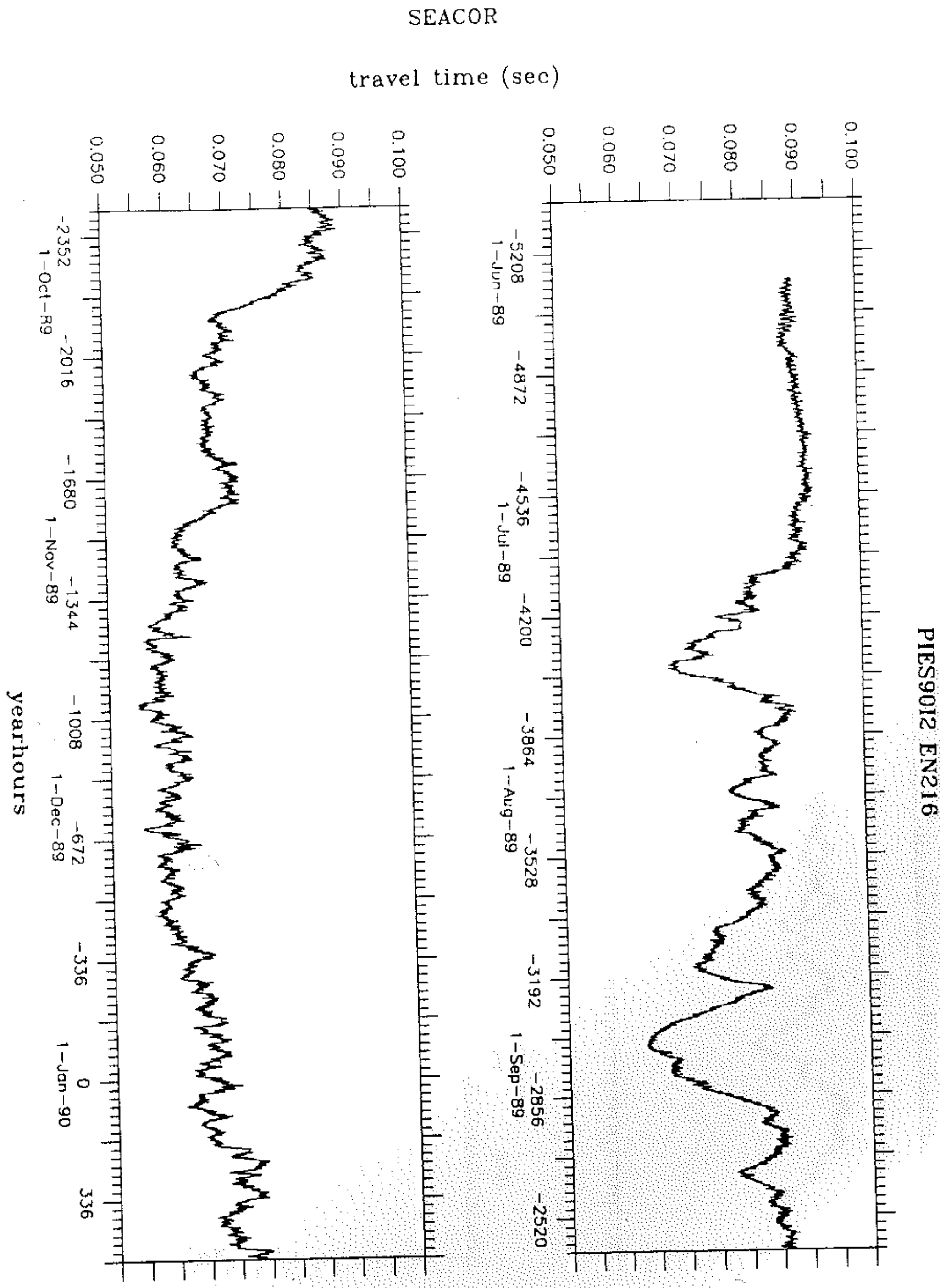
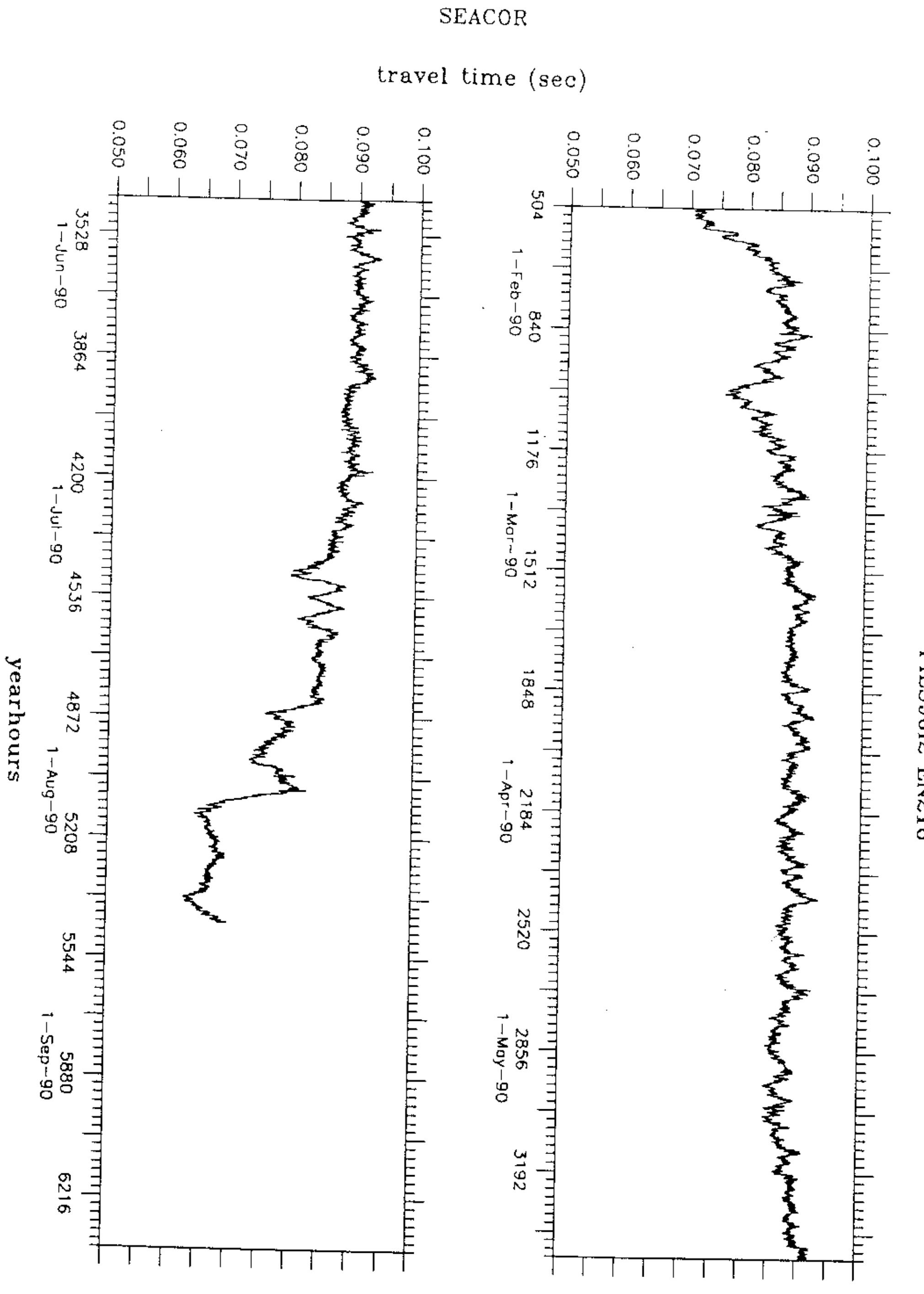


Figure 9.24: Half-Hourly Travel Times. PIES90I2


SEACOR
travel time (sec)
PIES90I2 EN216
0.050
0.060
0.070
0.080
0.090
0.100
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

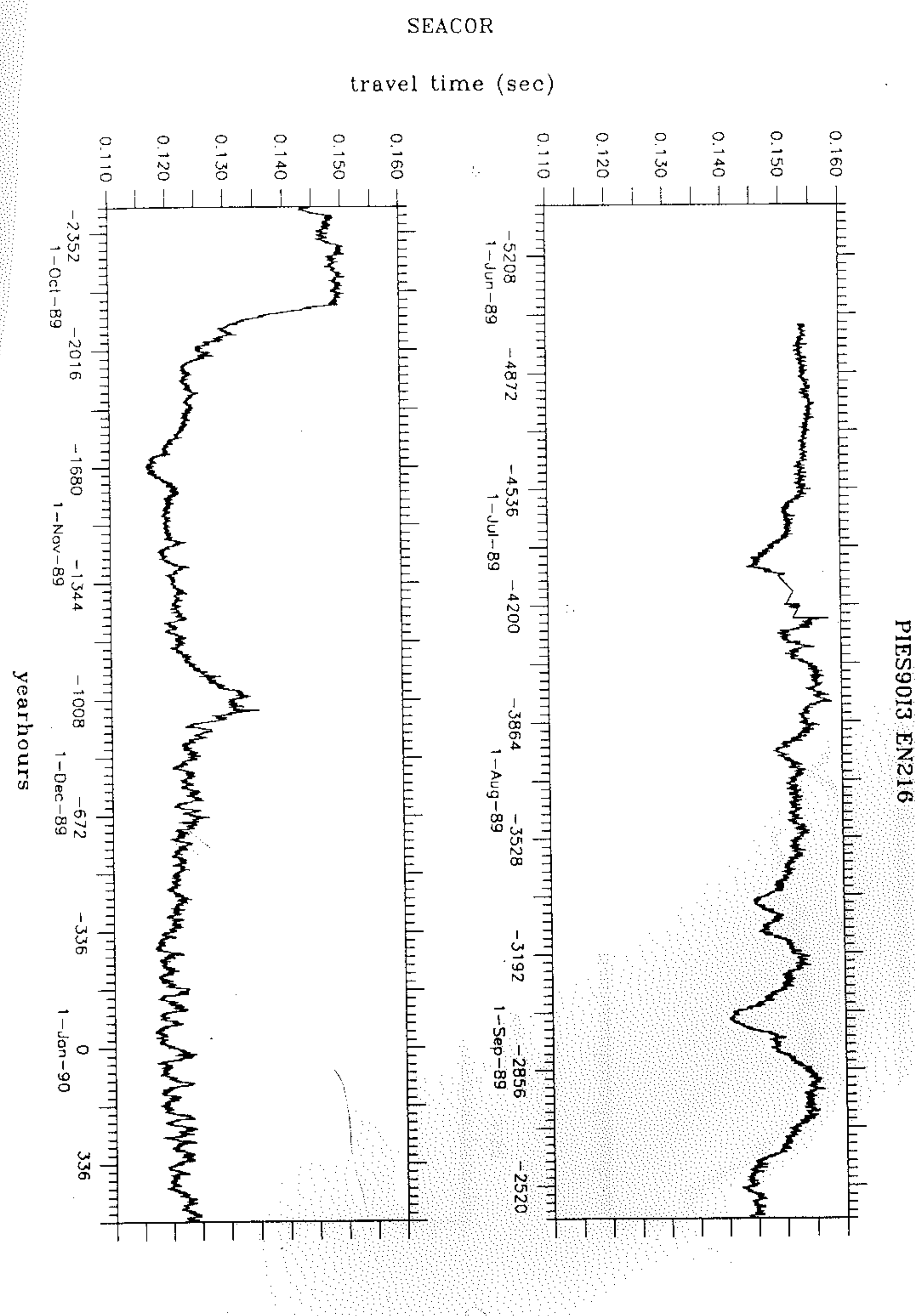
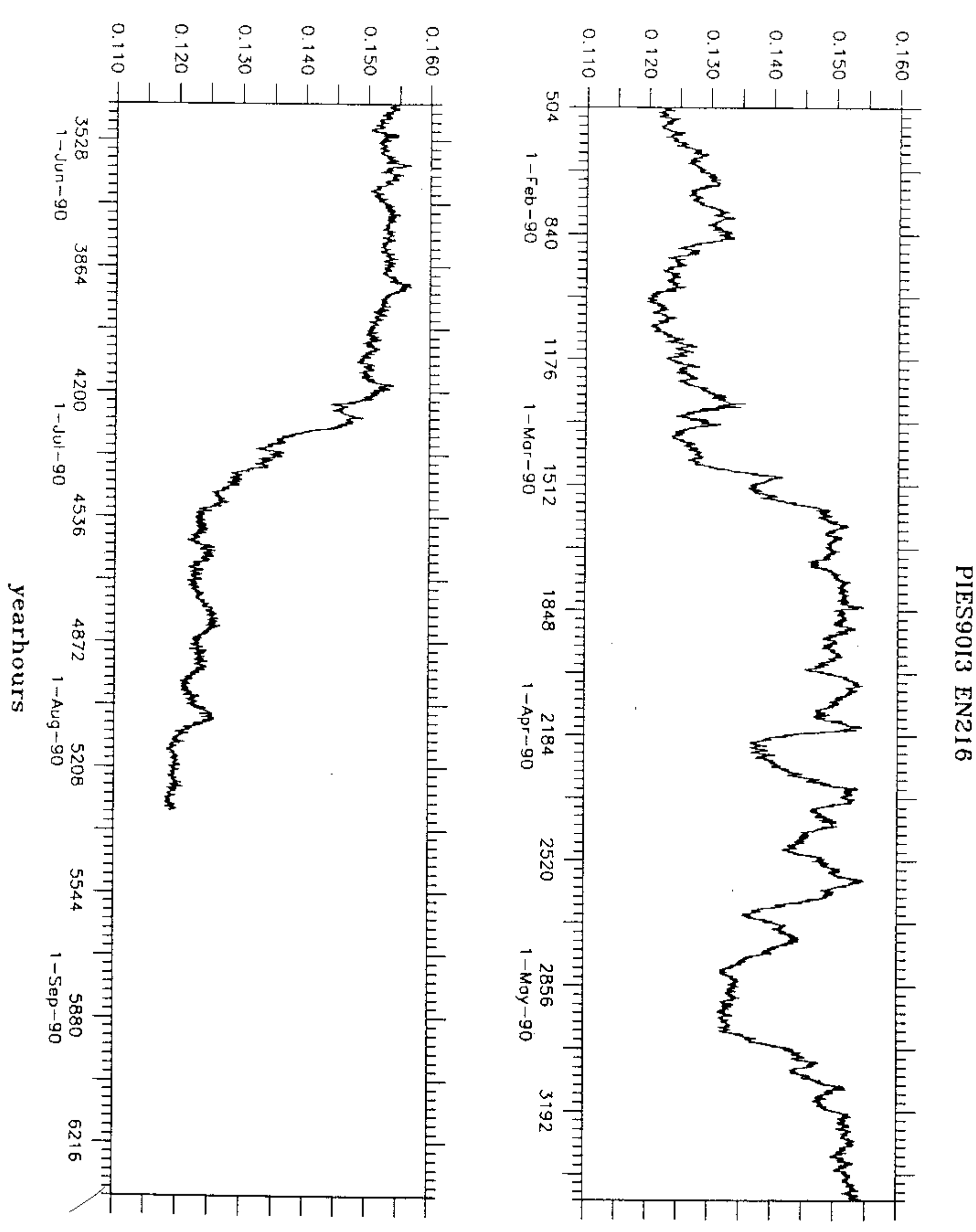


Figure 9.25: Half-Hourly Travel Times. PIES90I3

SEACOR

travel time (sec)



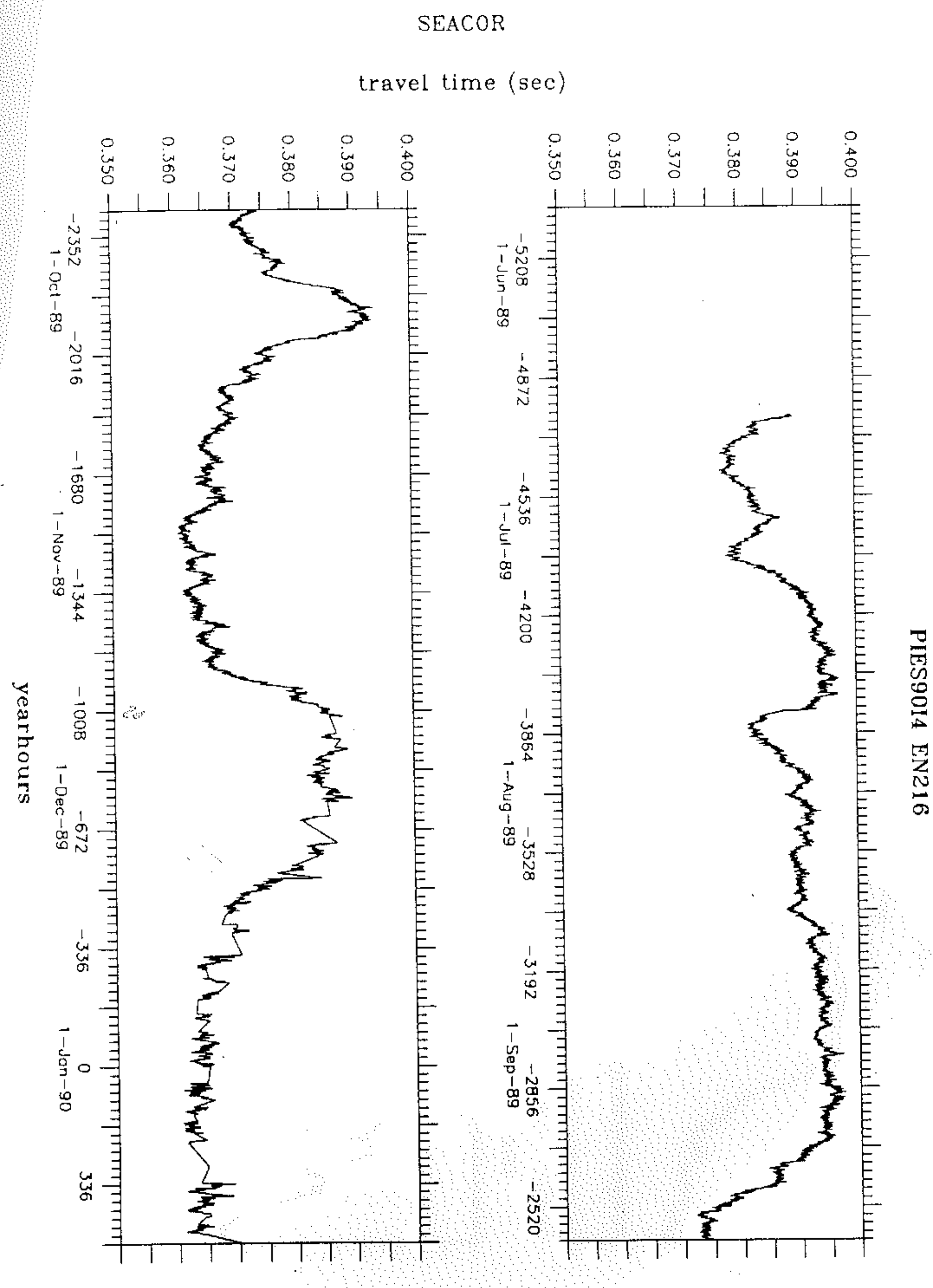
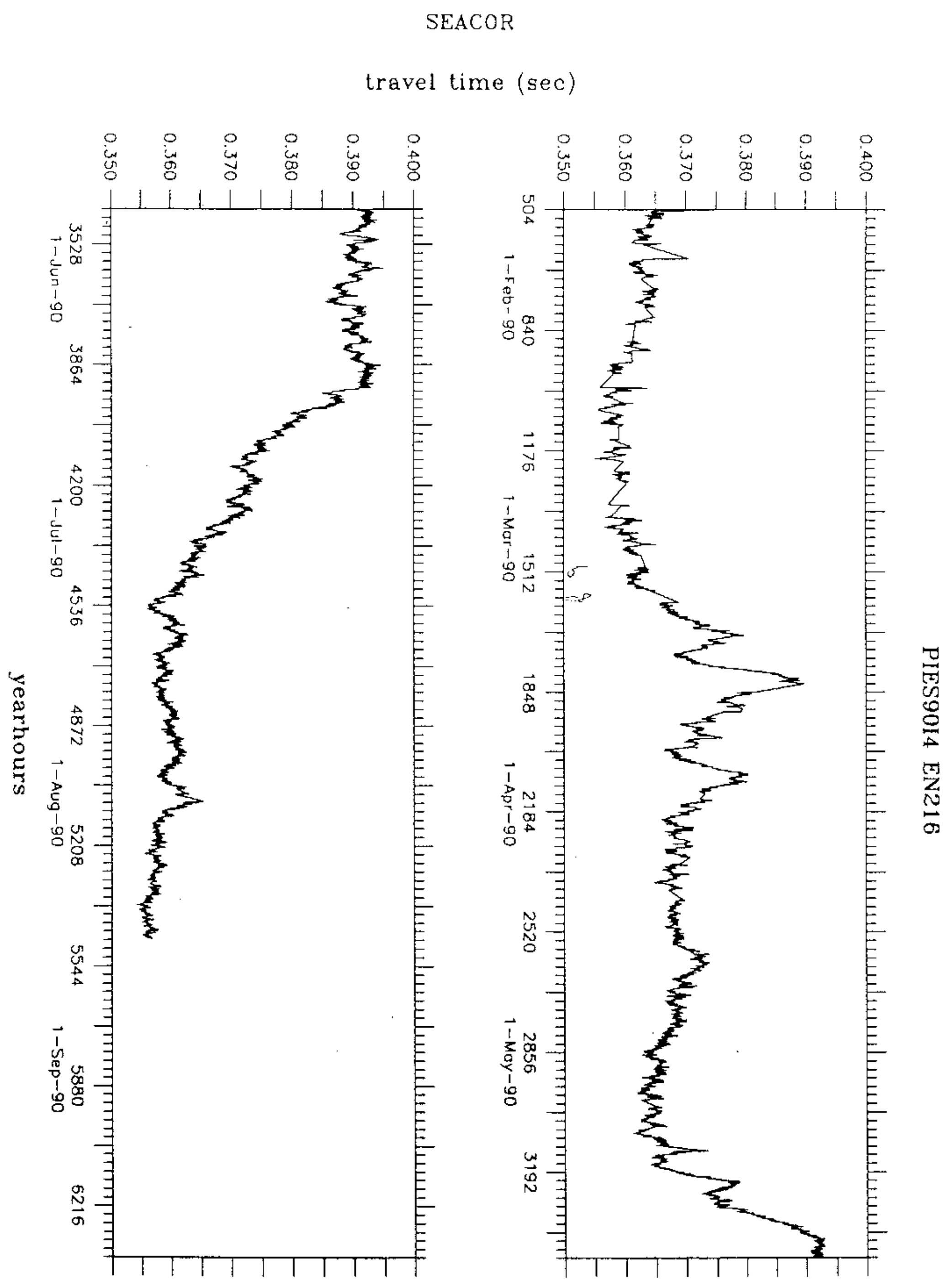


Figure 9.26: Half-Hourly Travel Times. PIES90I4



SEACOR
travel time (sec)
PIES90I4 EN216
0.350
0.360
0.370
0.380
0.390
0.400
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

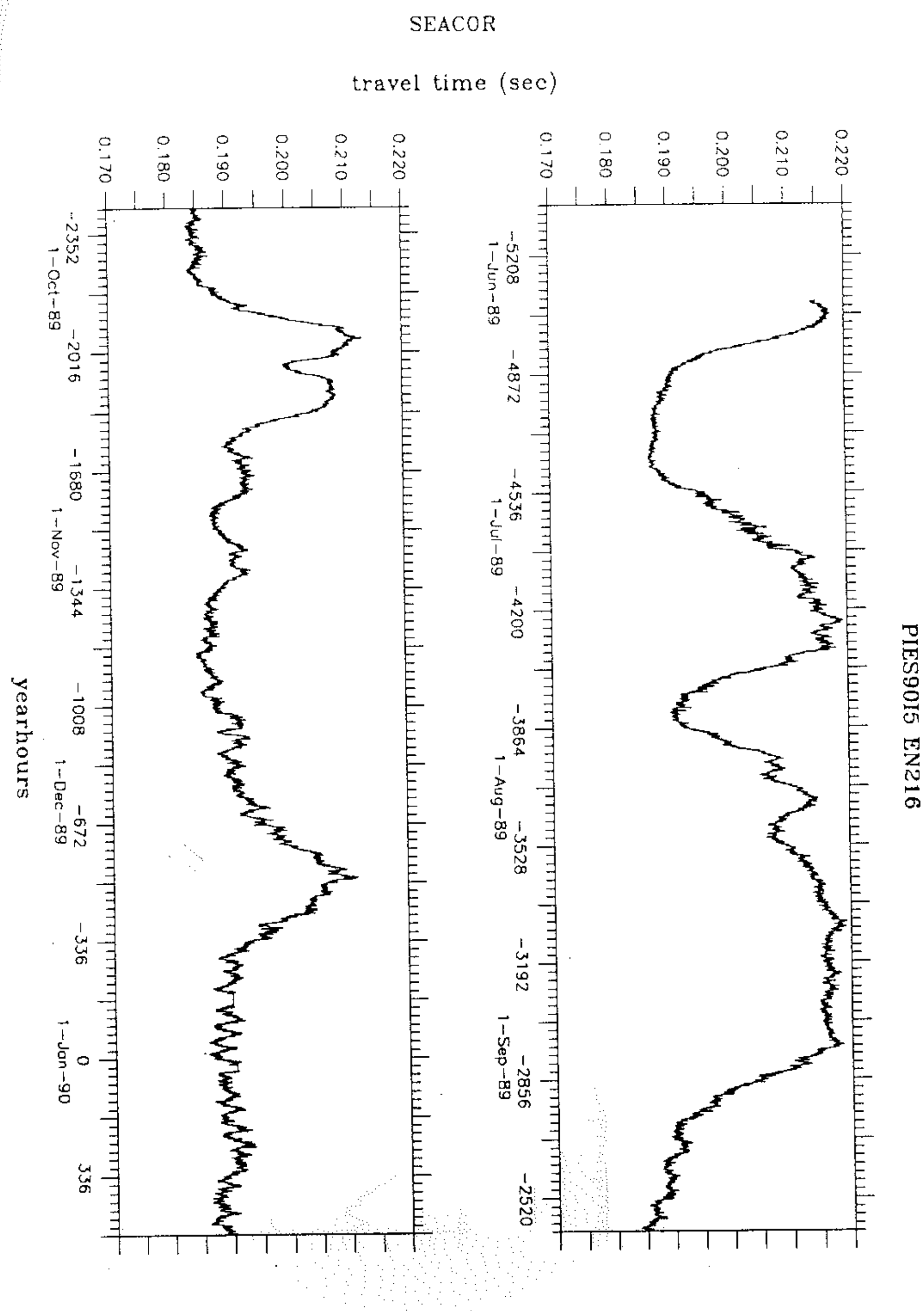
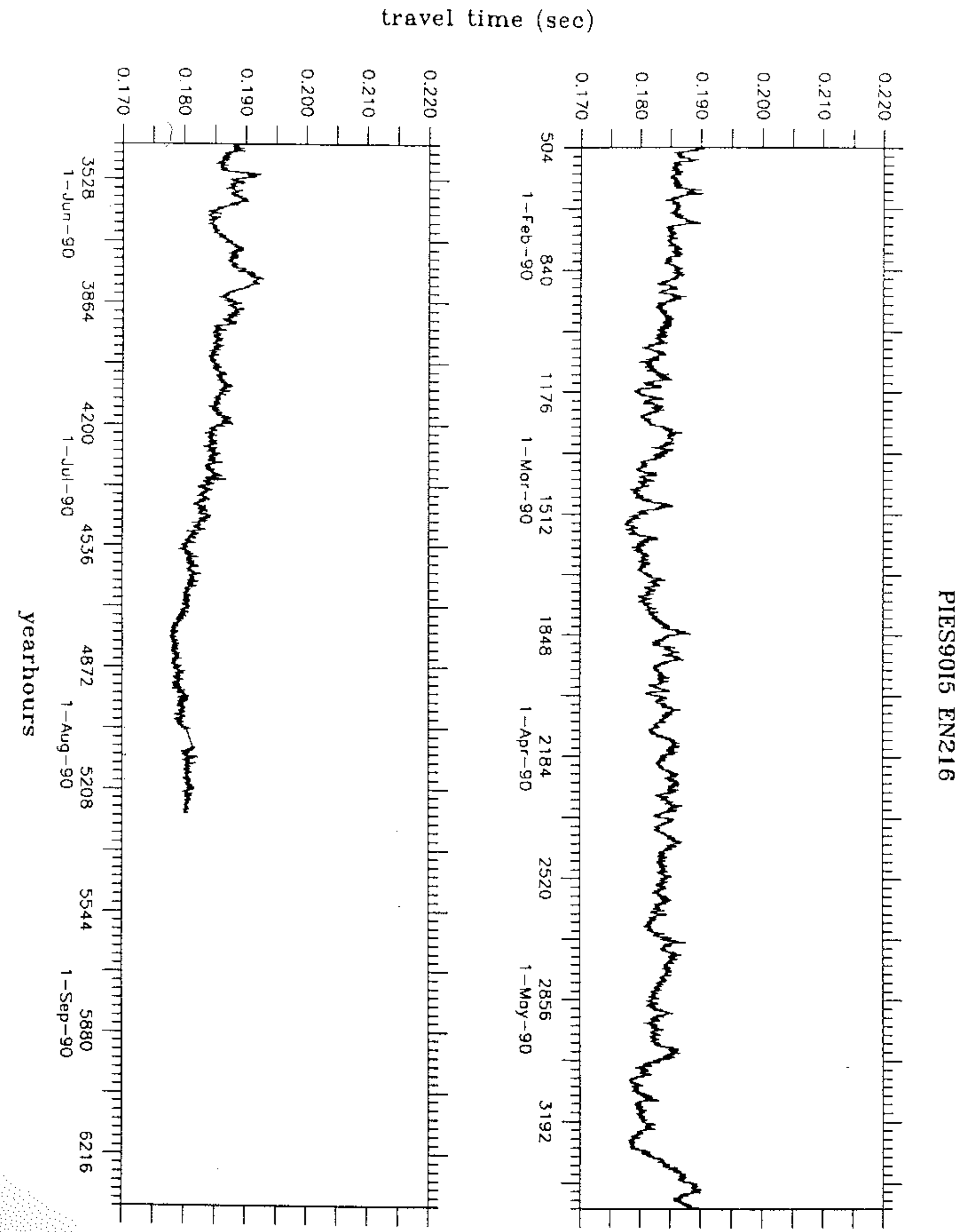


Figure 9.27: Half-Hourly Travel Times. PIES90I5

SEACOR


travel time (sec)
PIES90I5 EN216
0.170
0.180
0.190
0.200
0.210
0.220
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5580
1-Sep-90
6216
yearhours

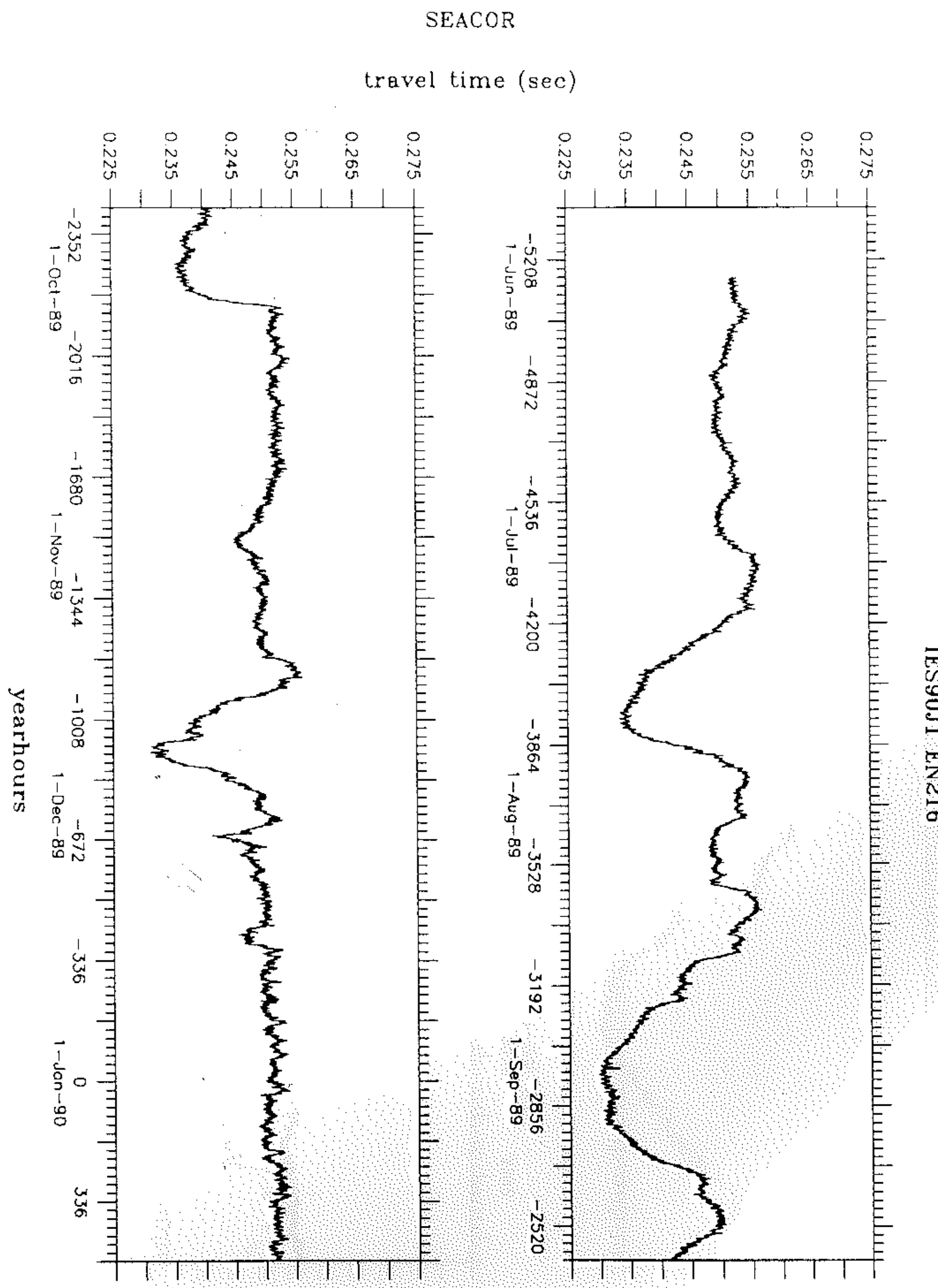
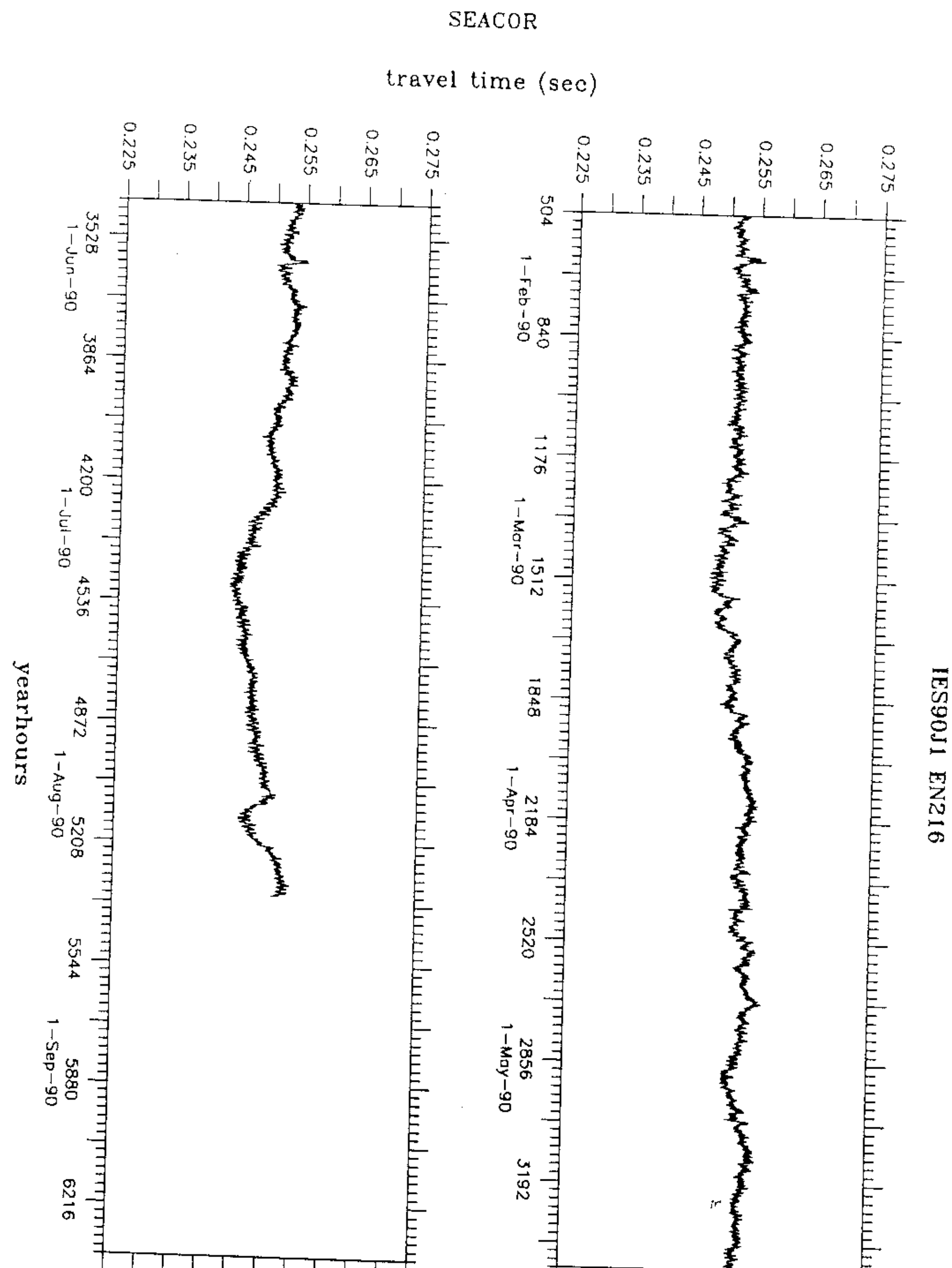


Figure 9.28: Half-Hourly Travel Times. IES90J1


SEACOR
IES90J1 EN216
travel time (sec)
0.225
0.235
0.245
0.255
0.265
0.275
504
1-Feb-90
840
1176
1-Mar-90
1512
1848
1-Apr-90
2184
2520
1-May-90
2856
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
1-Sep-90
5880
6216
yearhours

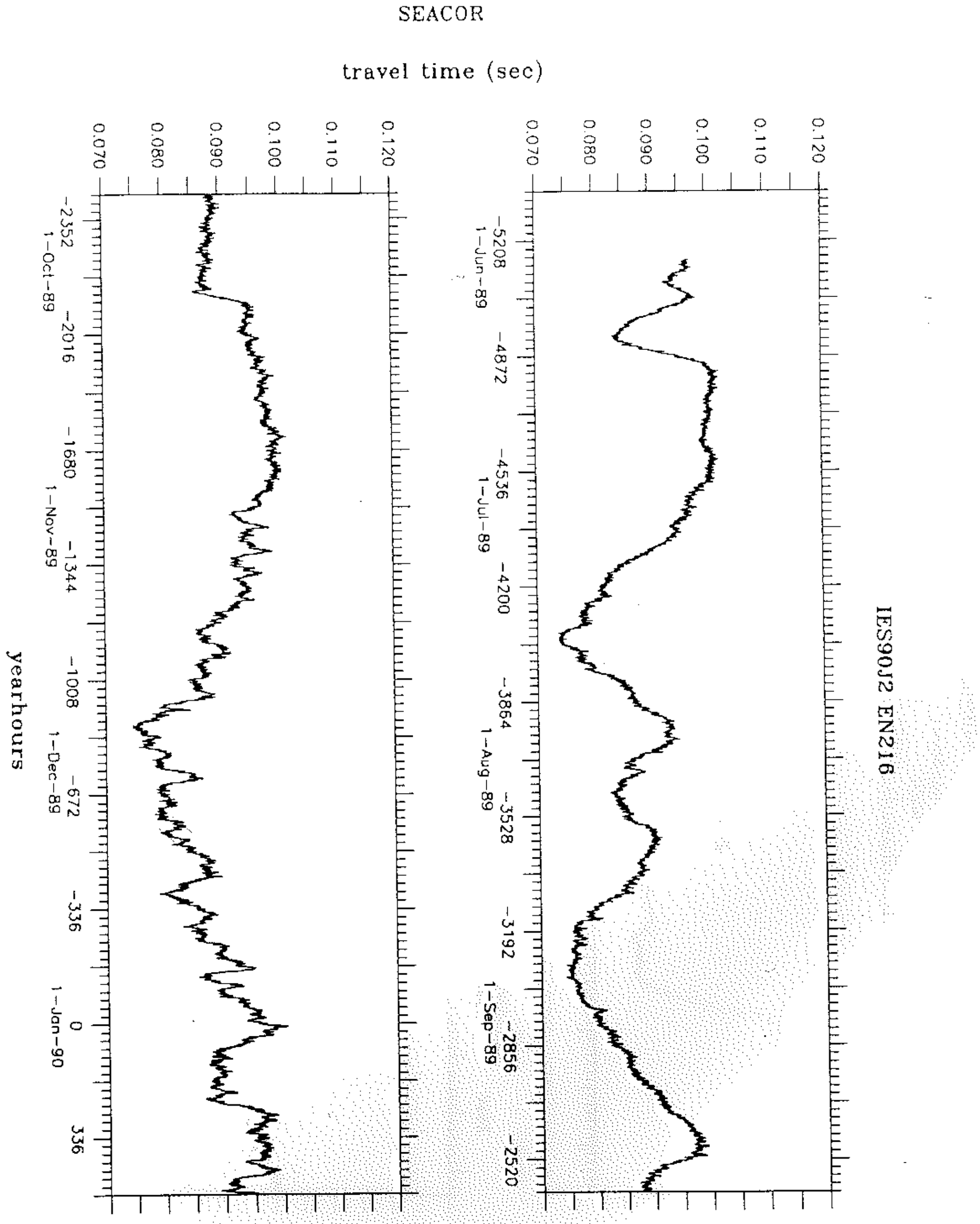
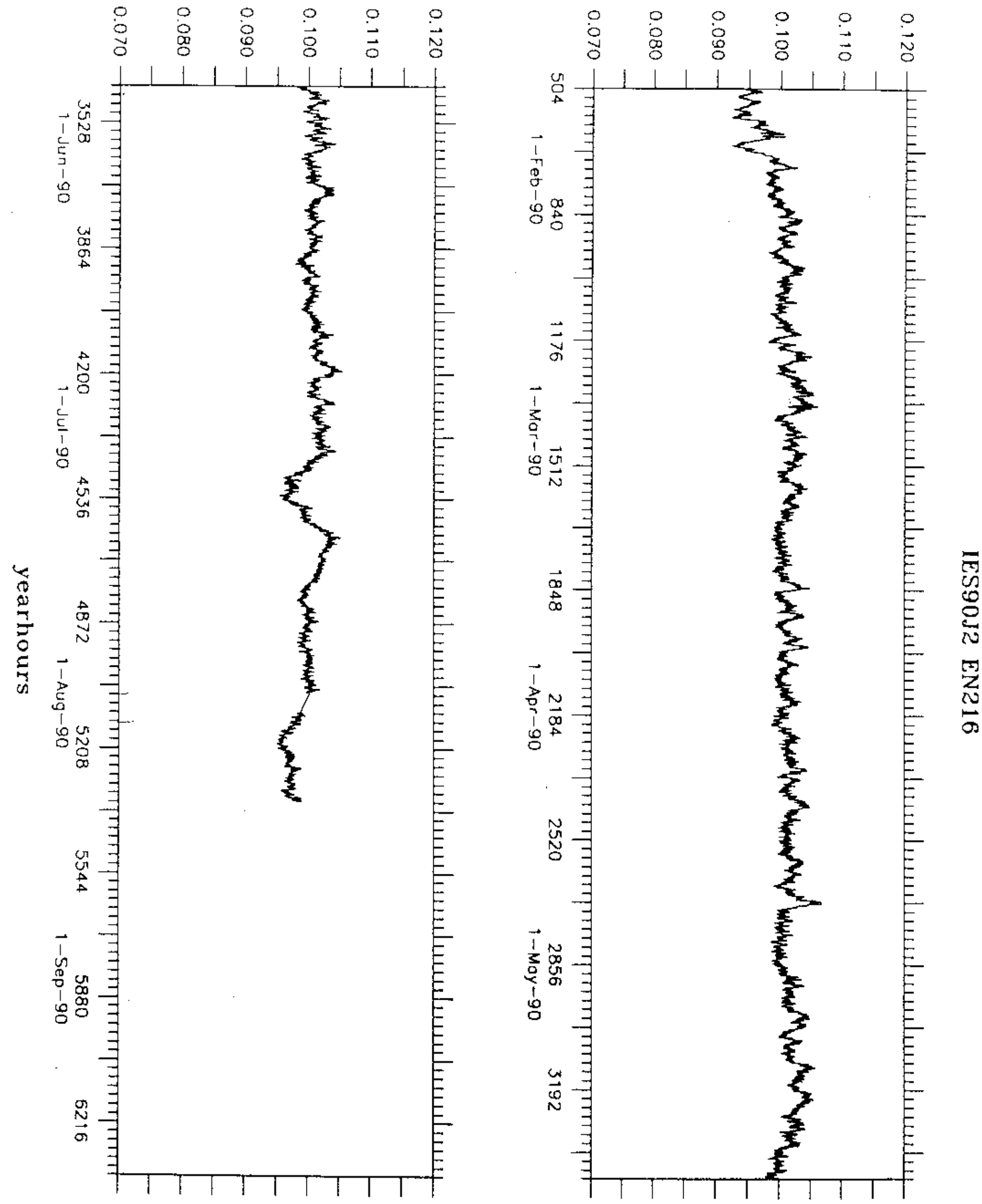


Figure 9.29: Half-Hourly Travel Times. IES90J2

SEACOR

travel time (sec)



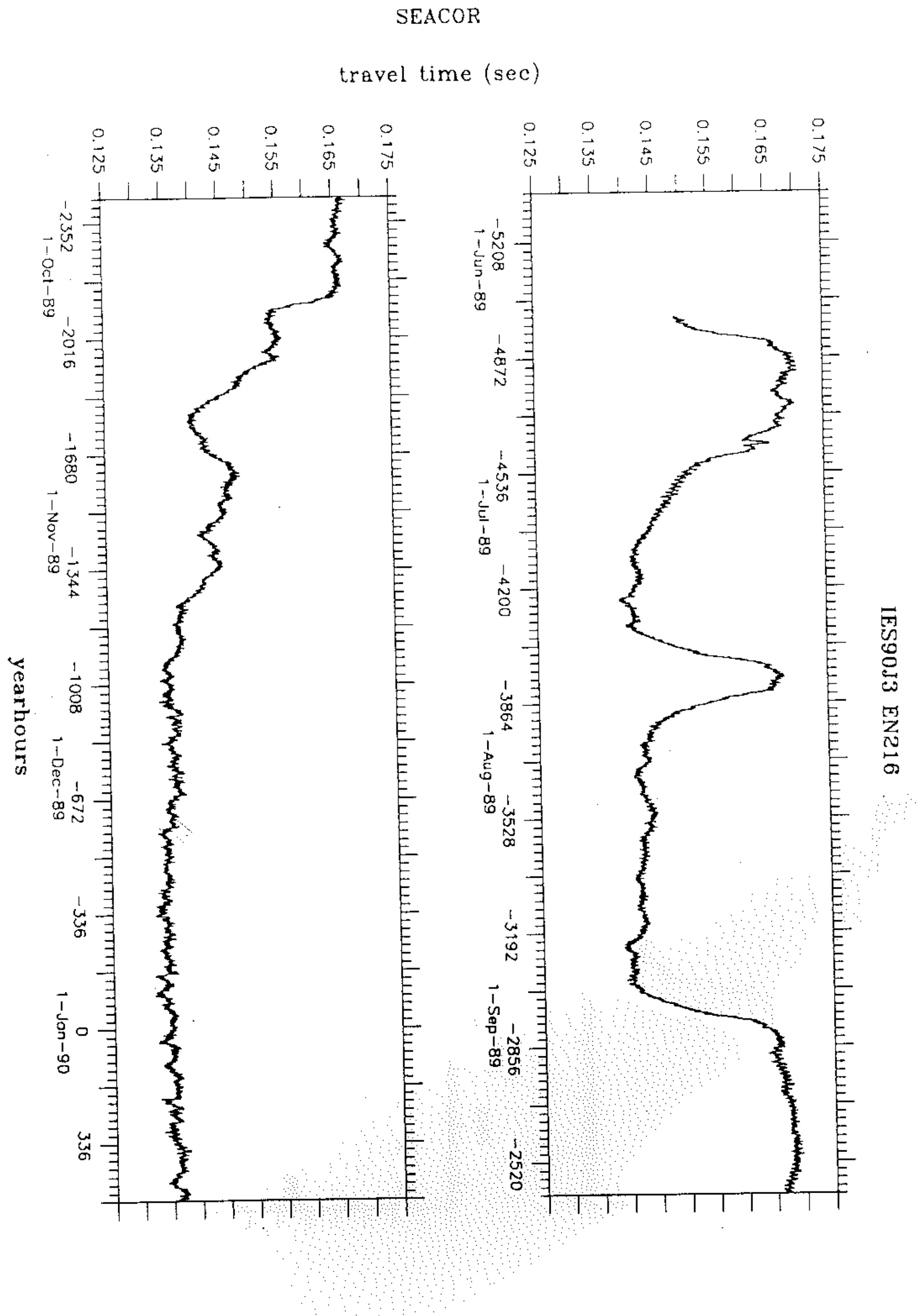
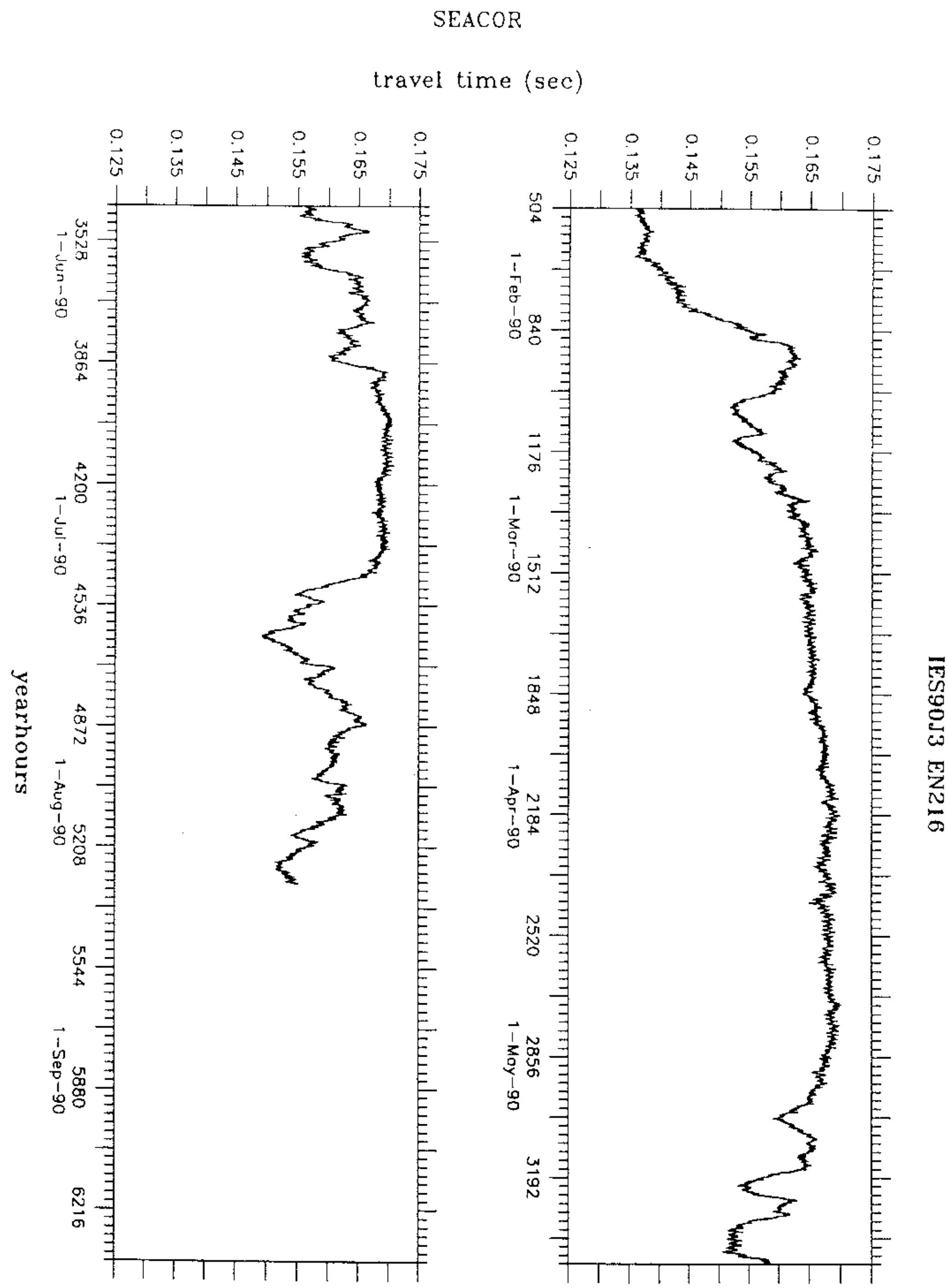


Figure 9.30: Half-Hourly Travel Times. IES90J3


IES90J3 EN216
SEACOR
travel time (sec)
0.125
0.135
0.145
0.155
0.165
0.175
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

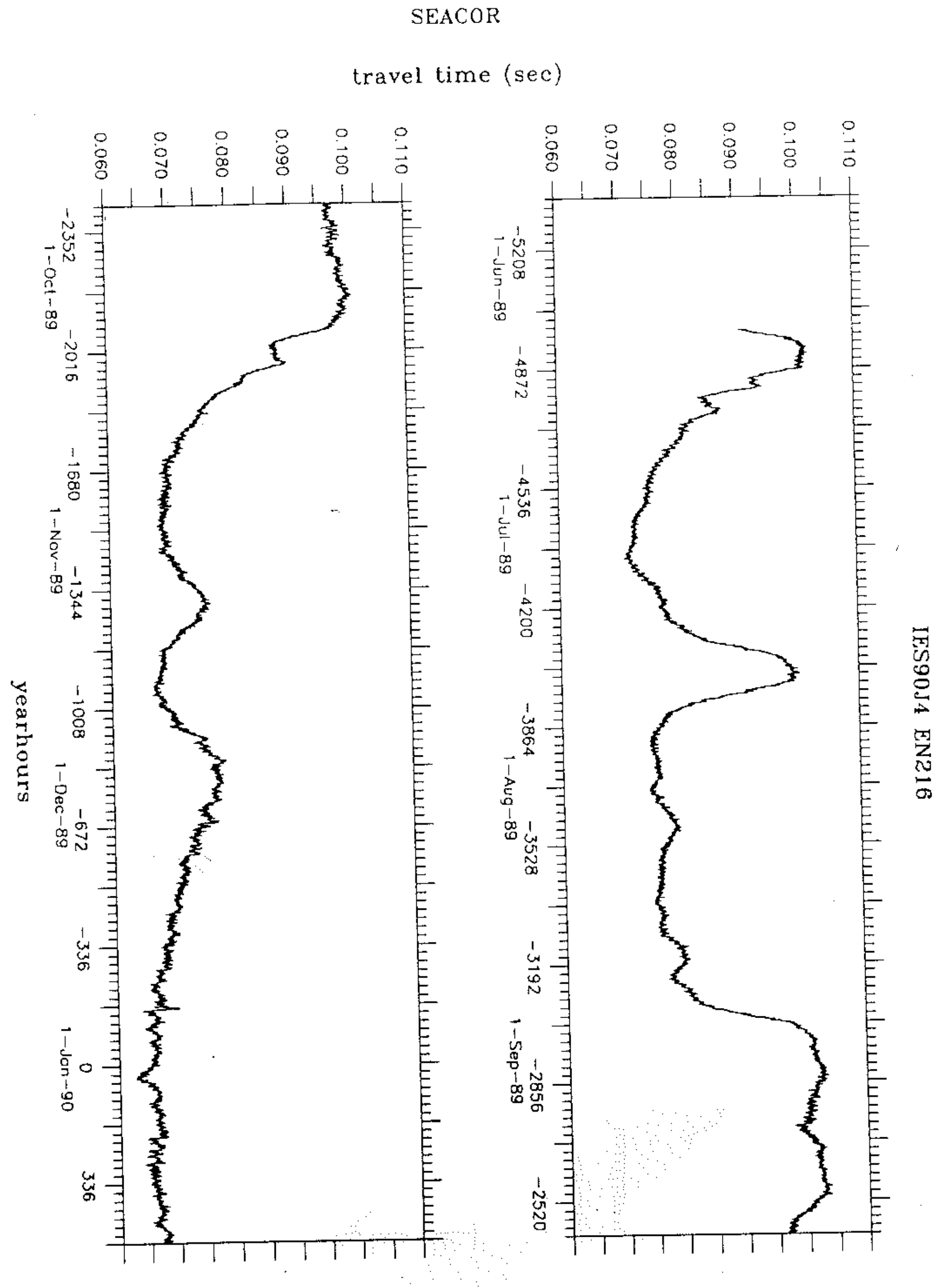
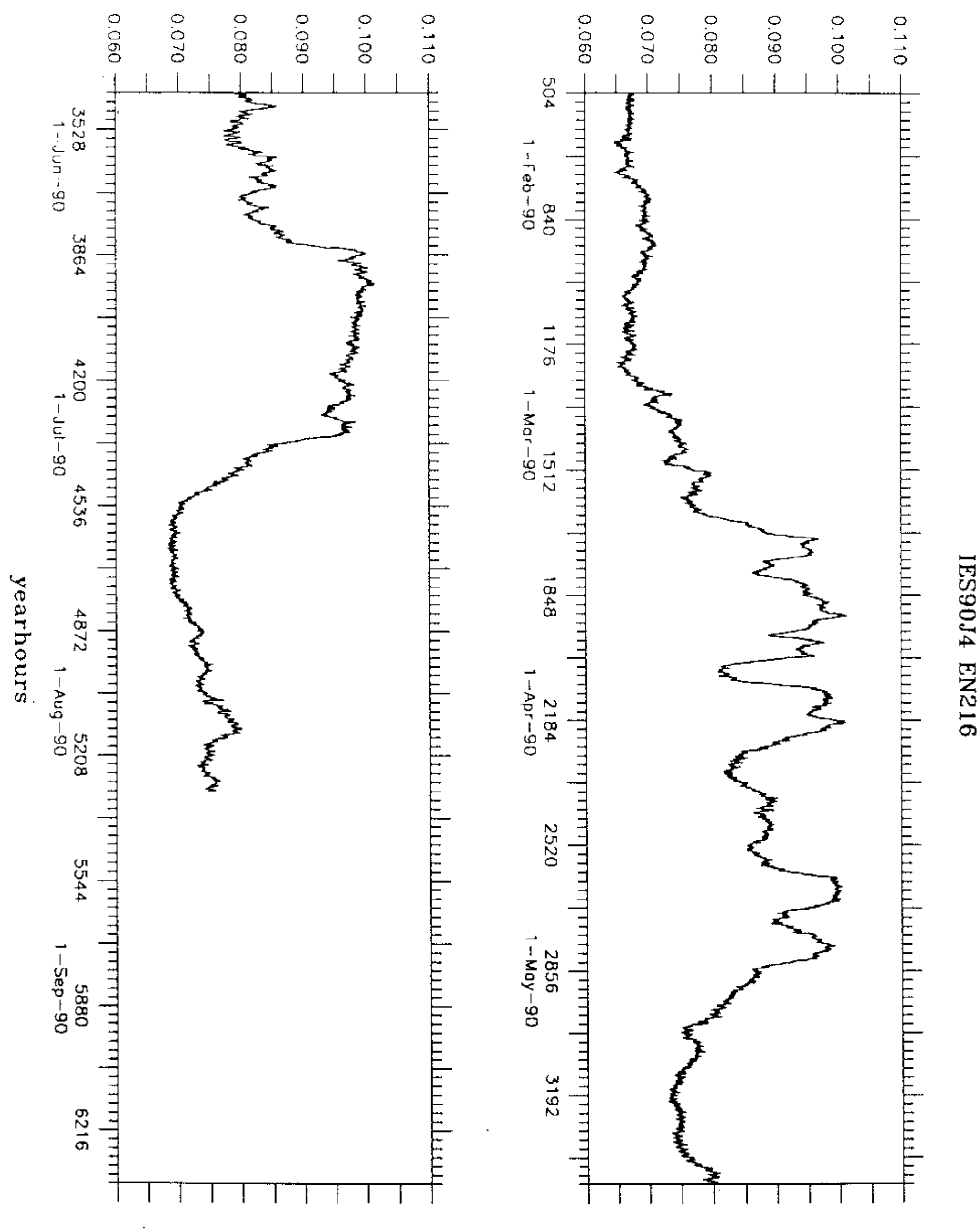


Figure 9.31: Half-Hourly Travel Times. IES90J4

SEACOR

travel time (sec)



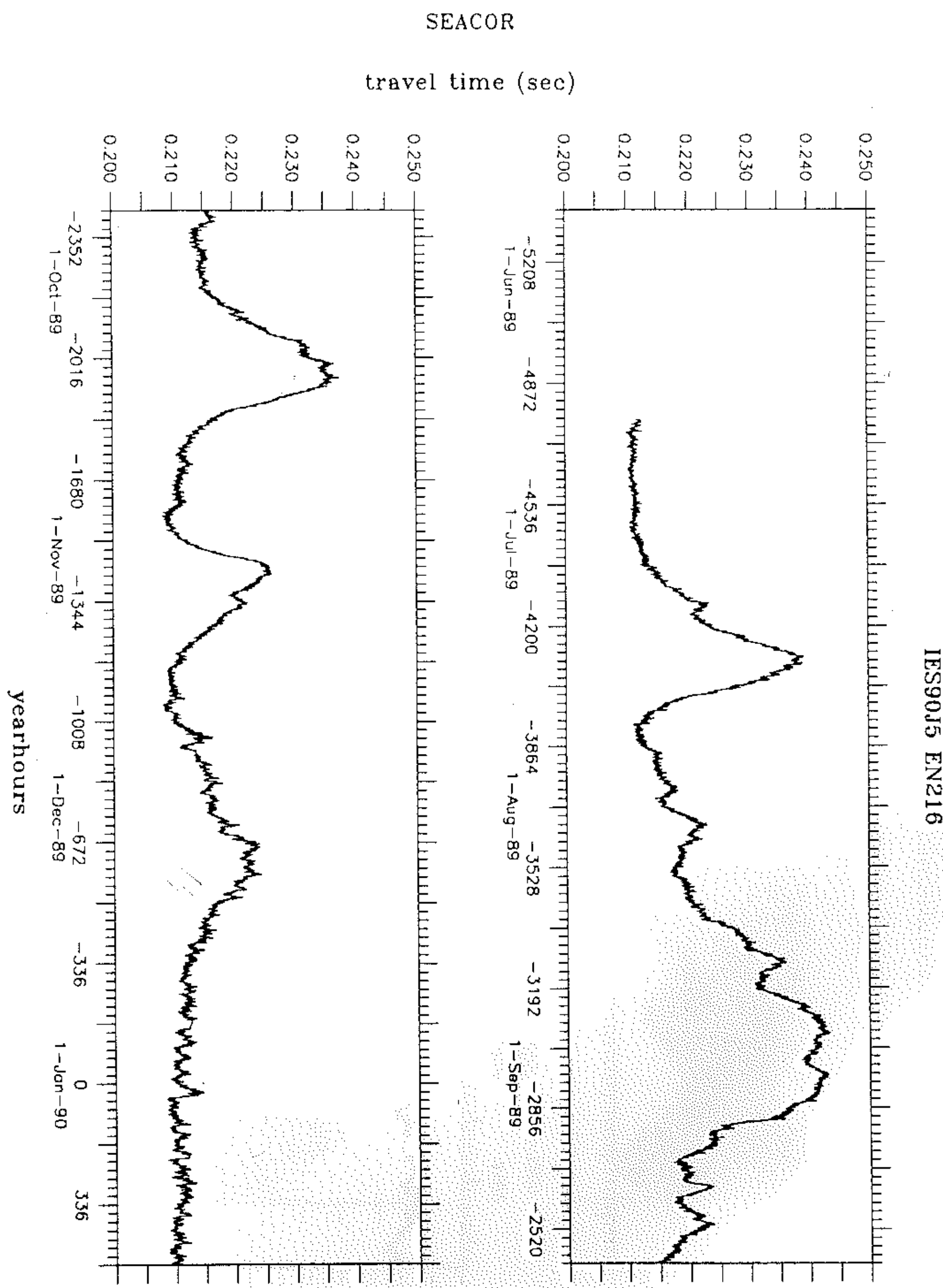
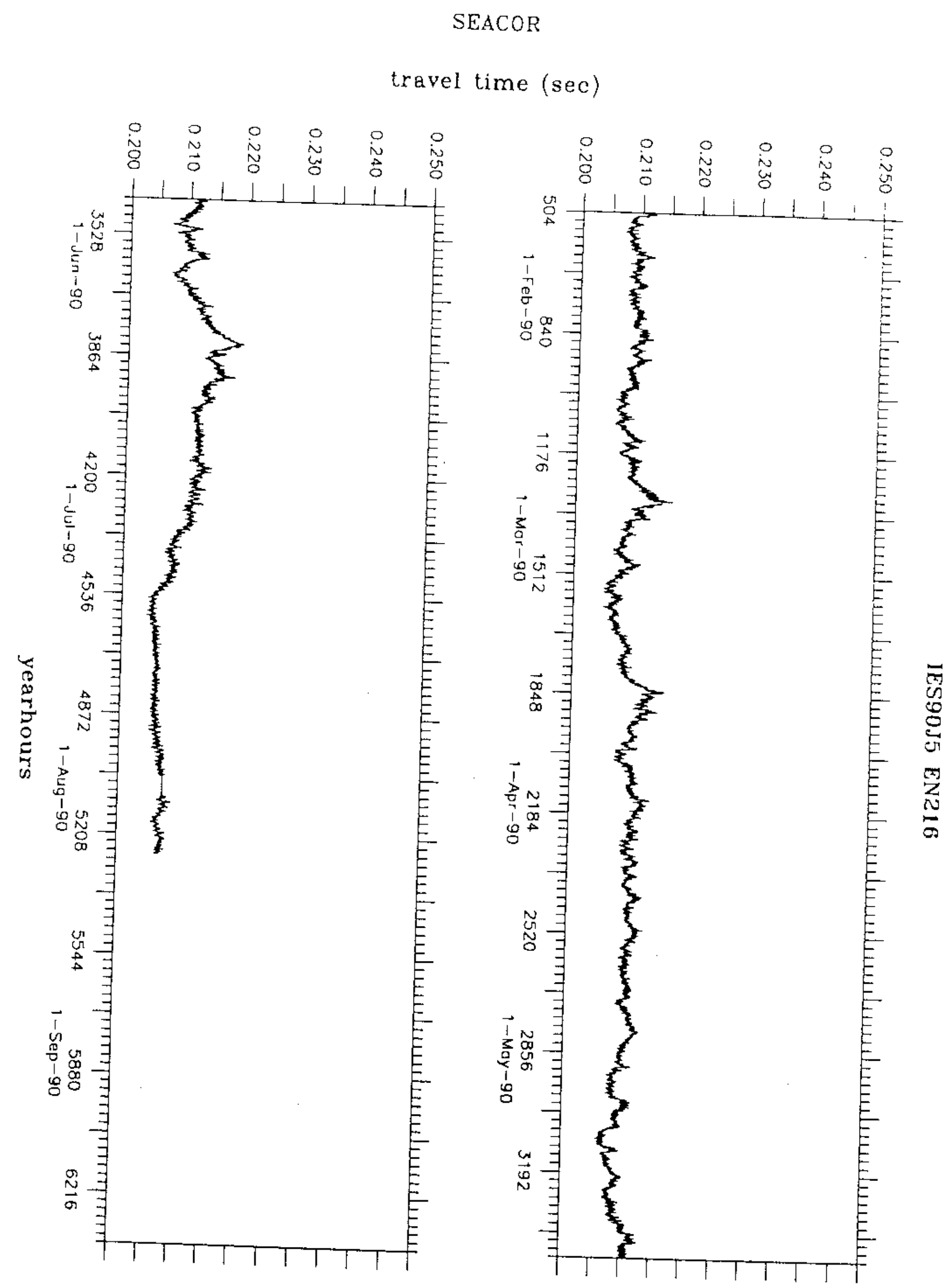


Figure 9.32: Half-Hourly Travel Times. IES90j5



SEACOR
travel time (sec)
IES90J5 EN216
0.200
0.210
0.220
0.230
0.240
0.250
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

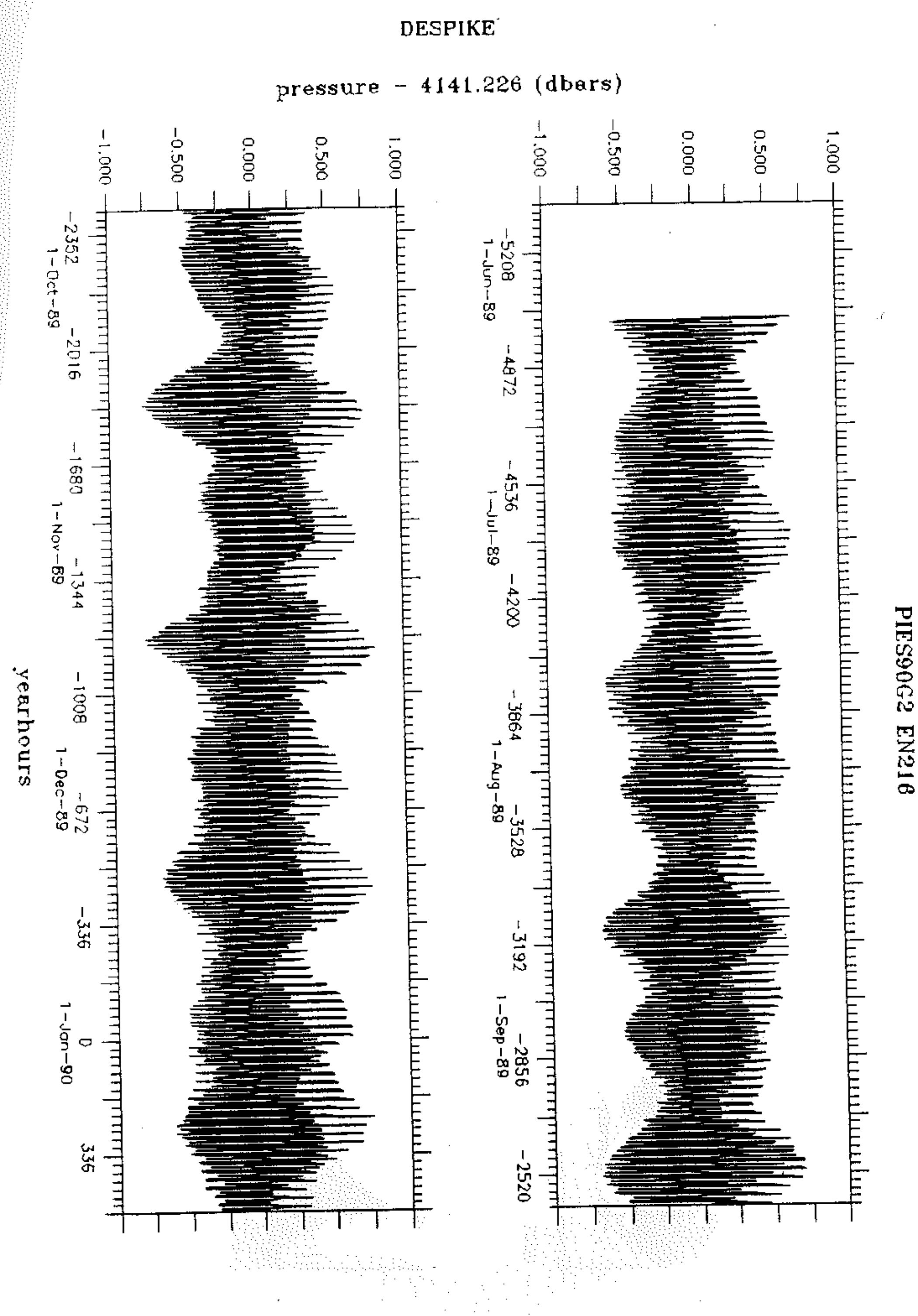
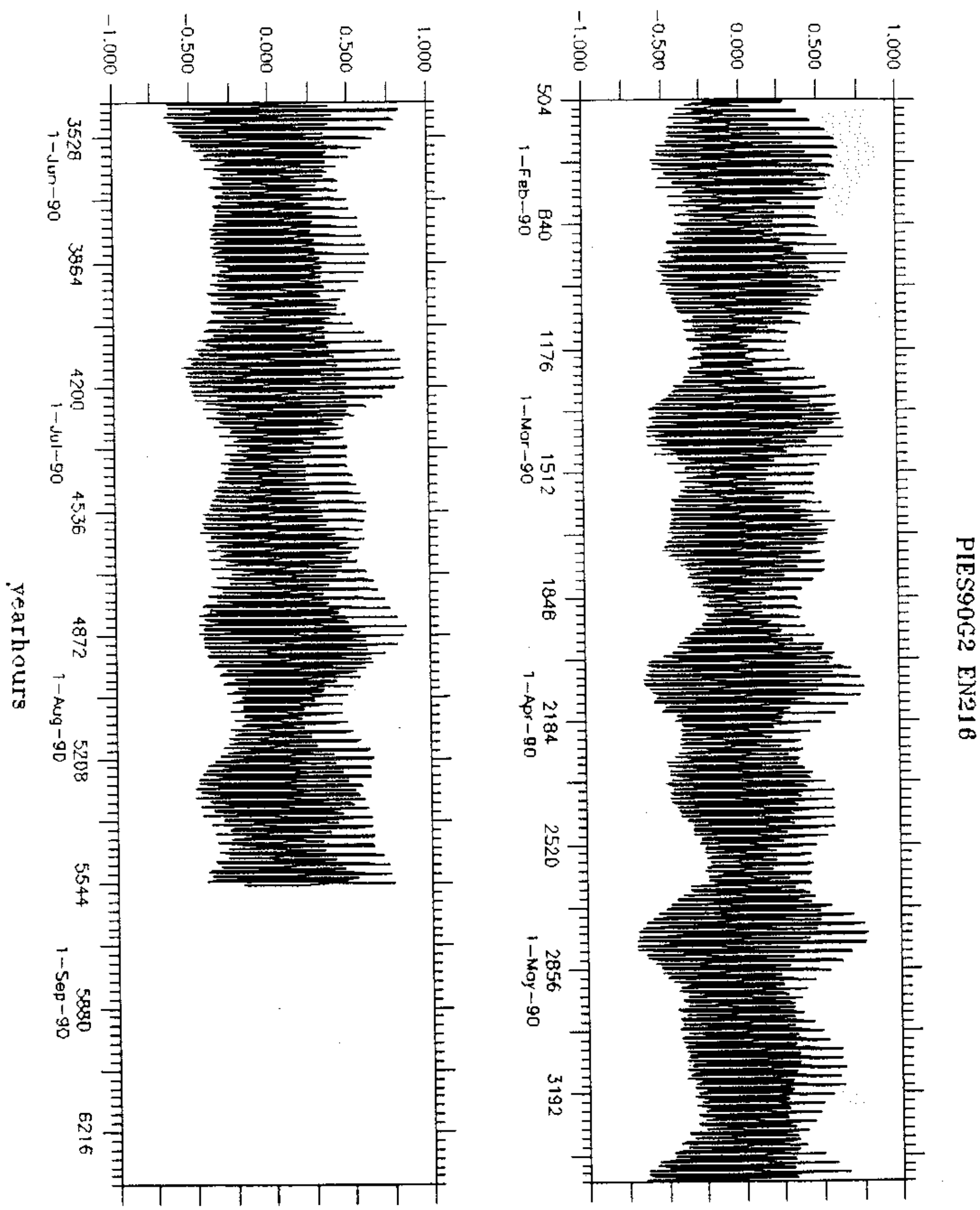


Figure 10.1: Half-Hourly Bottom Pressure. PIES90G2

DESPIKE

pressure - 4141.226 (dbars)



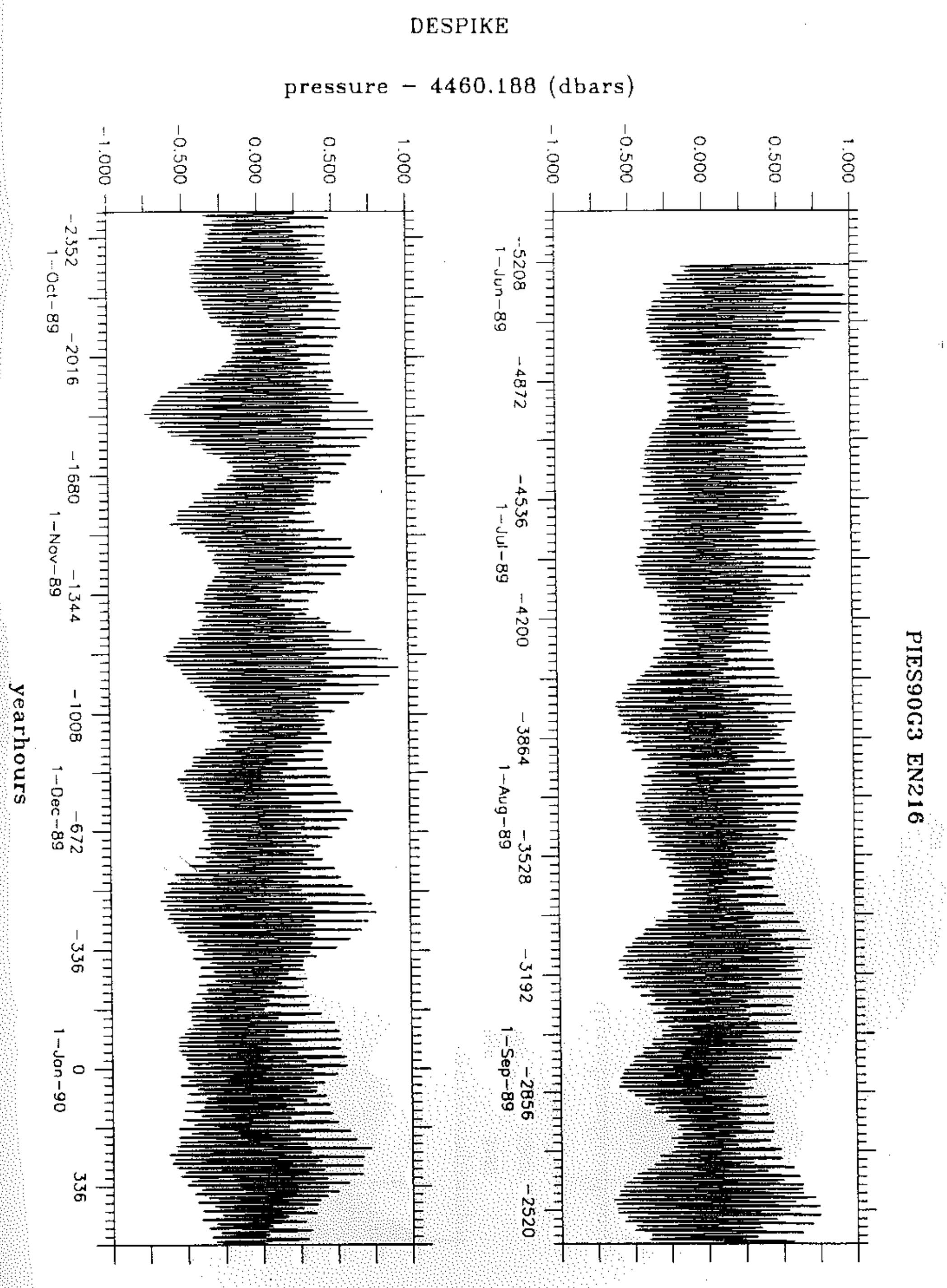
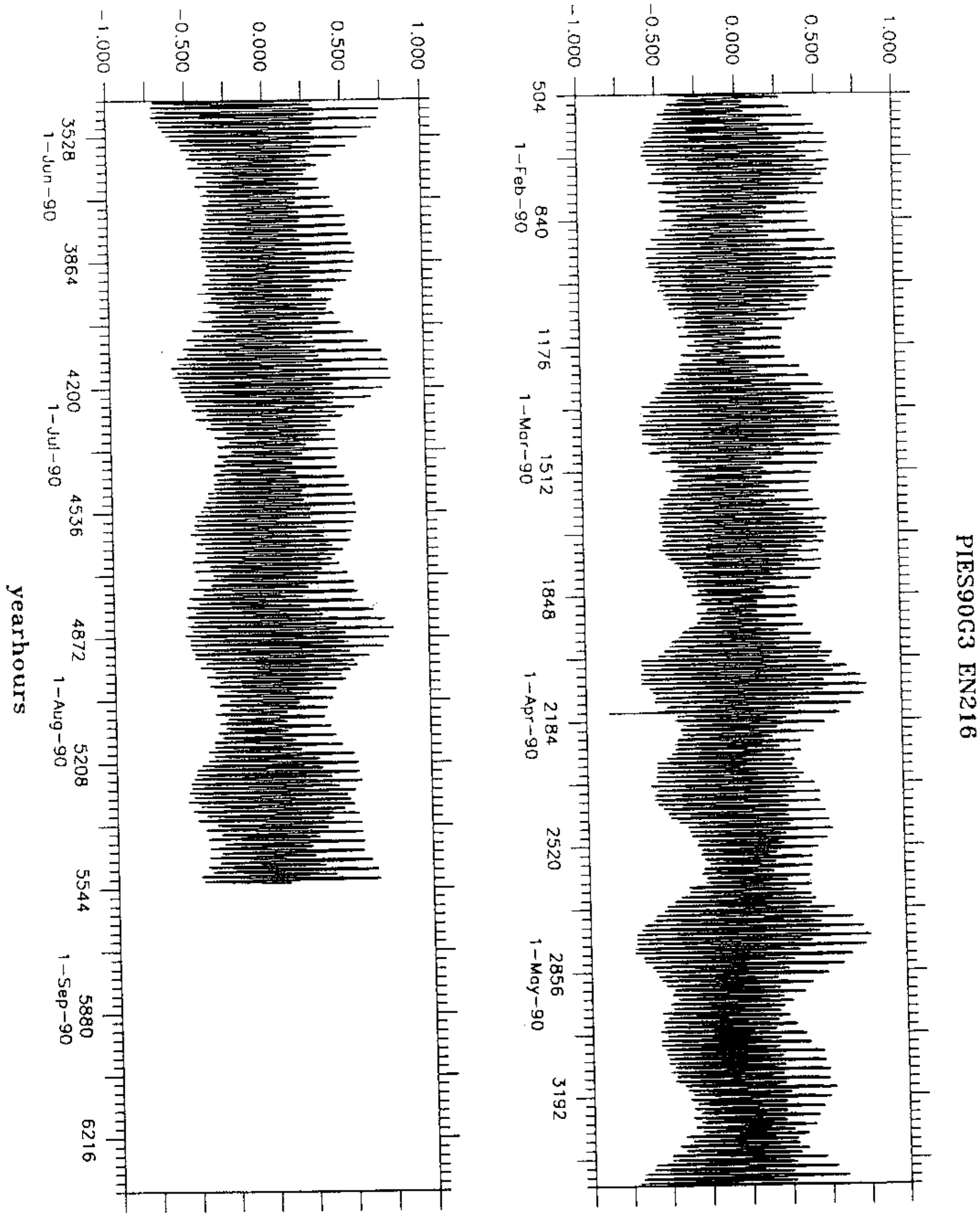


Figure 10.2: Half-Hourly Bottom Pressure. PIES90G3

DESPIKE

pressure - 4460.188 (dbars)



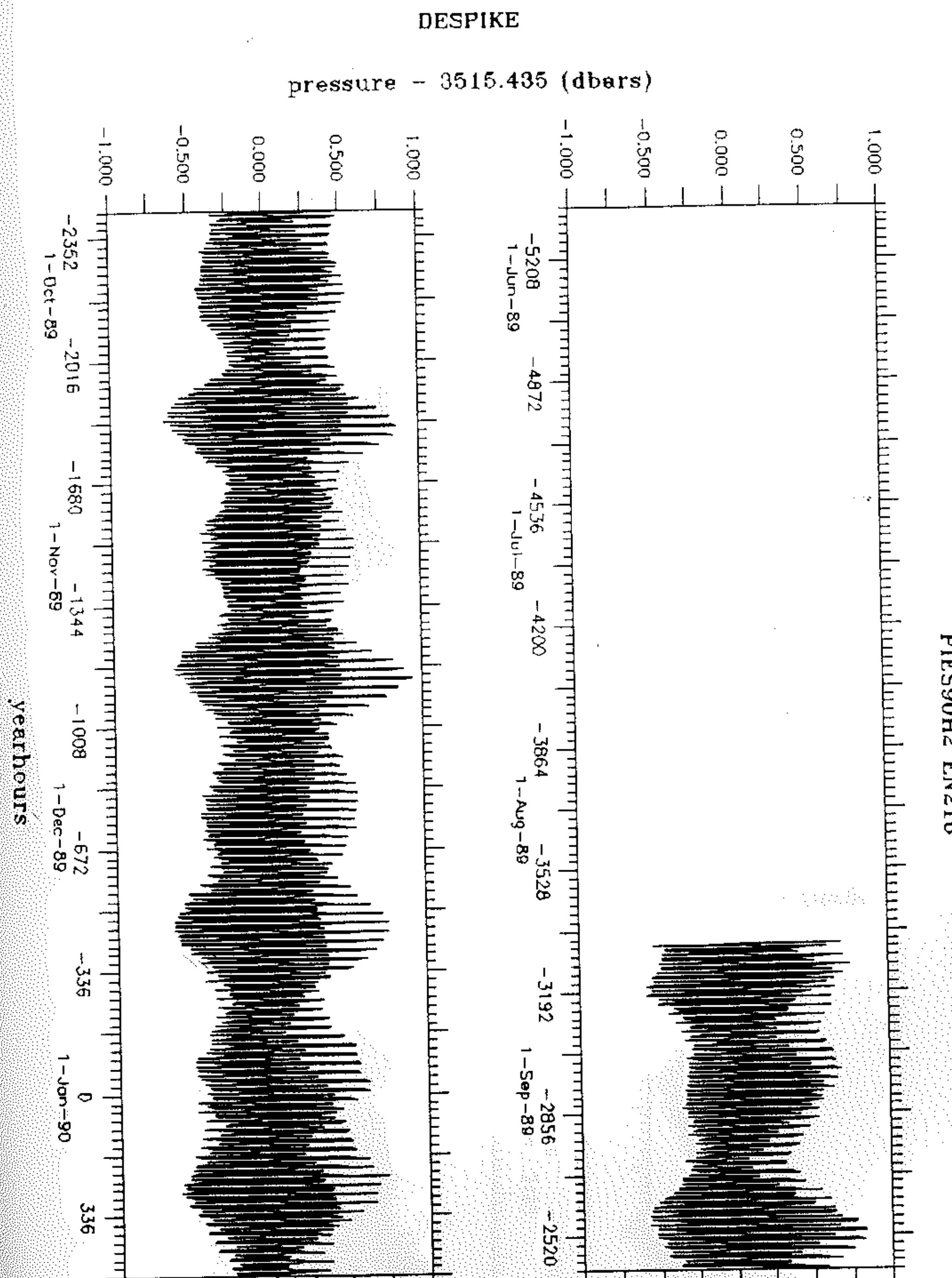
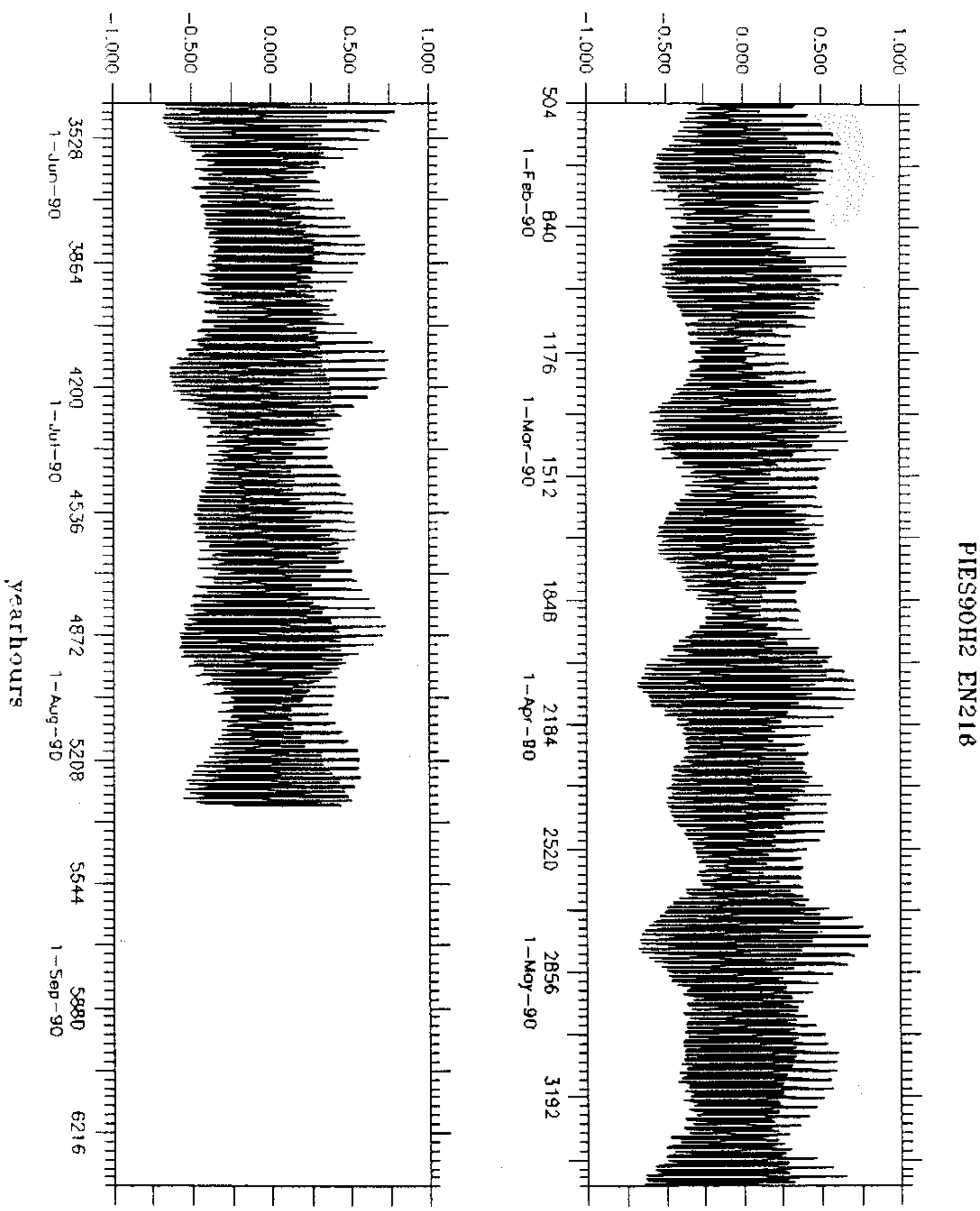


Figure 10.3: Half-Hourly Bottom Pressure. PIES90H2

DESPIKE

pressure - 3515.435 (dbars)



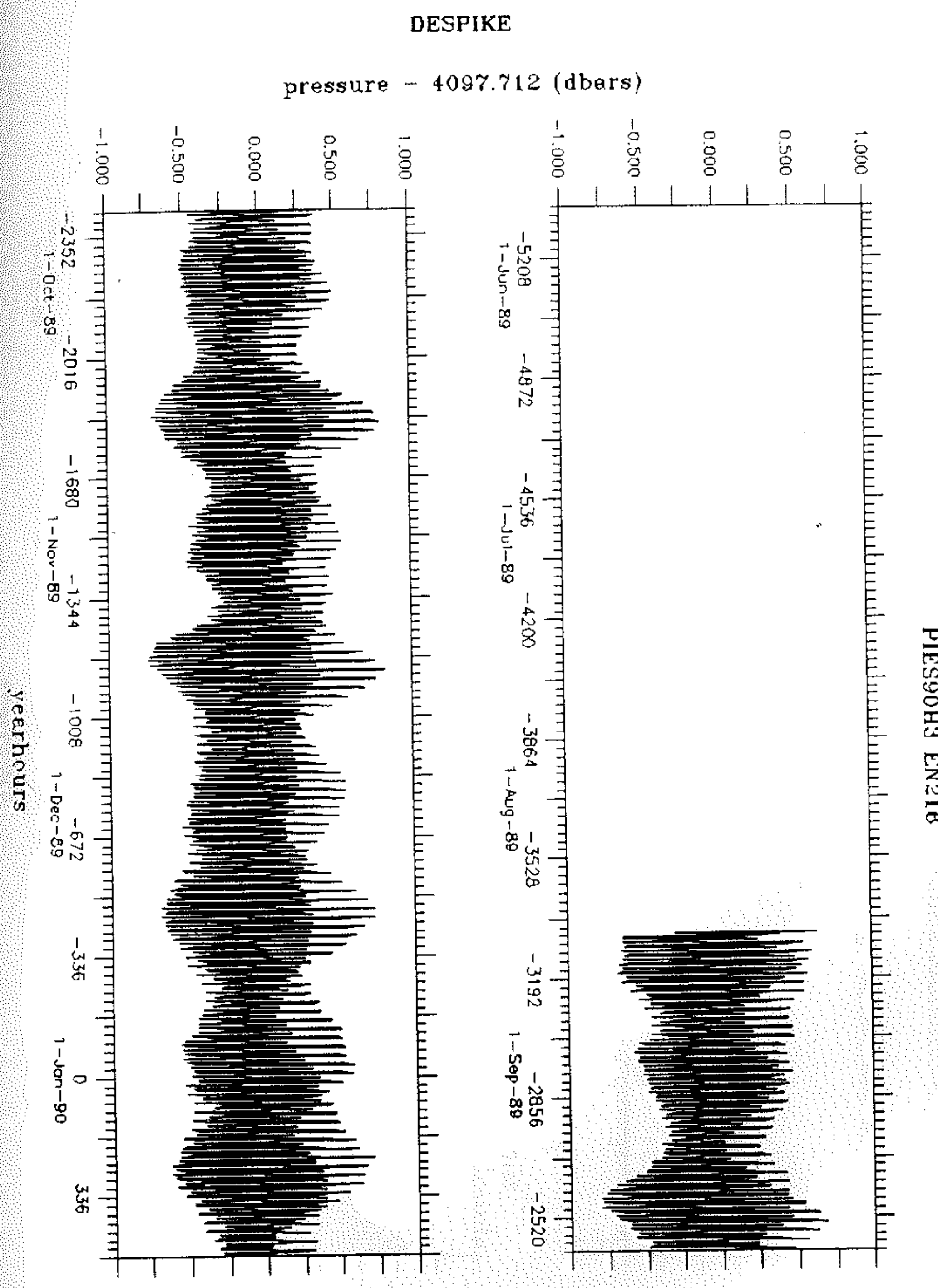
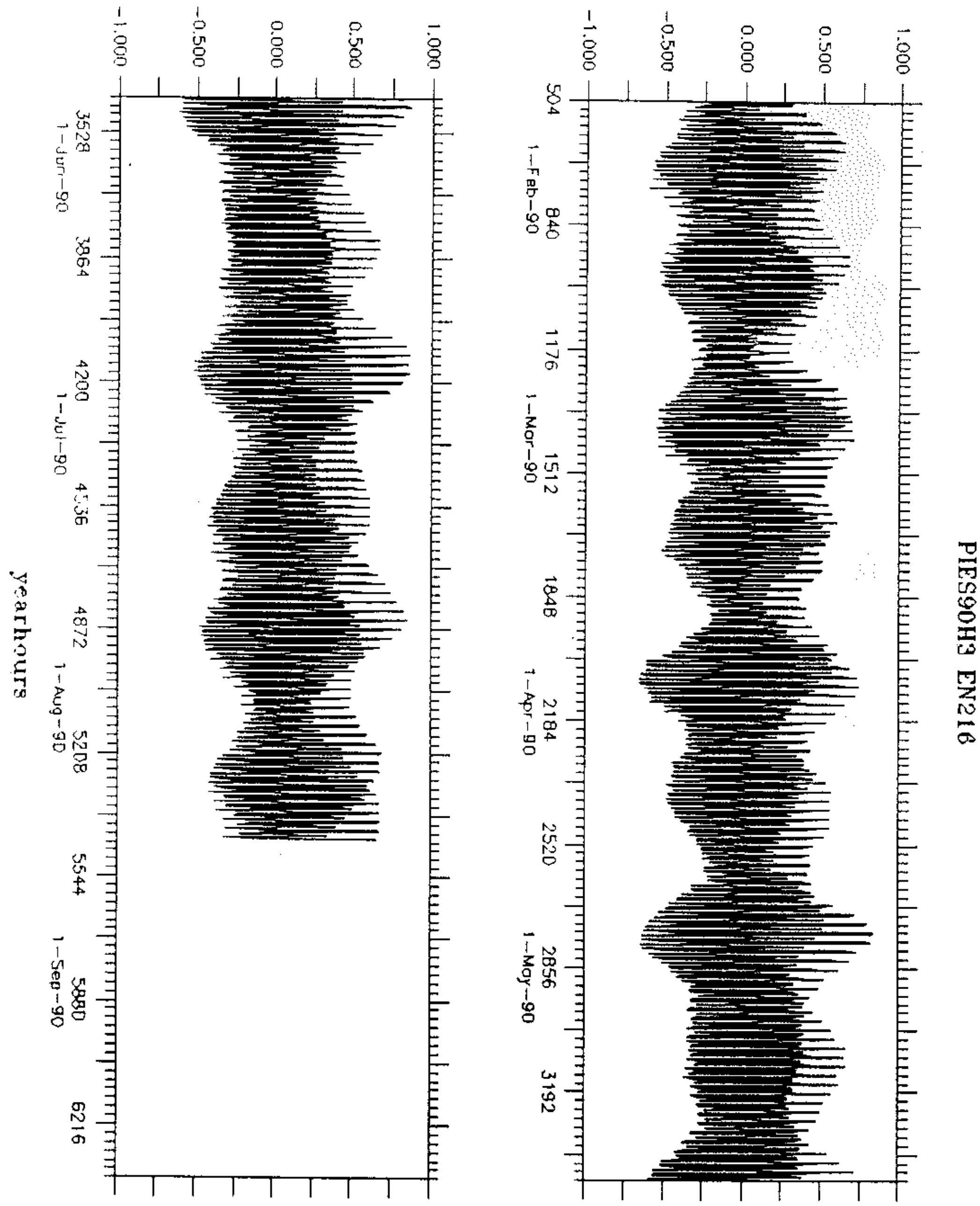


Figure 10.4: Half-Hourly Bottom Pressure. PIES90H3

DESPIKE

pressure - 4097.712 (dbars)



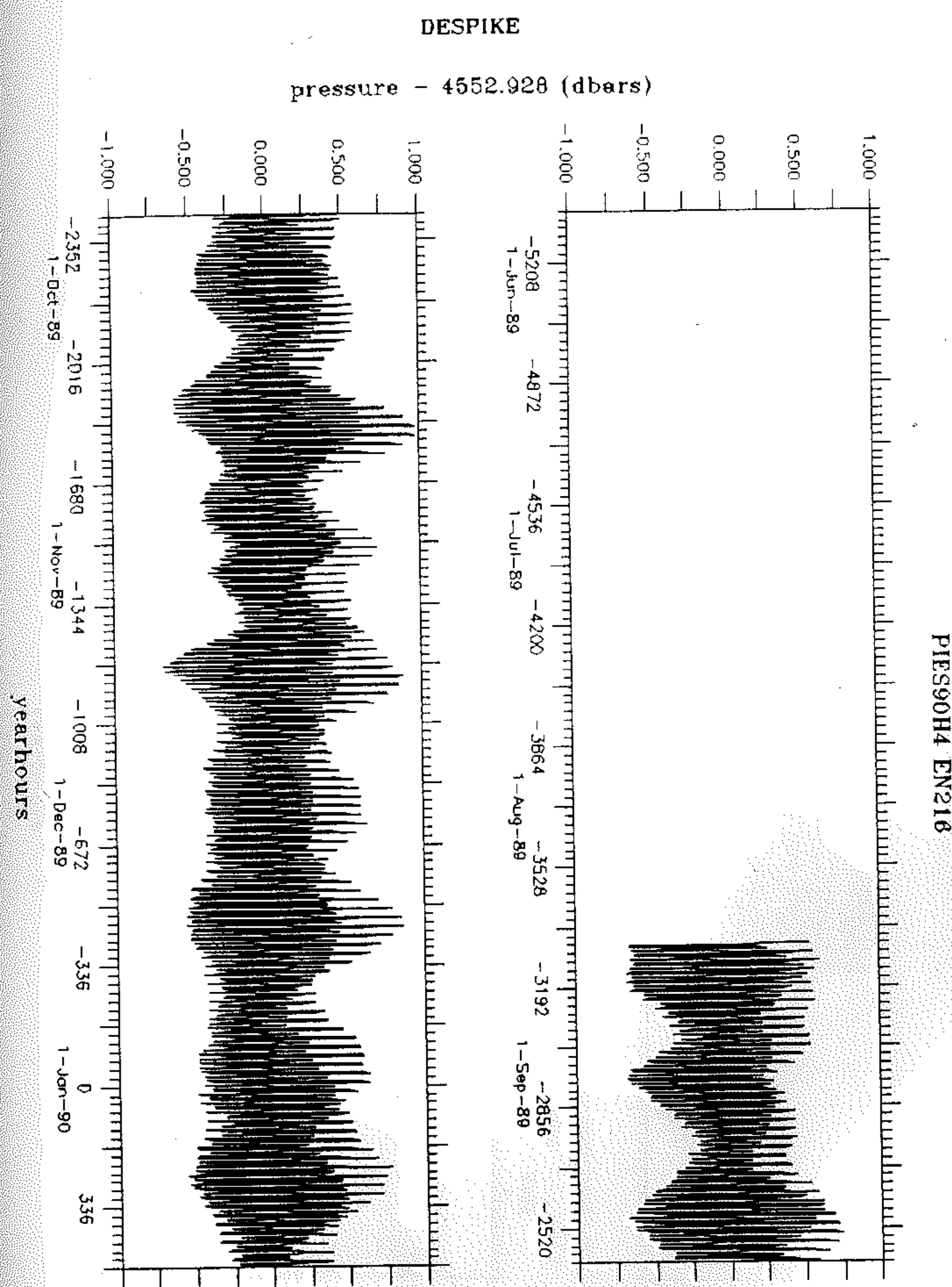
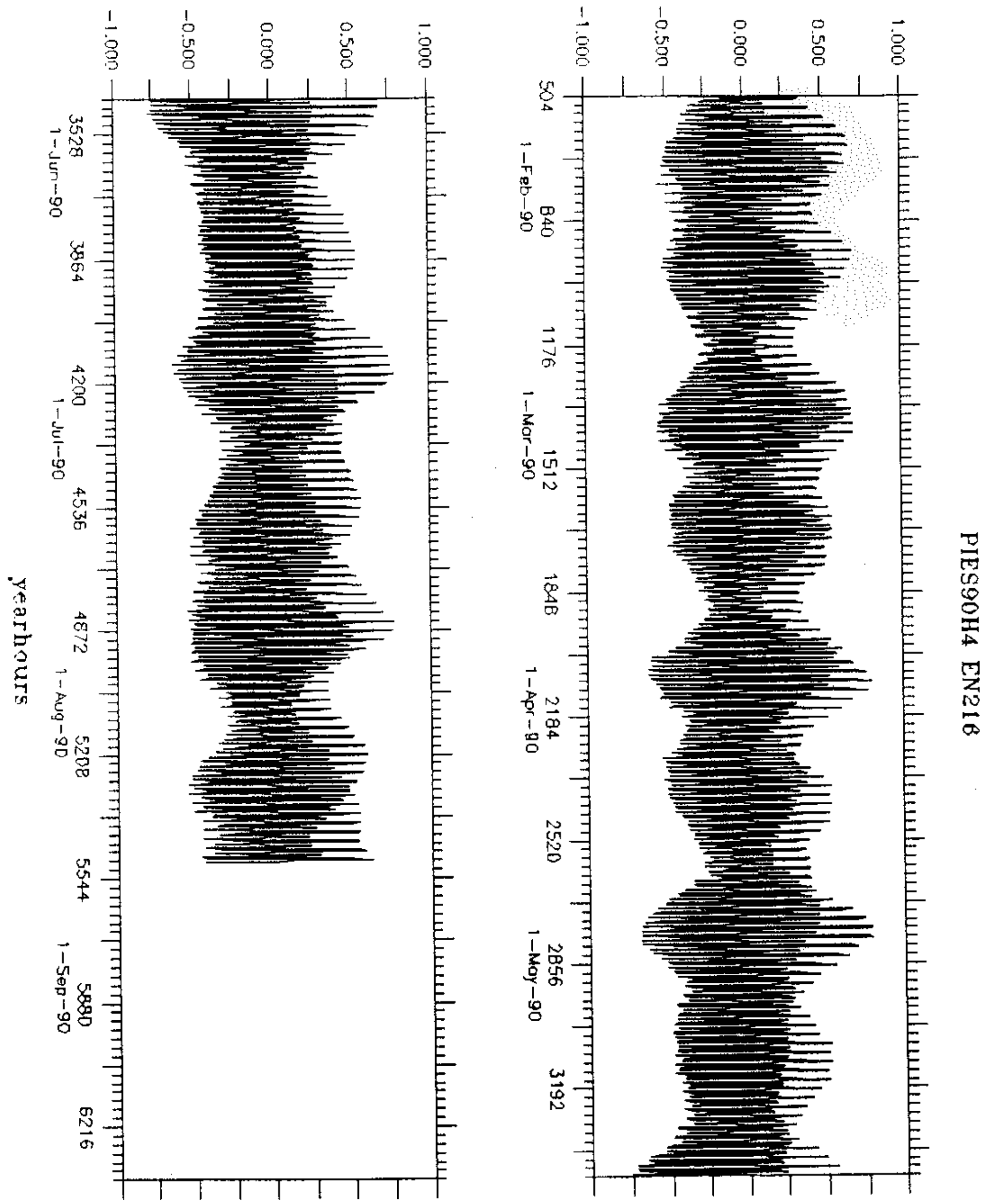


Figure 10.5: Half-Hourly Bottom Pressure. PIES90H4

DESPIKE

pressure - 4552.928 (dbars)



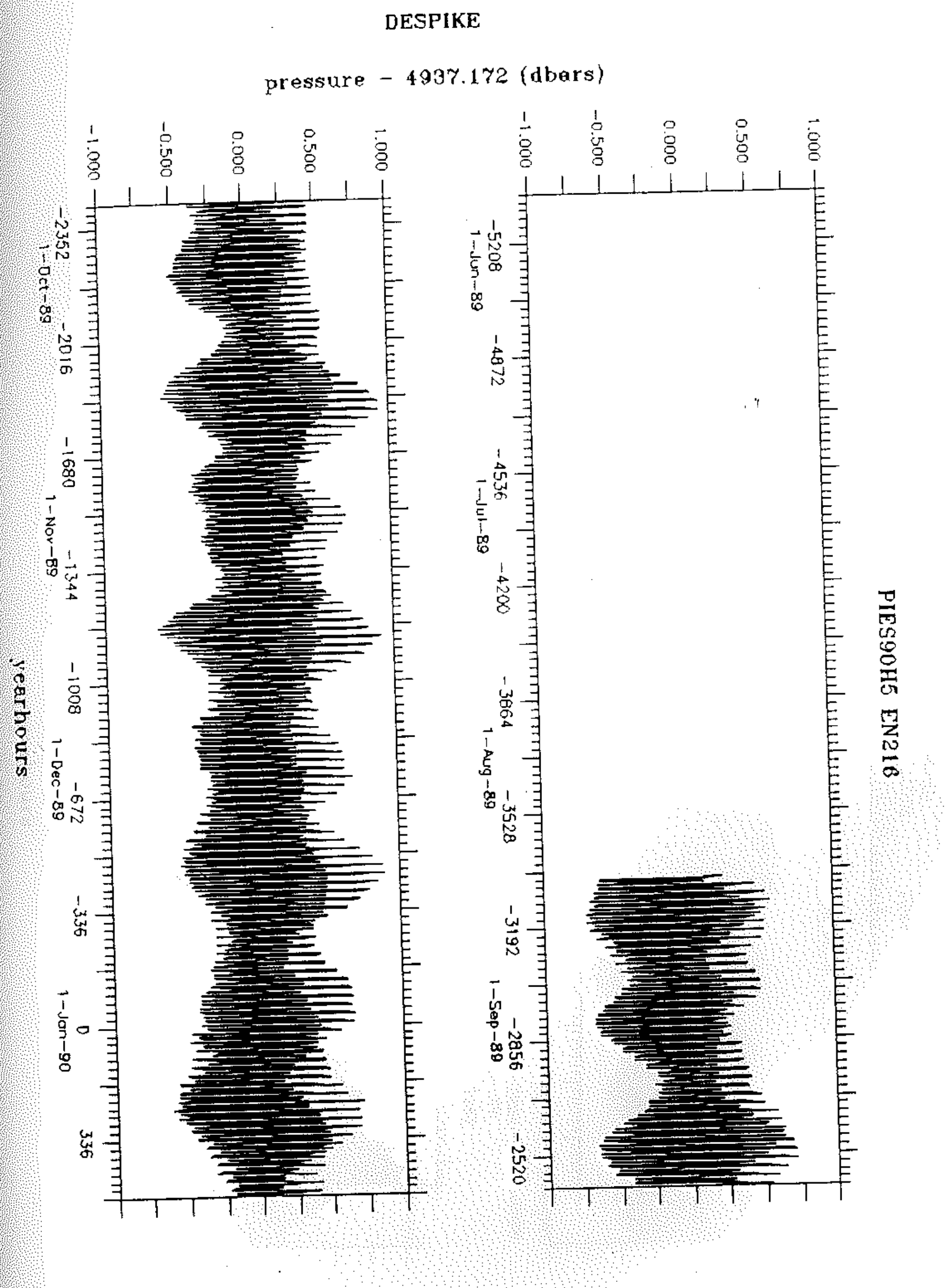
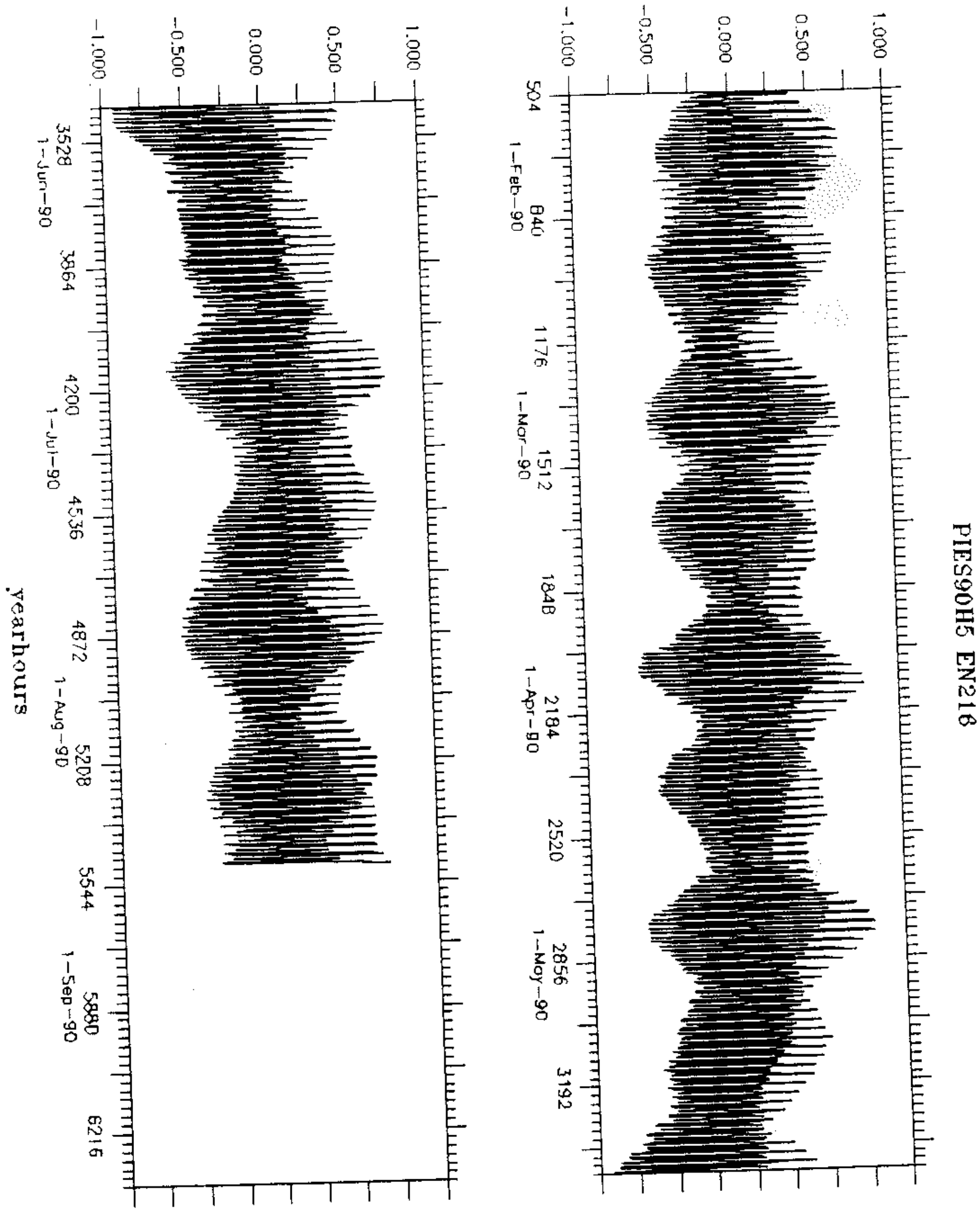


Figure 10.6: Half-Hourly Bottom Pressure. PIES90H5

DESPIKE

pressure - 4937.172 (dbars)



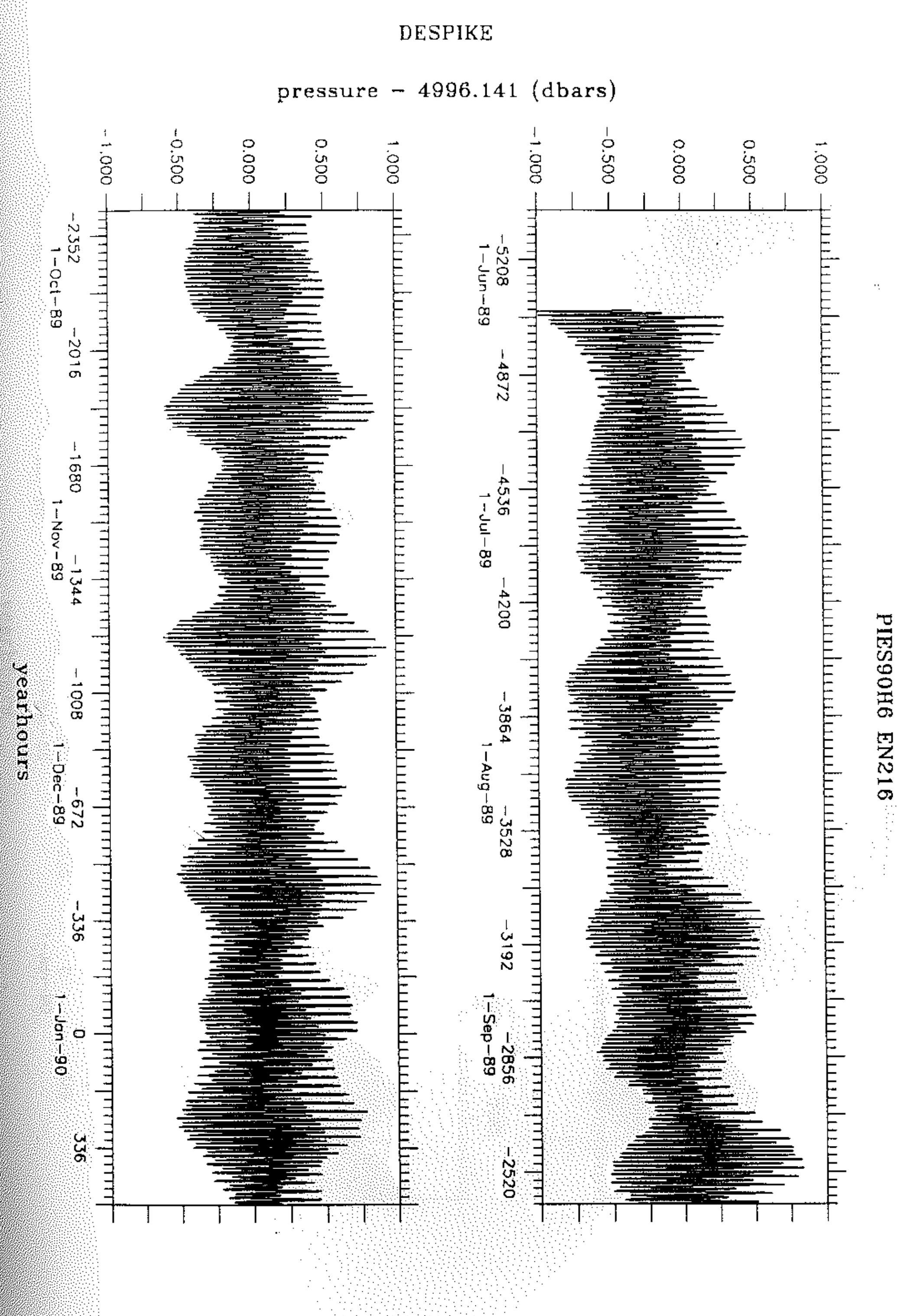
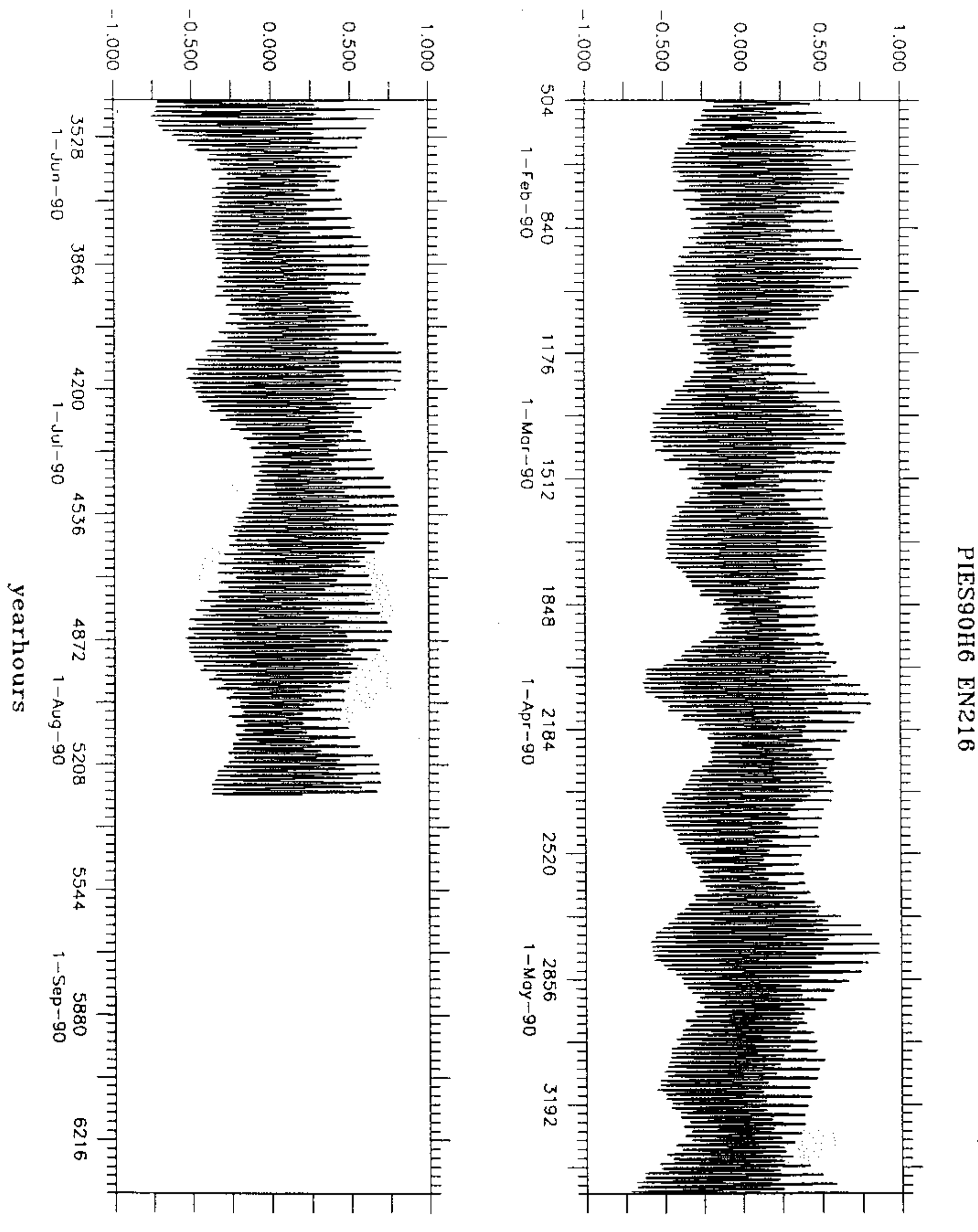


Figure 10.7: Half-Hourly Bottom Pressure. PIES90H6

DESPIKE

pressure - 4996.141 (dbars)



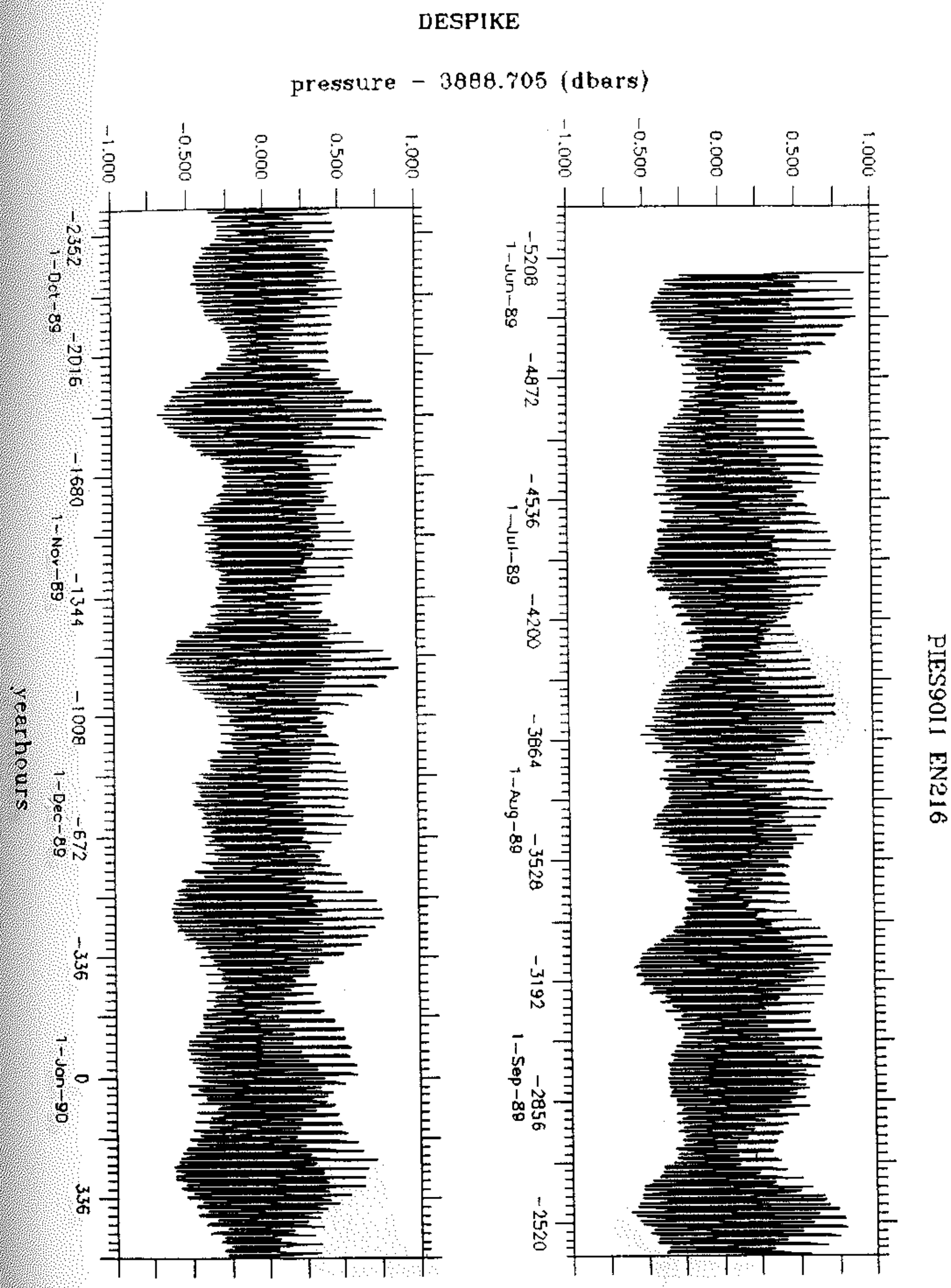
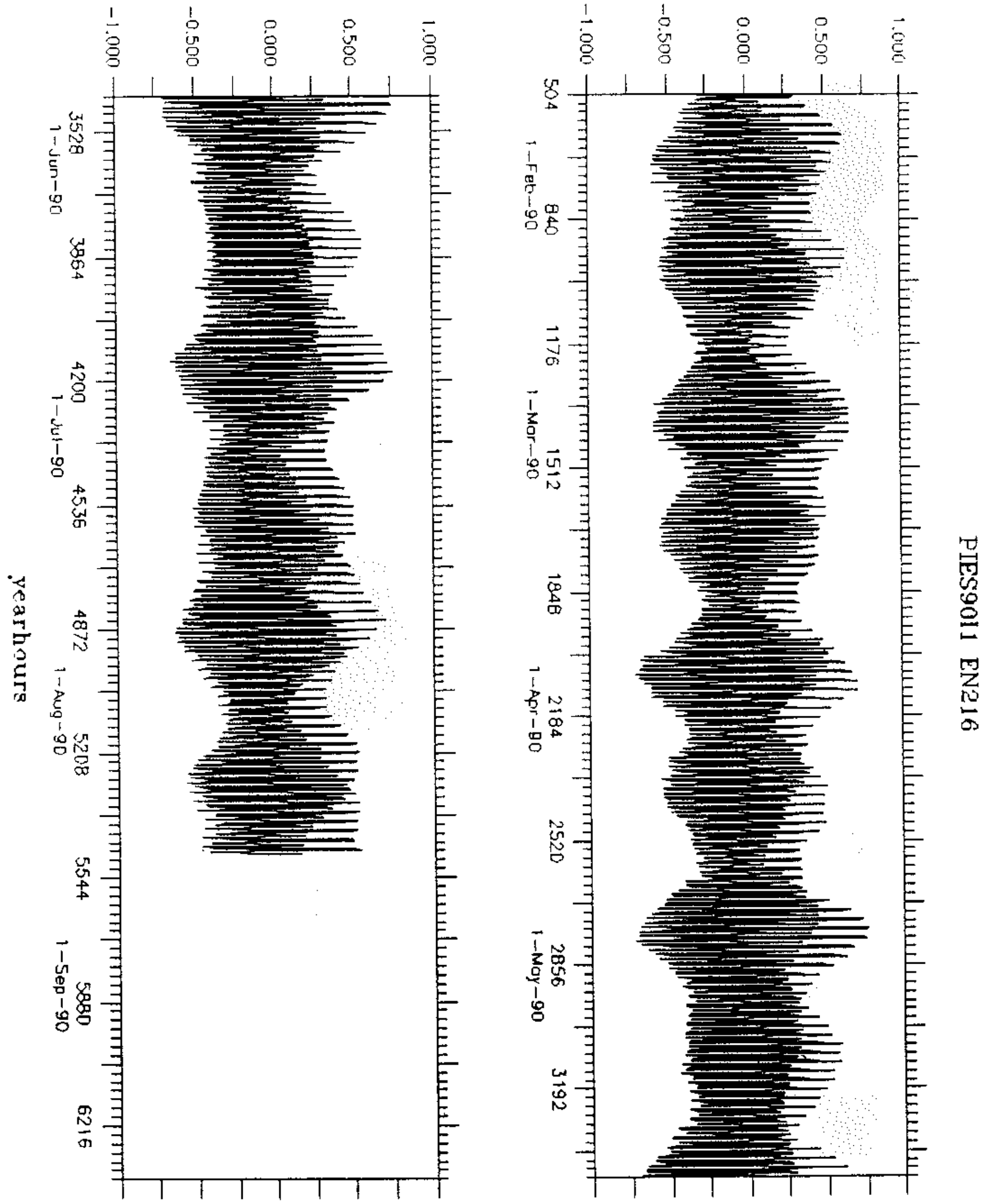


Figure 10.8: Half-Hourly Bottom Pressure. PIES90I1

DESPIKE

pressure - 3888.705 (dbars)



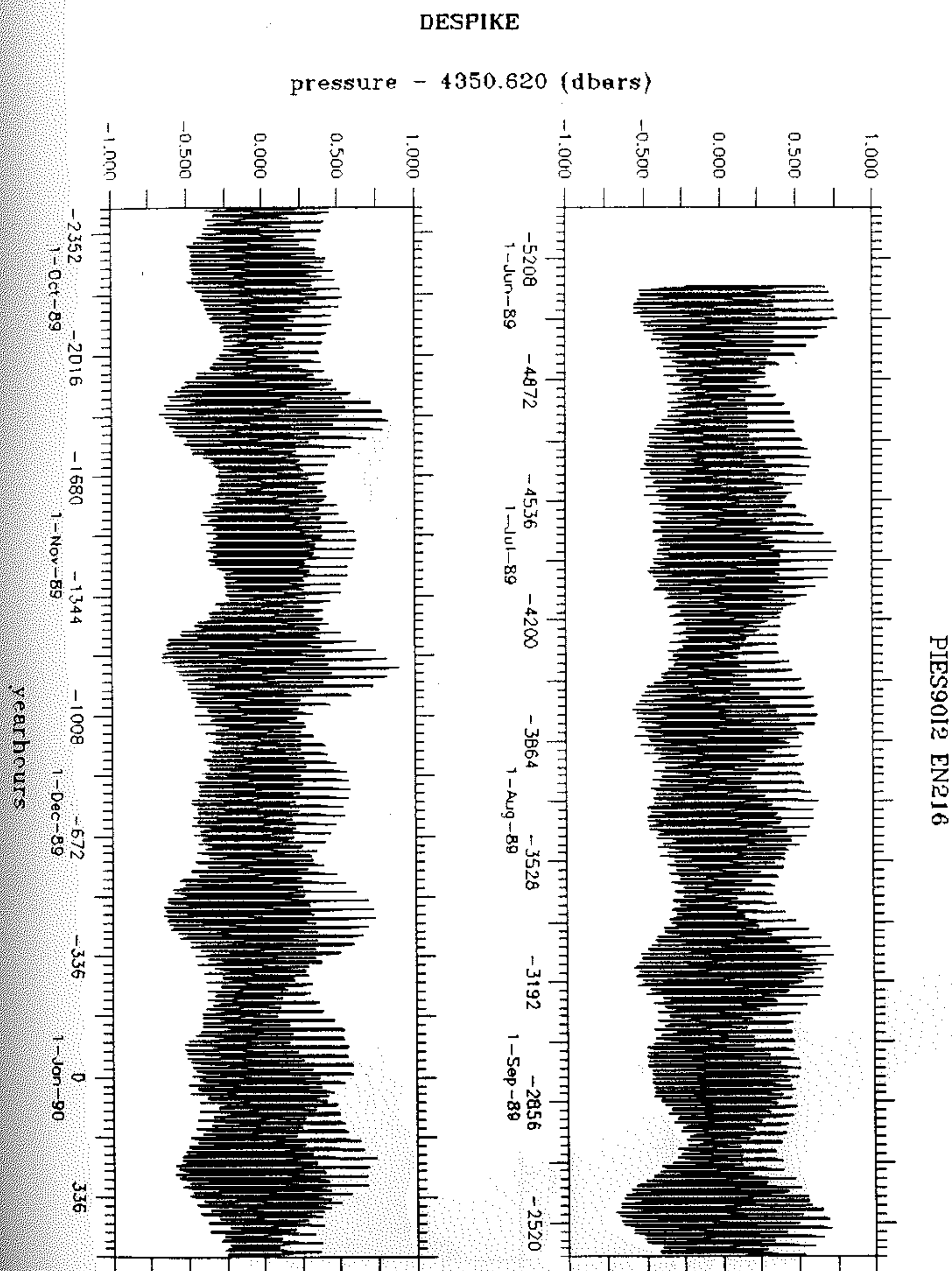
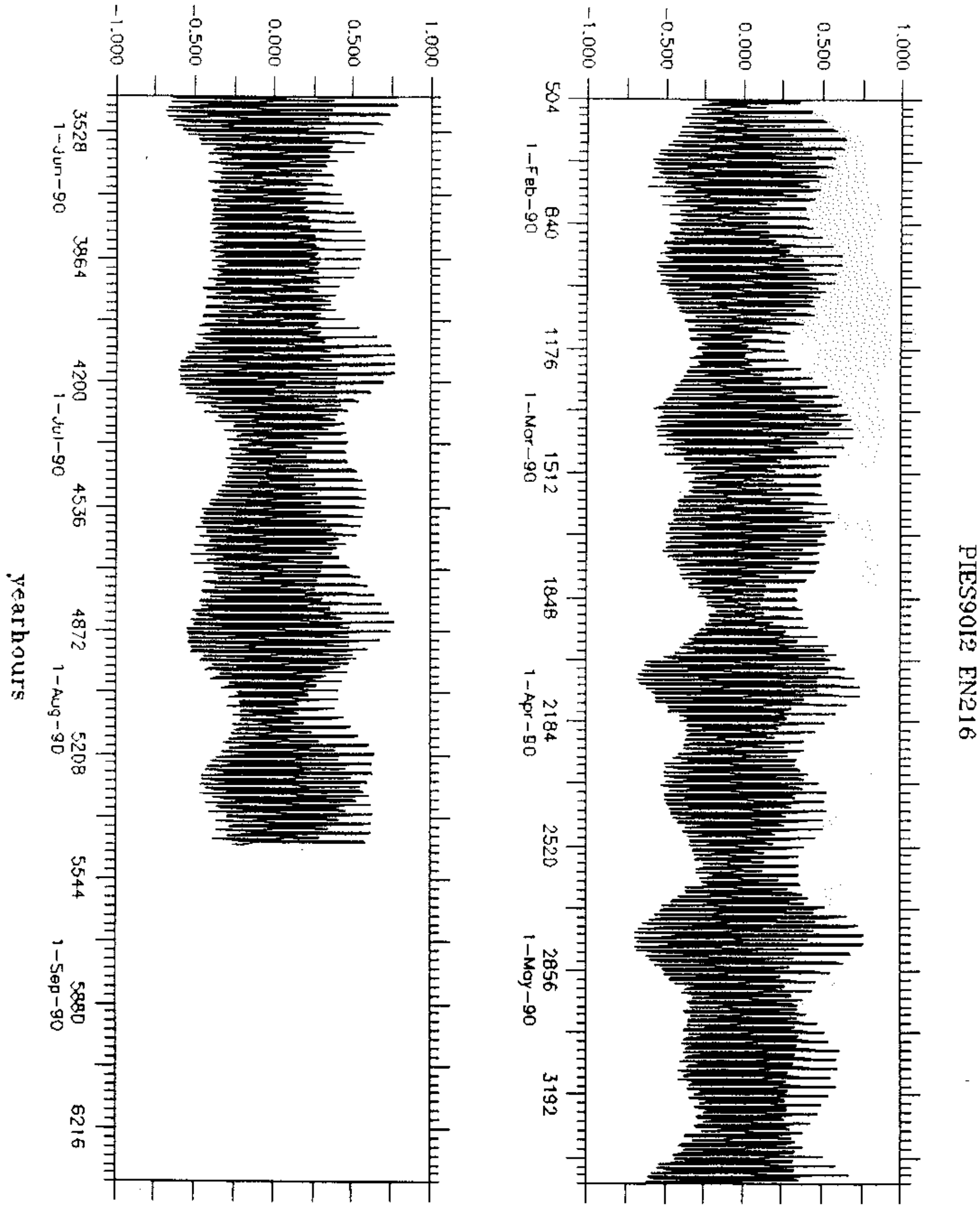


Figure 10.9: Half-Hourly Bottom Pressure. PIES90I2

DESPIKE

pressure – 4350.620 (dbars)



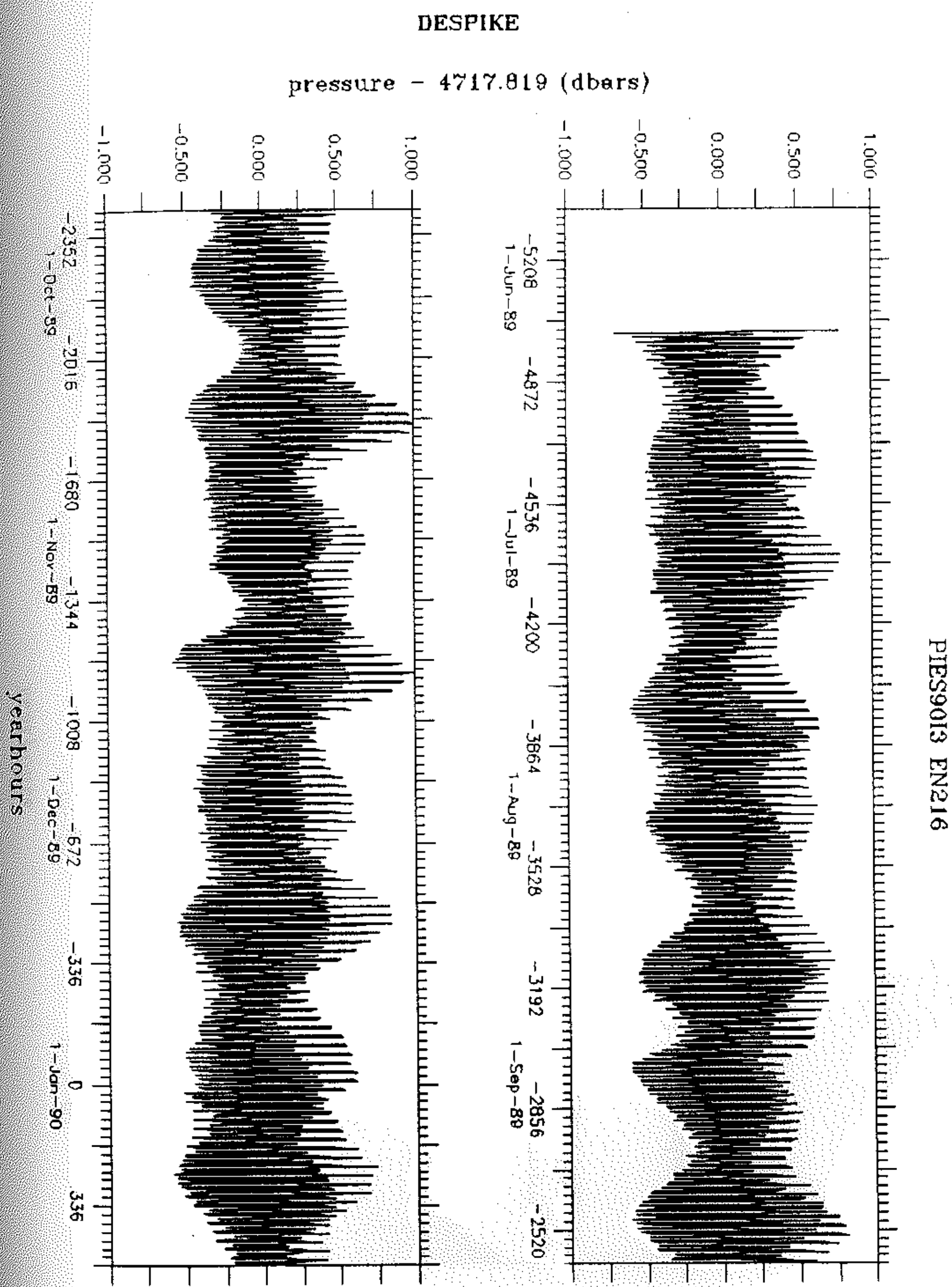
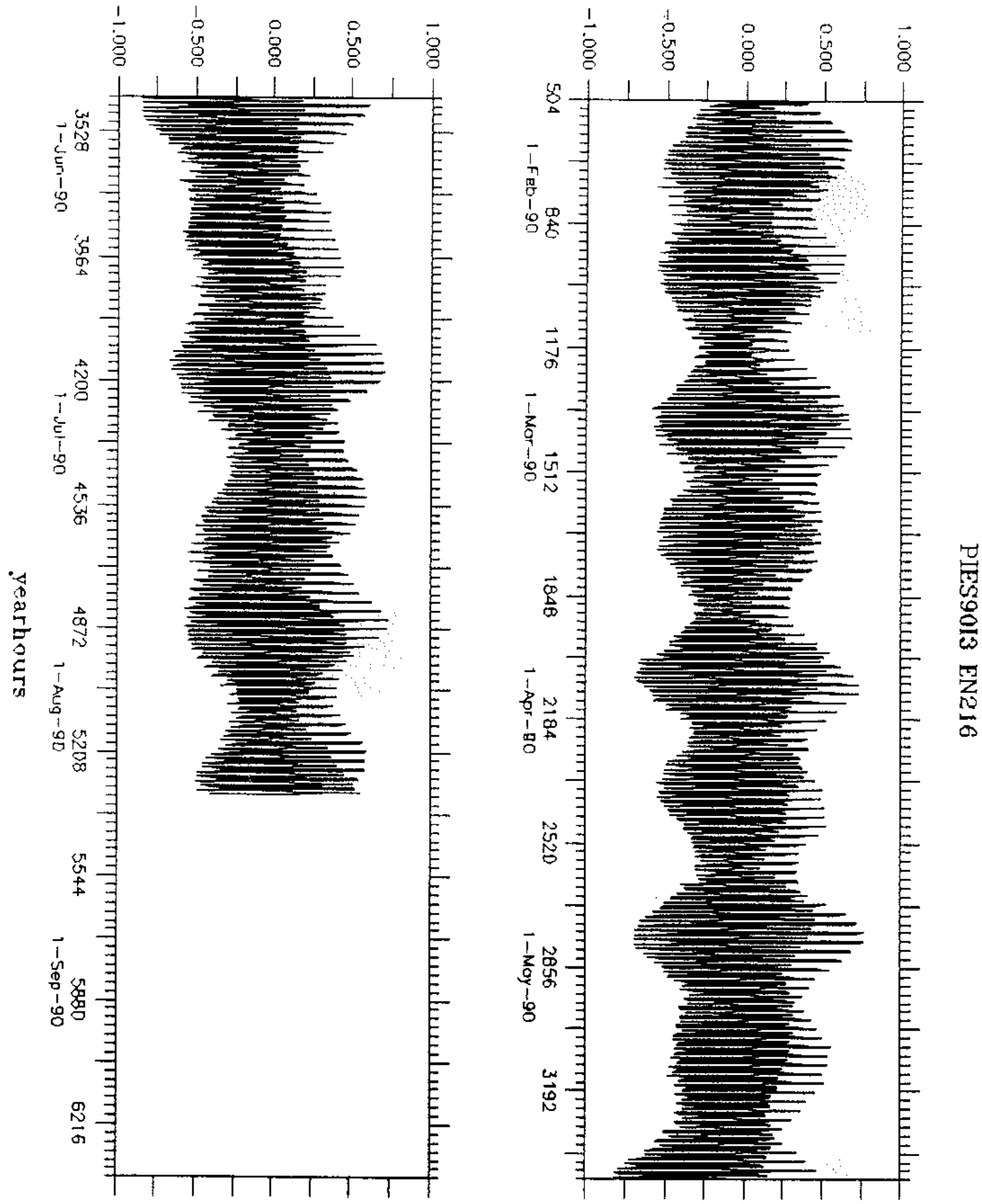


Figure 10.10: Half-Hourly Bottom Pressure. PIES90I3

DESPIKE

pressure - 4717.819 (dbars)



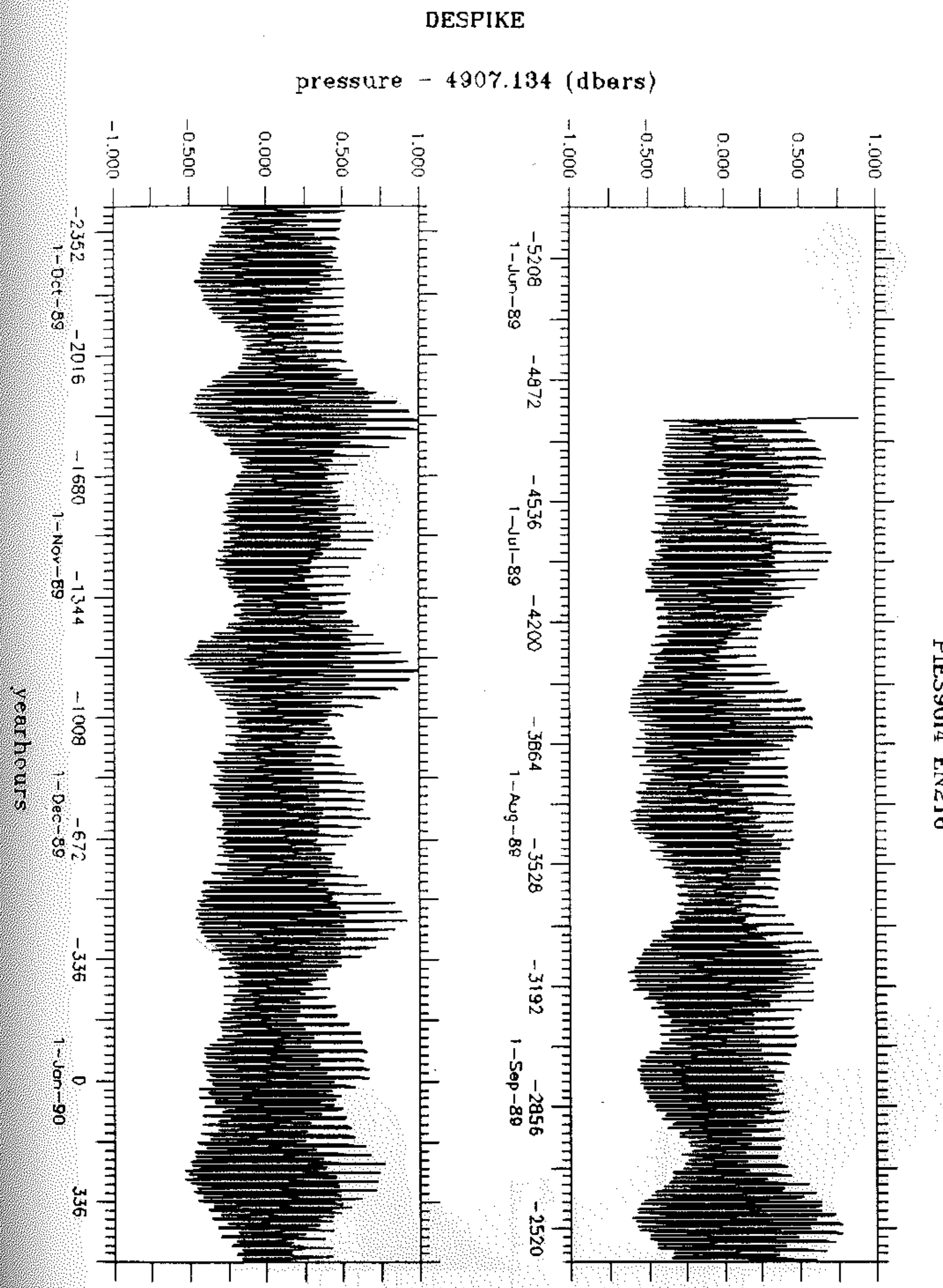
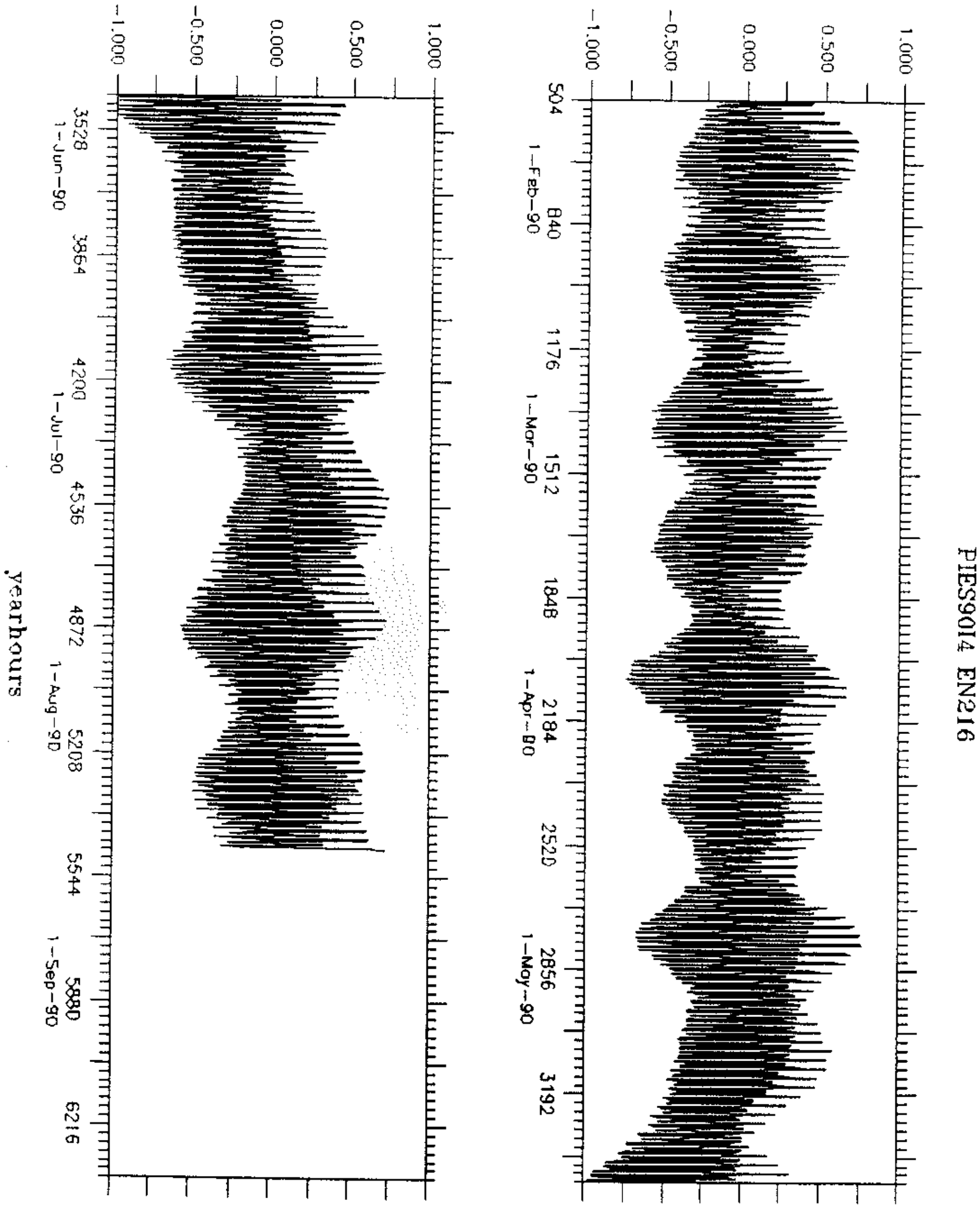


Figure 10.11: Half-Hourly Bottom Pressure. PIES90I4

DESPIKE

pressure - 4907.134 (dbars)



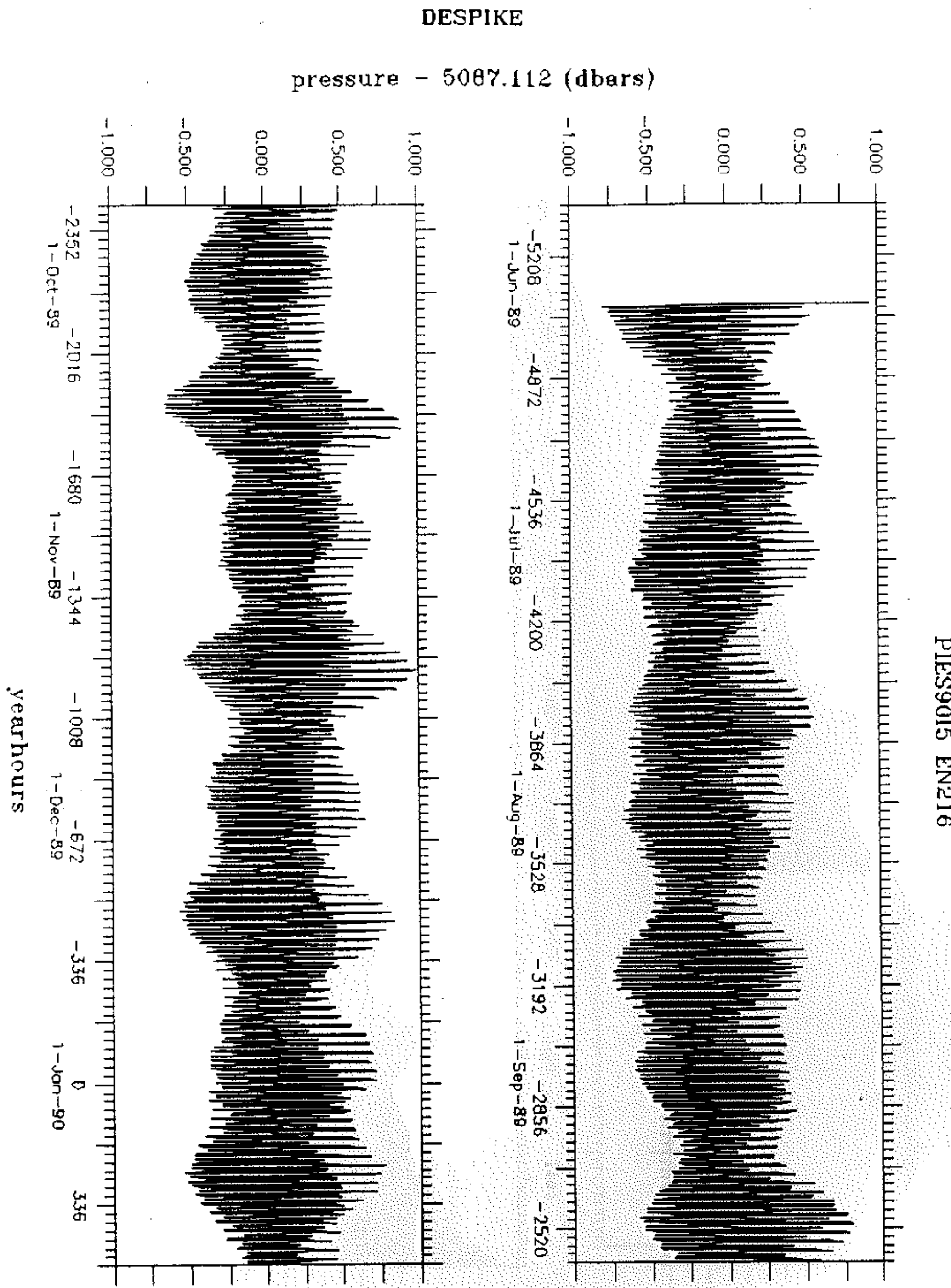
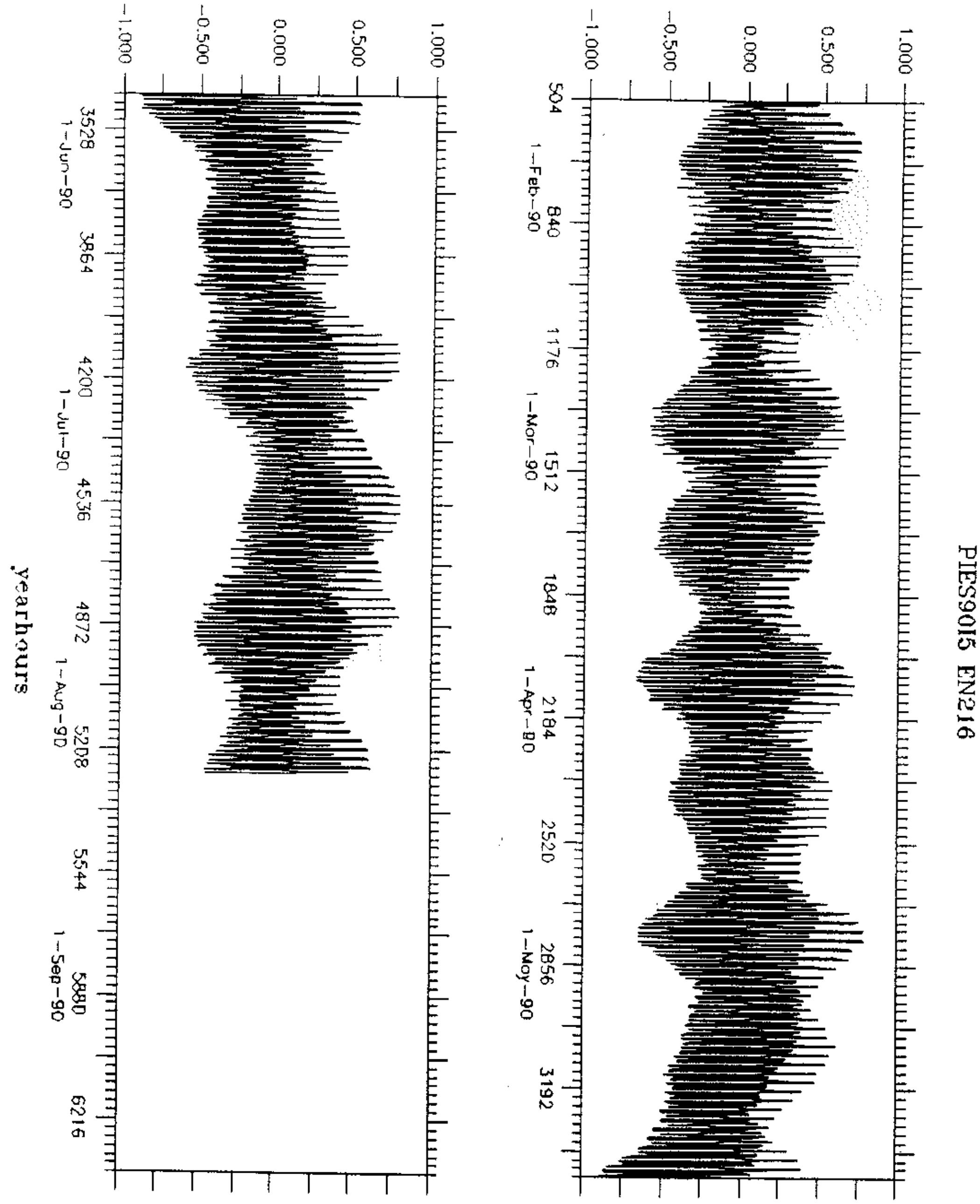


Figure 10.12: Half-Hourly Bottom Pressure. PIES90I5

DESPIKE

pressure - 5087.112 (dbars)



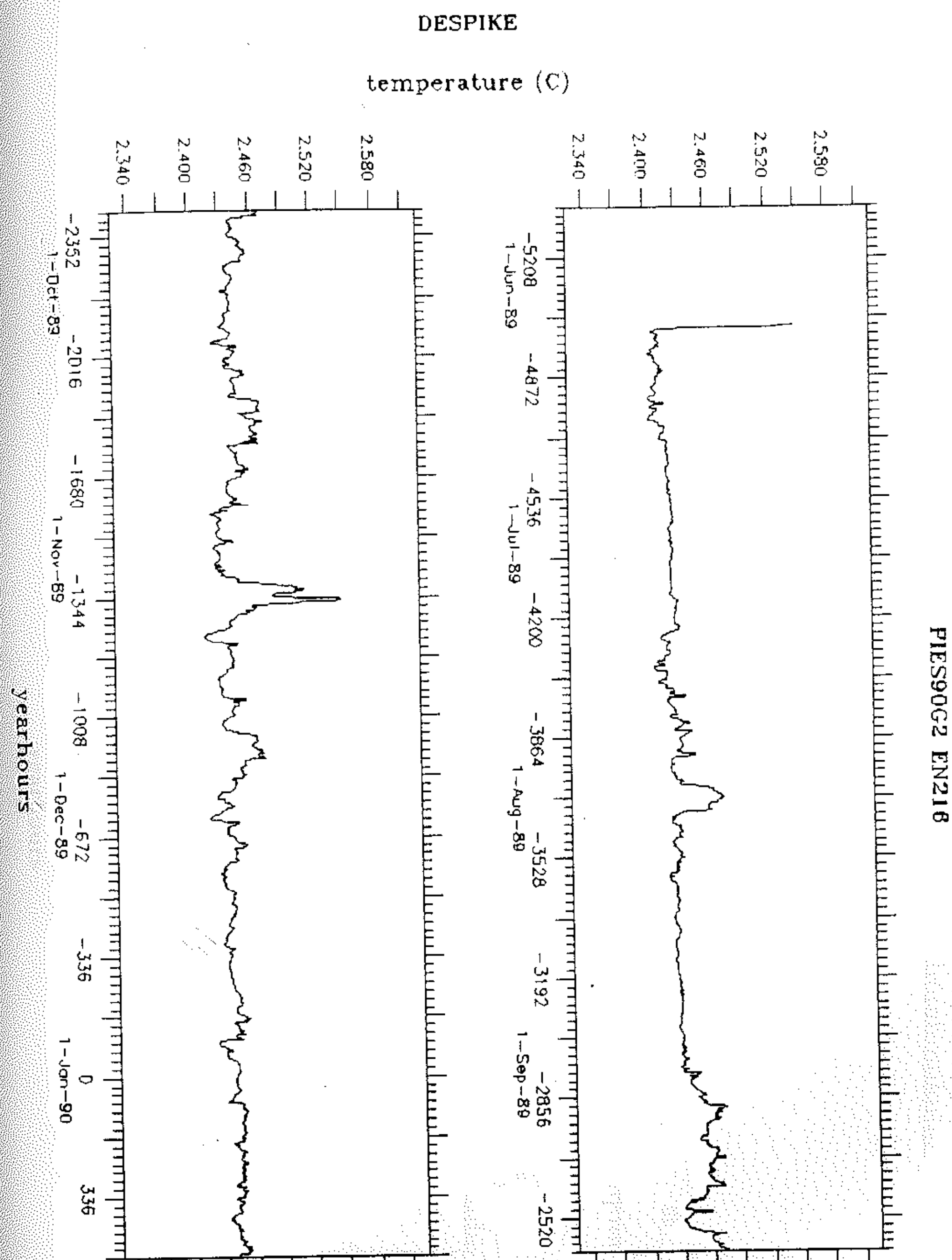
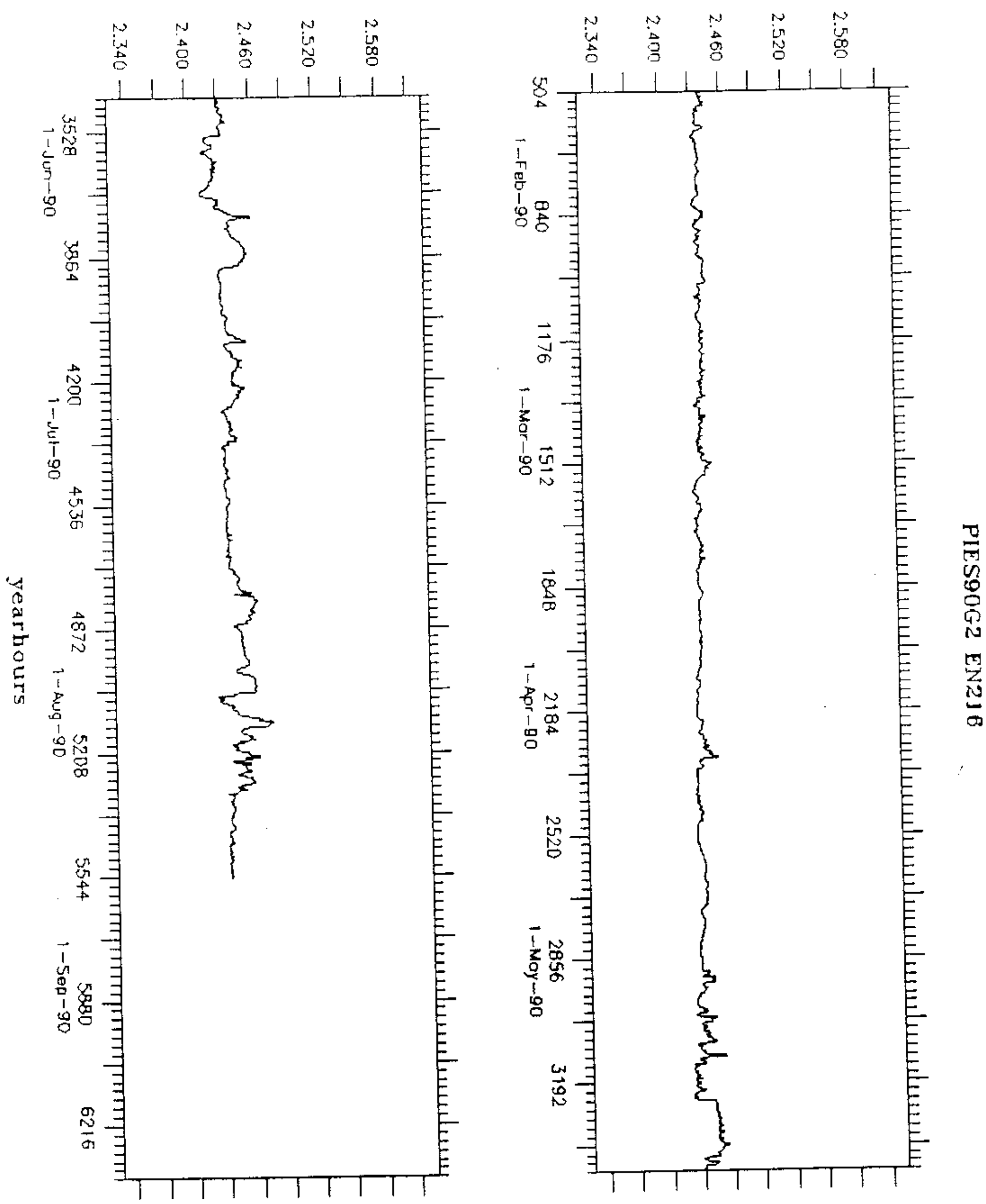


Figure 11.1: half-Hourly Temperature. PIES90G2

DESPIKE

temperature (C)



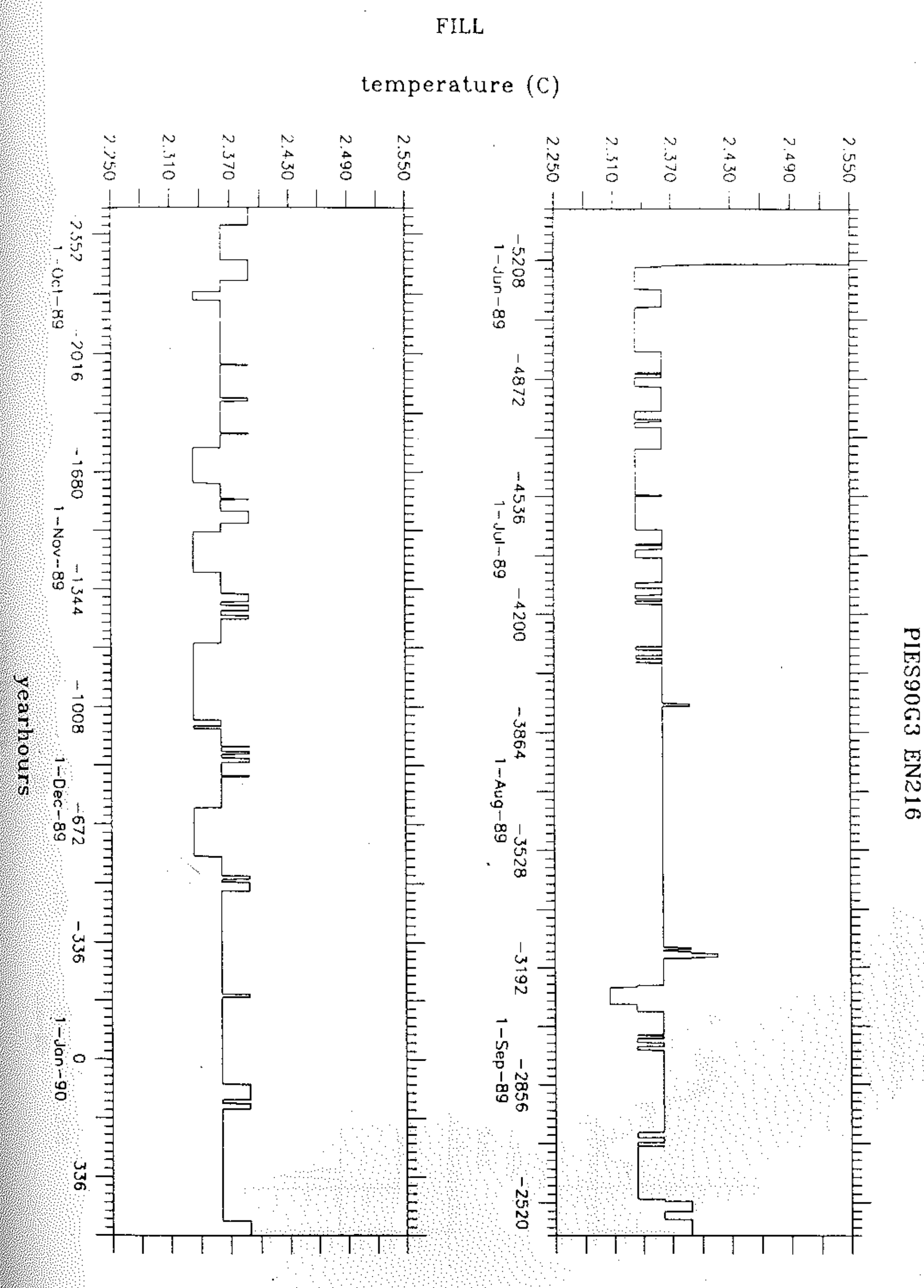
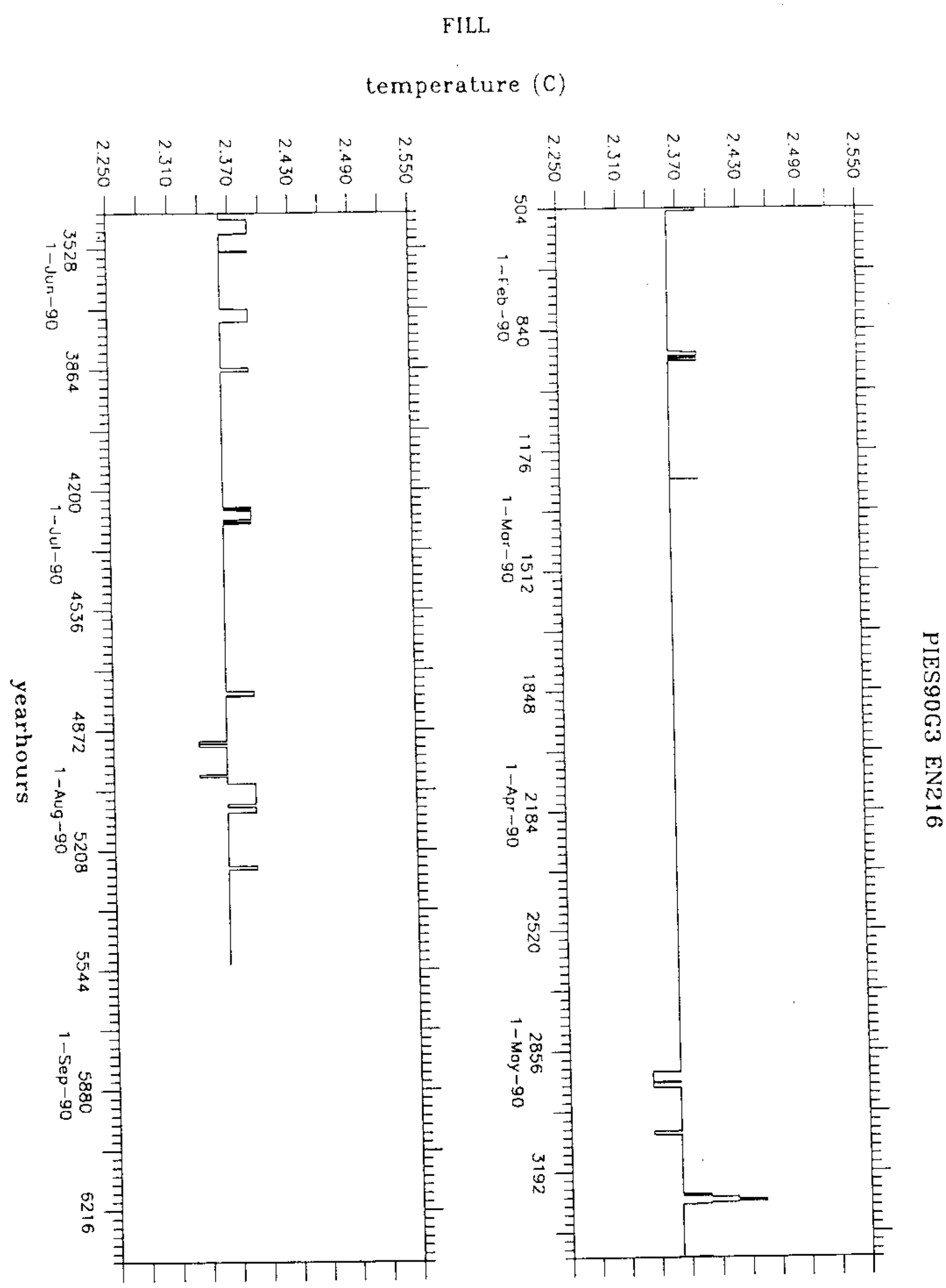


Figure 11.2: Half-Hourly Temperature. PIES90G3


PIES90G3 EN216
FILL
temperature (C)
2.250
2.310
2.370
2.430
2.490
2.550
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

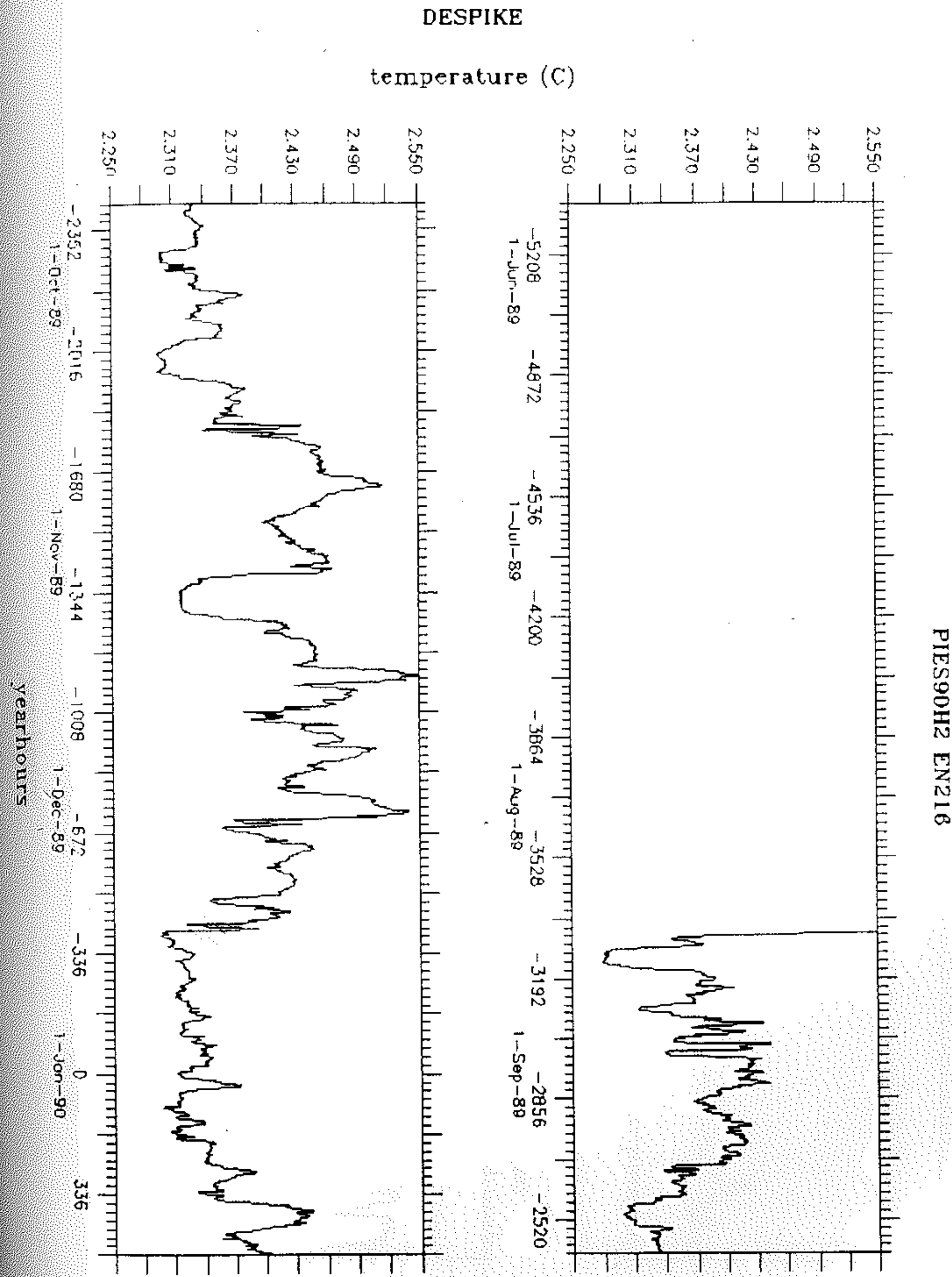
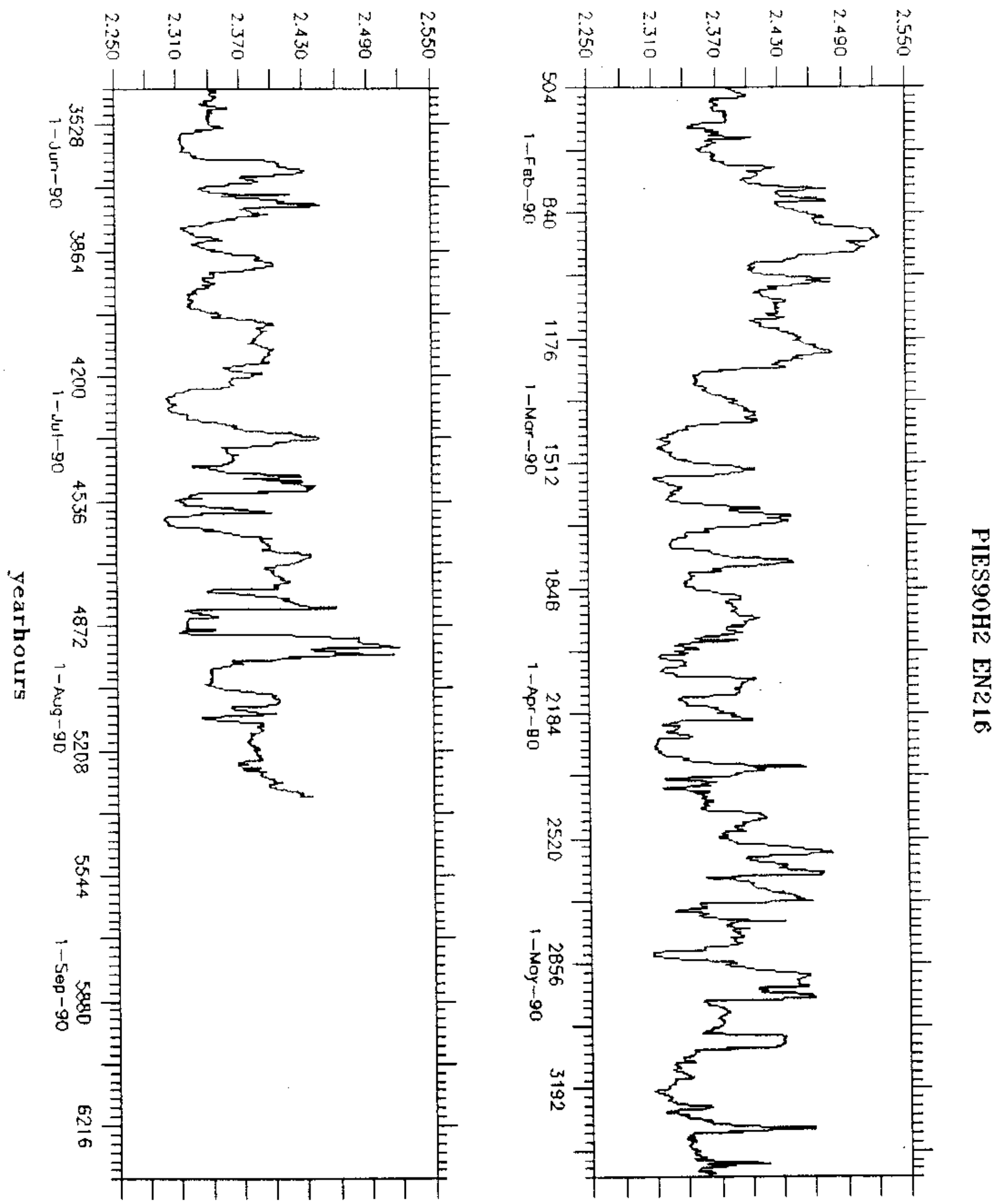


Figure 11.3: Half-Hourly Temperature. PIES90H2

DESPIKE

temperature (C)



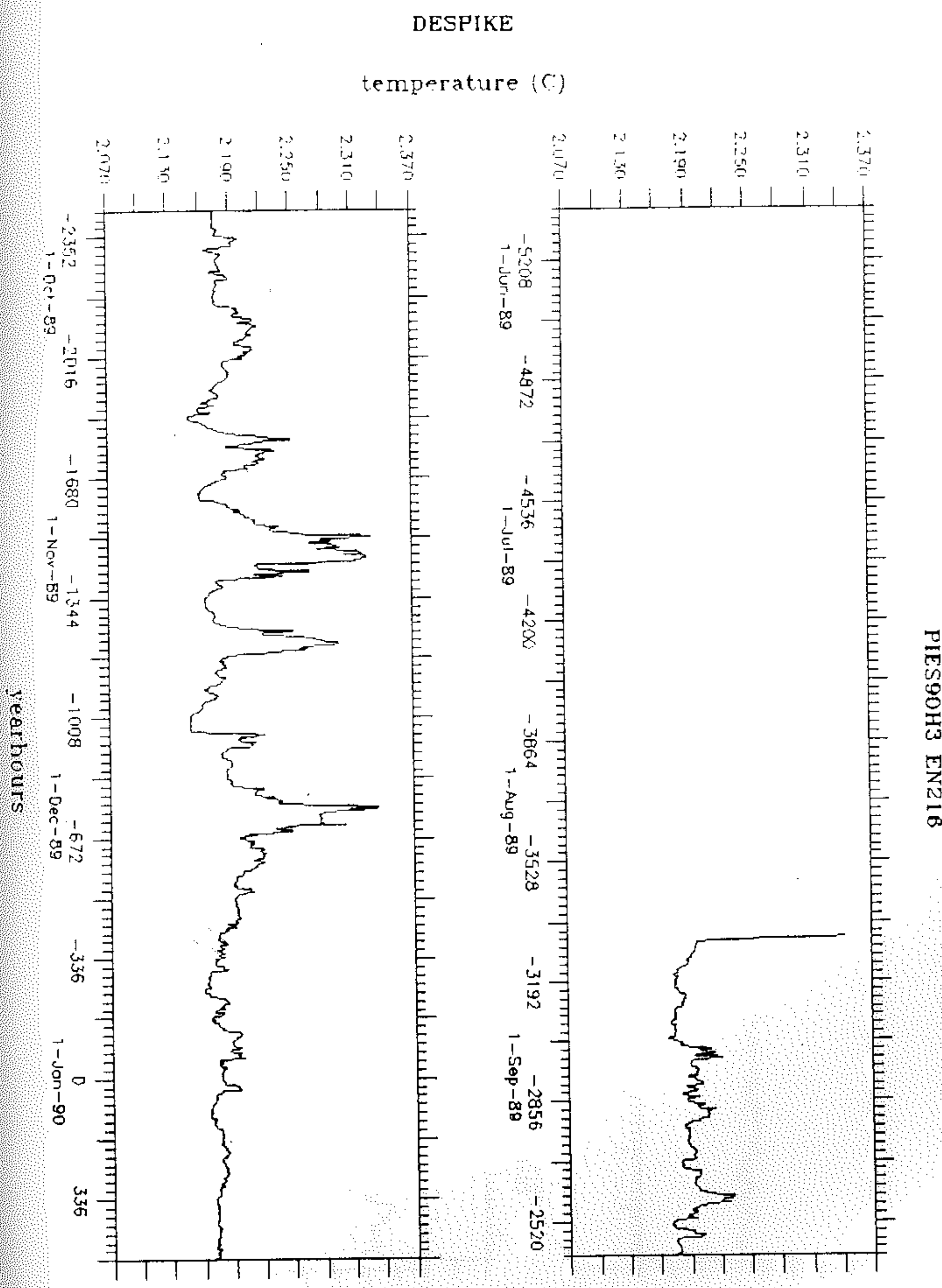
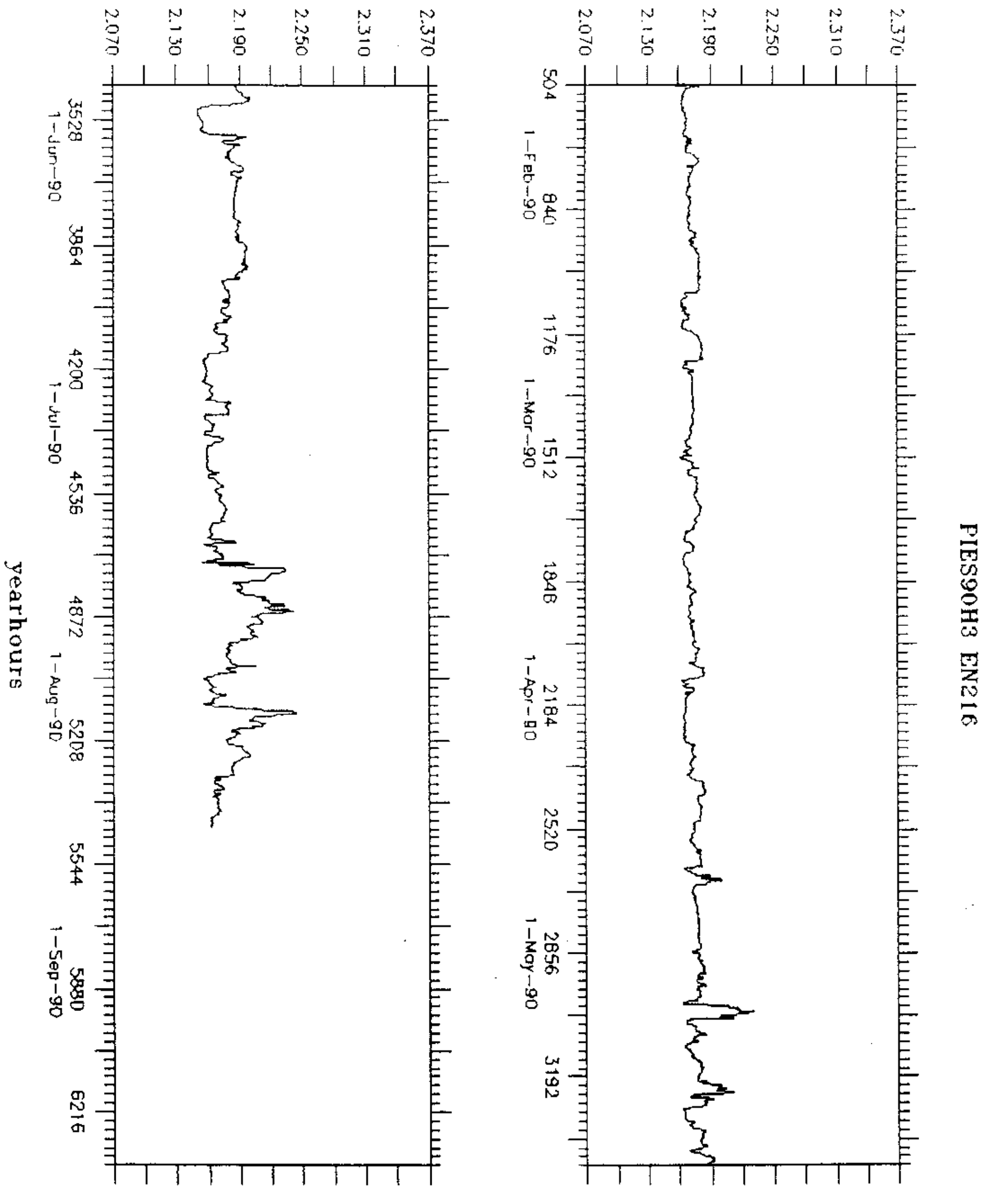


Figure 11.4: Half-Hourly Temperature. PIES90H3

DESPIKE

temperature (C)



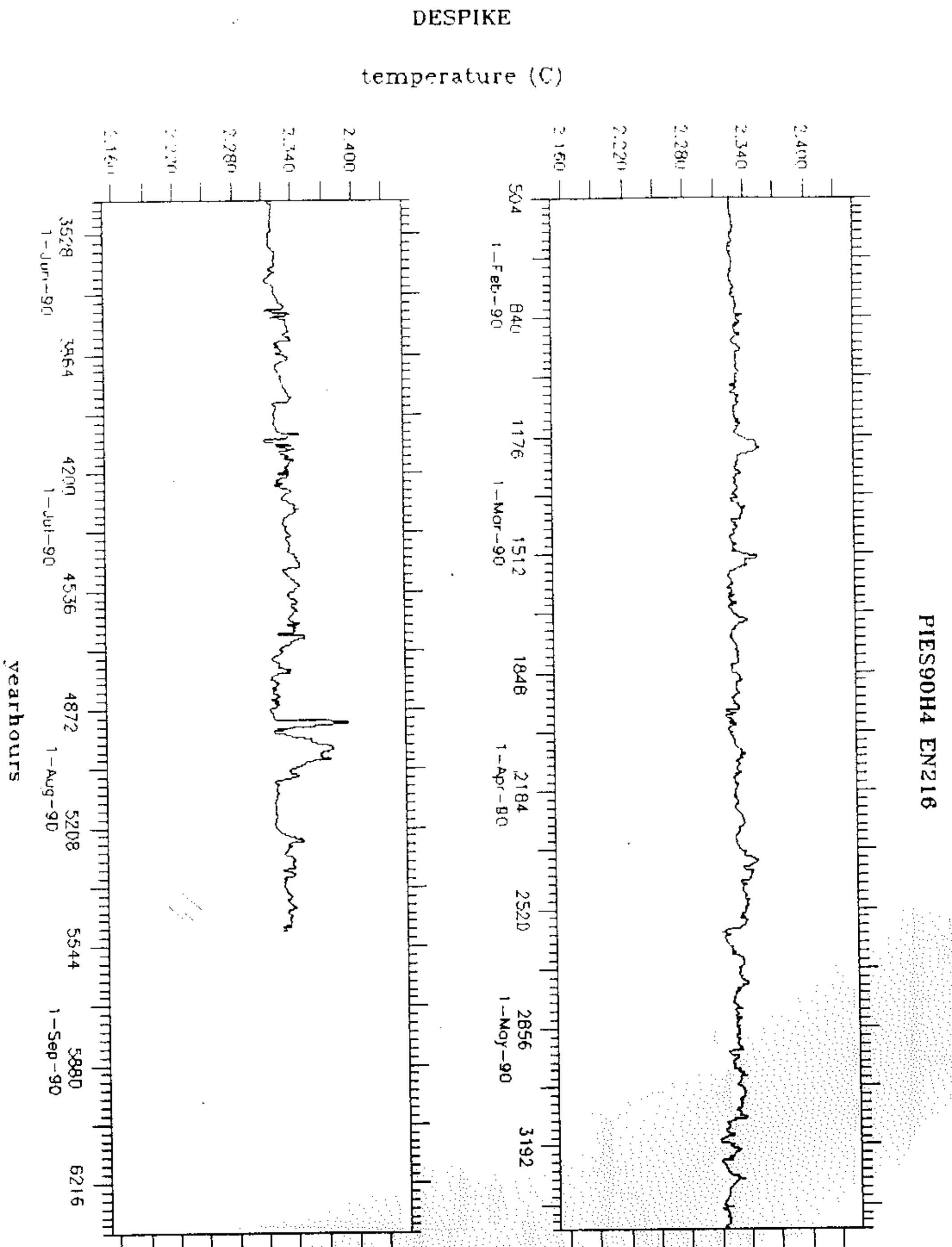
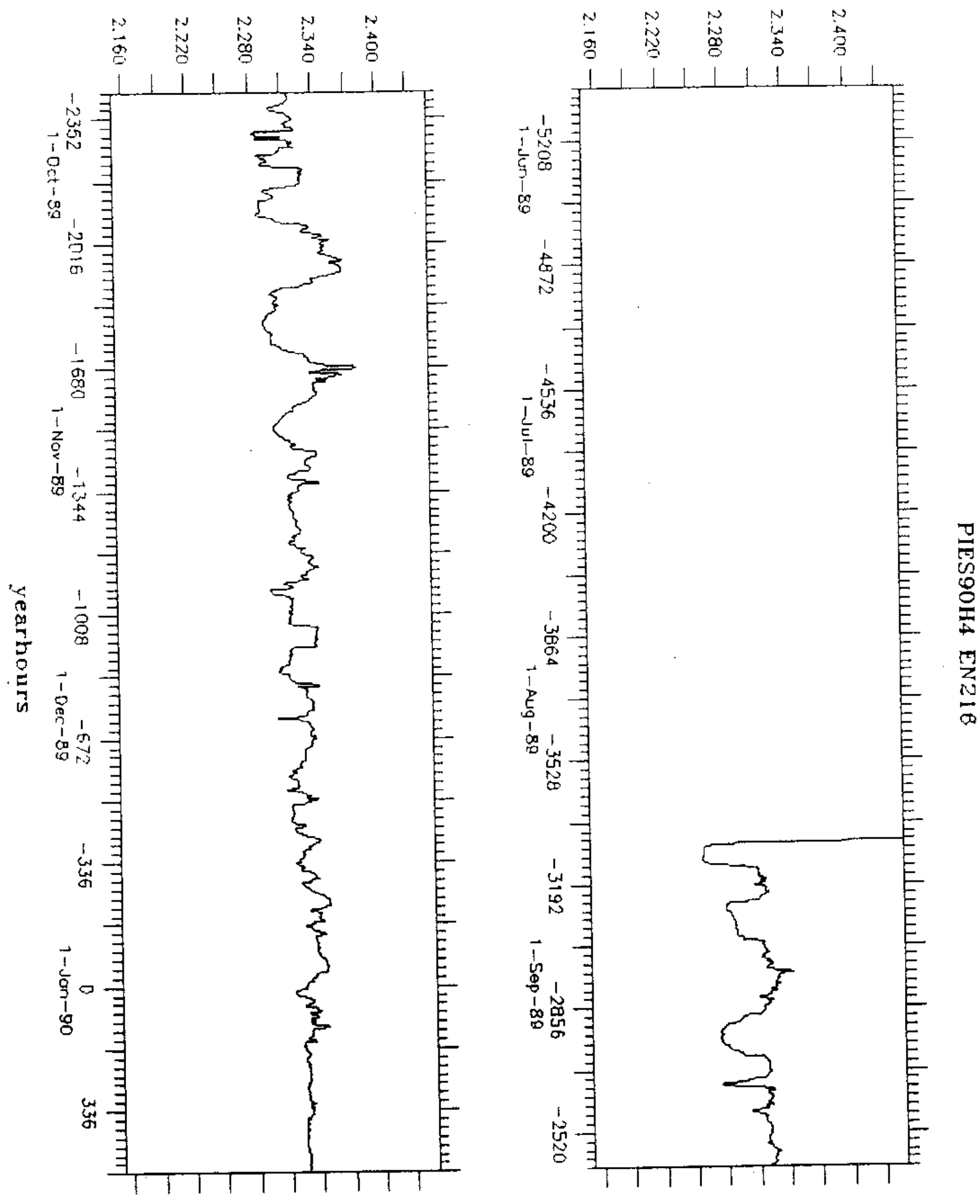


Figure 11.5: Half-Hourly Temperature. PIES90H4

DESPIKE

temperature (C)



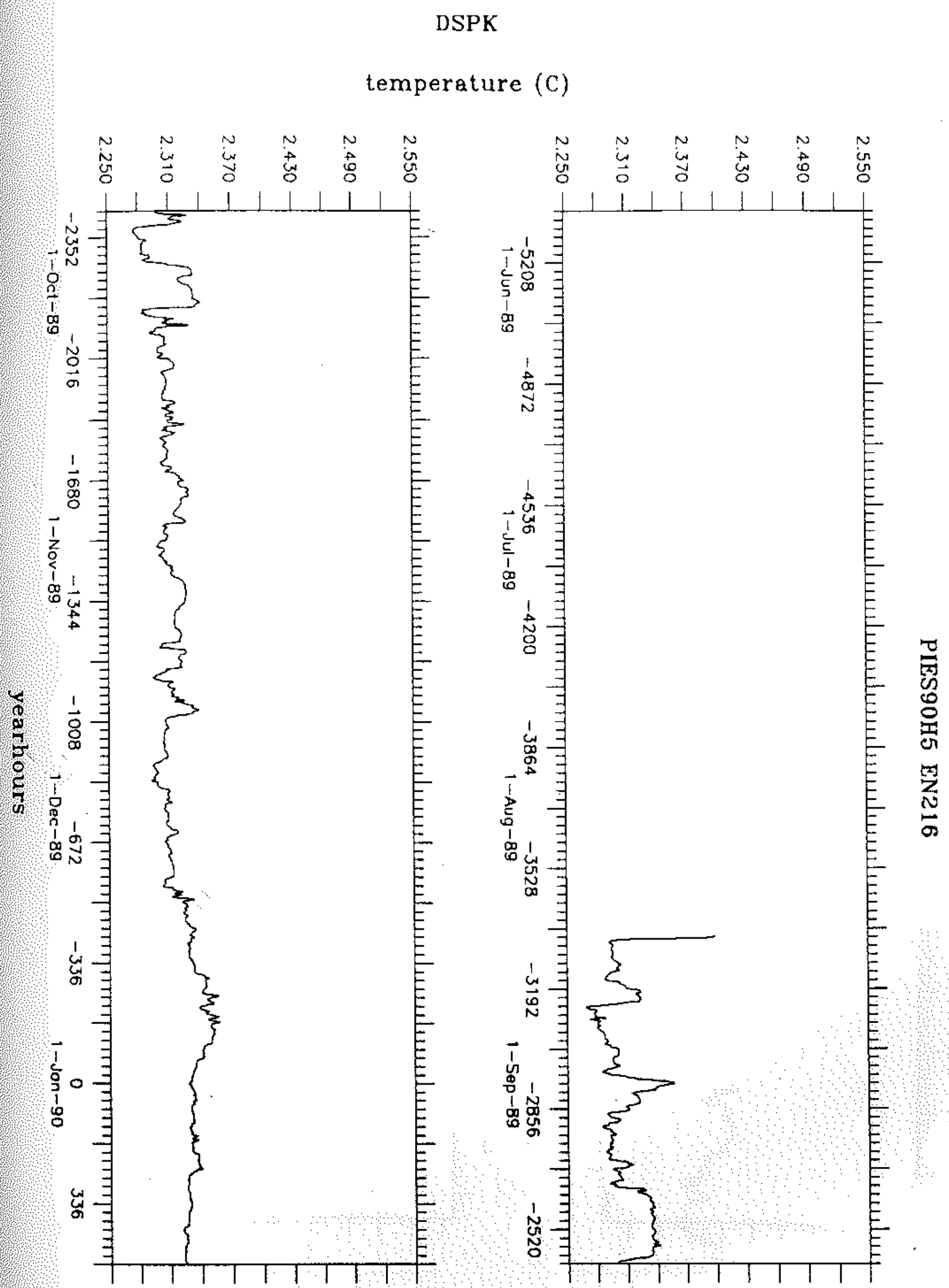
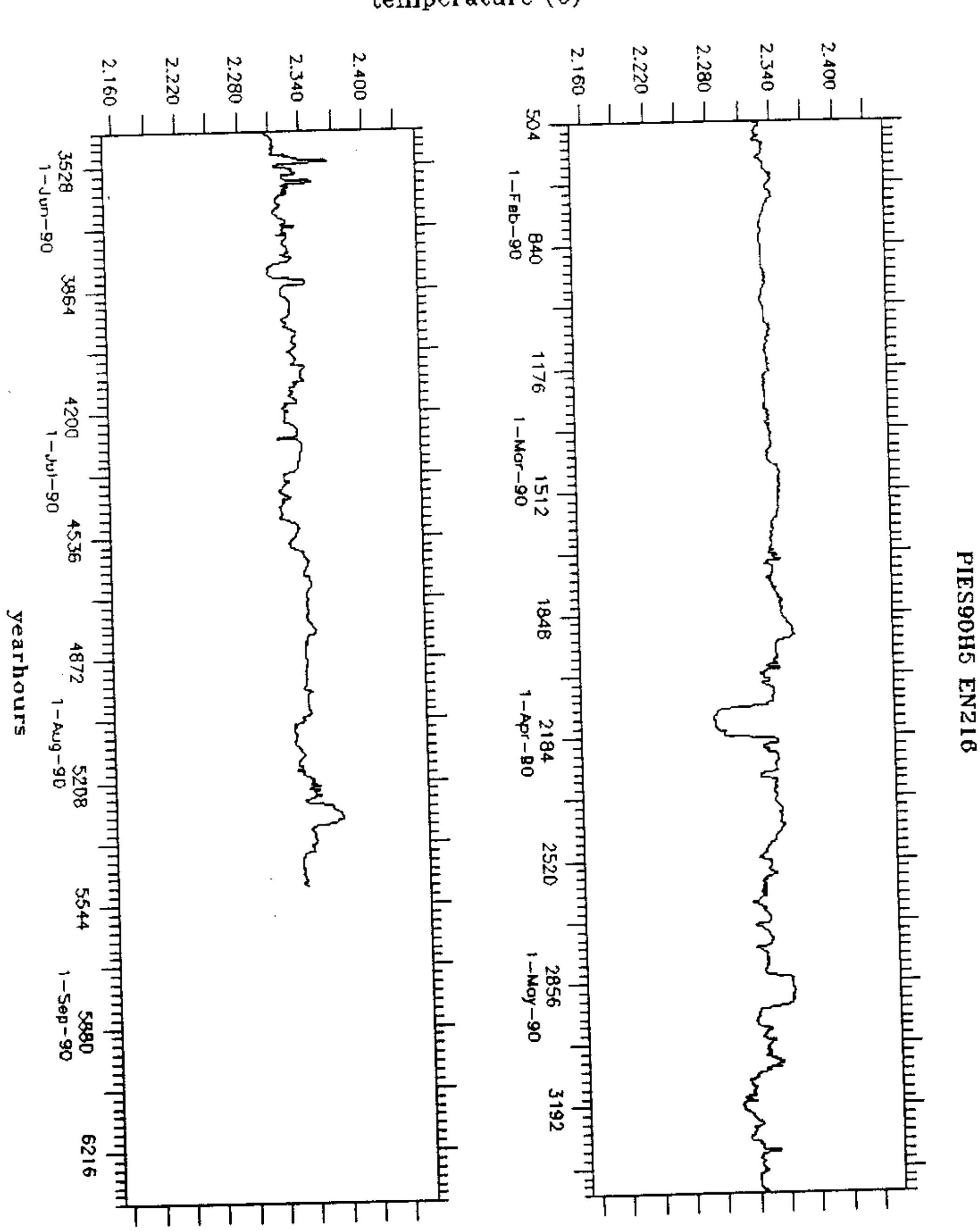


Figure 11.6: Half-Hourly Temperature. PIES90H5

DESPIKE


PIES90H5 EN216
temperature (C)
2.160
2.220
2.280
2.340
2.400
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

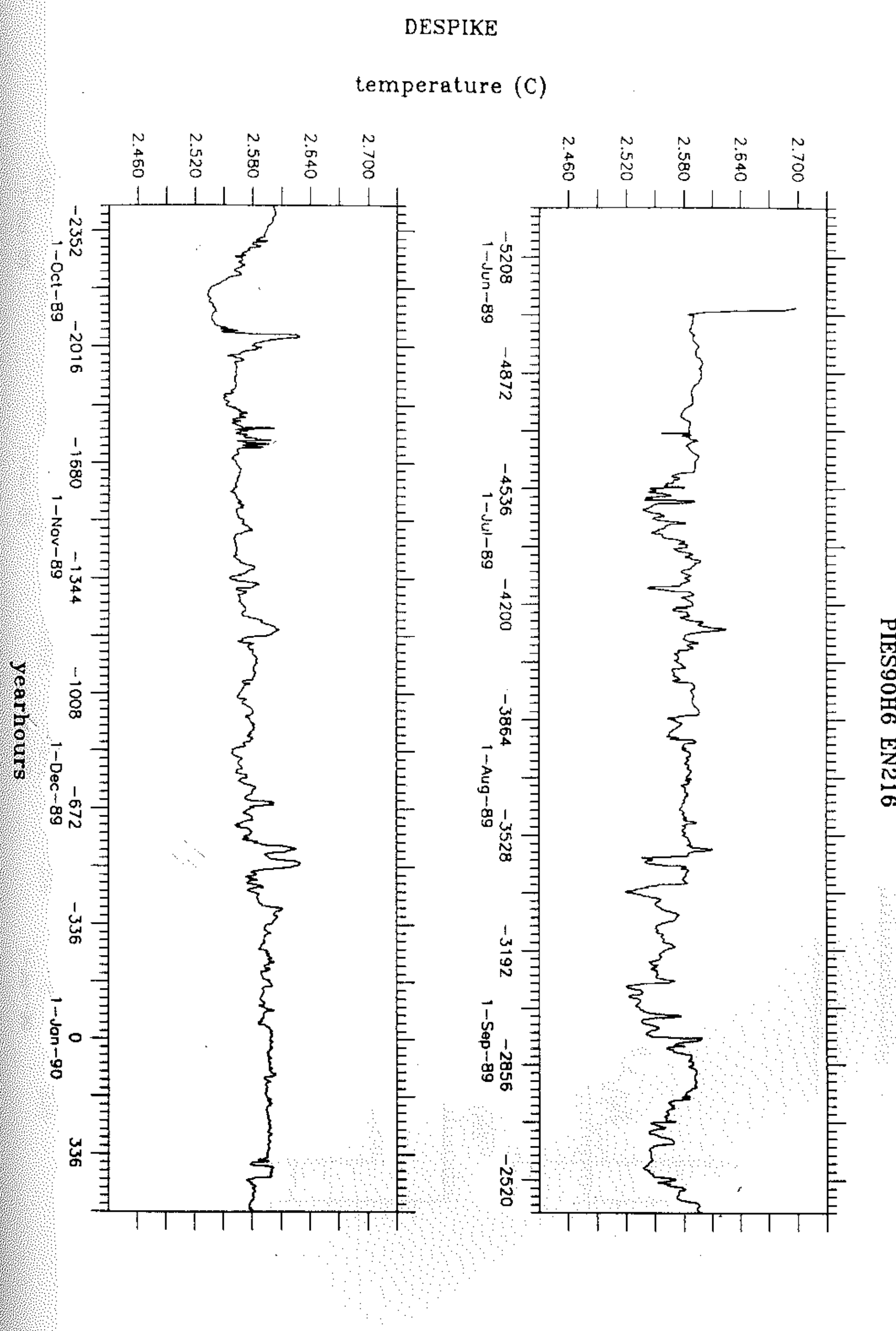
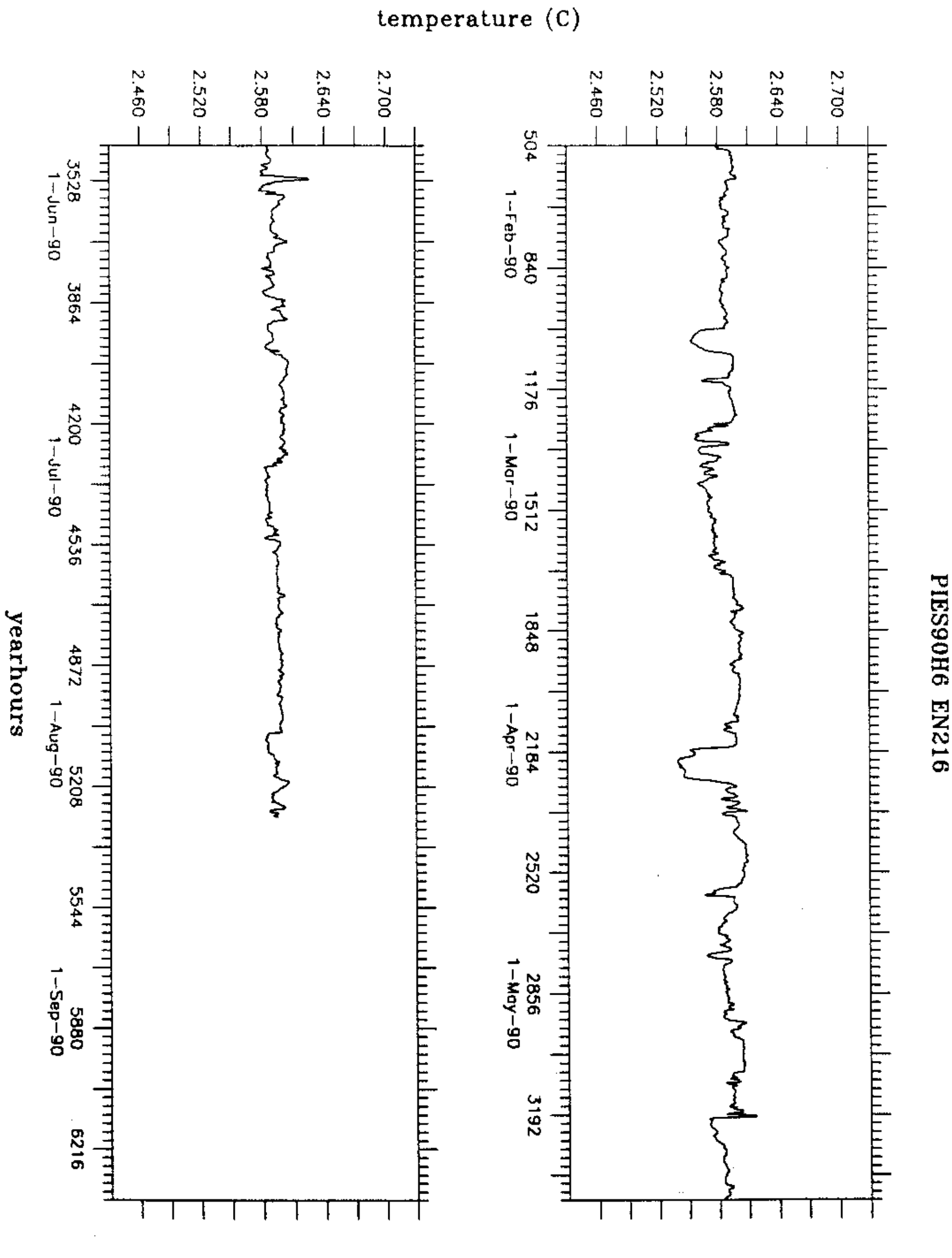


Figure 11.7: Half-Hourly Temperature. PIES90H6

DESPIKE


PIES90H6 EN216
temperature (C)
2.460
2.520
2.580
2.640
2.700
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

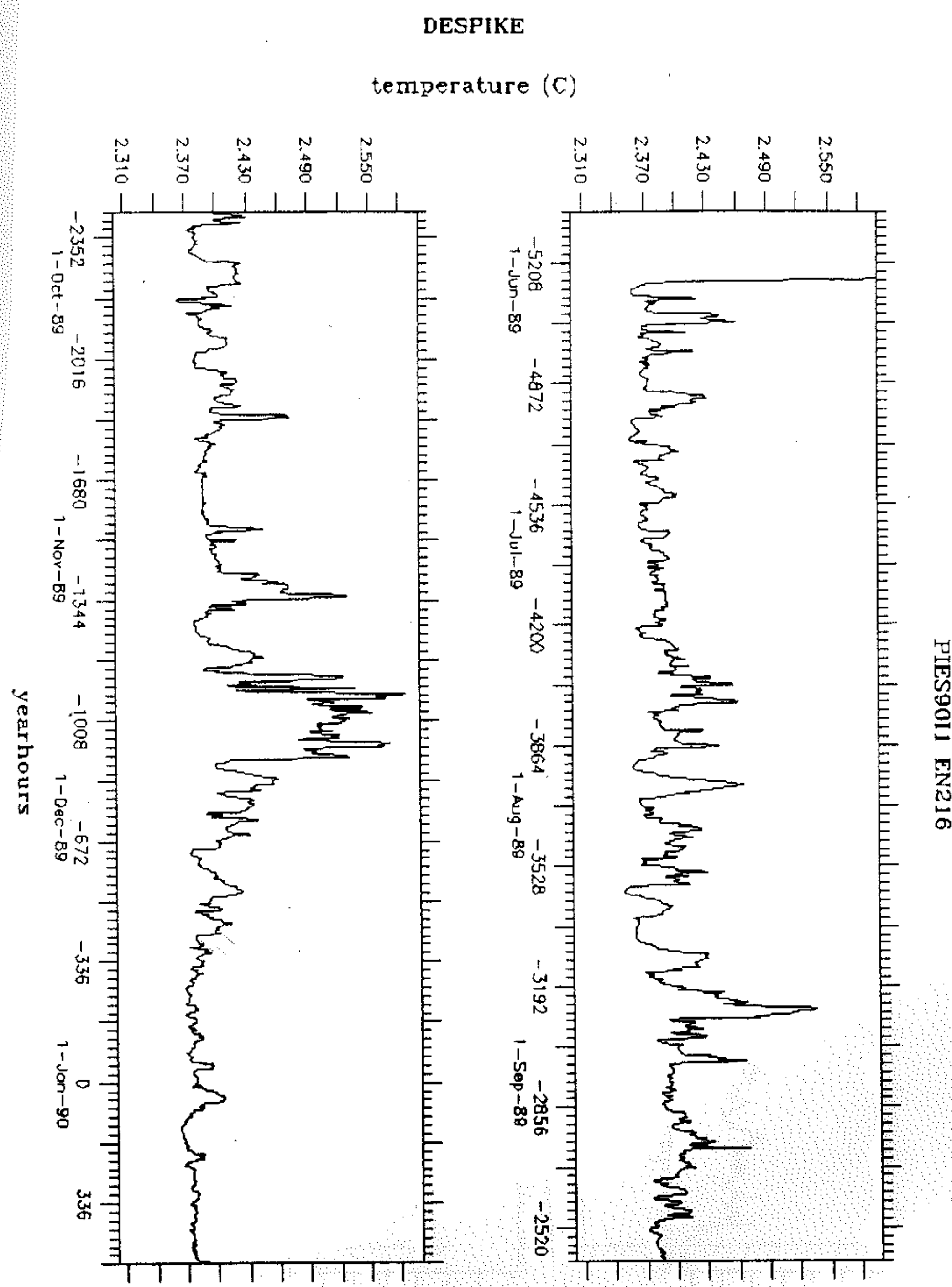
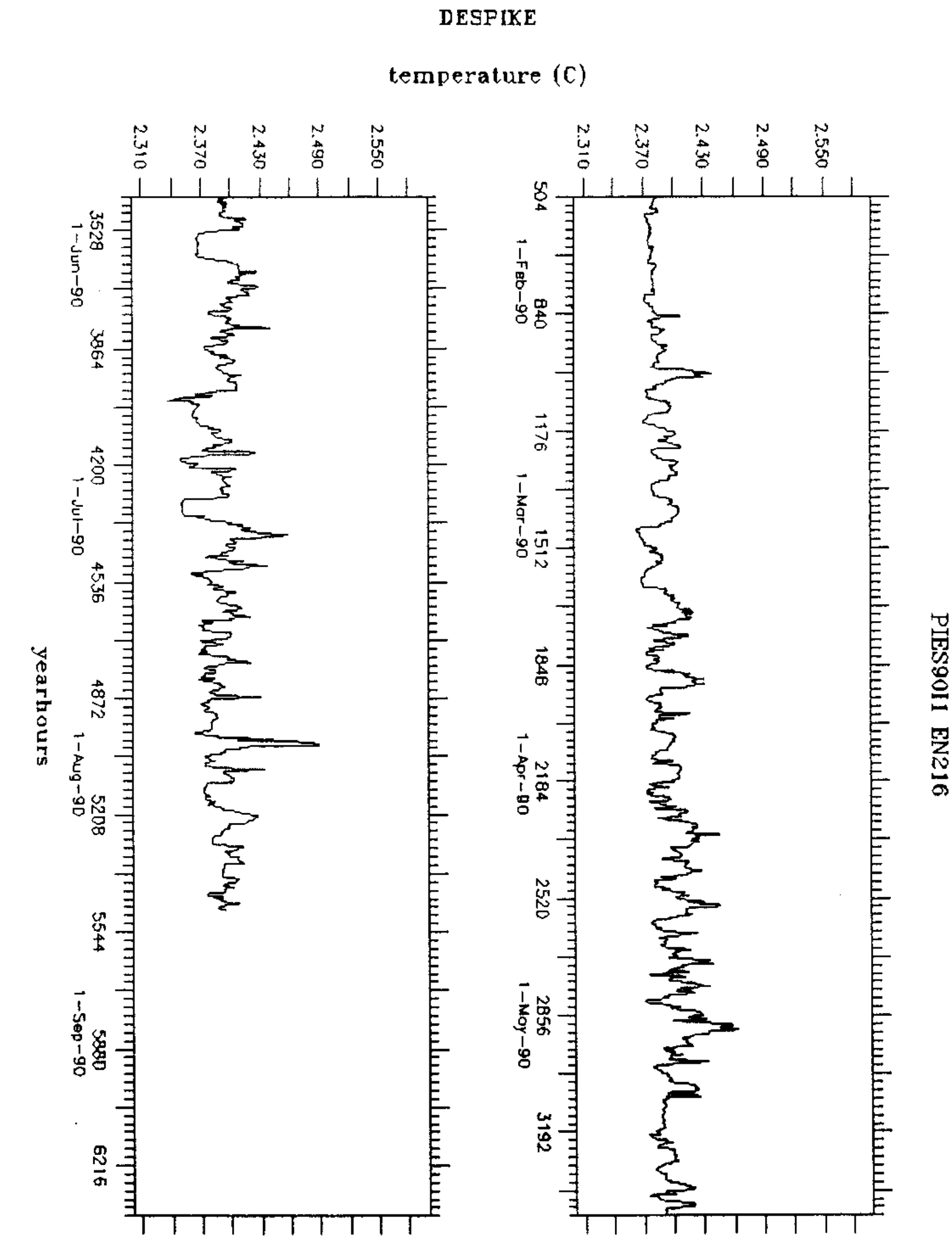


Figure 11.8: Half-Hourly Temperature. PIES90I1



DESPIKE
temperature (C)
PIES90I1 EN216
2.310
2.370
2.430
2.490
2.550
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

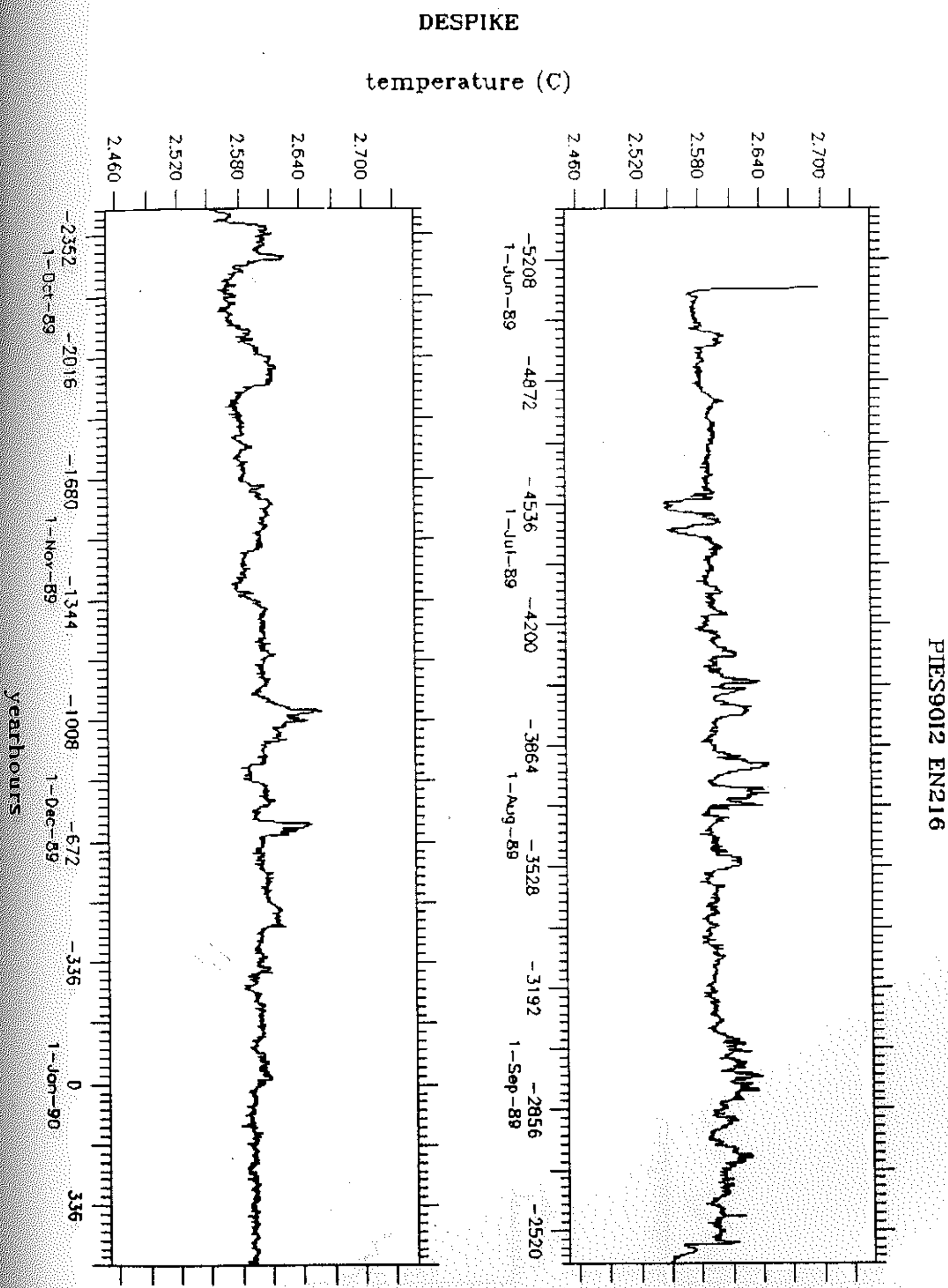
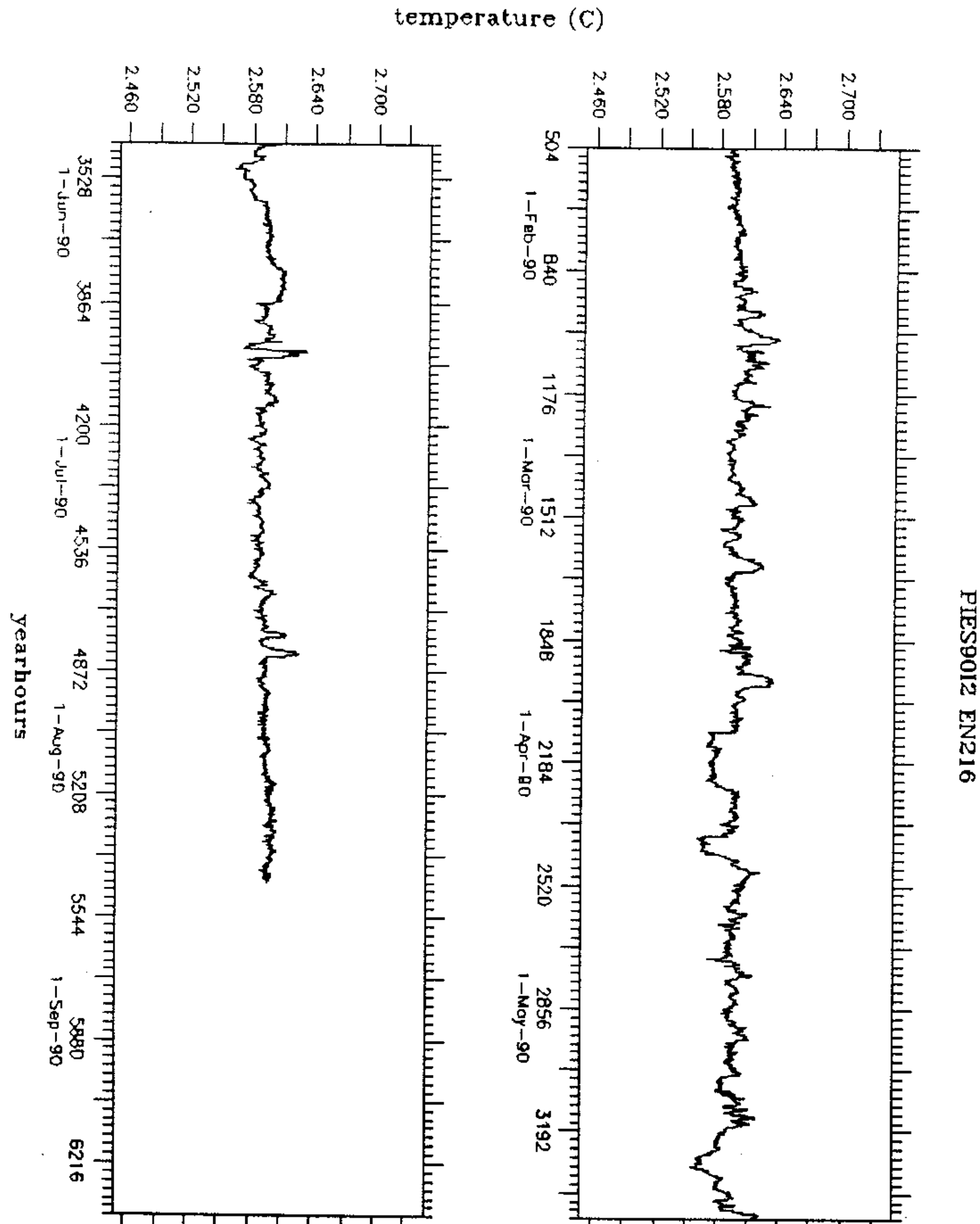


Figure 11.9: Half-Hourly Temperature. PIES90I2

DESPIKE


temperature (C)
PIES90I2 EN216
2.460
2.520
2.580
2.640
2.700
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

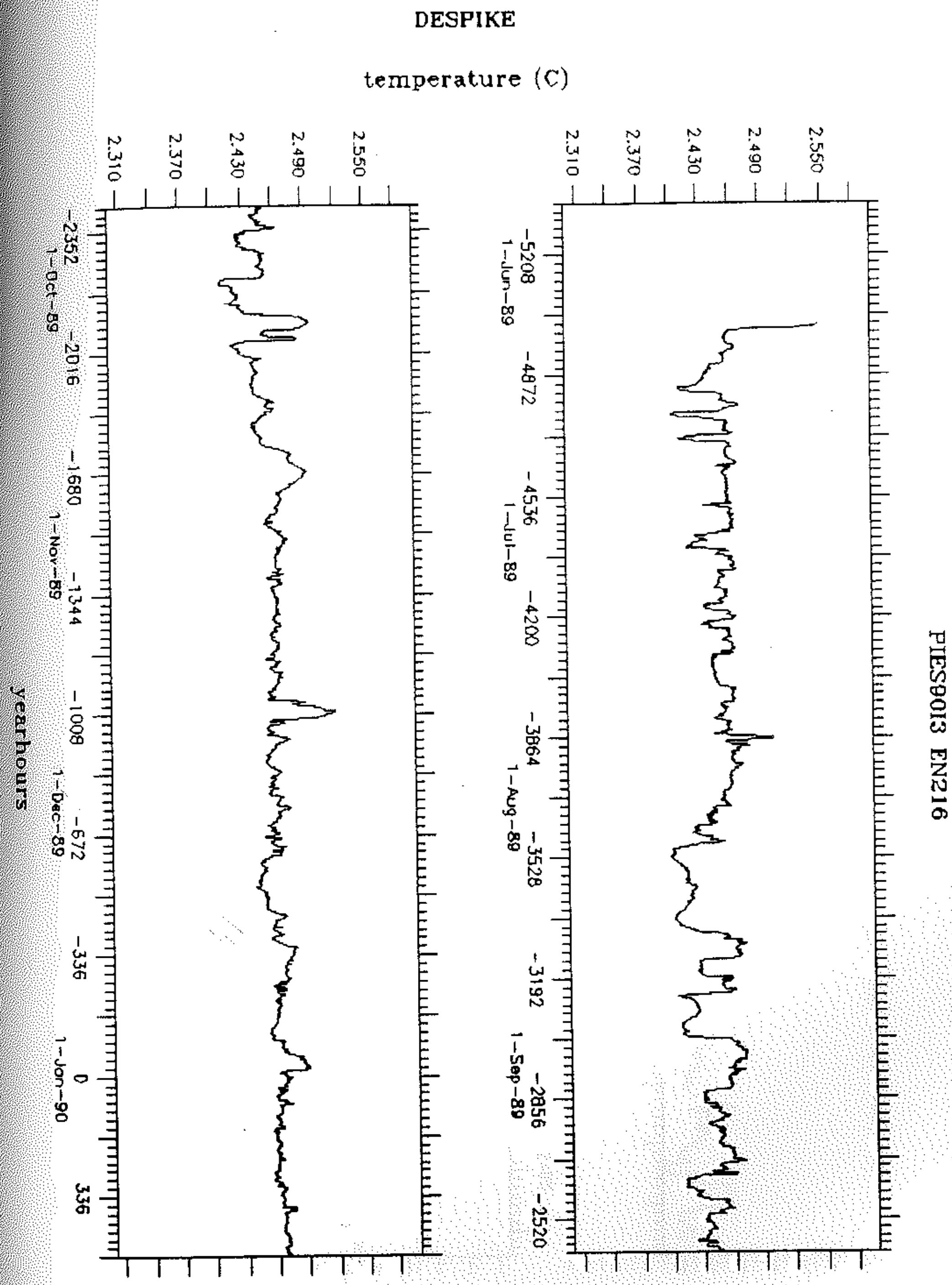
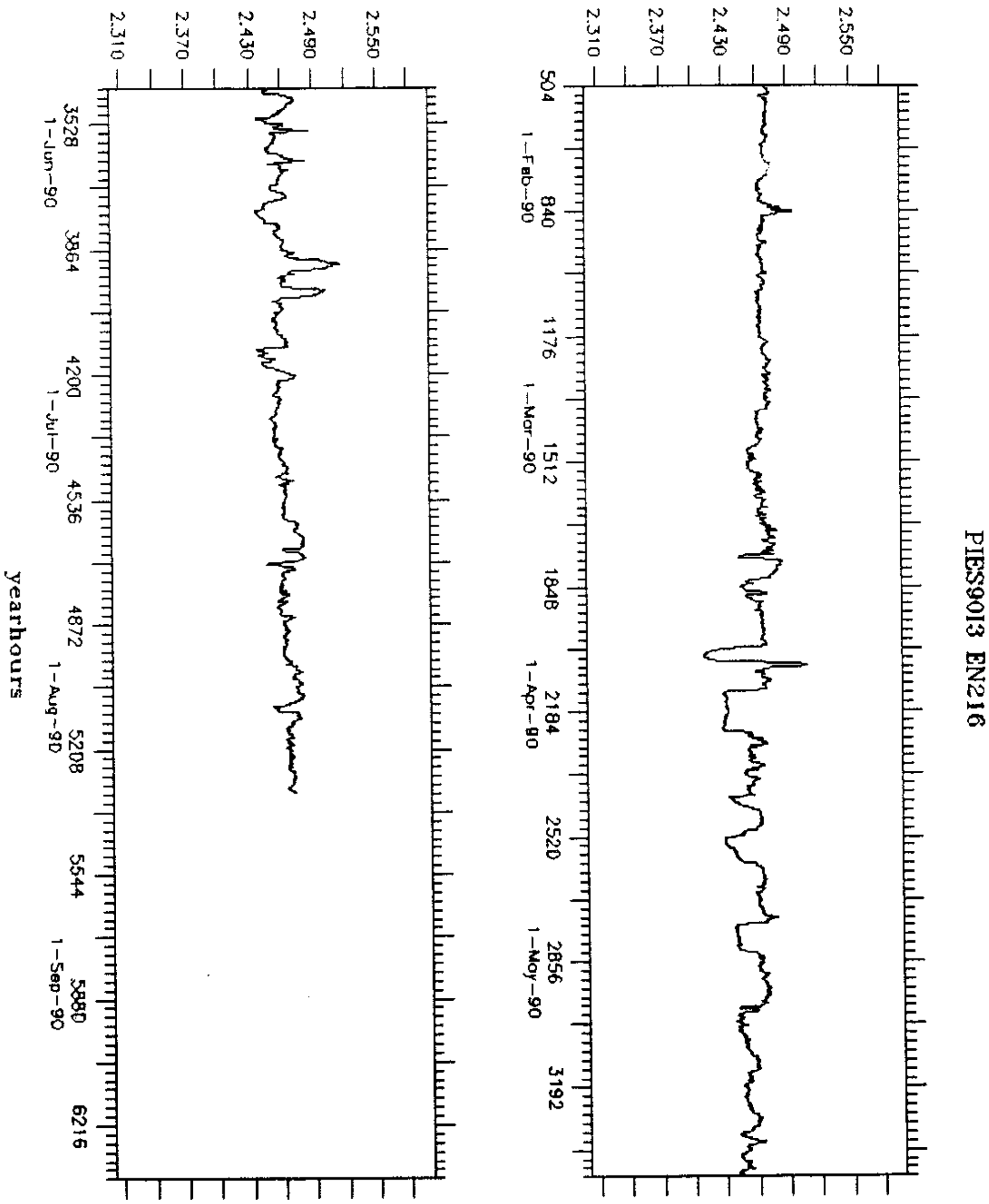


Figure 11.10: Half-Hourly Temperature. PIES90I3

DESPIKE

temperature (C)



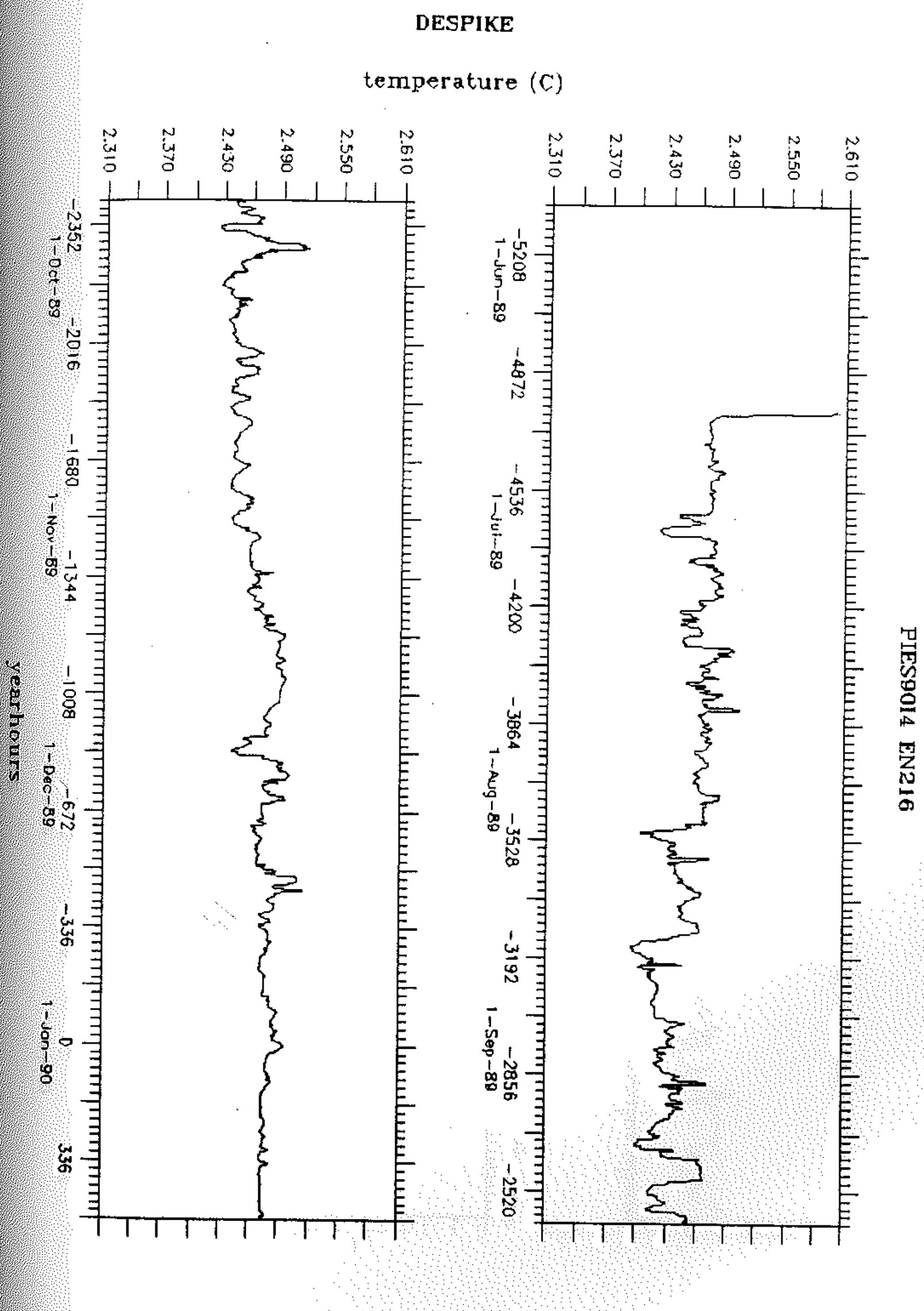
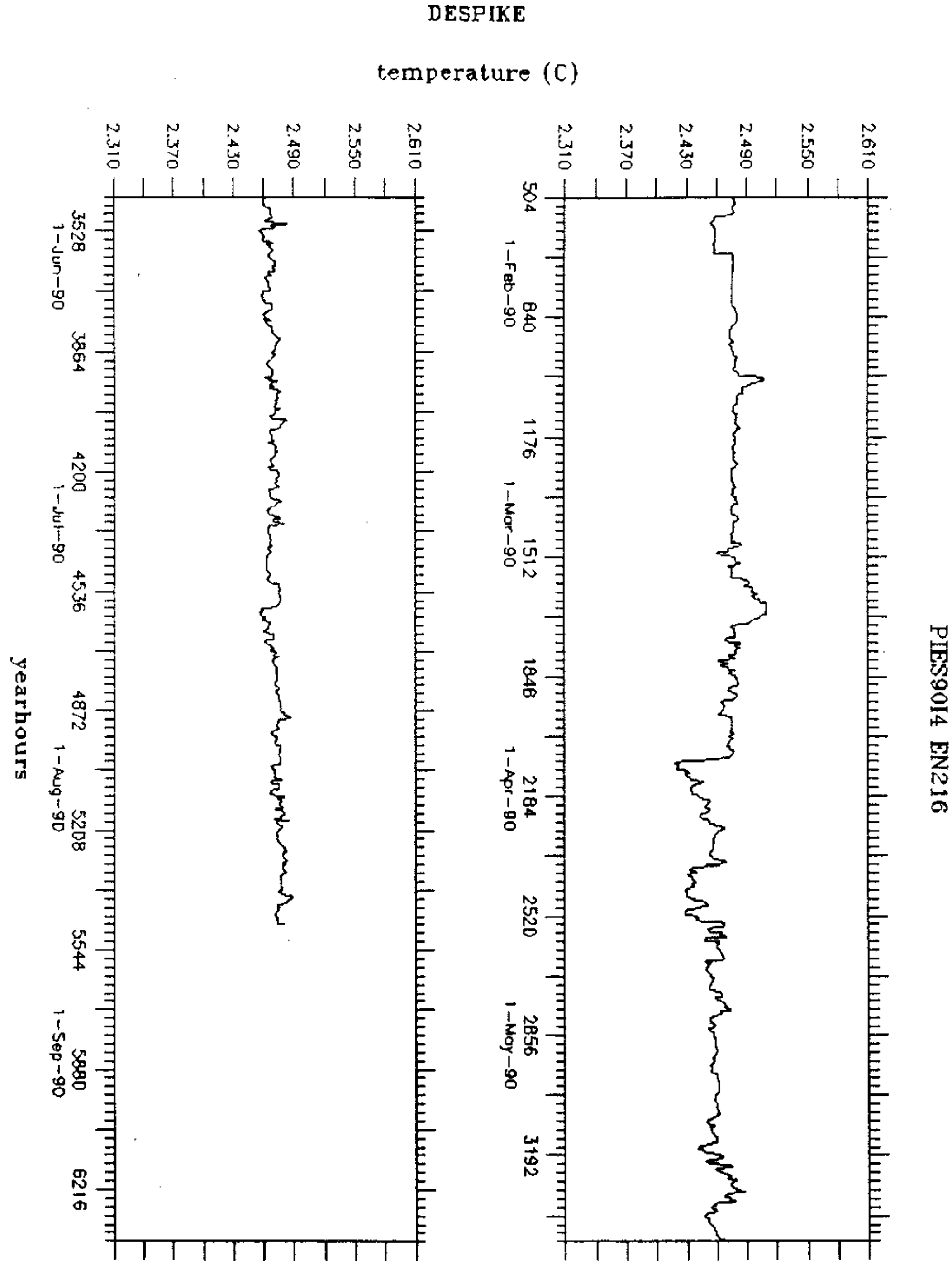


Figure 11.11: Half-Hourly Temperature. PIES90I4


DESPIKE
temperature (C)
PIES9014 EN216
2.310
2.370
2.430
2.490
2.550
2.610
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

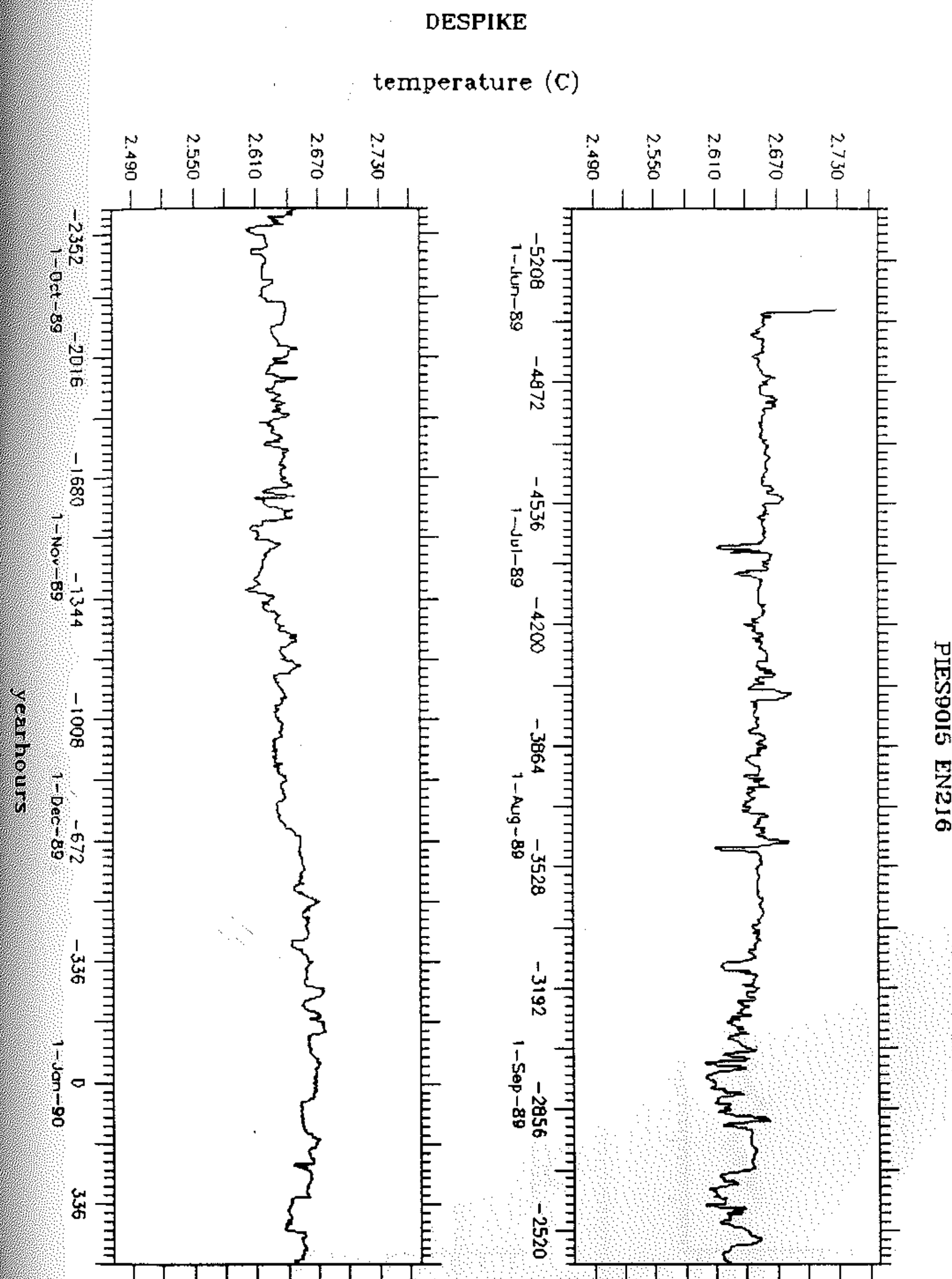
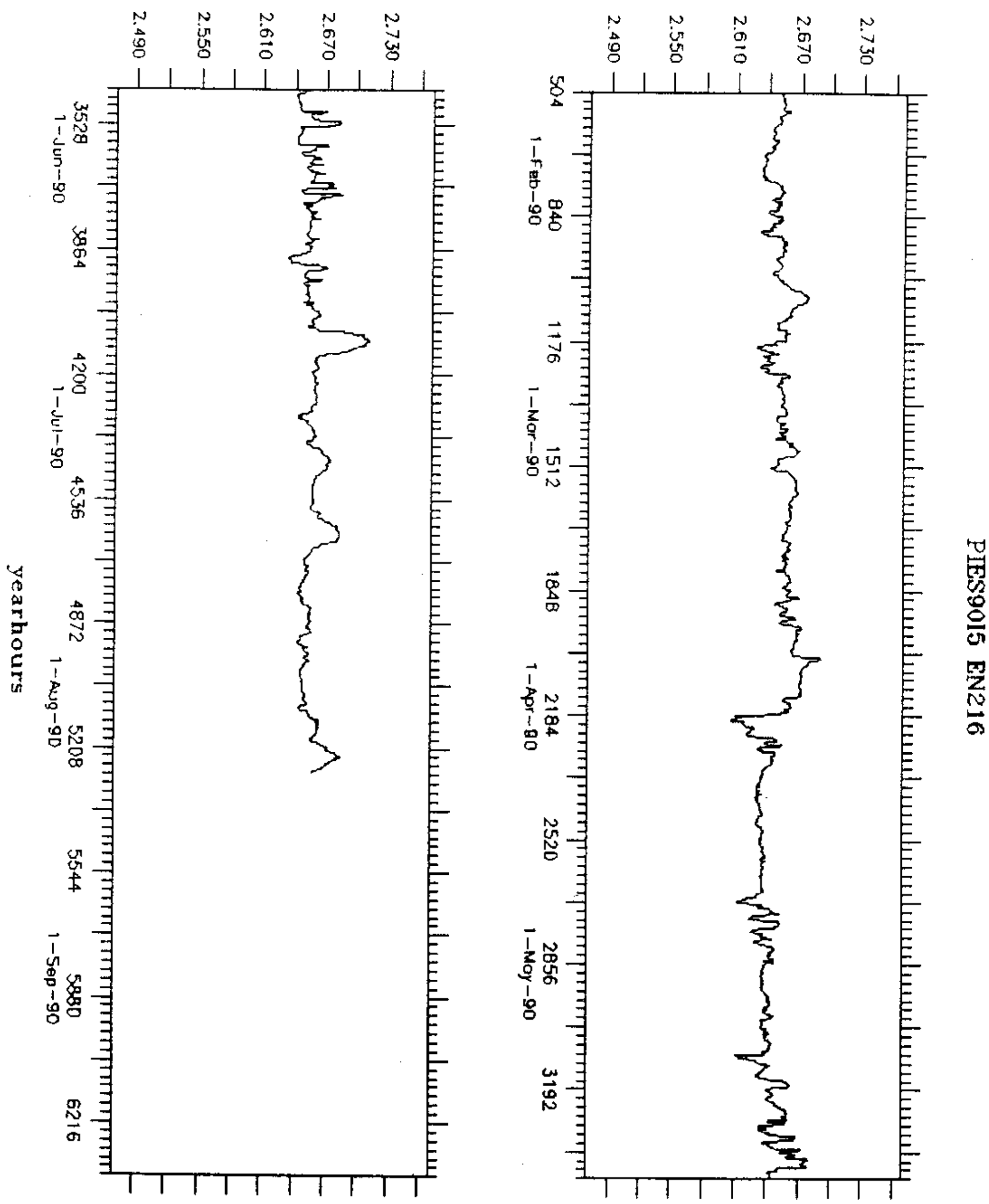


Figure 11.12: Half-Hourly Temperature. PIES90I5

DESPIKE

temperature (C)



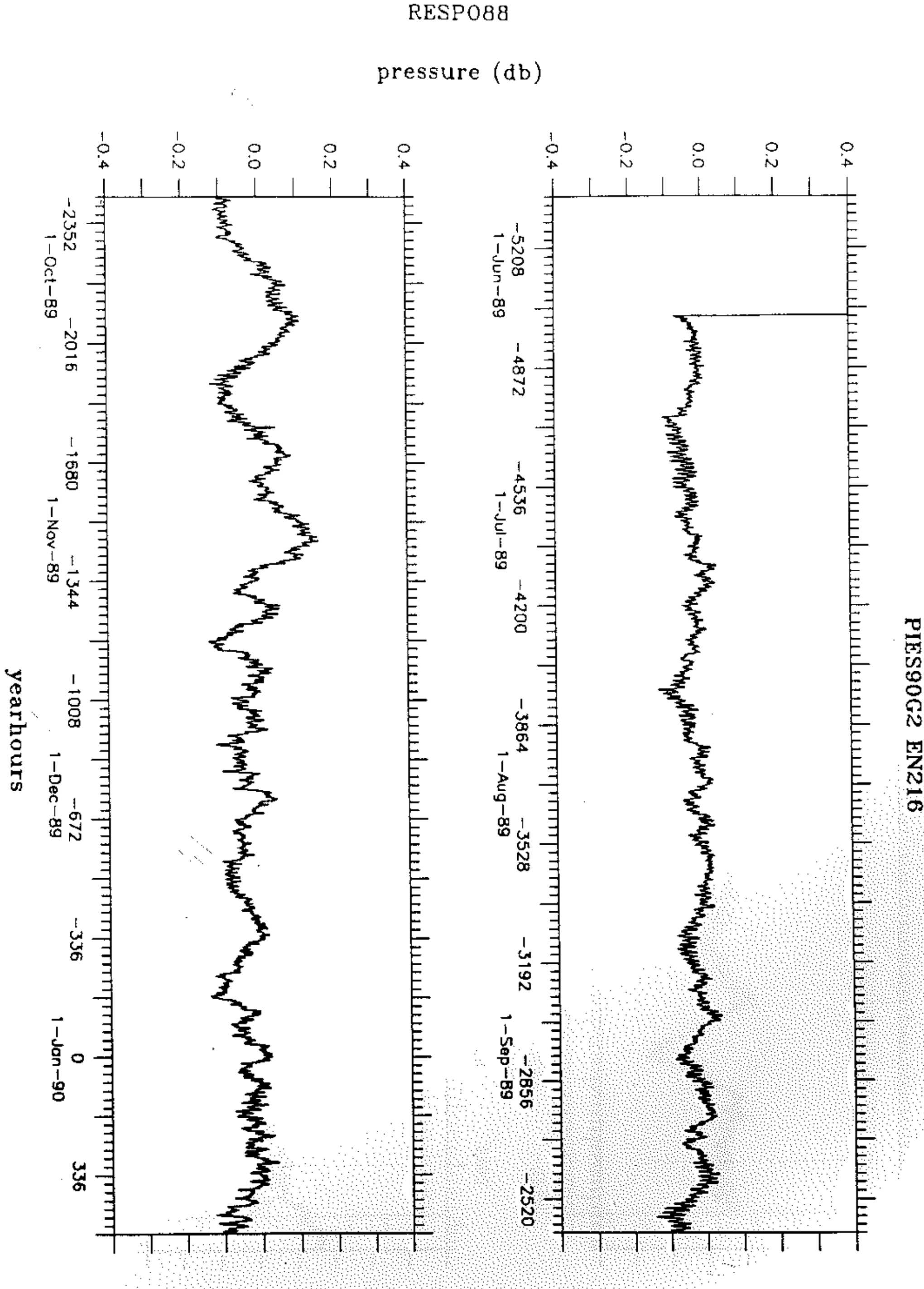
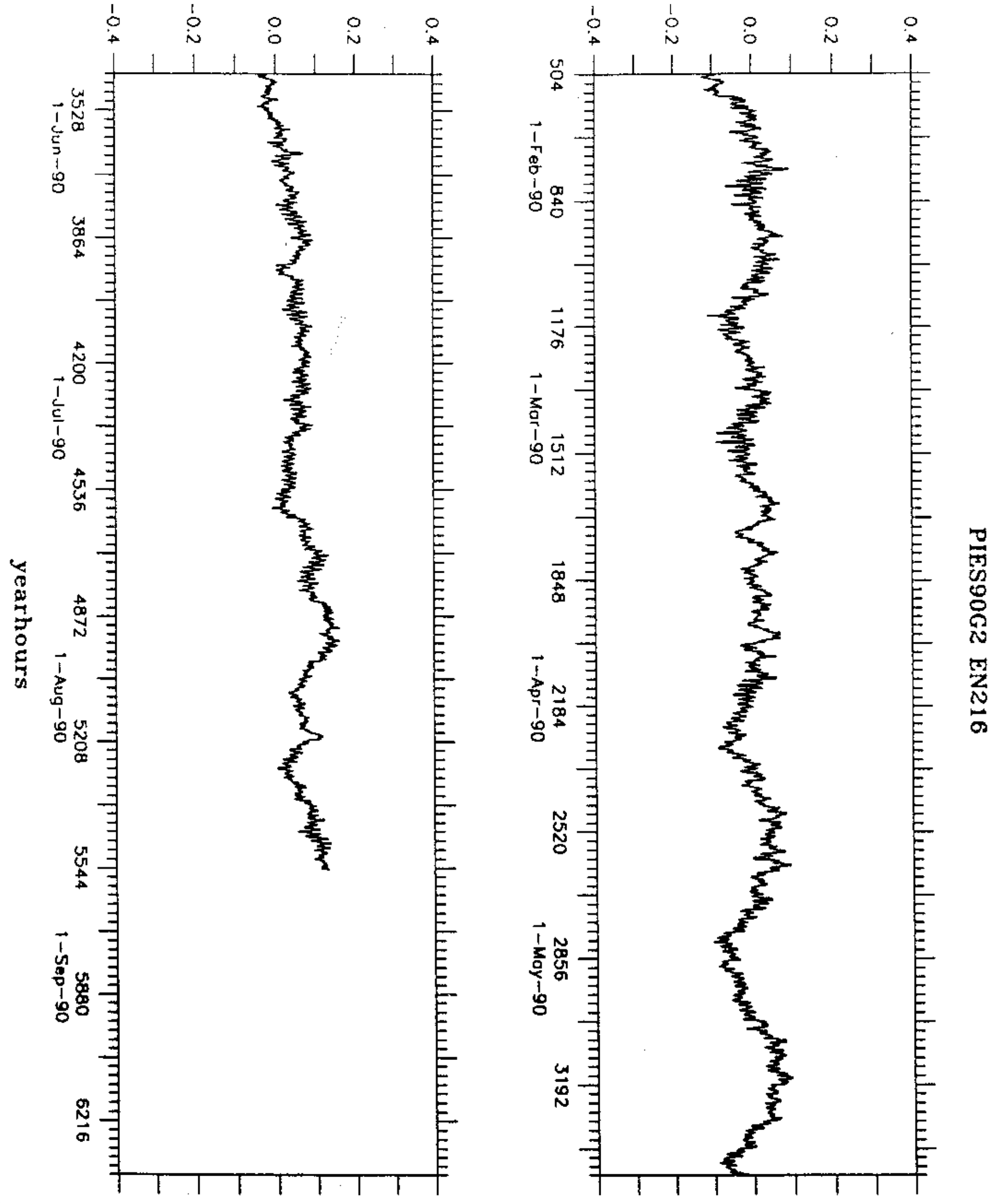


Figure 12.1: Half-Hourly Residual Bottom Pressure. PIES90G2

RESPO88

pressure (db)



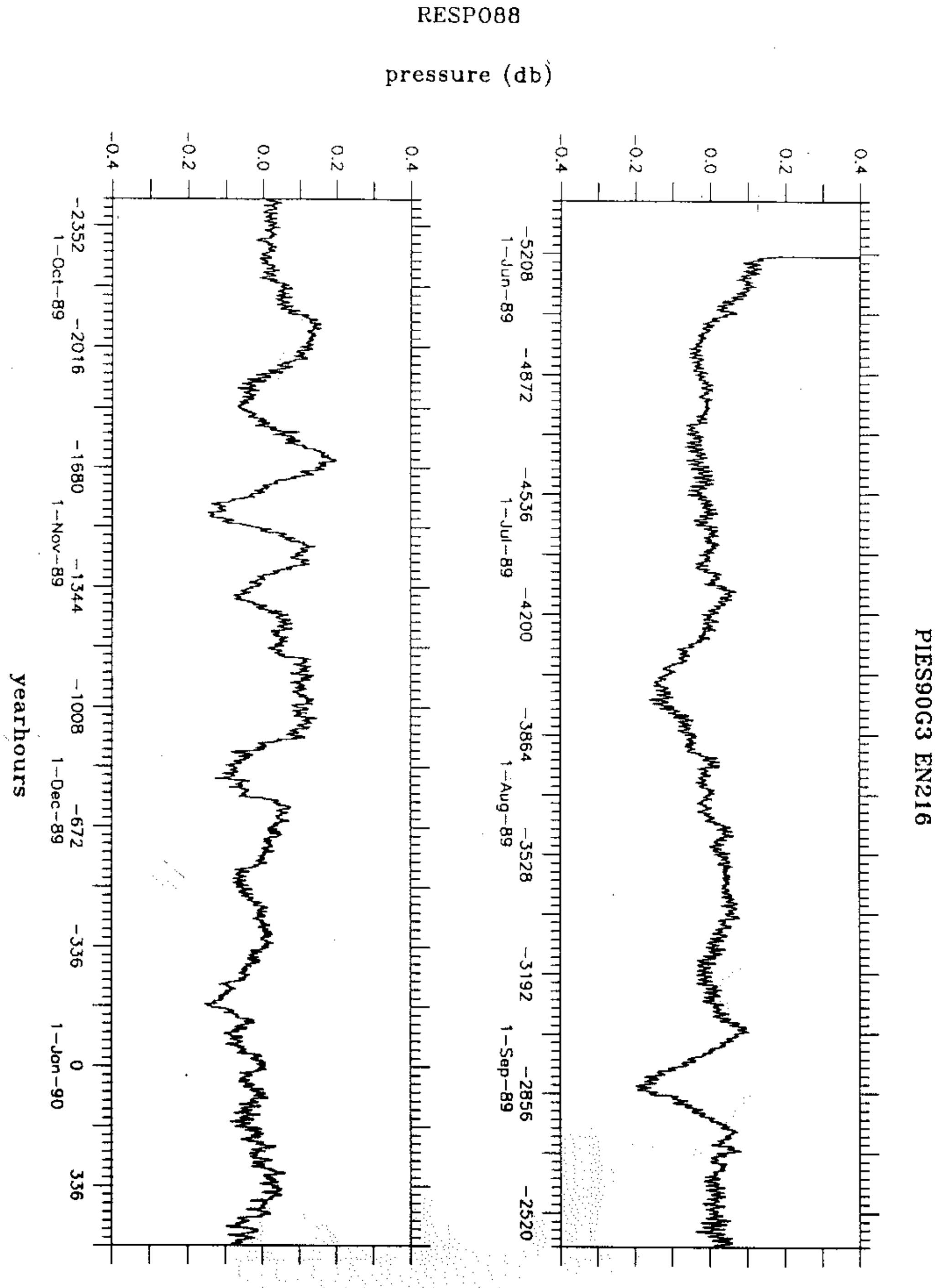
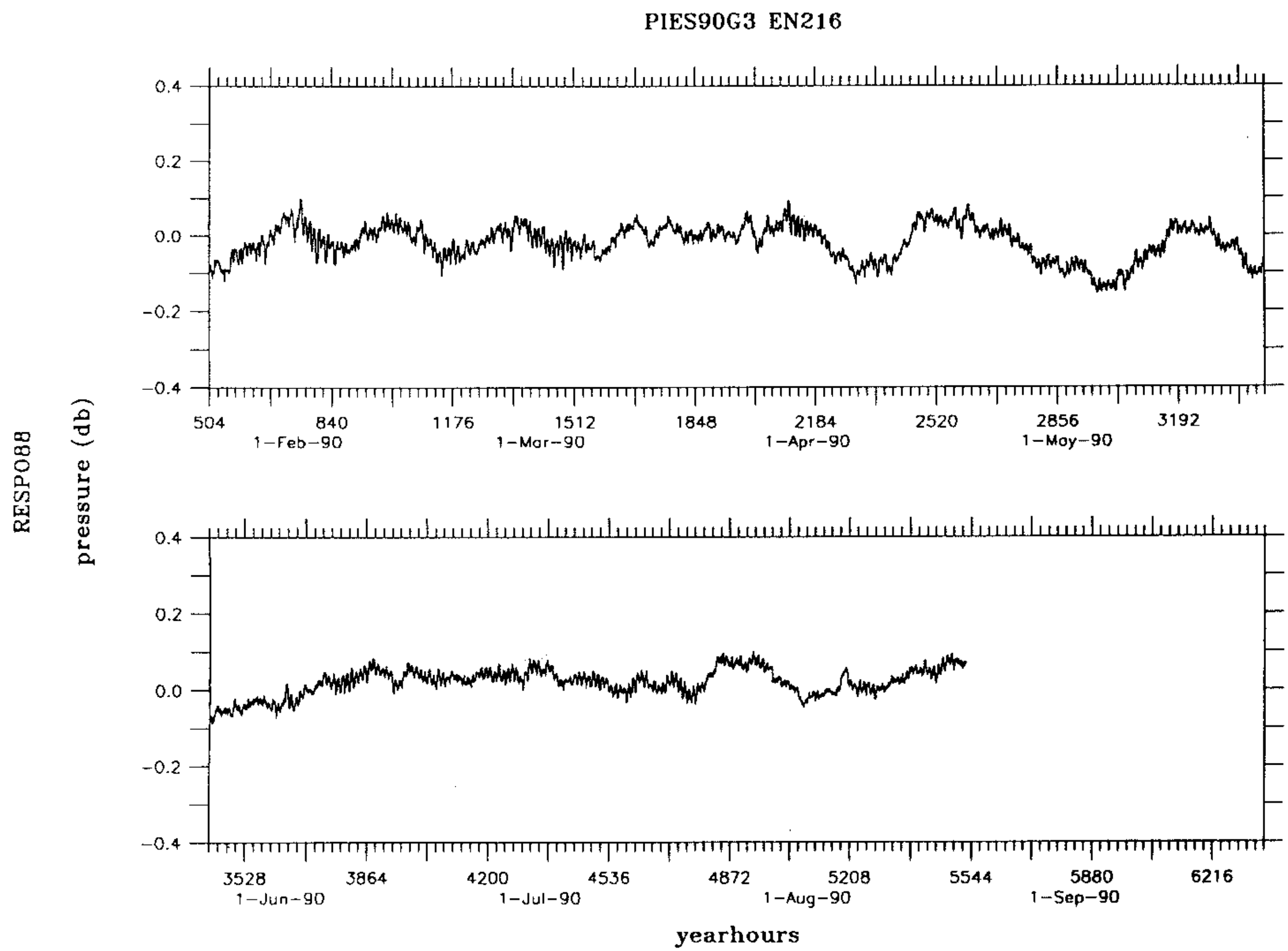


Figure 12.2: Half-Hourly Residual Bottom Pressure. PIES90G3


PIES90G3 EN216
RESPO88
pressure (db)
0.4
0.2
0.0
-0.2
-0.4
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

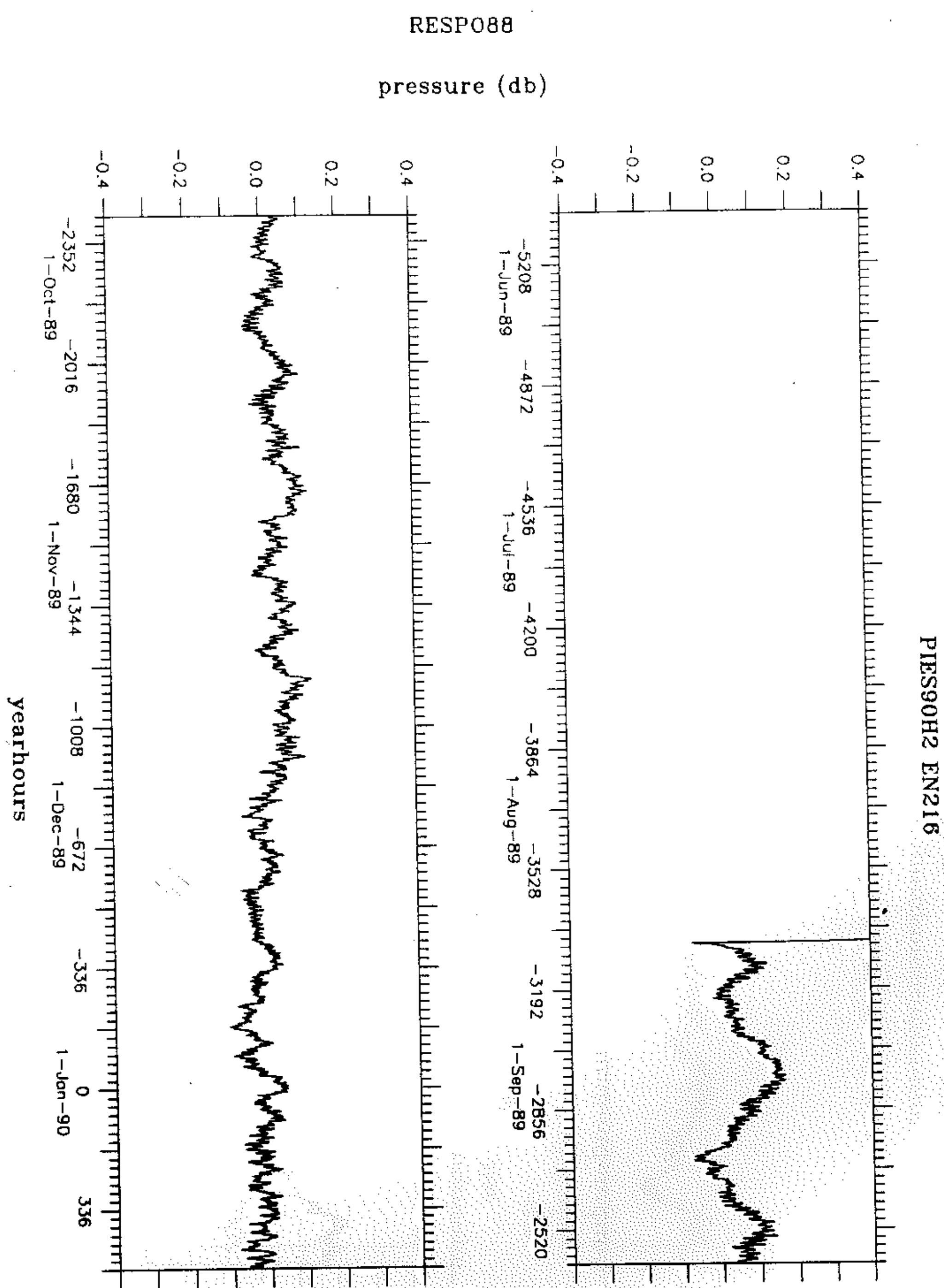
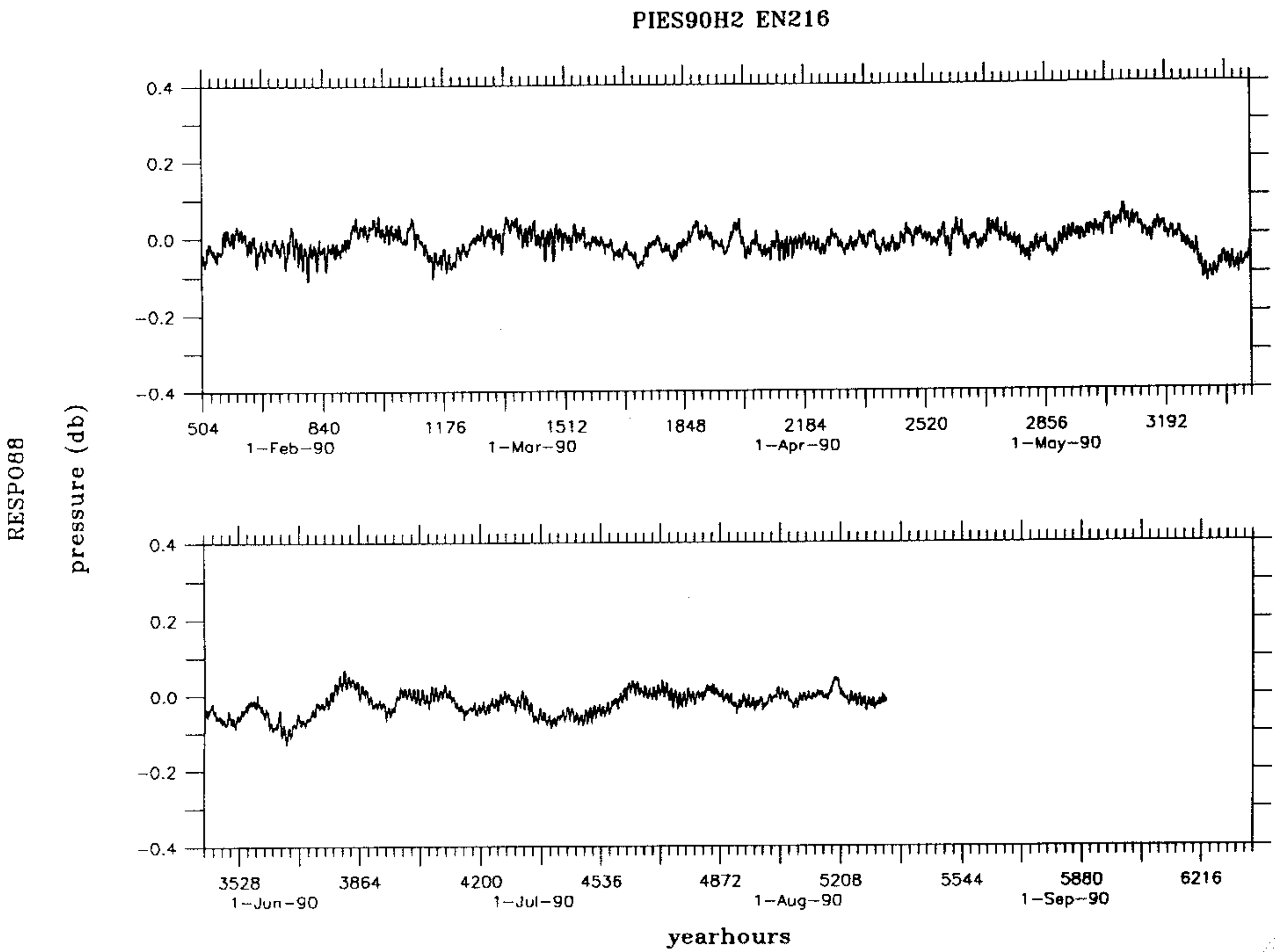


Figure 12.3: Half-Hourly Residual Bottom Pressure. PIES90H2


PIES90H2 EN216
RESPO88
pressure (db)
0.4
0.2
0.0
-0.2
-0.4
504
1-Feb-90
840
1176
1-Mar-90
1512
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
5208
1-Aug-90
5544
5880
1-Sep-90
6216
yearhours

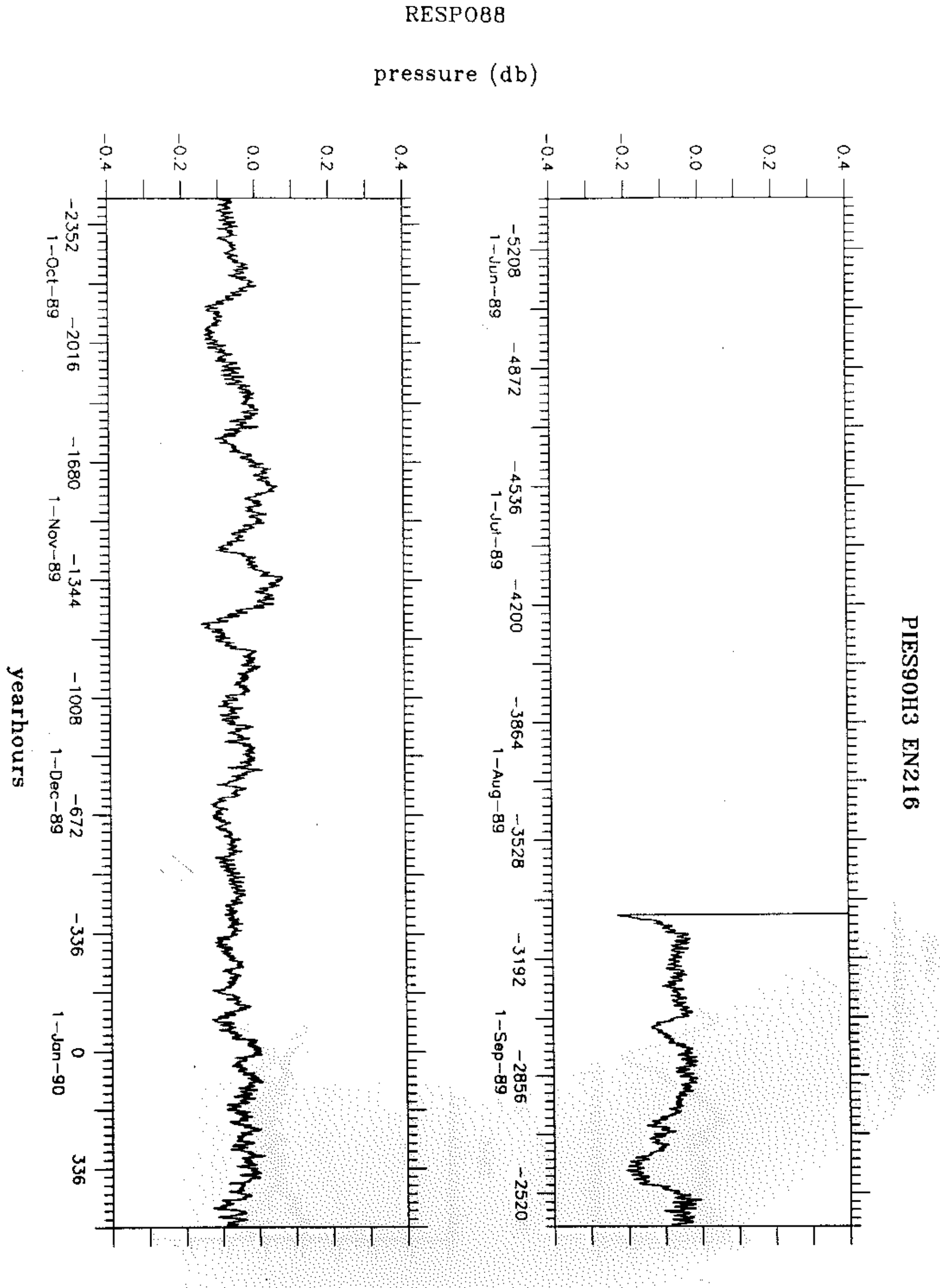
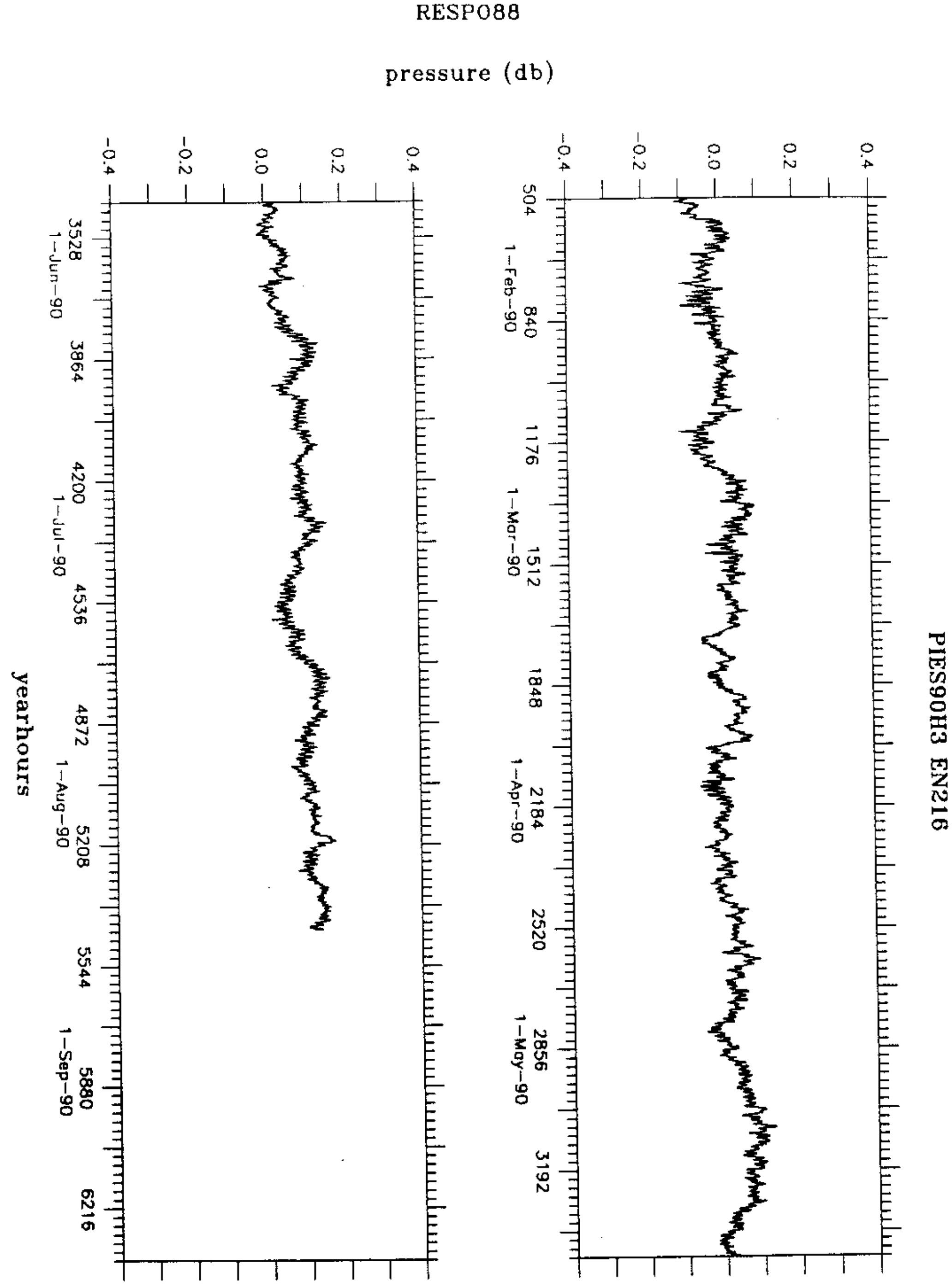


Figure 12.4: Half-Hourly Residual Bottom Pressure. PIES90H3


RESPO88
pressure (db)
PIES90H3 EN216
0.4
0.2
0.0
-0.2
-0.4
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

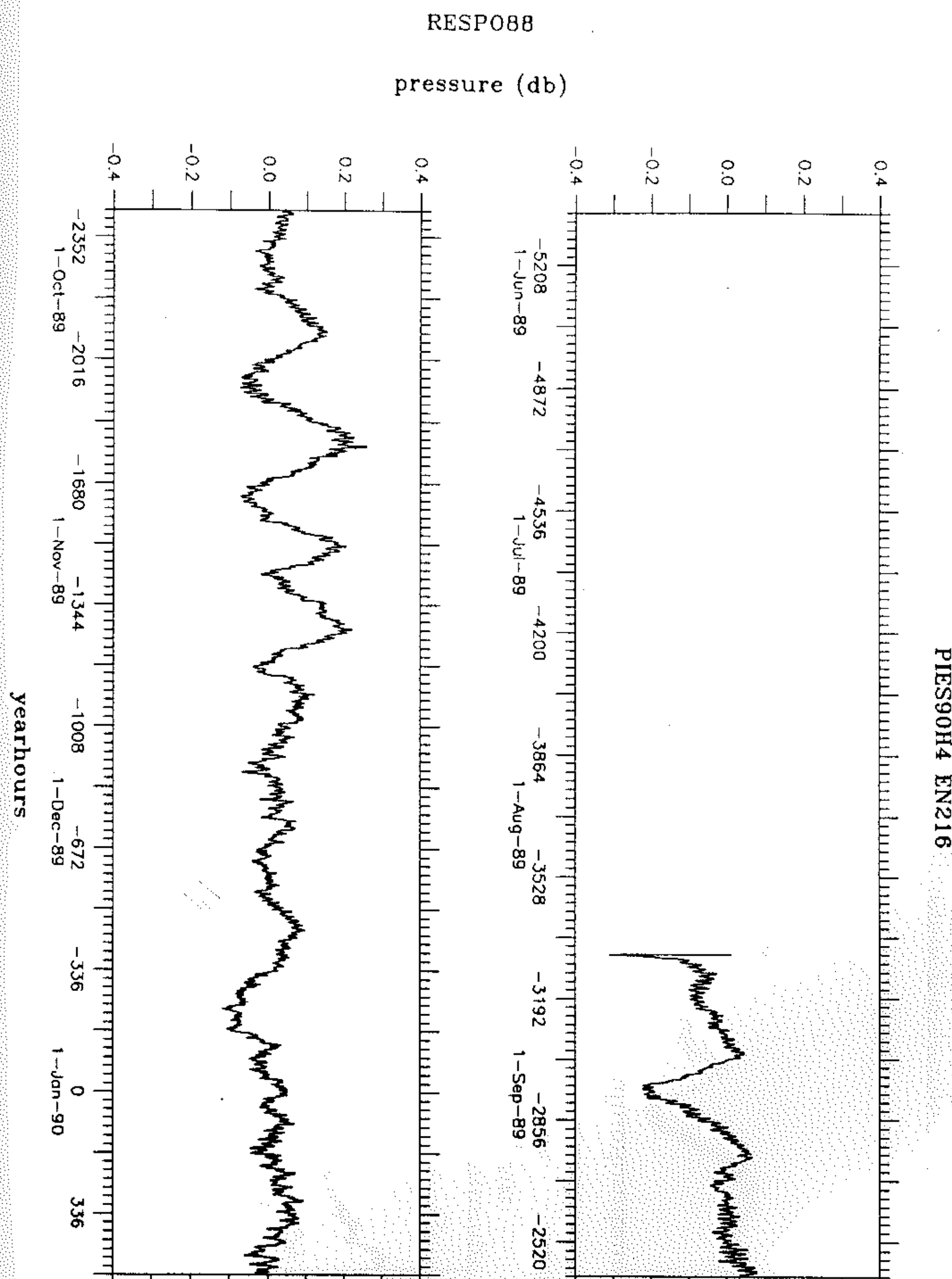
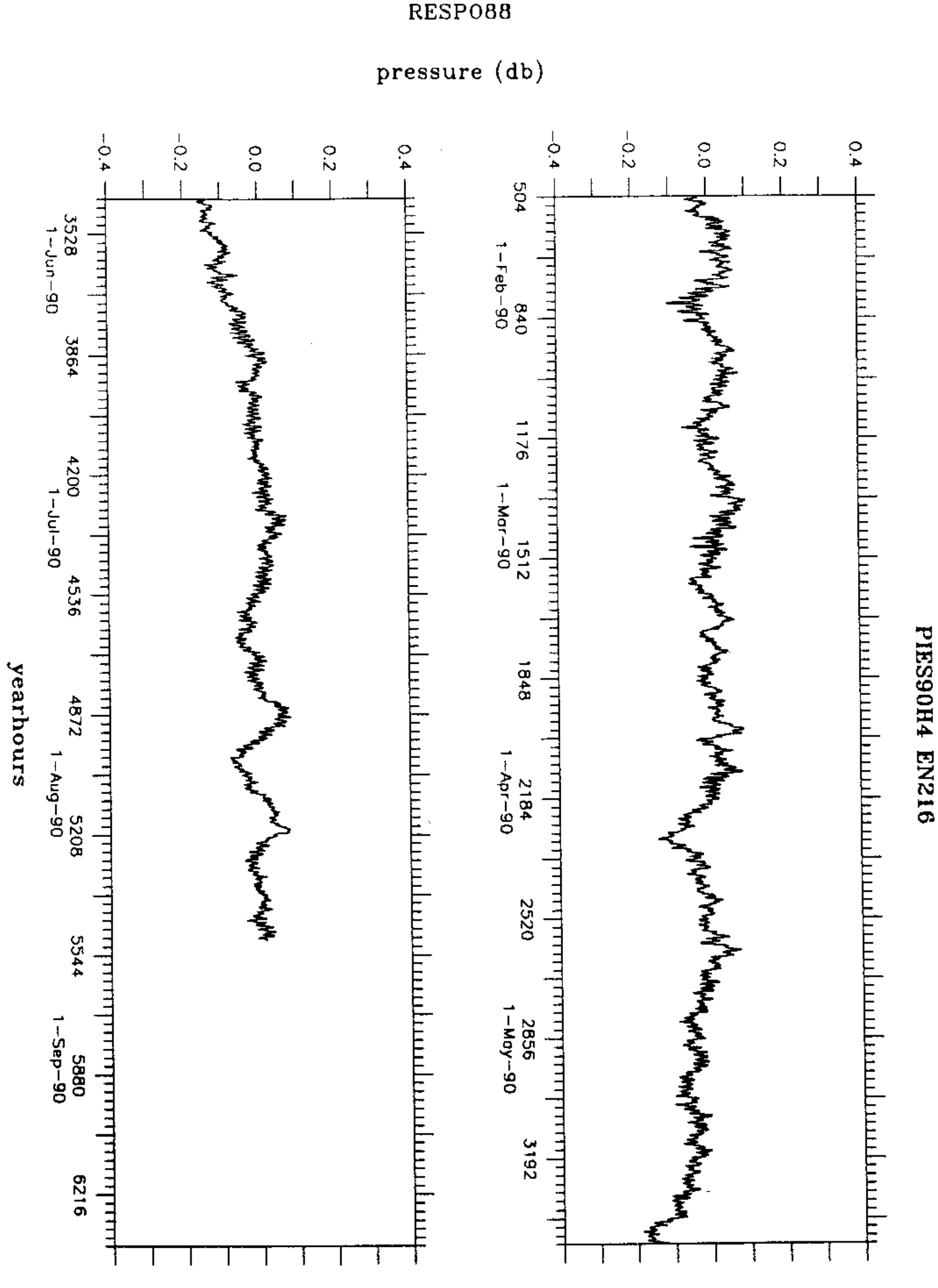


Figure 12.5: Half-Hourly Residual Bottom Pressure. PIES90H4


RESP088
pressure (db)
PIES90H4 EN216
yearhours
-0.4
-0.2
0.0
0.2
0.4
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90

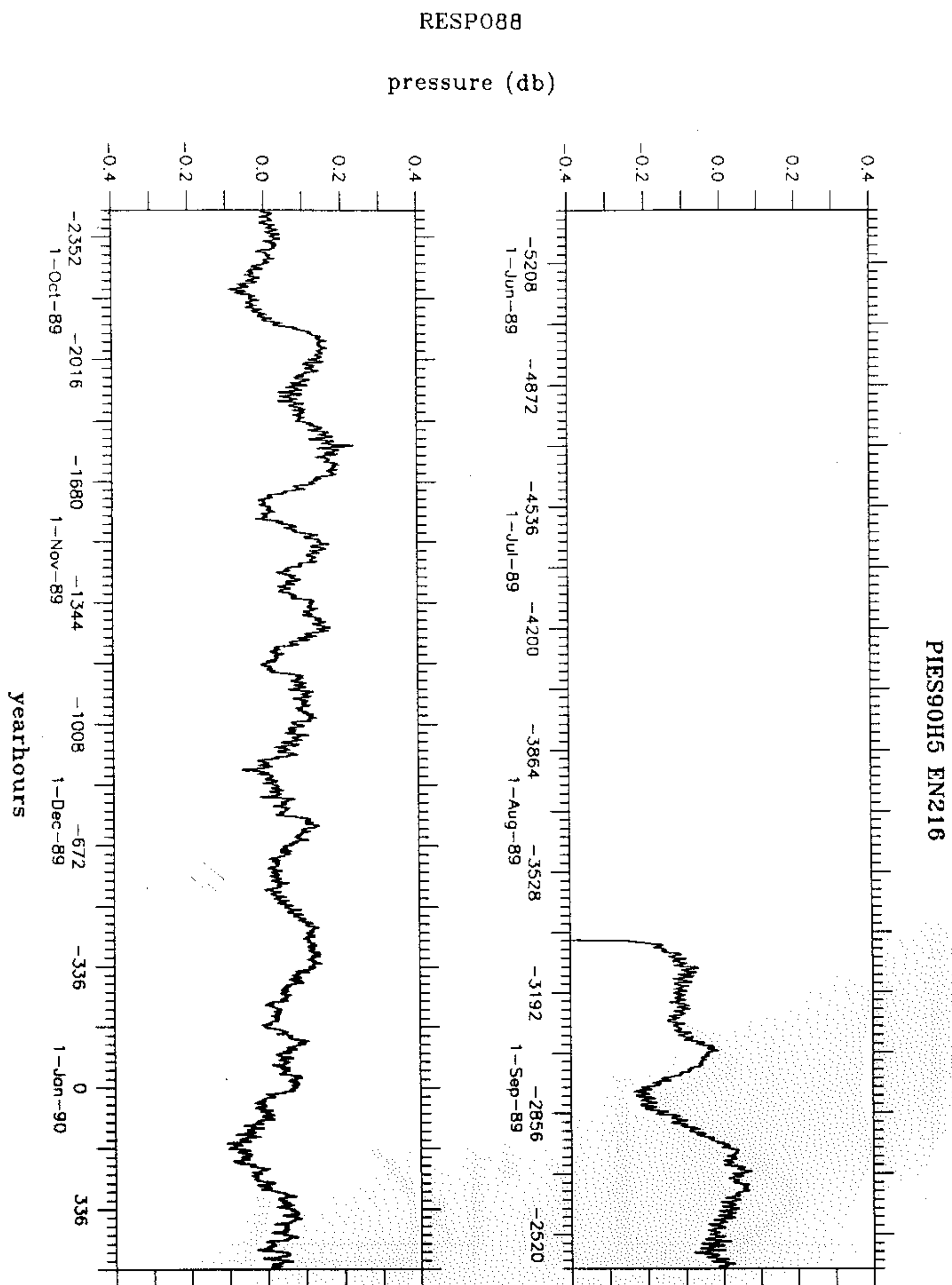
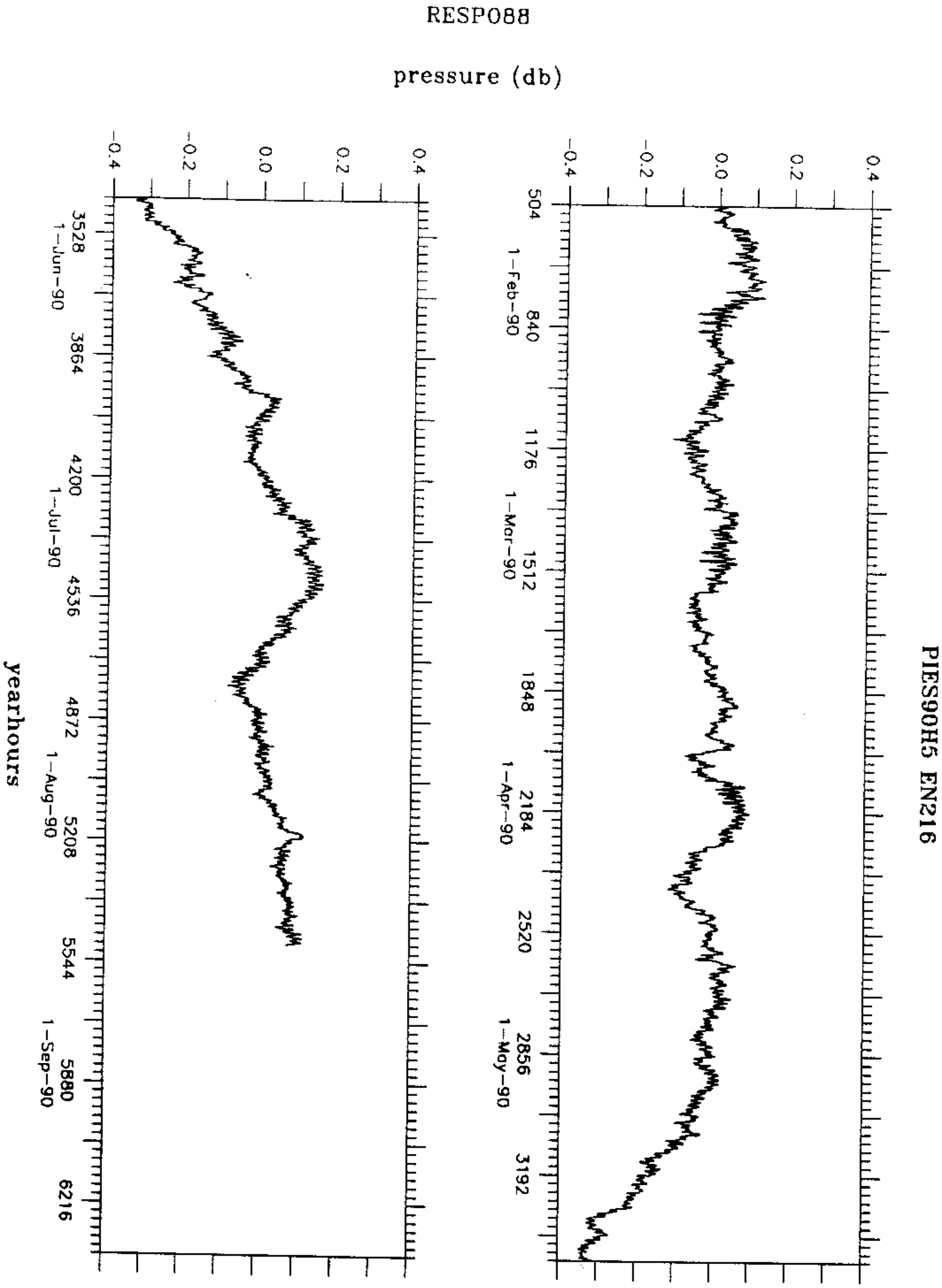


Figure 12.6: Half-Hourly Residual Bottom Pressure. PIES90H5


PIES90H5 EN216
RESP088
pressure (db)
0.4
0.2
0.0
-0.2
-0.4
504
840
1-Feb-90
1176
1-Mar-90
1512
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

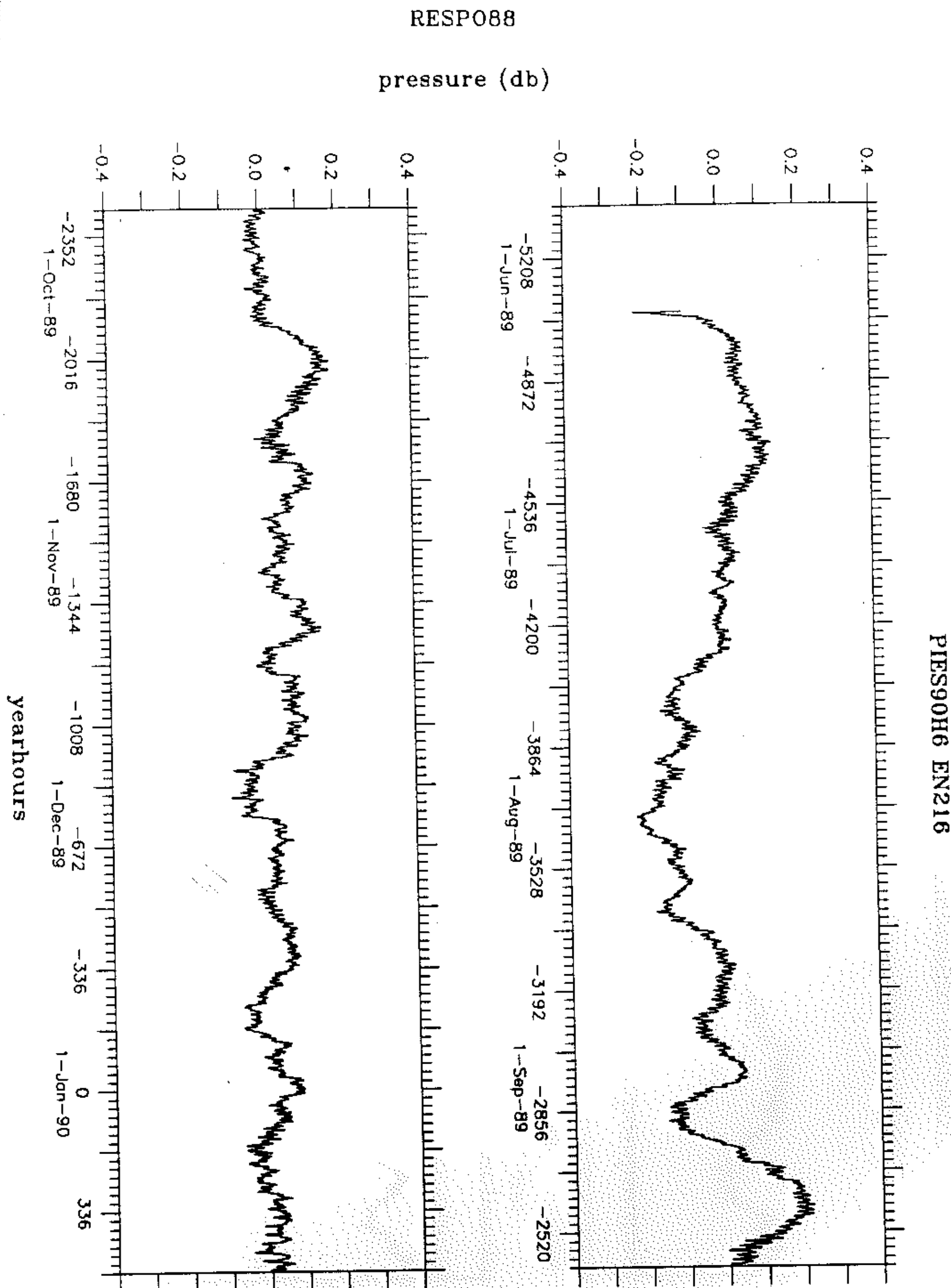
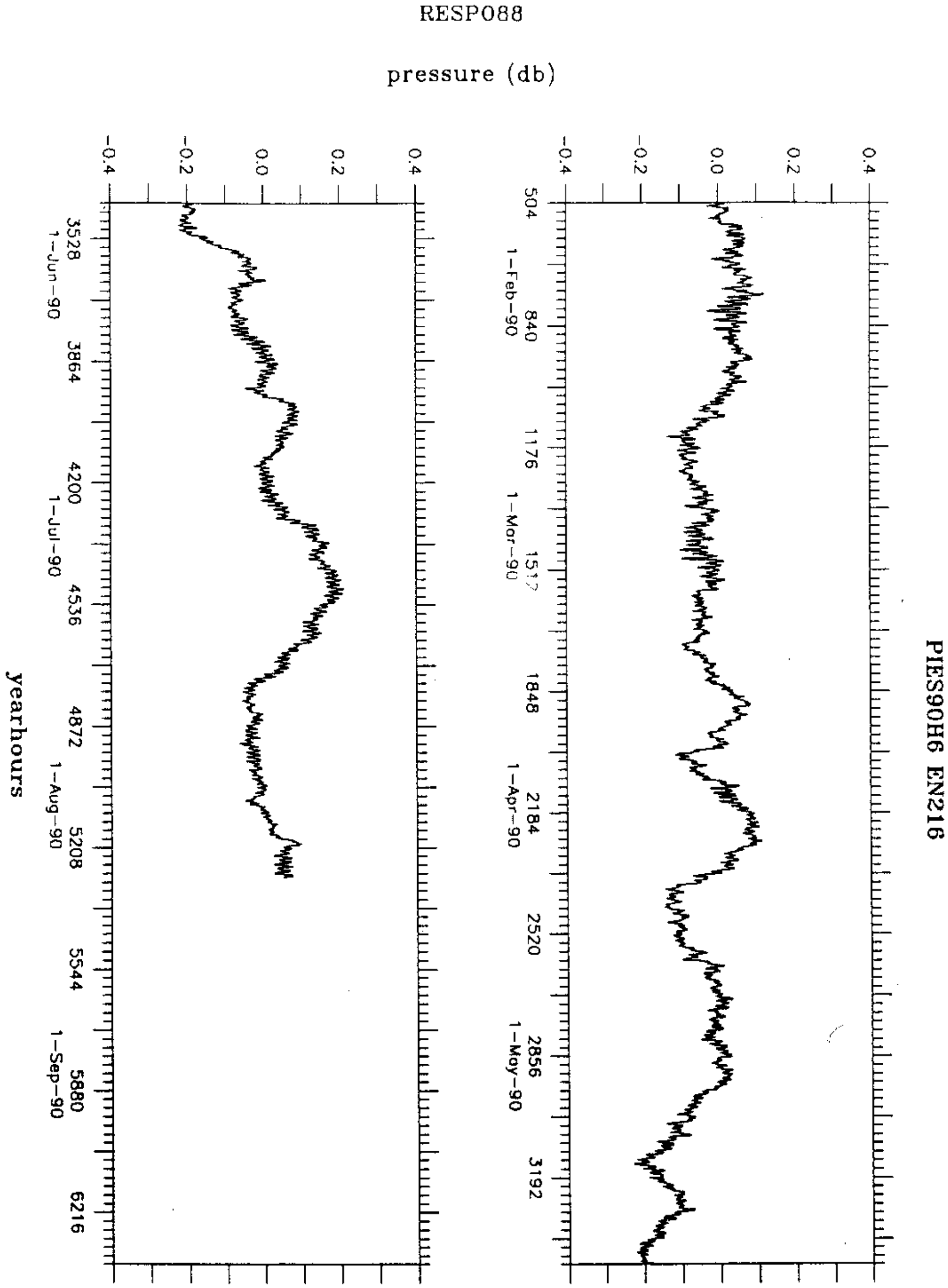


Figure 12.7: Half-Hourly Residual Bottom Pressure. PIES90H6


PIES90H6 EN216
RESPO88
pressure (db)
-0.4
-0.2
0.0
0.2
0.4
504
840
1176
1517
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

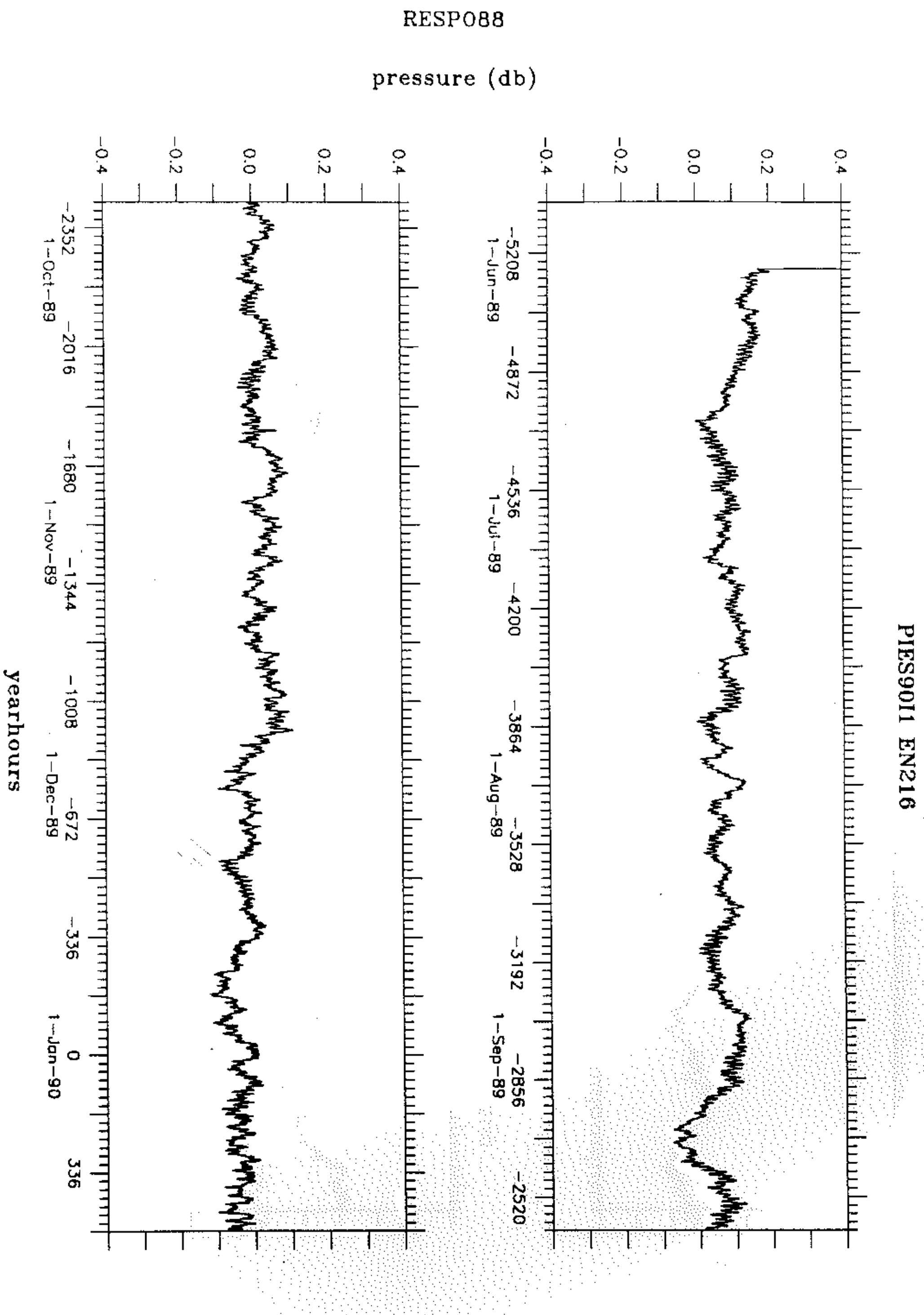
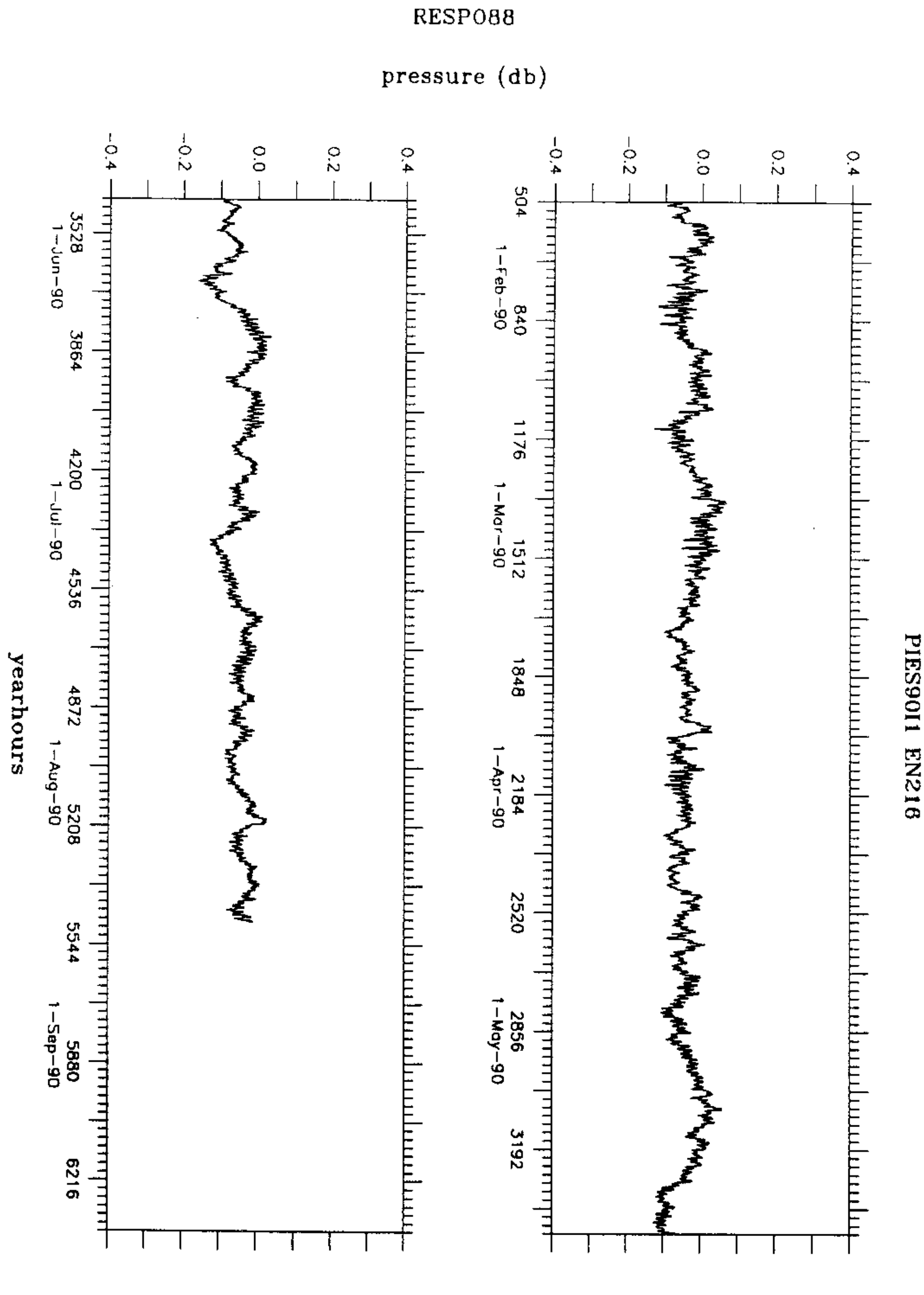


Figure 12.8: Half-Hourly Residual Bottom Pressure. PIES90I1


PIES9011 EN216
RESP088
pressure (db)
0.4
0.2
0.0
-0.2
-0.4
504
840
1176
1512
1848
2184
2520
2856
3192
1-Feb-90
1-Mar-90
1-Apr-90
1-May-90
3528
3864
4200
4536
4872
5208
5544
5880
6216
1-Jun-90
1-Jul-90
1-Aug-90
1-Sep-90
yearhours

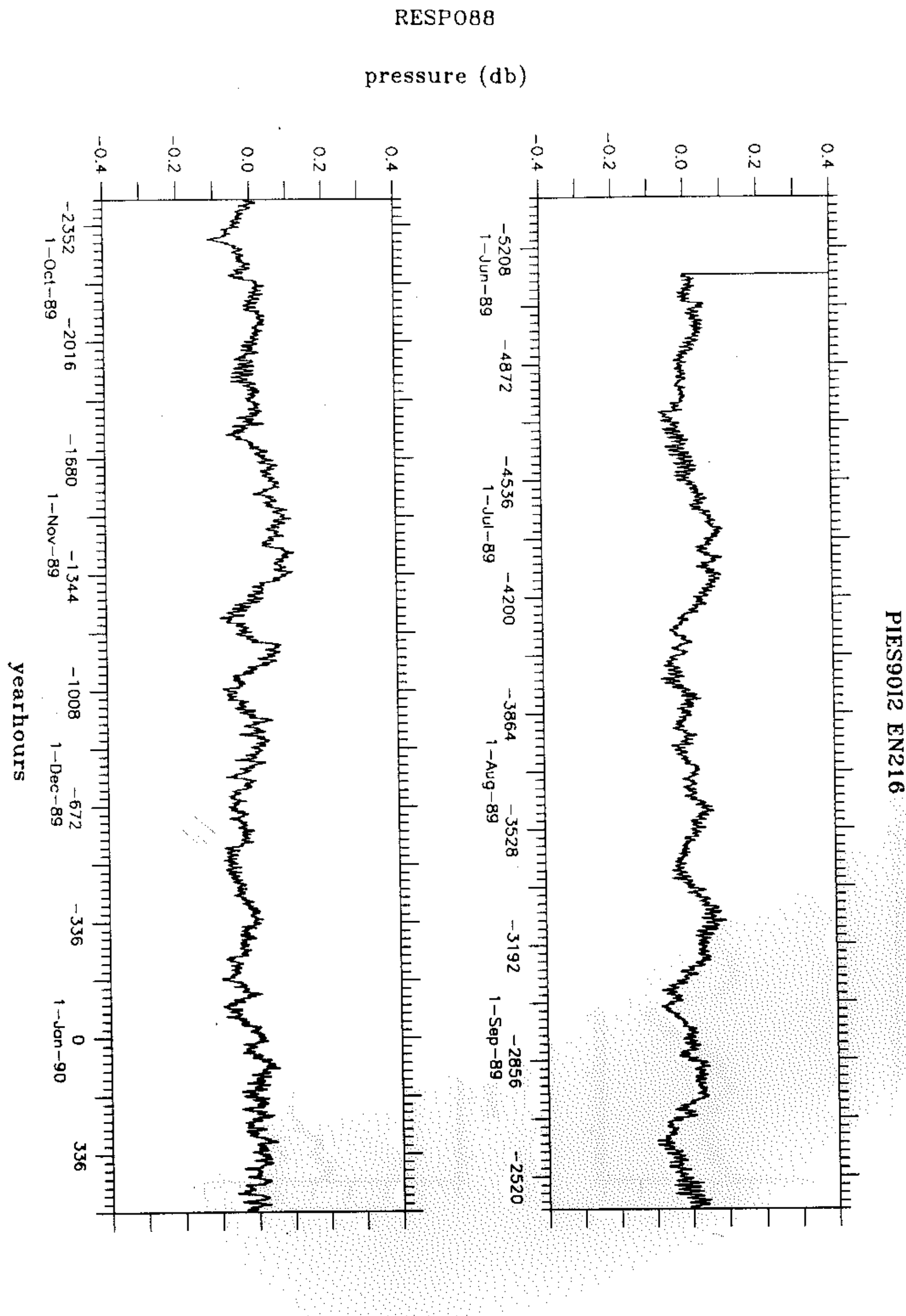
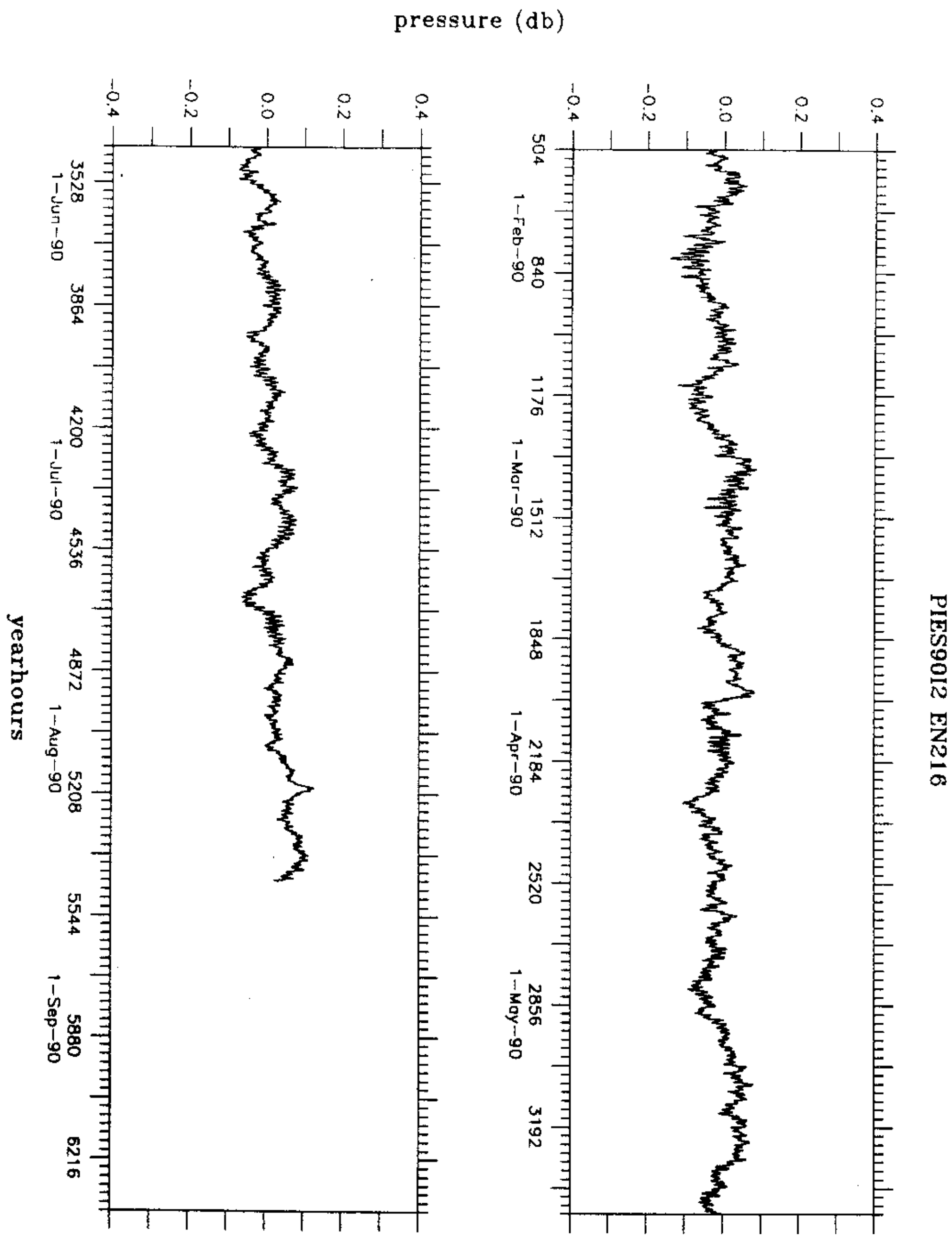


Figure 12.9: Half-Hourly Residual Bottom Pressure. PIES90I2

RESPO88


pressure (db)
PIES90I2 EN216
-0.4
-0.2
0.0
0.2
0.4
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

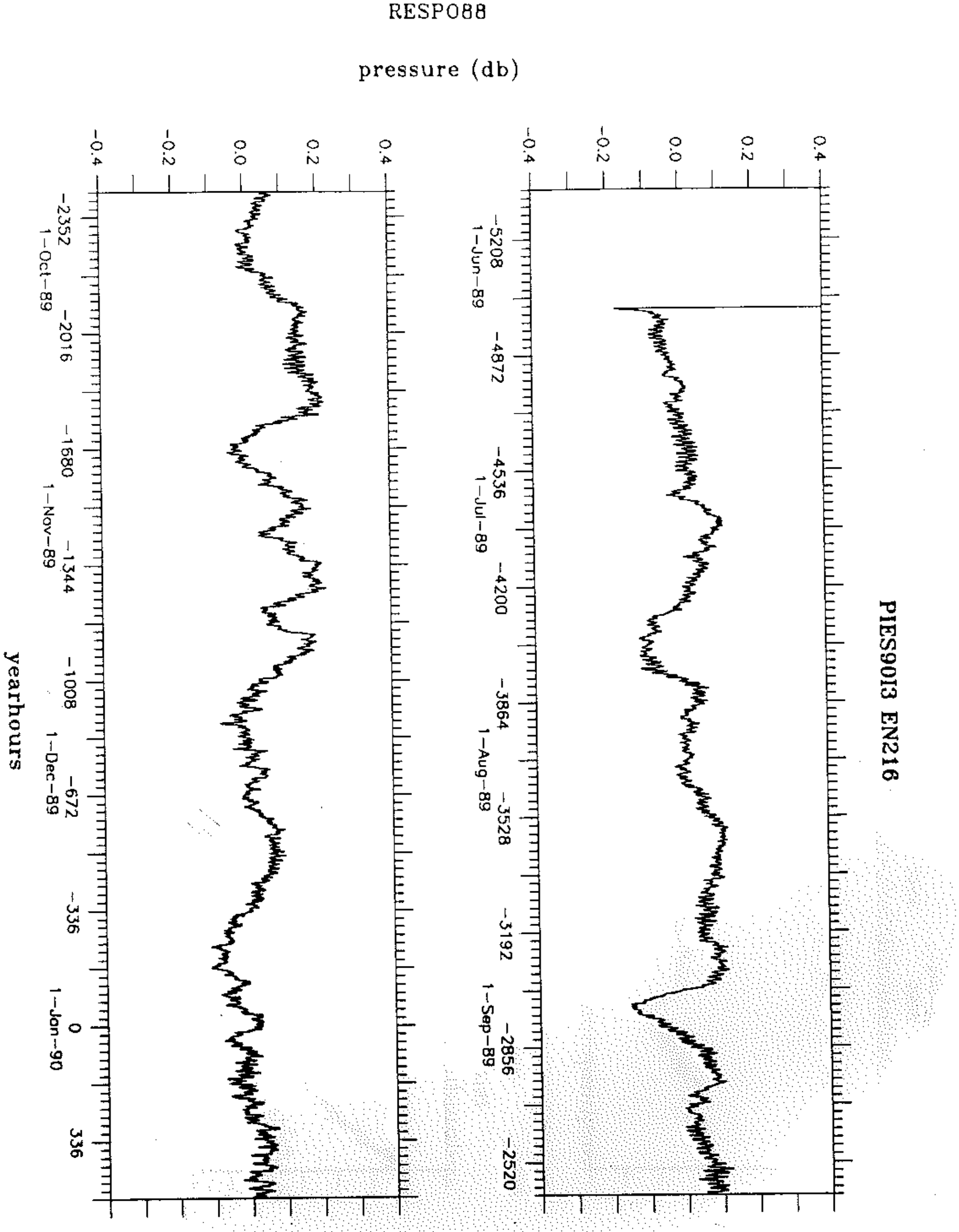
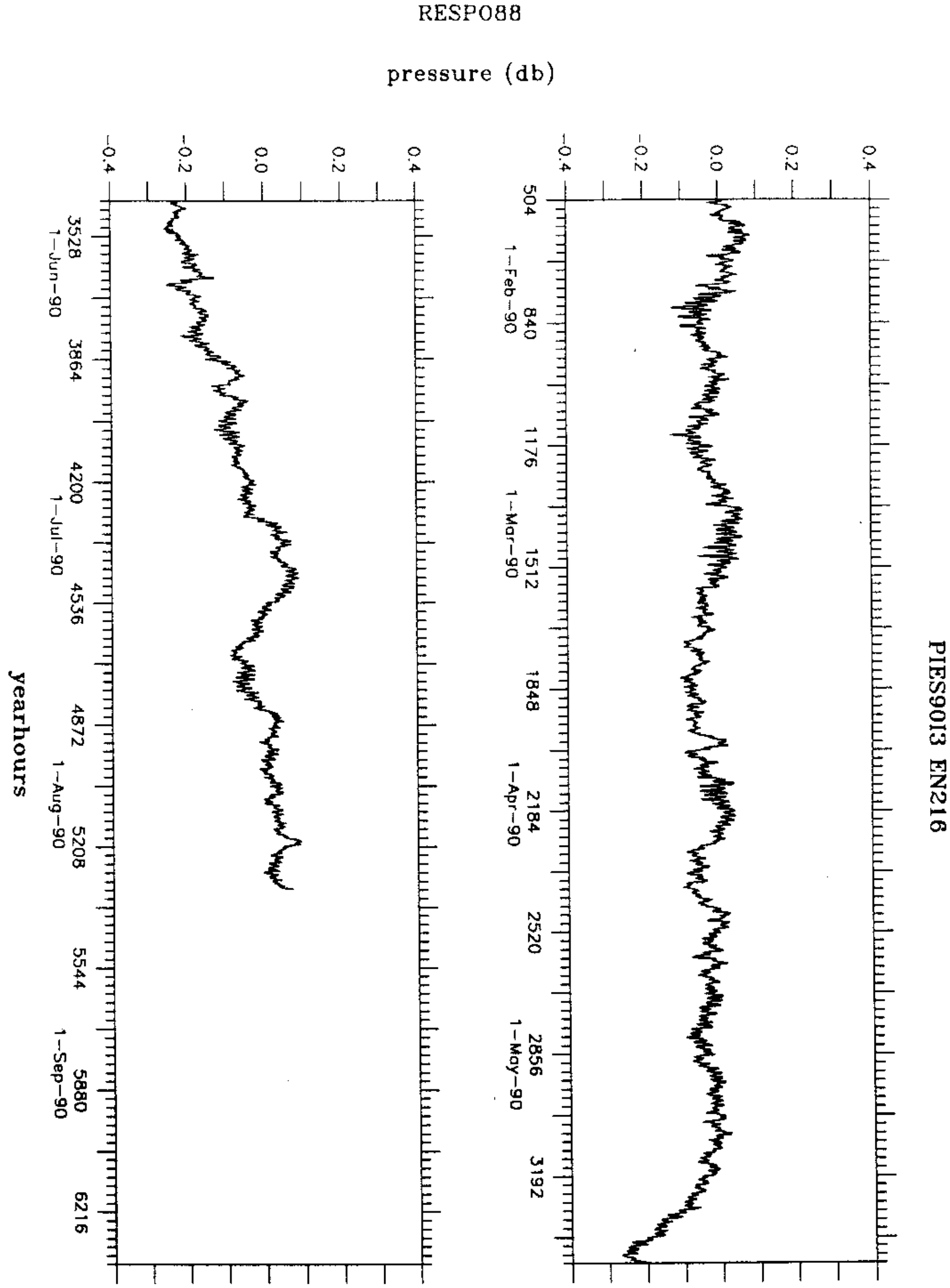


Figure 12.10: Half-Hourly Residual Bottom Pressure. PIES90I3



PIES90I3 EN216
RESP088
pressure (db)
-0.4
-0.2
0.0
0.2
0.4
504
840
1-Feb-90
1176
1512
1-Mar-90
1848
2184
1-Apr-90
2520
2856
1-May-90
3192
3528
1-Jun-90
3864
4200
1-Jul-90
4536
4872
1-Aug-90
5208
5544
5880
1-Sep-90
6216
yearhours

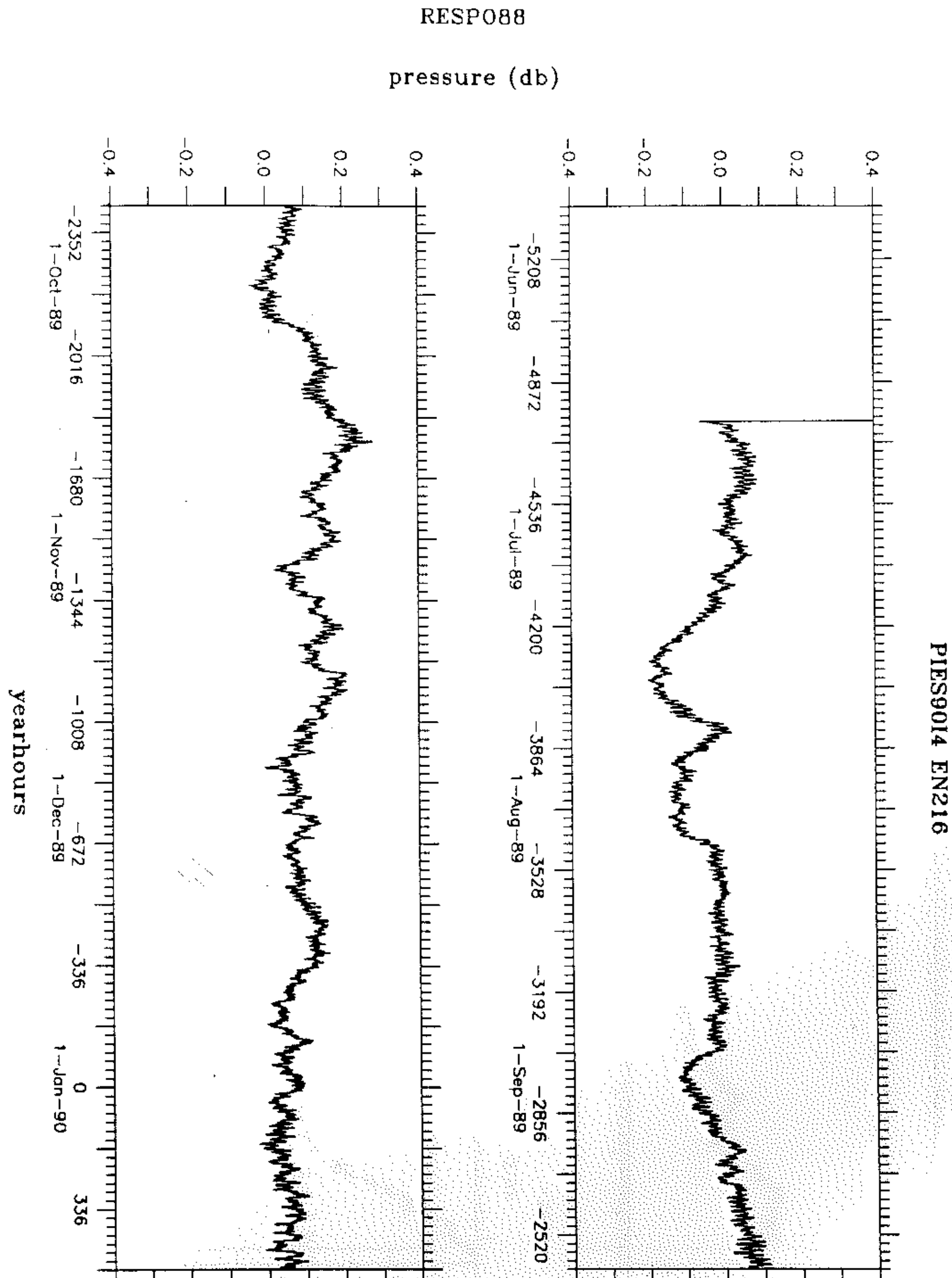
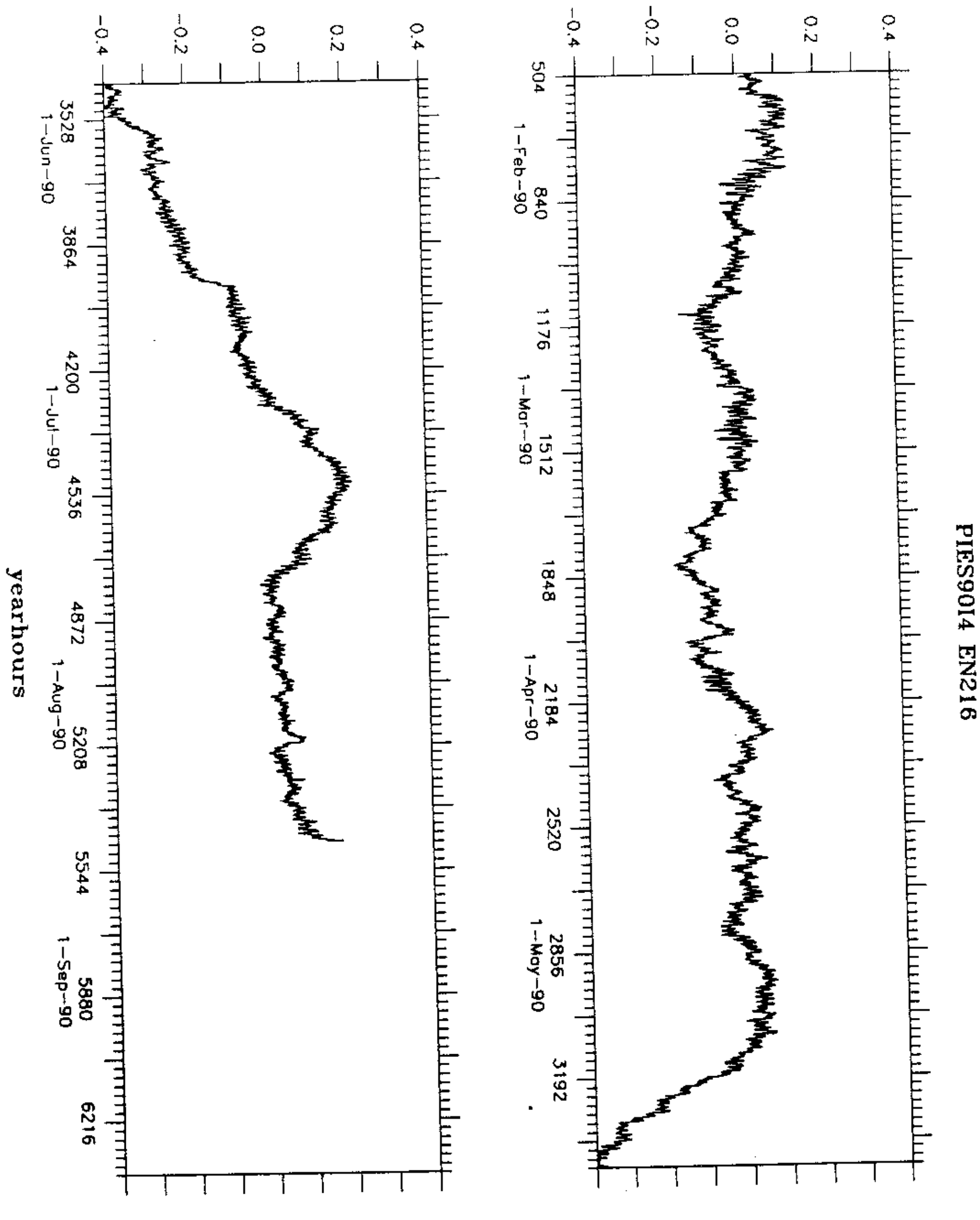


Figure 12.11: Half-Hourly Residual Bottom Pressure. PIES90I4

RESP088

pressure (db)



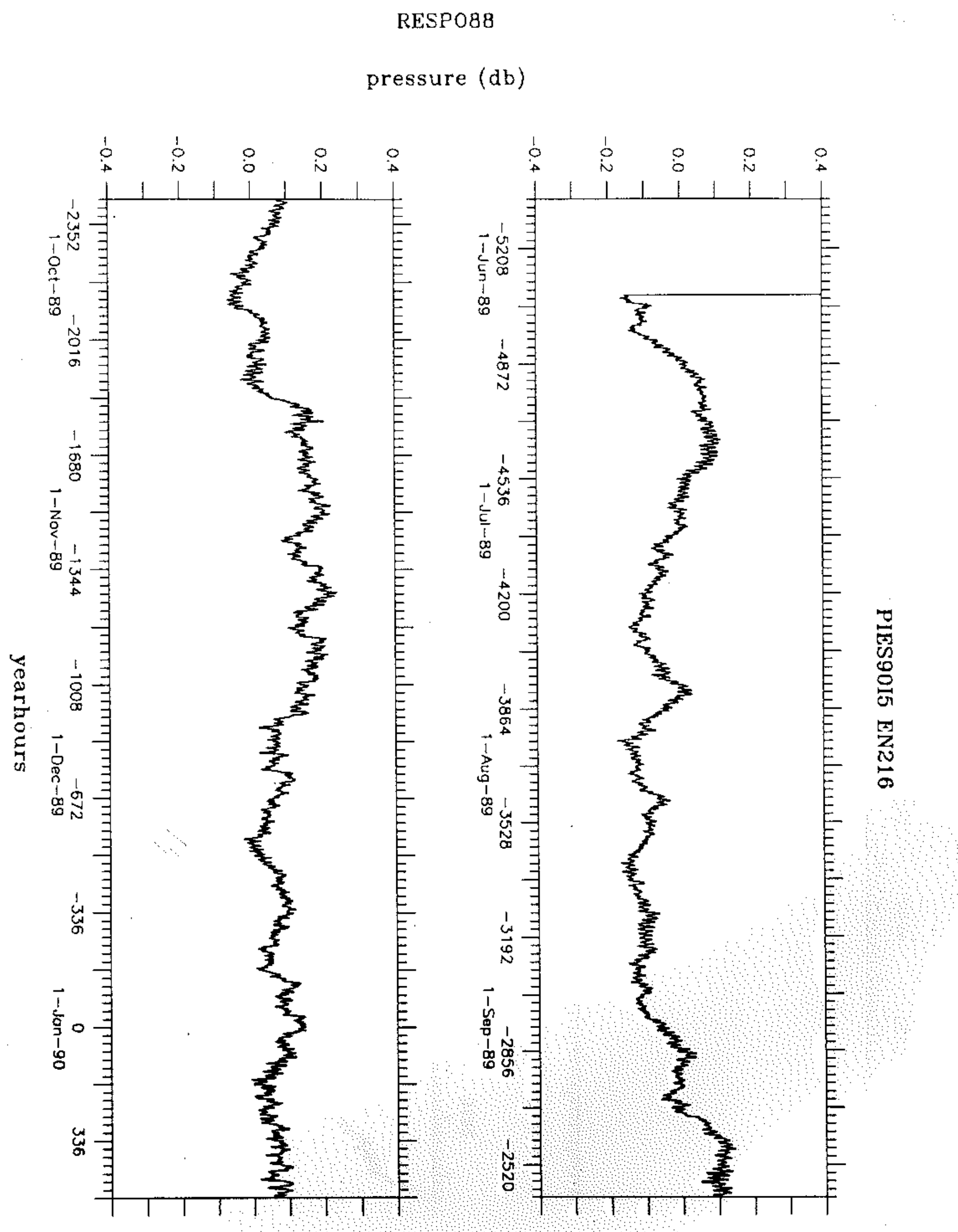
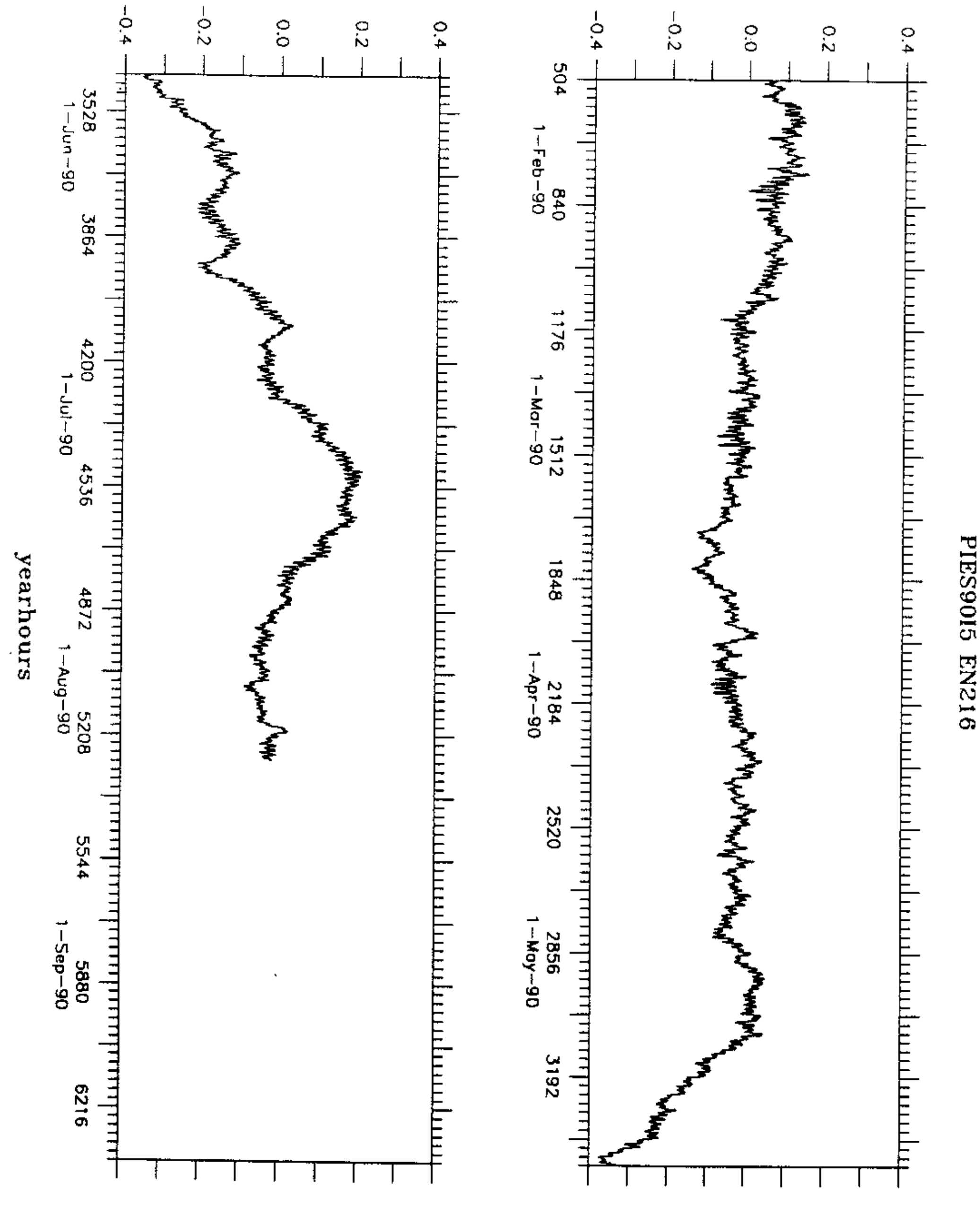


Figure 12.12: Half-Hourly Residual Bottom Pressure. PIES90I5

RESP088

pressure (db)



4 Half-Hourly Line Plots

Line plots display all records from a given section across the Gulf Stream on a single page (with exception of the H-line τs which required two pages). Travel time, residual bottom pressure, and temperature are plotted in this section, grouped according to instrument lines, A, B, C, ..., etc. The time axis of all line plots extends from −6000 hr to 7000 hr in increments of 1000 hr. As with the individual plots, labels indicating specific dates are centered about their yearhour equivalents (for example a label associates "1-Jan-90" with 0.0 yearhour).

For the line plots of each variable, the vertical axes for all IESs have common increments.

The individual records that compose the line plots are labeled with the site at the right, centered within the record's vertical axis. The records of travel time of TIES89C2 and TIES90C2 are plotted together in the same panel rather than separately. It was necessary to subtract an offset of .13 sec from TIES89C2 so that the records would form a continuous series and fit in the 50–msec window. The offset was introduced because TIES90C2 was at a shallower bottom depth than TIES89C2.

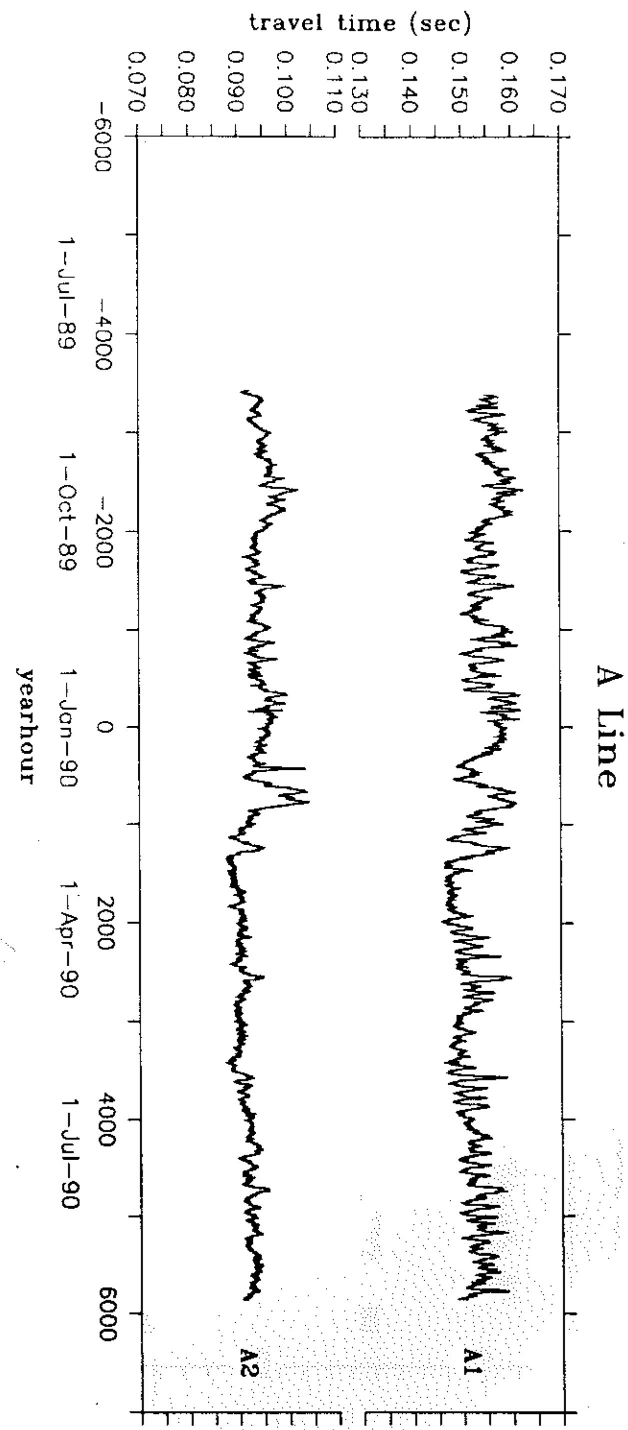


Figure 13.1: Half-Hourly Travel Times. A line

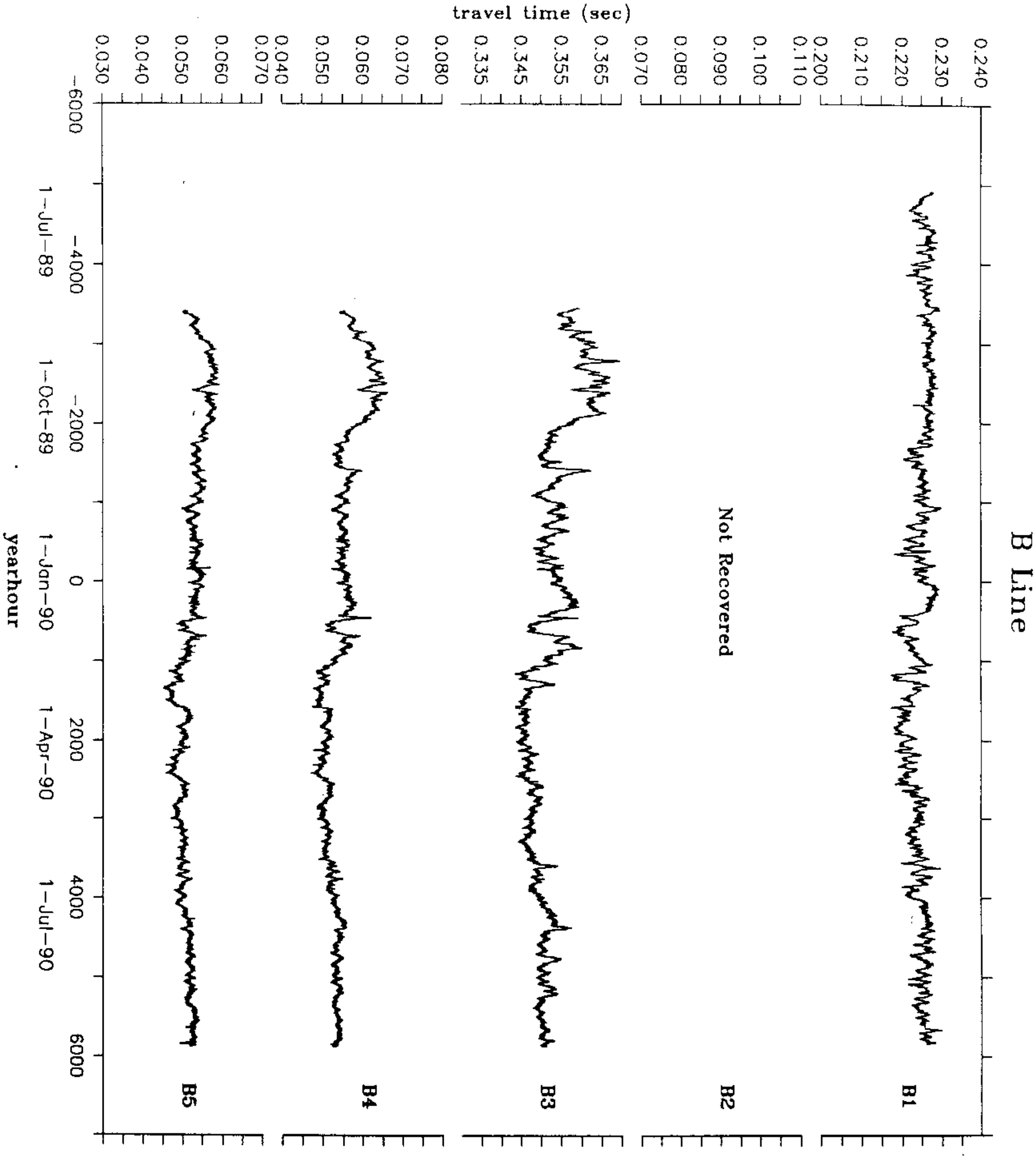


Figure 13.2: Half-Hourly Travel Times. B line

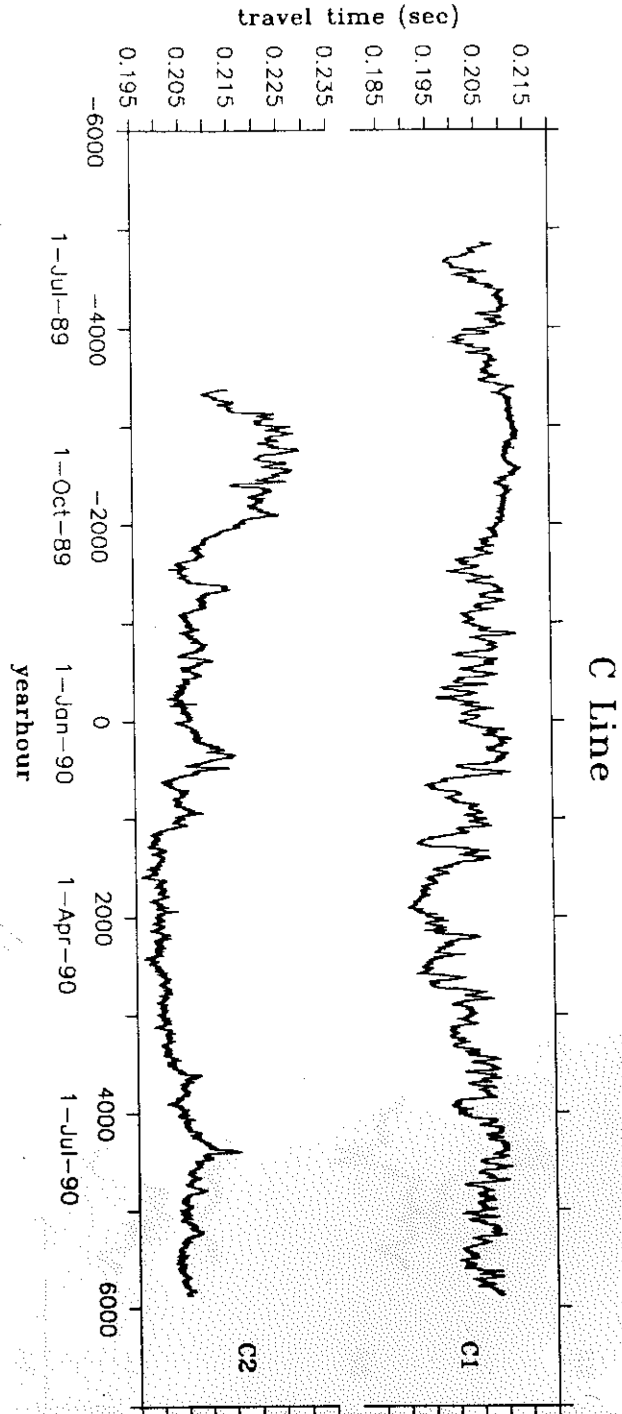


Figure 13.3: Half-Hourly Travel Times. C line

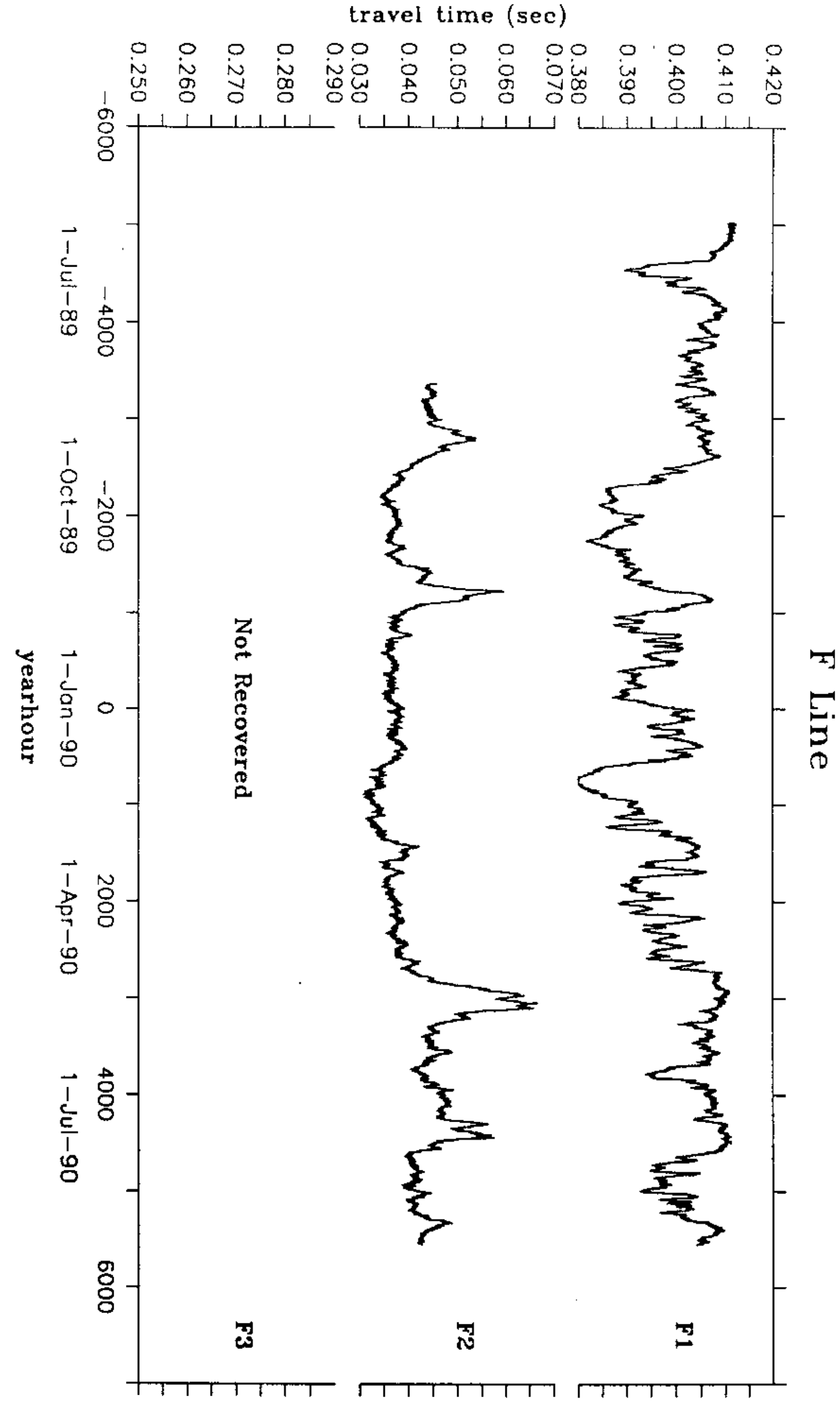


Figure 13.4: Half-Hourly Travel Times. F line

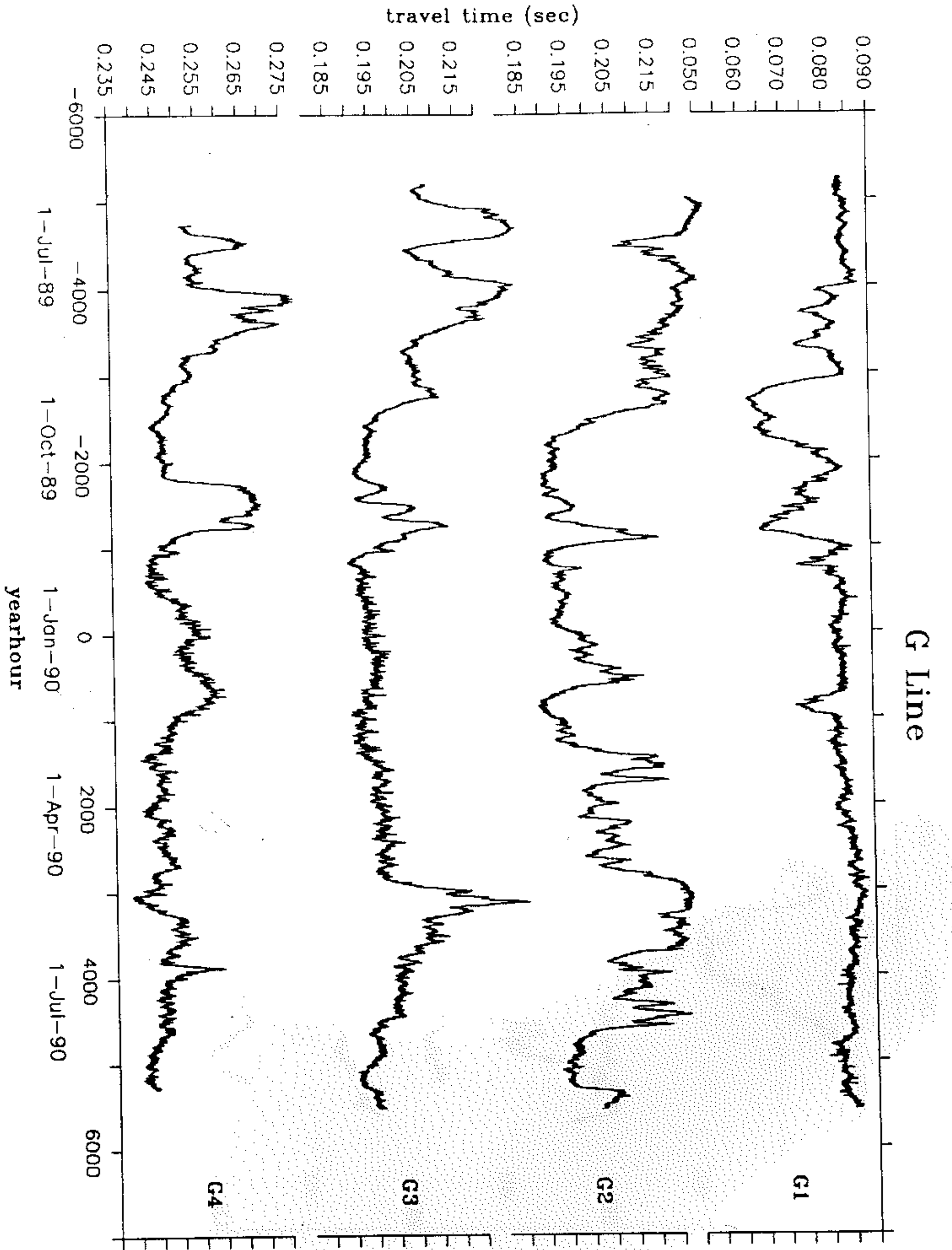


Figure 13.5: Half-Hourly Travel Times. G line

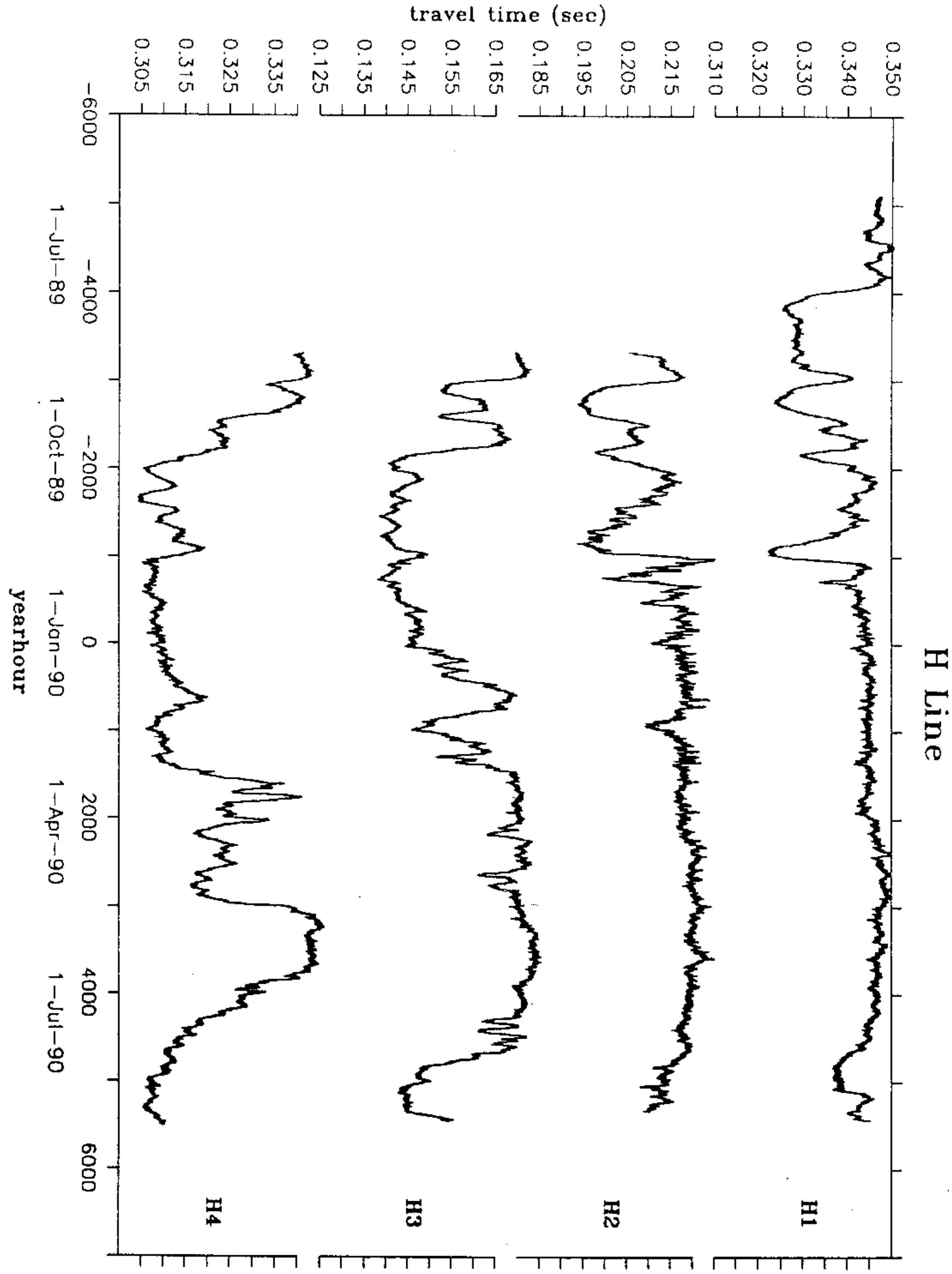
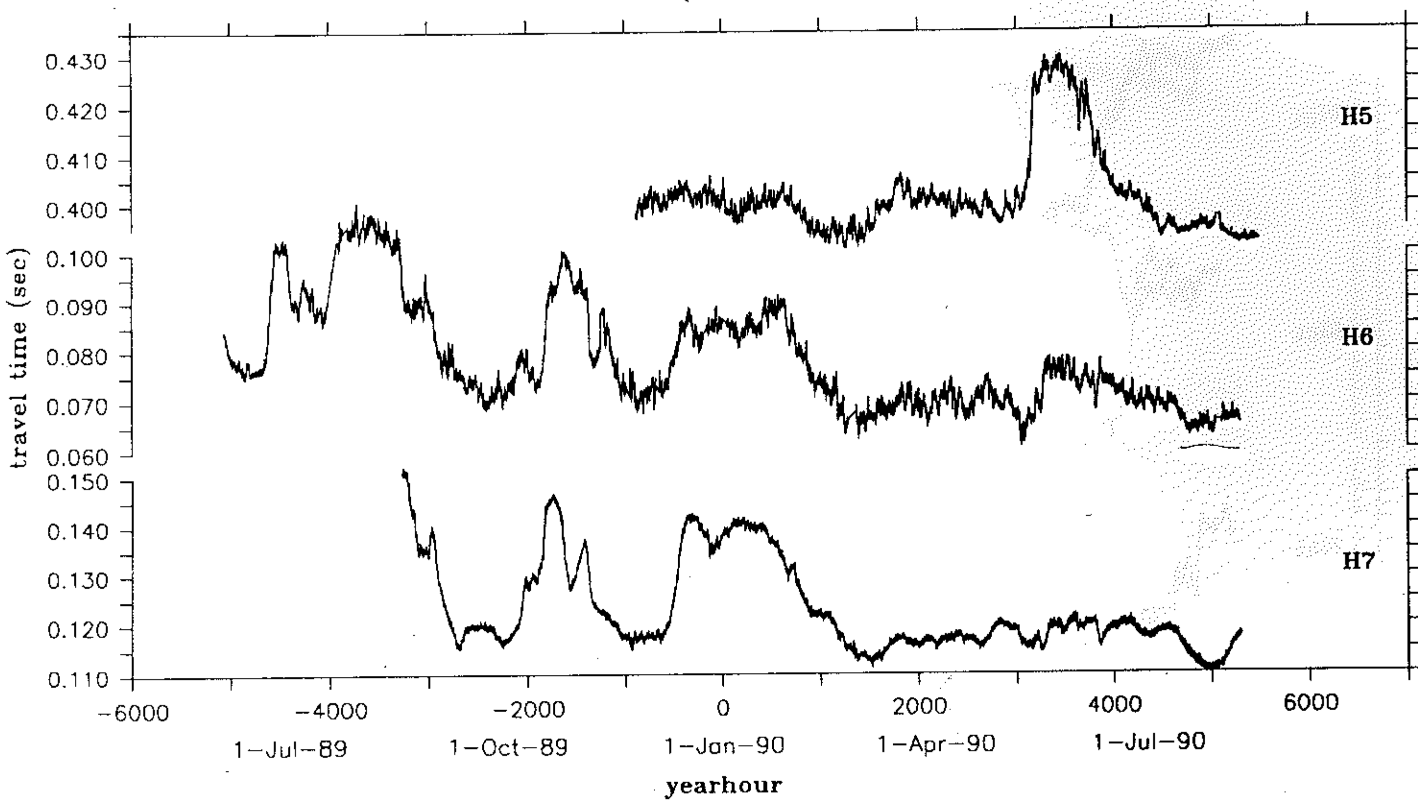


Figure 13.6: Half-Hourly Travel Times. H line

H Line (continued)



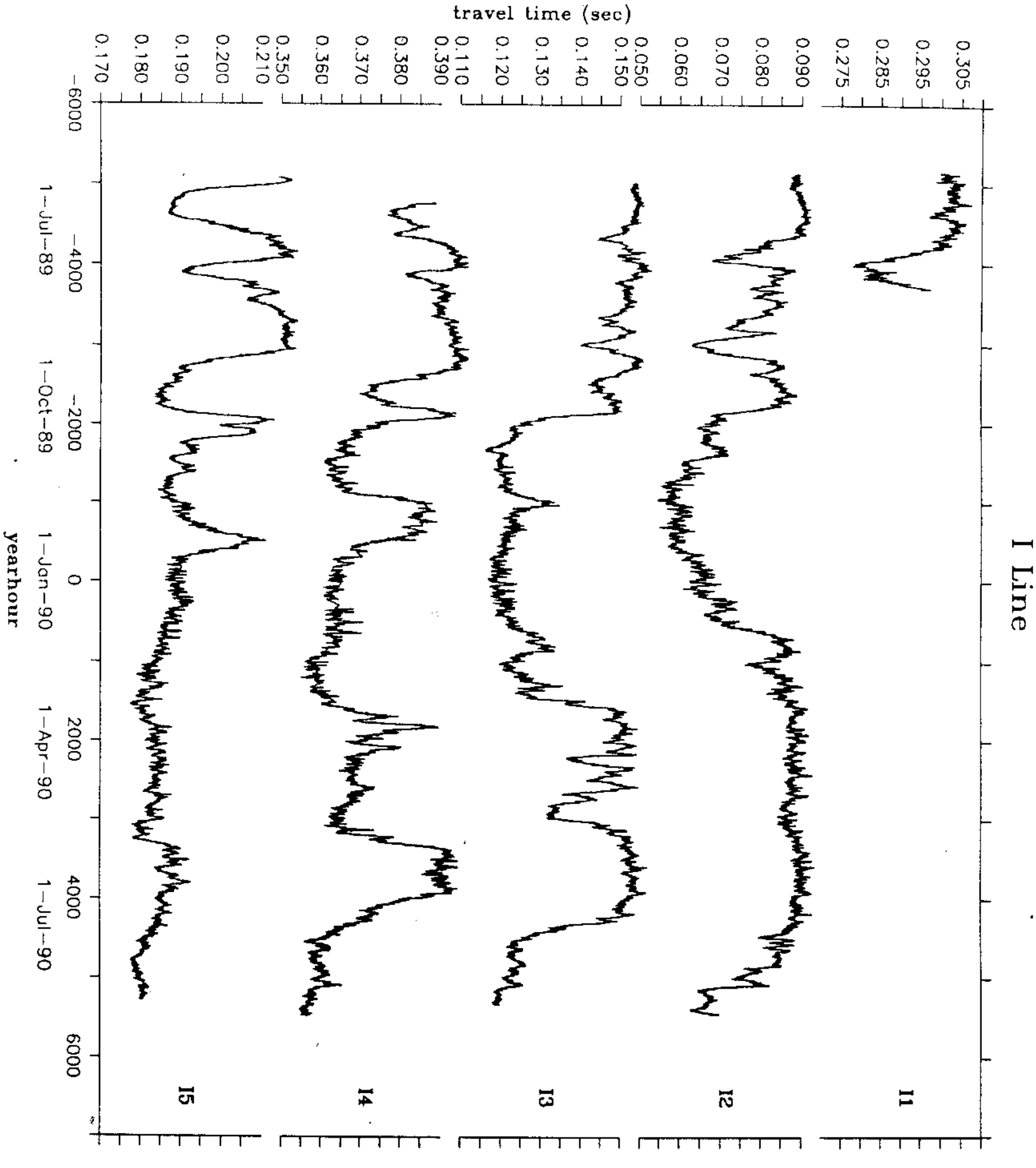


Figure 13.7: Half-Hourly Travel Times. I line

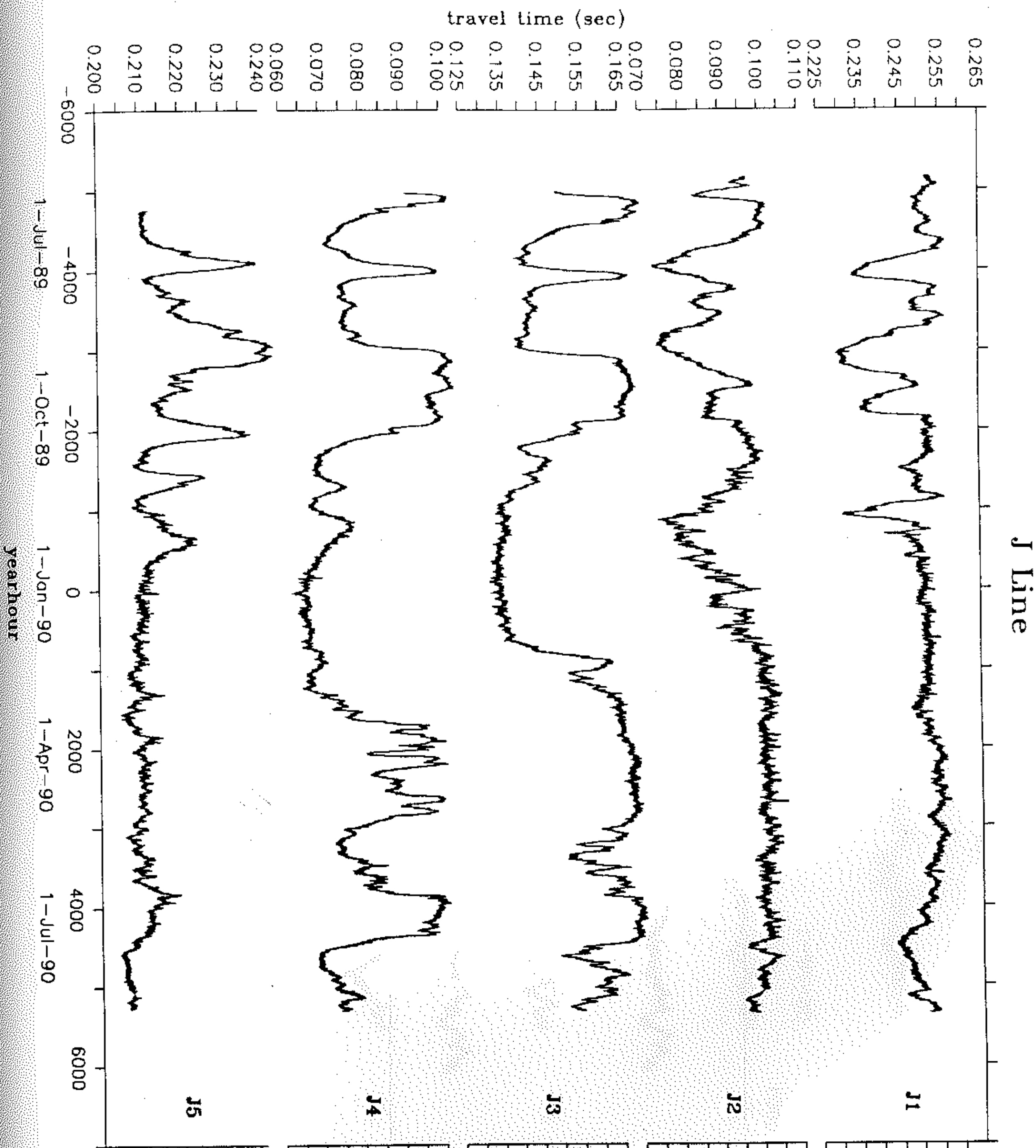


Figure 13.8: Half-Hourly Travel Times. J line

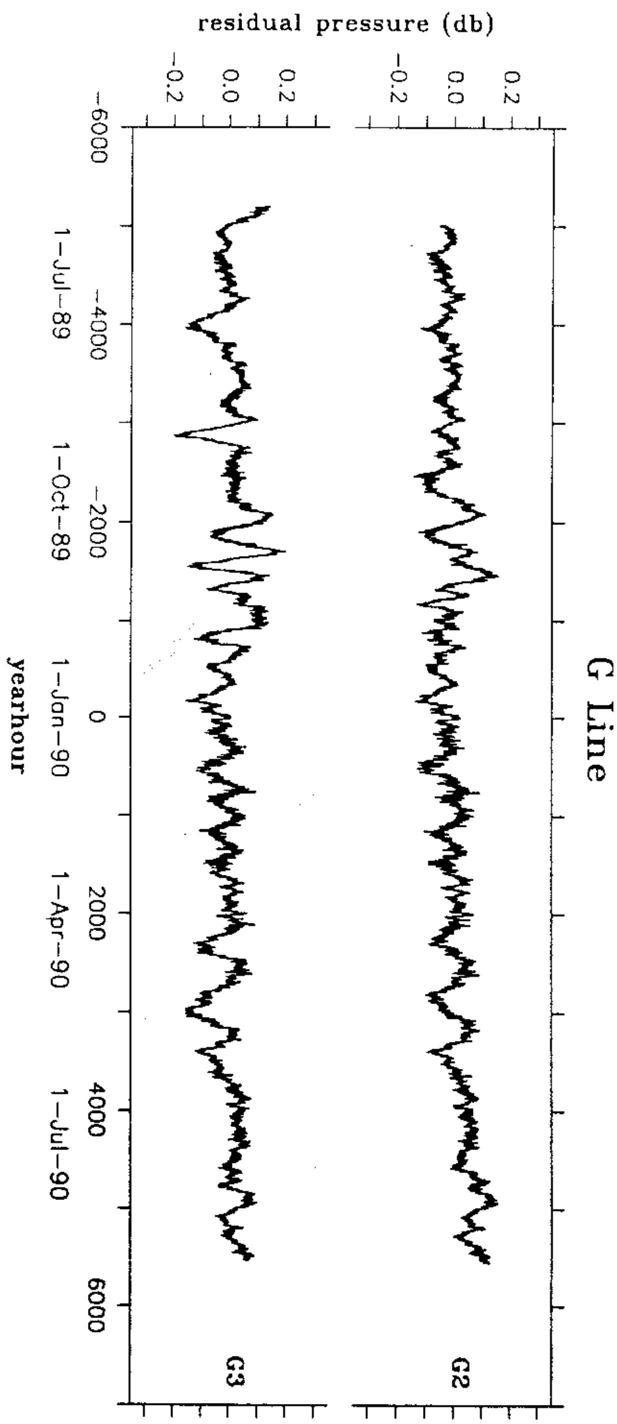


Figure 14.1: Half-Hourly Residual Bottom Pressure. G line

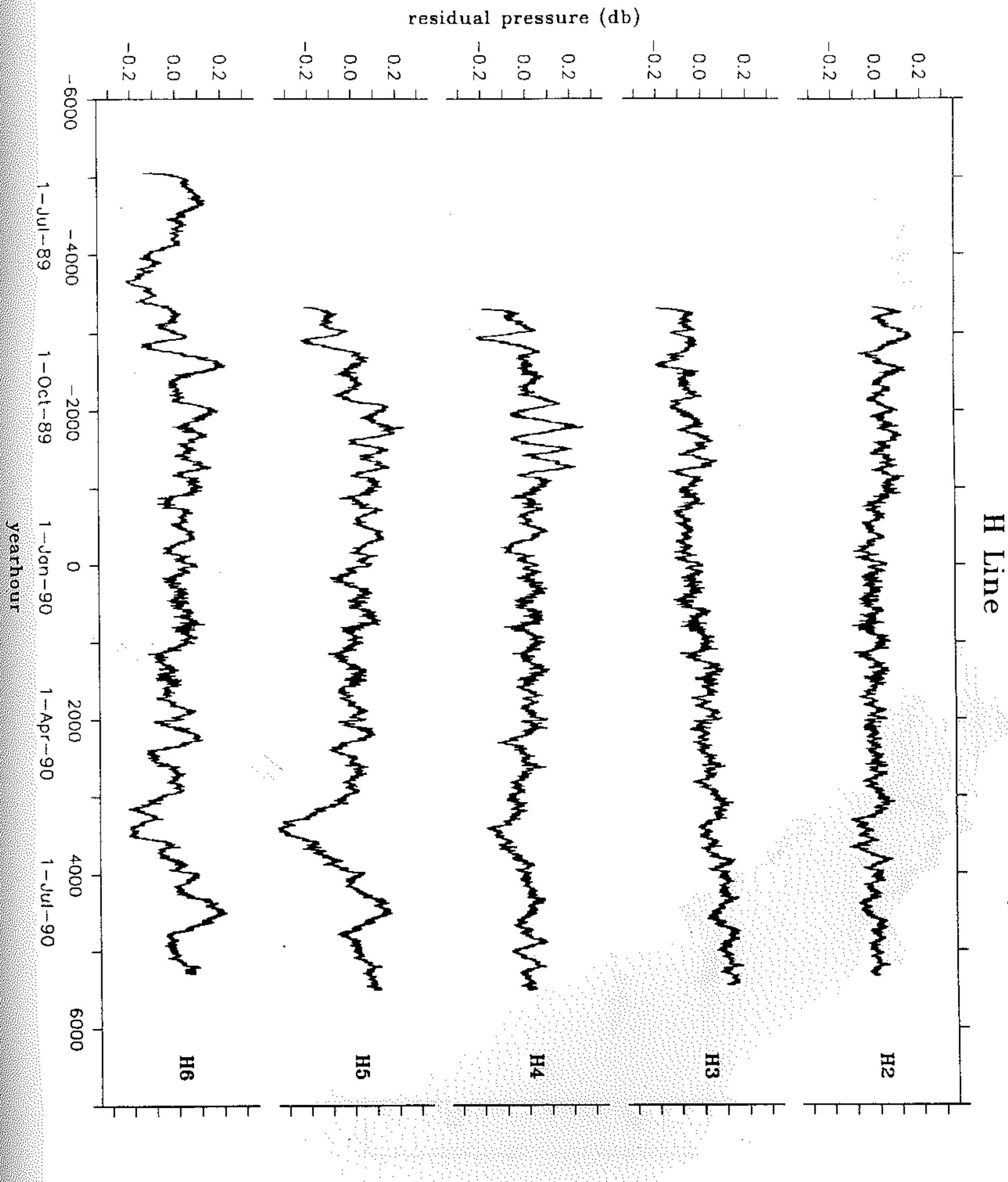


Figure 14.2: Half-Hourly Residual Bottom Pressure. H line

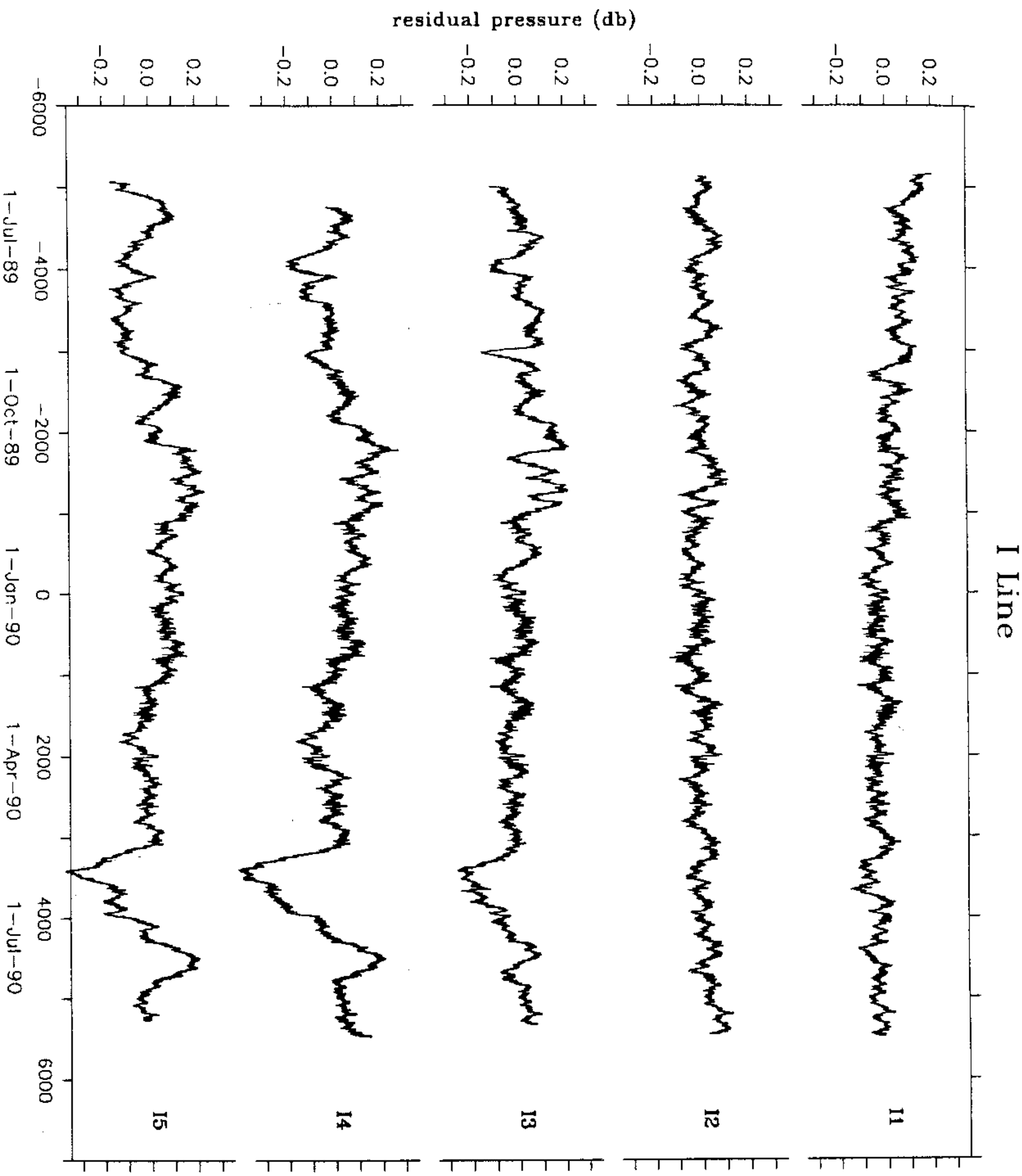


Figure 14.3: Half-Hourly Residual Bottom Pressure. I line

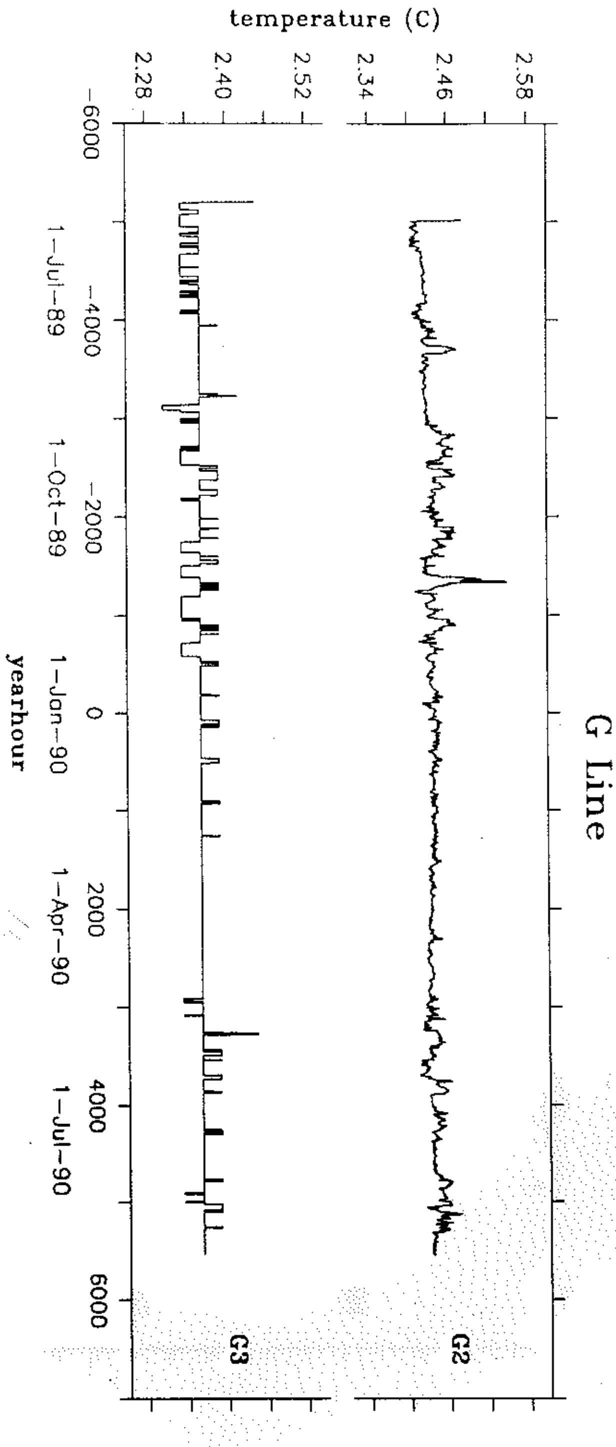


Figure 15.1: Half-Hourly Temperature. G line

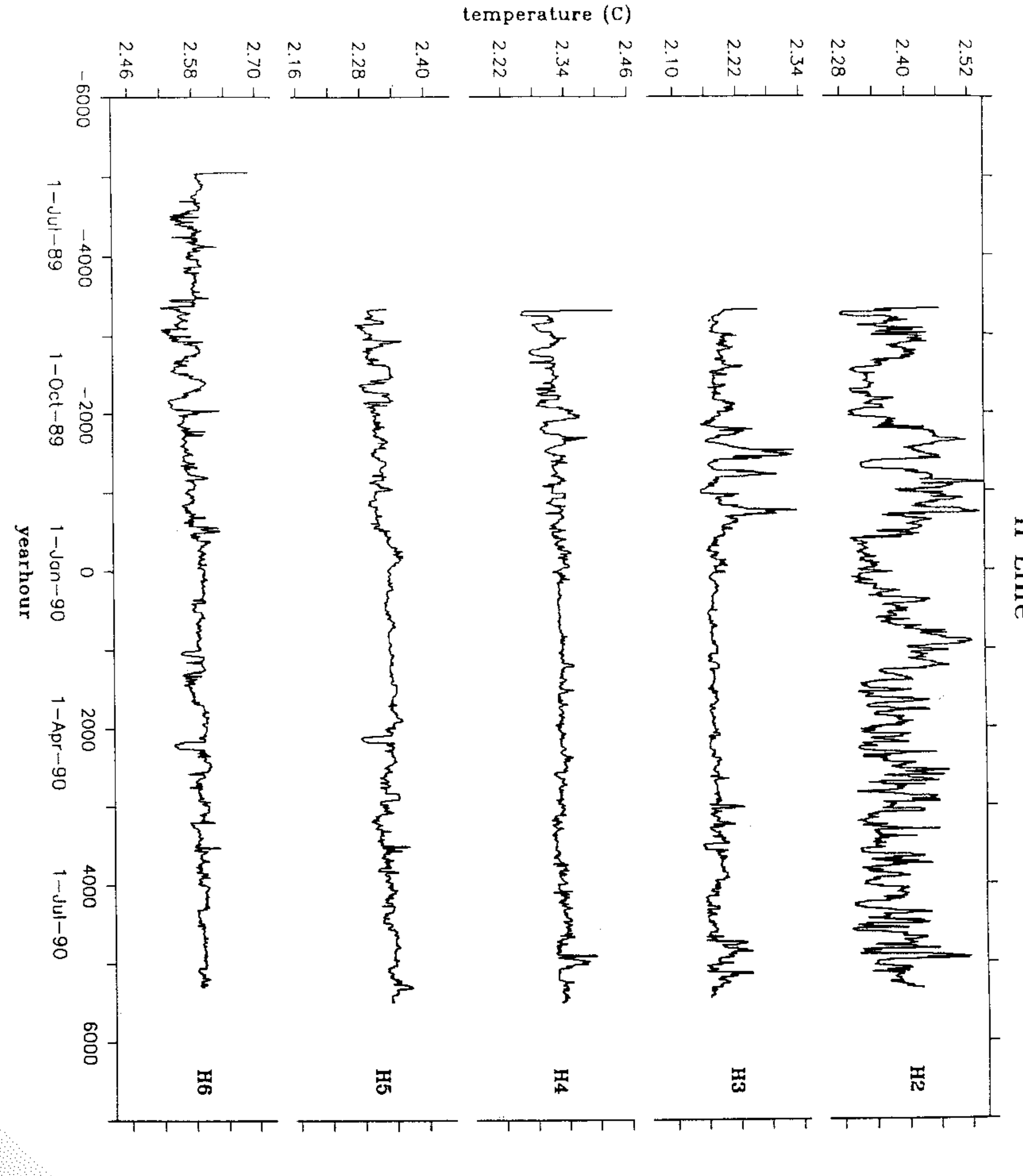


Figure 15.2: Half-Hourly Temperature. H line

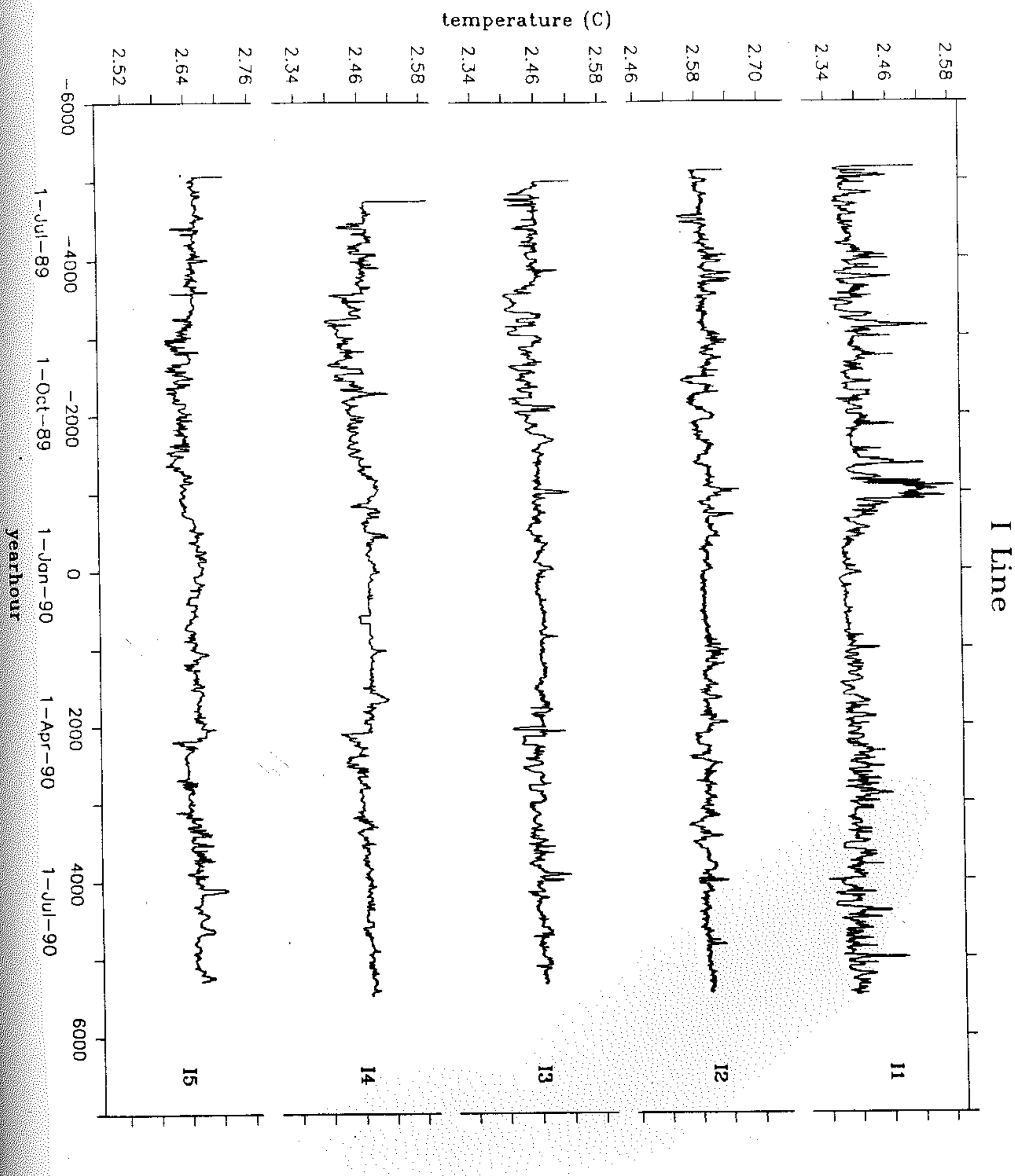


Figure 15.3: Half-Hourly Temperature. I line

5 40HRLP Line Plots

Line plots display all records from a given section across the Gulf Stream on a single page (with exception of the H-line Z_{12}s which required two pages). 40HRLP thermocline depth, residual bottom pressure, and temperature are plotted in this section, grouped according to instrument lines, A, B, C, ..., etc. The time axis of all line plots extends from −6000 hr to 7000 hr in increments of 1000 hr. As with the individual plots, labels indicating specific dates are centered about their yearhour equivalents (for example a label associates "1-Jan-90" with 0.0 yearhour).

The vertical axis for all Z_{12} plots ranges from 1000m depth to the surface in increments of 100 m. Also as in the non-filtered plots (section 4), vertical axes have a common increment.

The individual records that compose the line plots are labeled with the site at the right, centered within the record's vertical axis. TIES89C2 and TIES90C2 are plotted together in the same panel rather than separately.

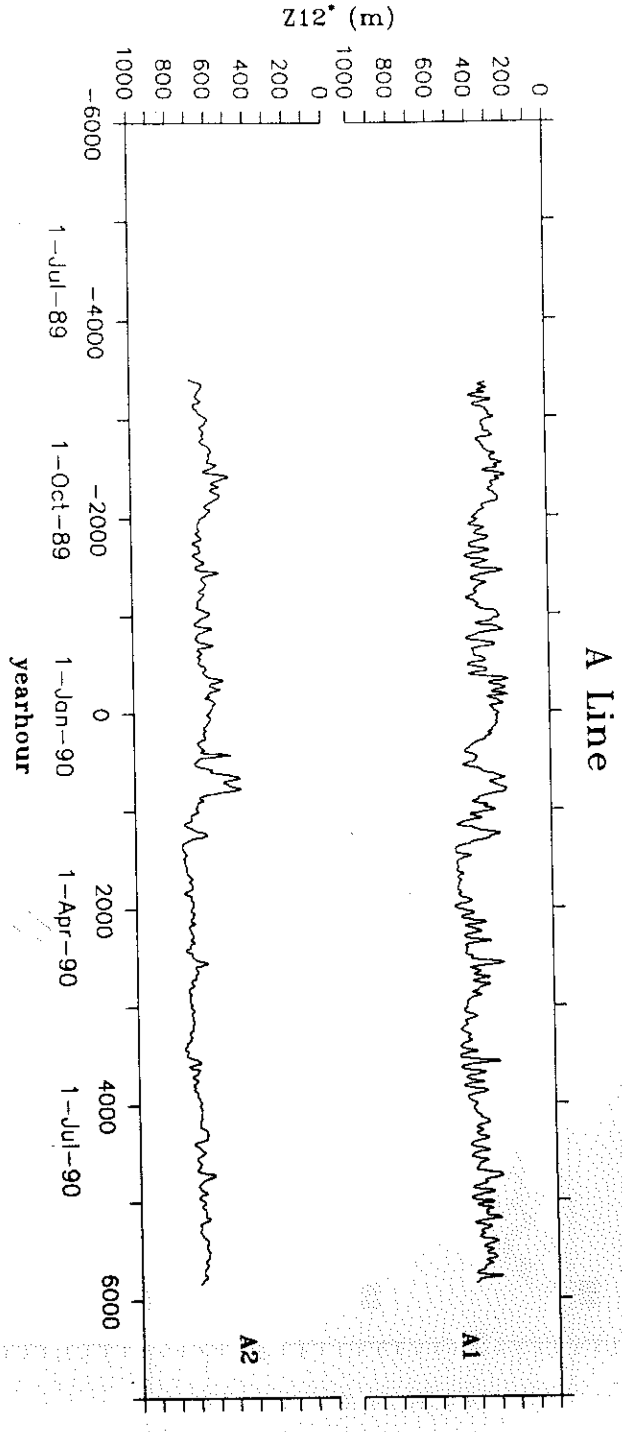


Figure 16.1: 40HRLP Z_{12}. A line

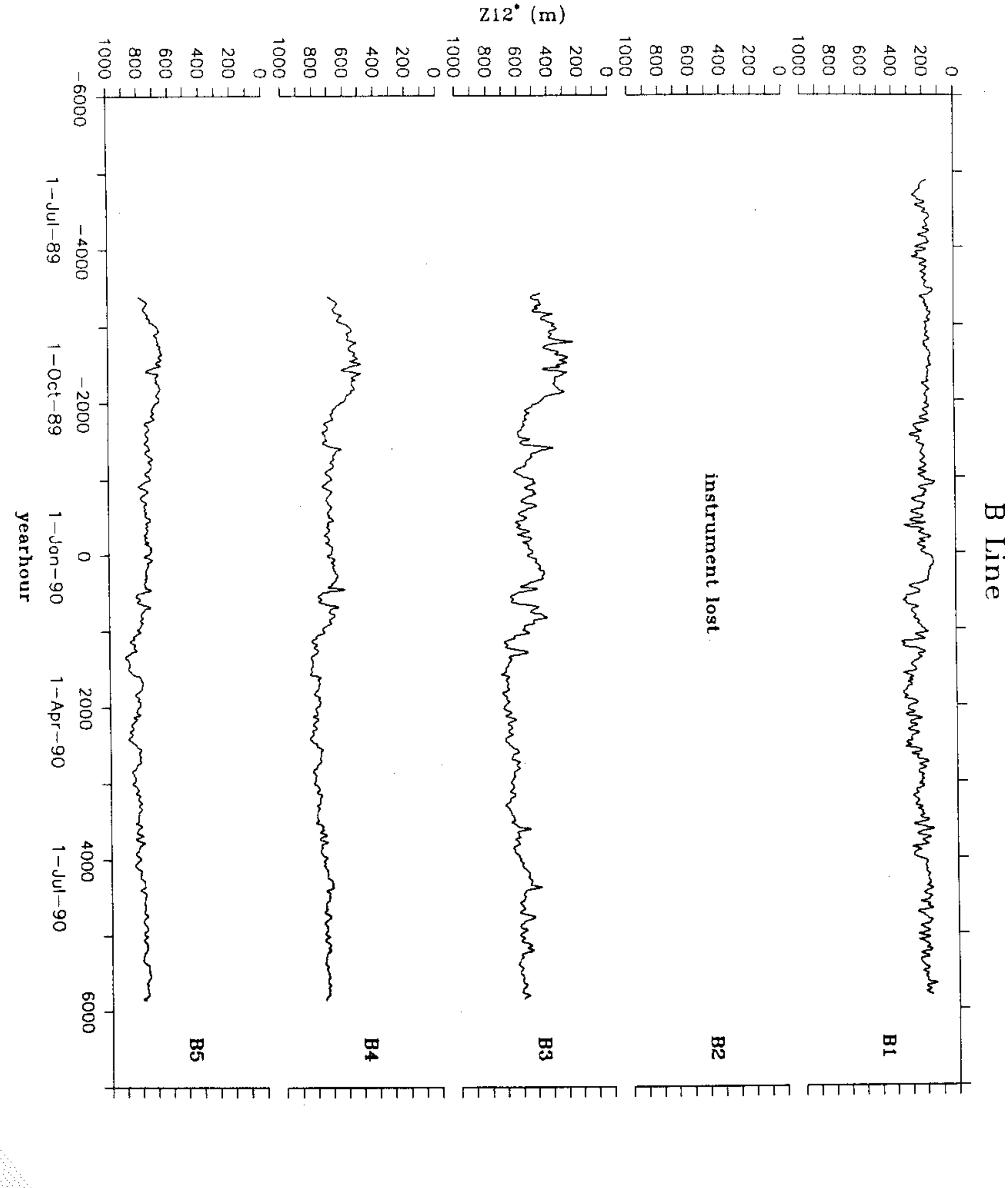


Figure 16.2: 40HRLP Z_{12}. B line

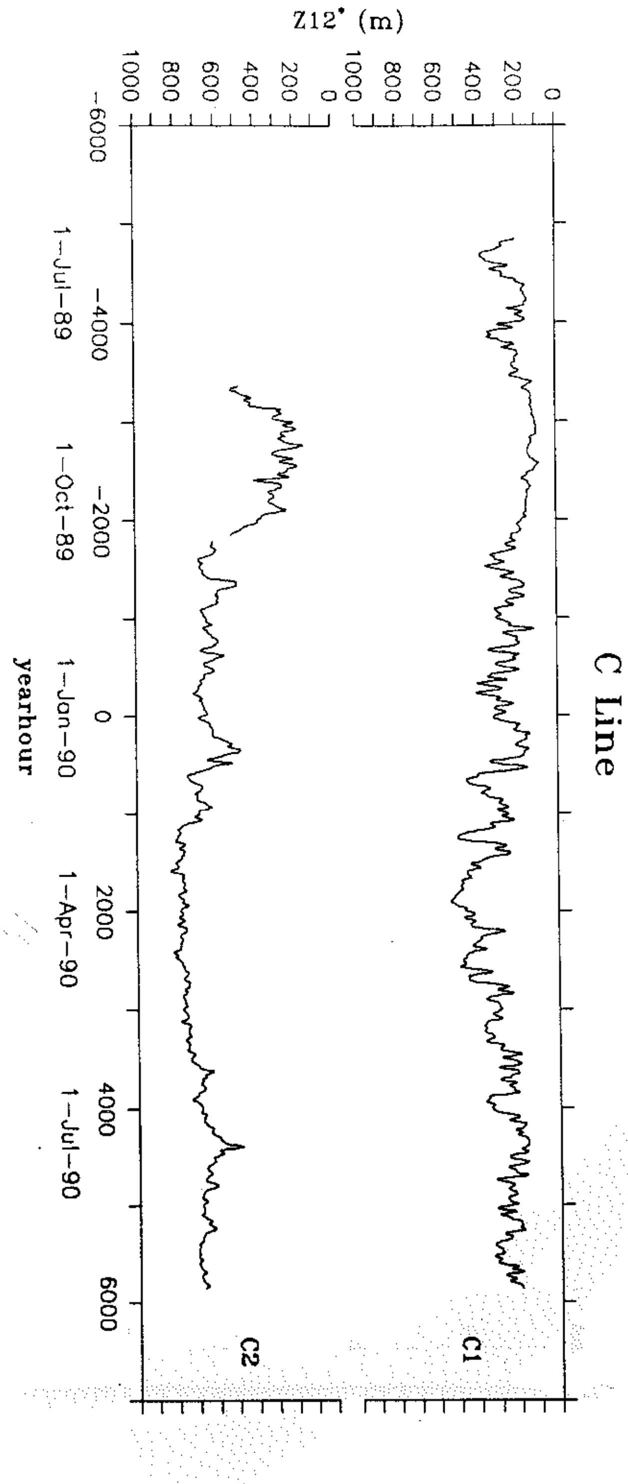


Figure 16.3: 40HRLP Z_{12}. C line

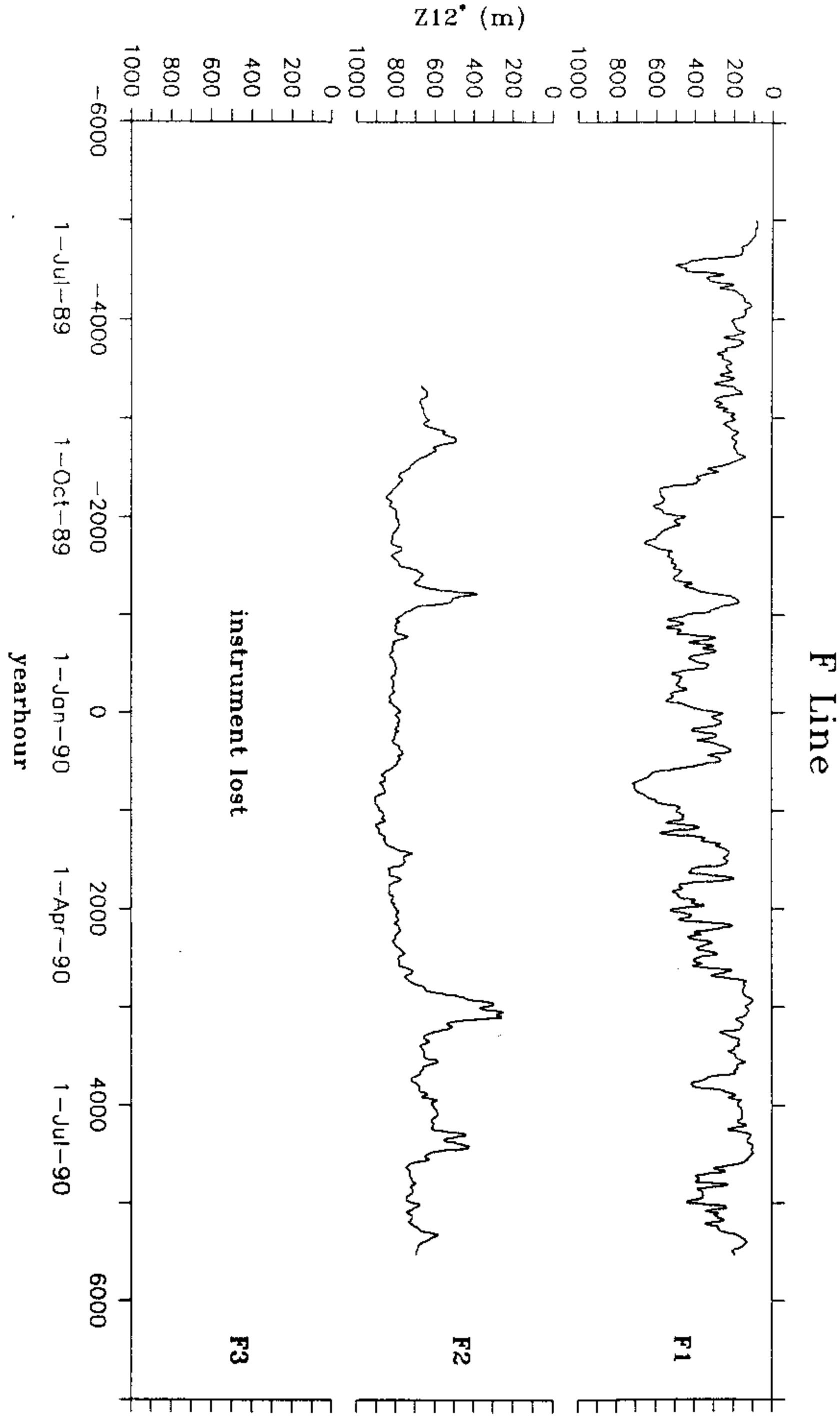


Figure 16.4: 40HRLP Z_{12}. F line

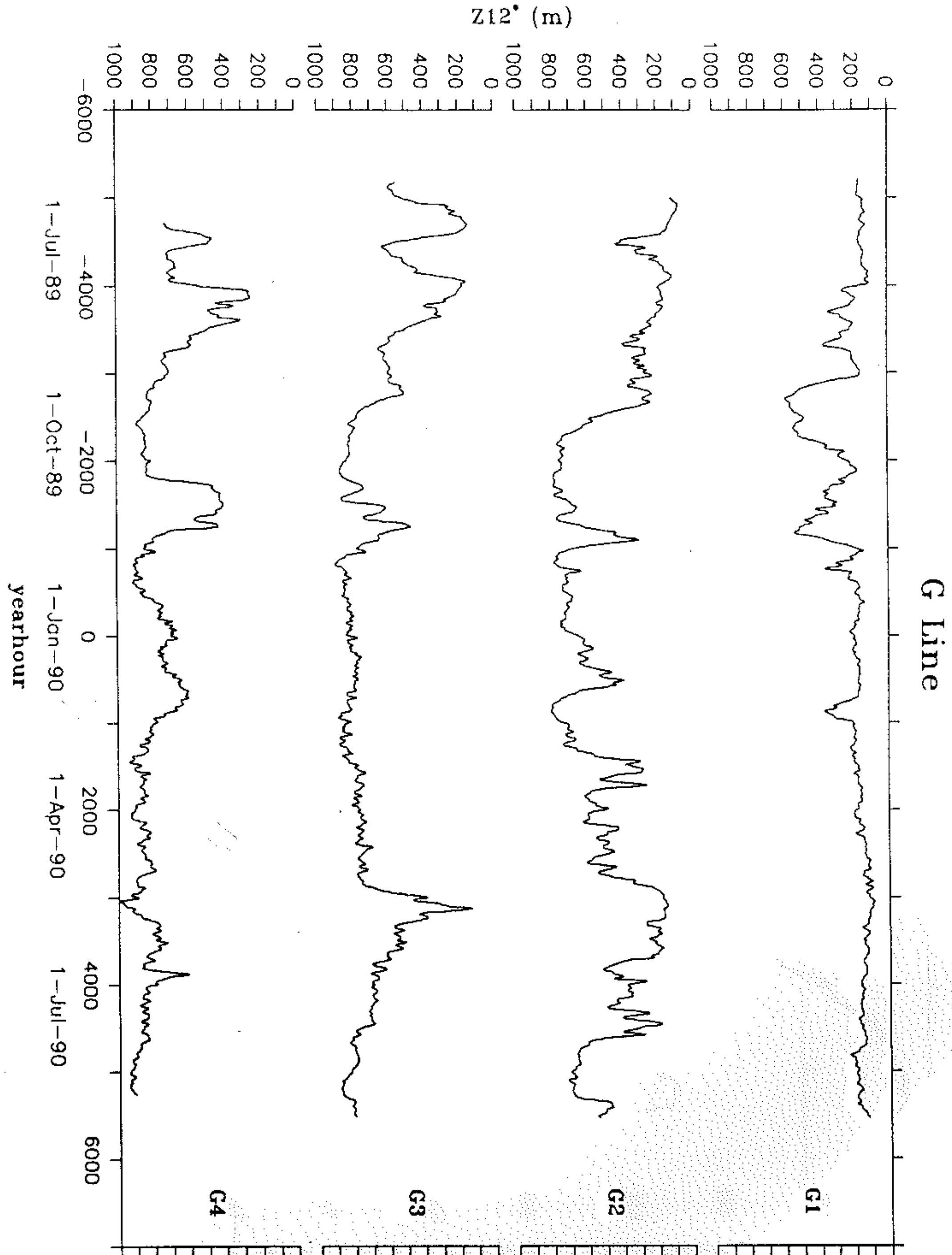


Figure 16.5: 40HRLP Z_{12}. G line

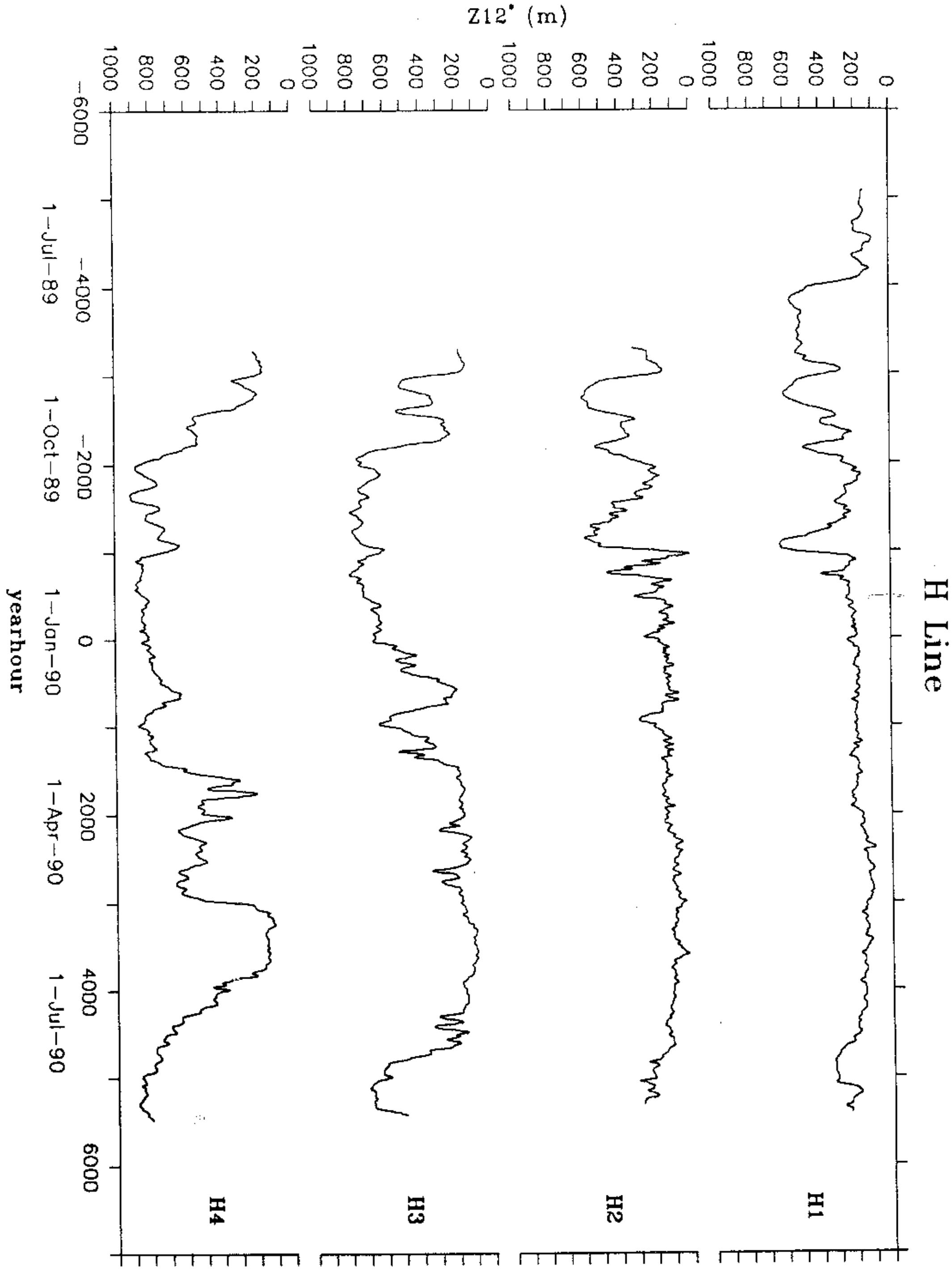
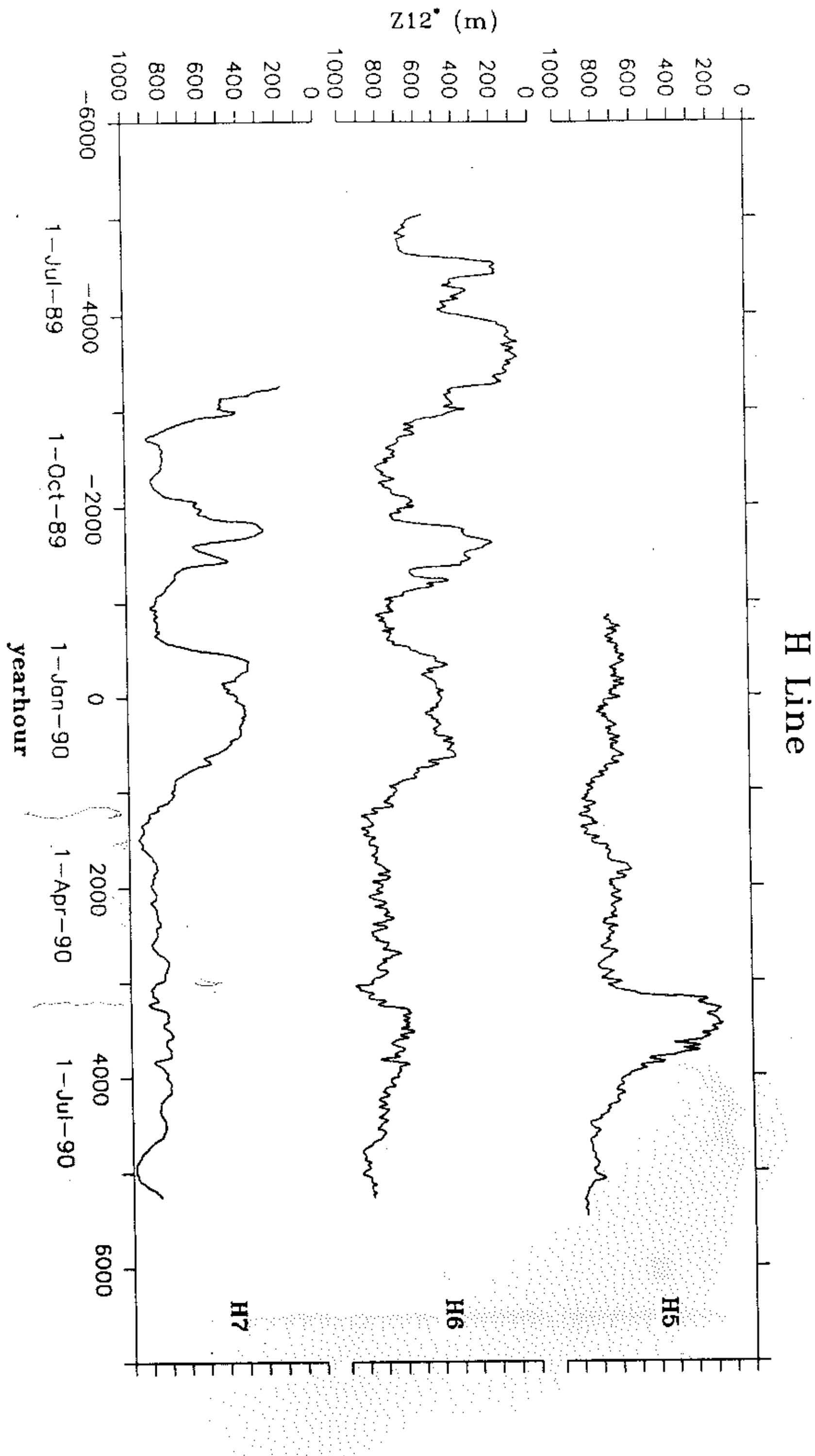


Figure 16.6: 40HRLP Z_{12}. H line


H Line
Z12* (m)
0
200
400
600
800
1000
H5
H6
H7
-6000
-4000
-2000
0
2000
4000
6000
1-Jul-89
1-Oct-89
1-Jan-90
1-Apr-90
1-Jul-90
yearhour

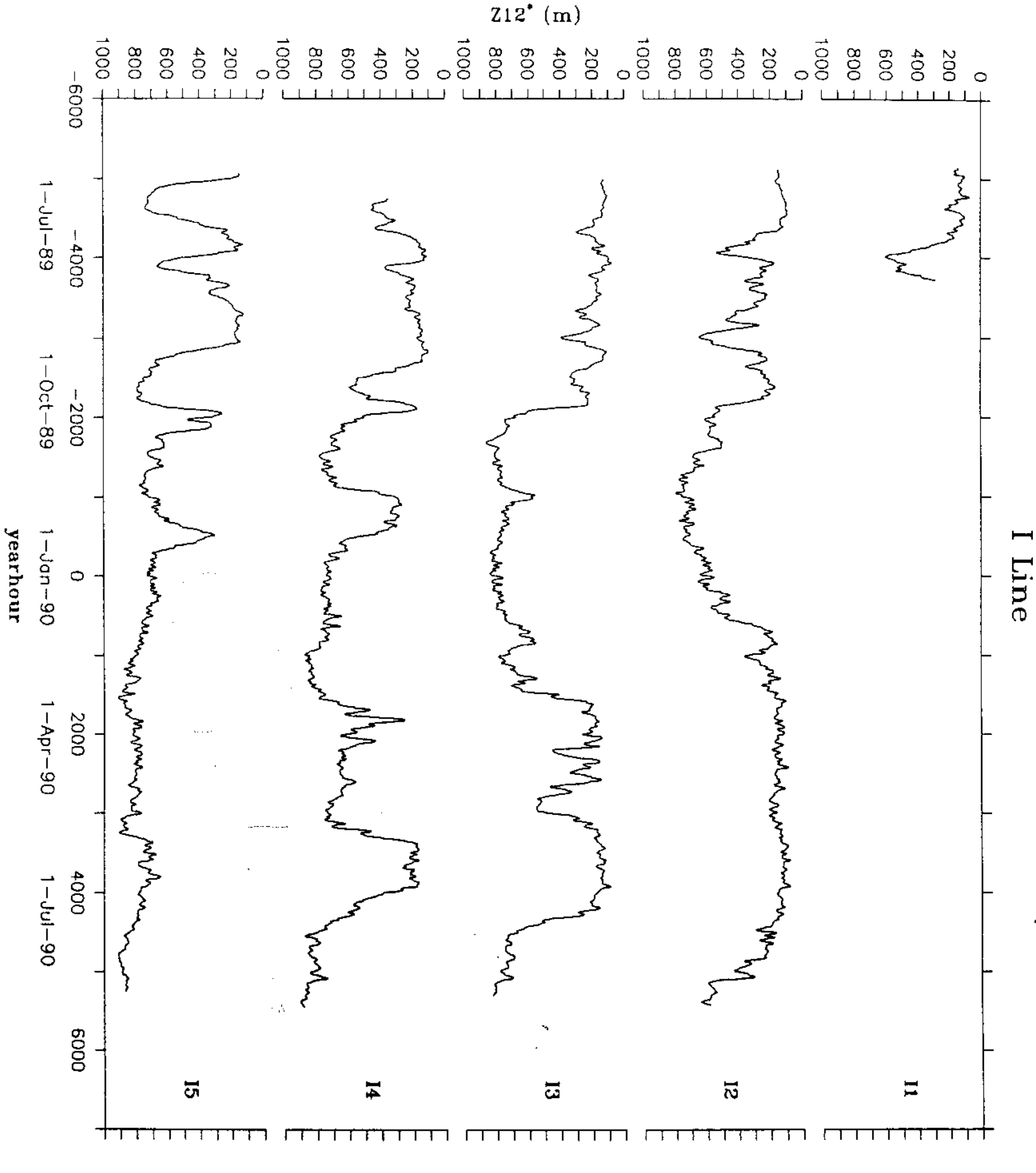


Figure 16.7: 40HRLP Z_{12}. I line

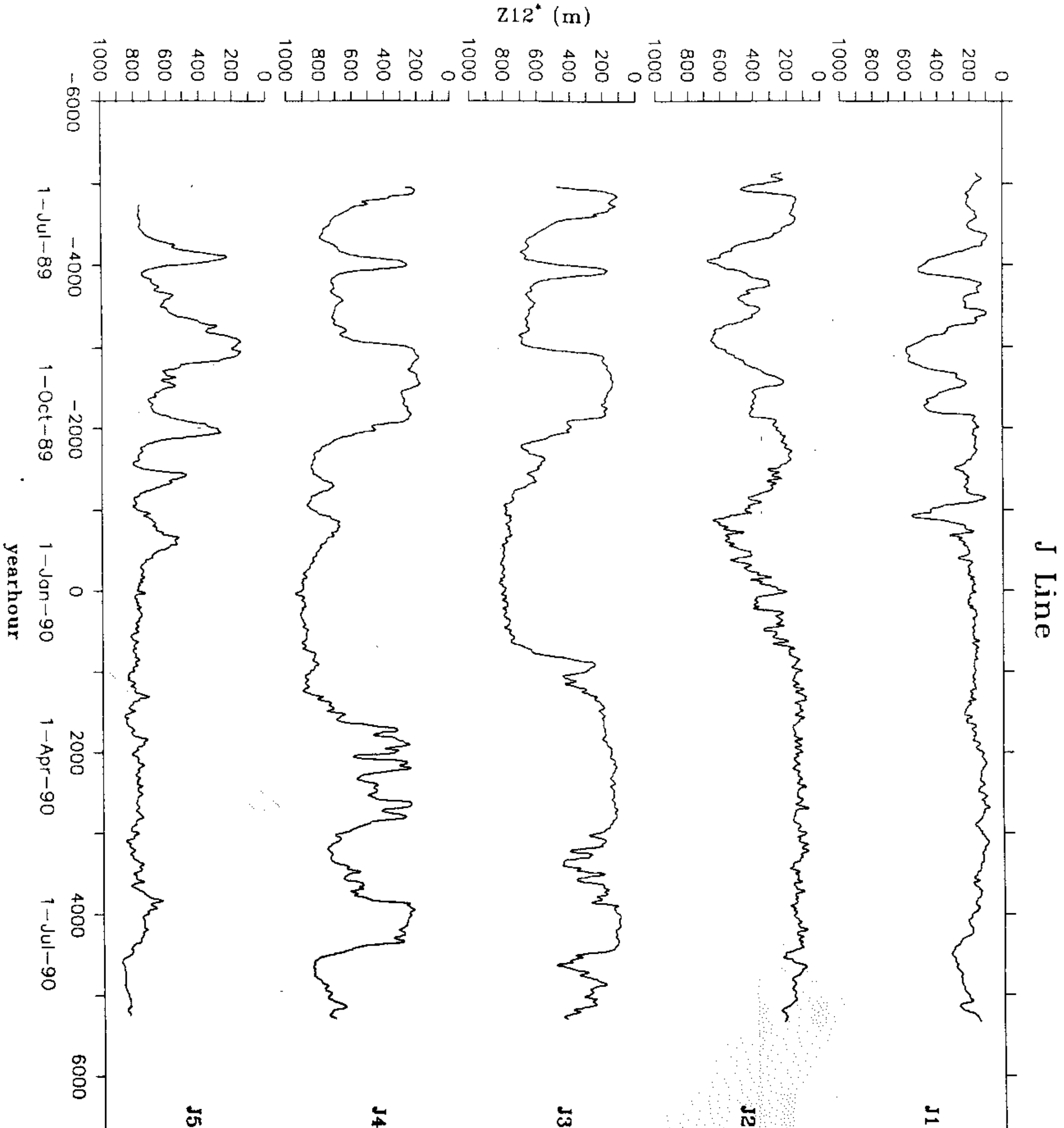


Figure 16.8: 40HRLP Z_{12}. J line

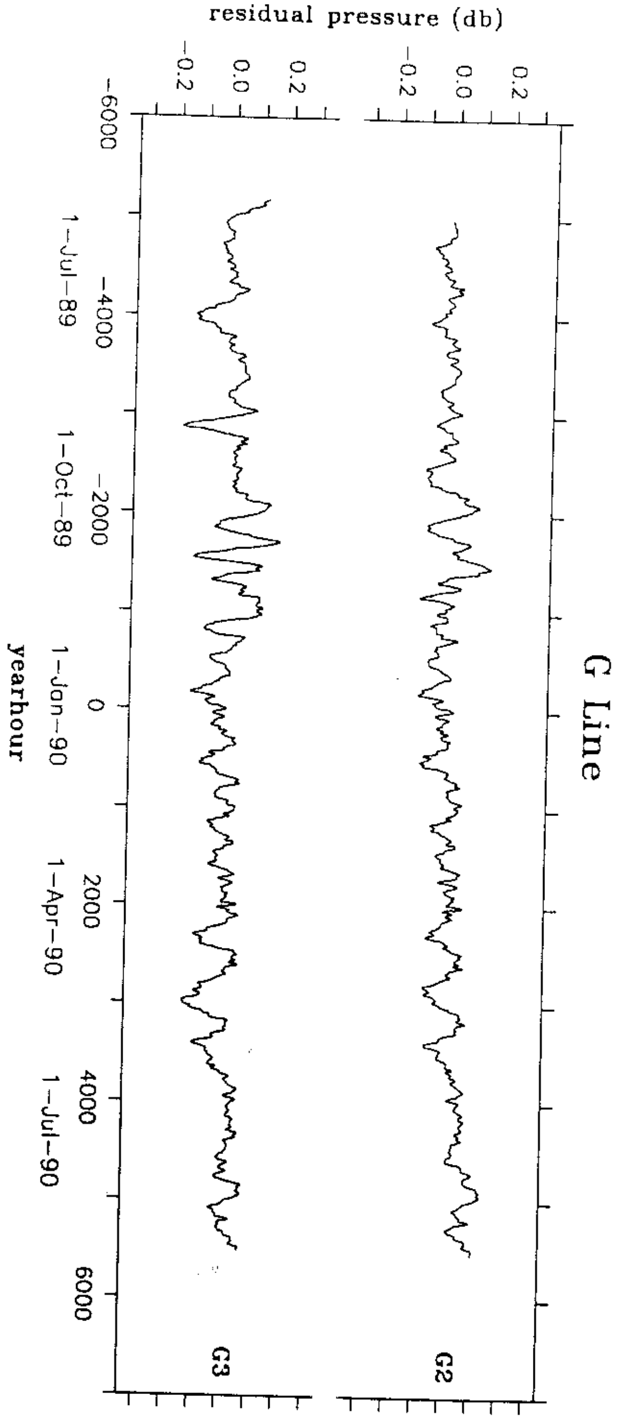


Figure 17.1: 40HRLP Residual Bottom Pressure. G line

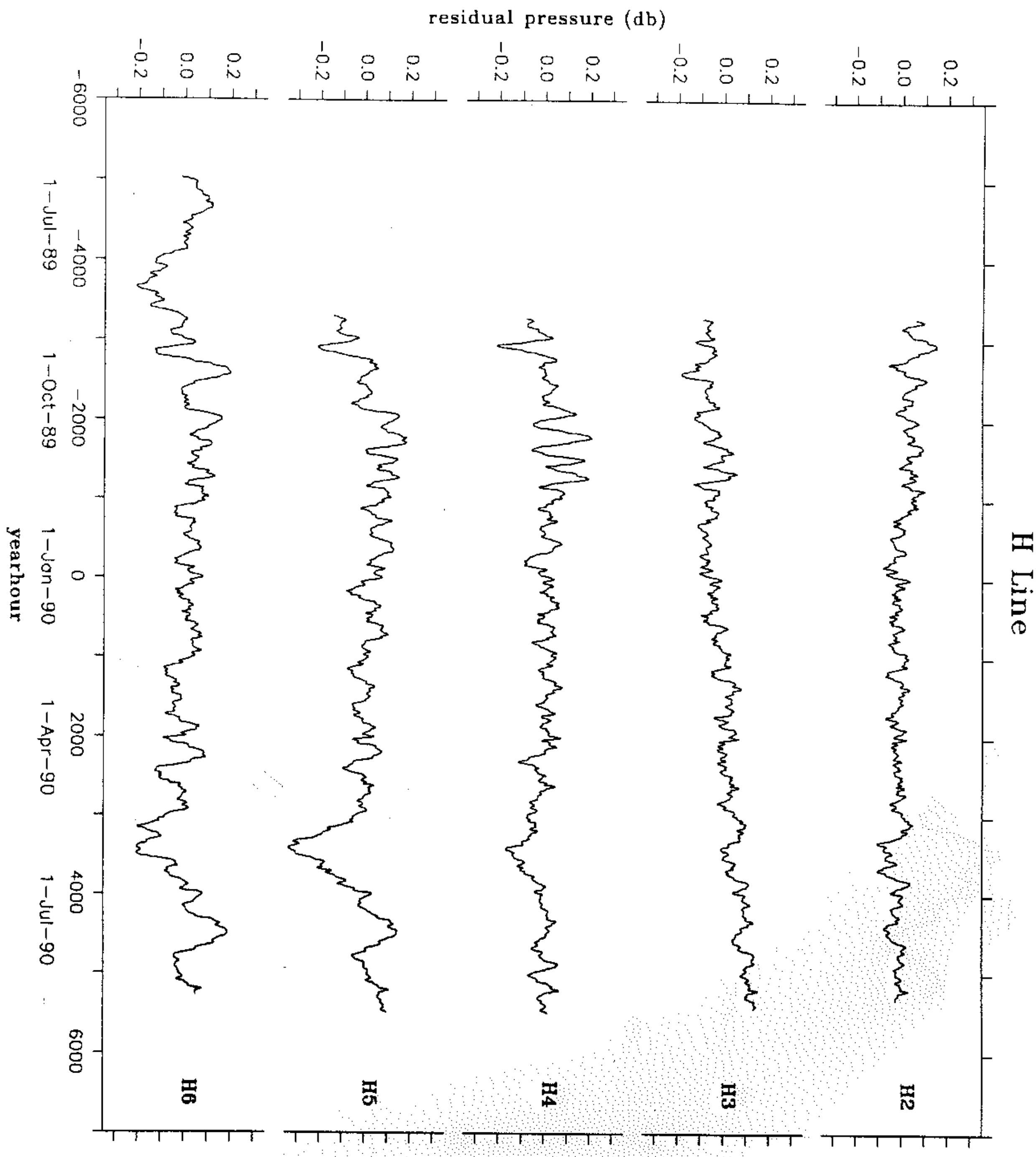


Figure 17.2: 40HRLP Residual Bottom Pressure. H line

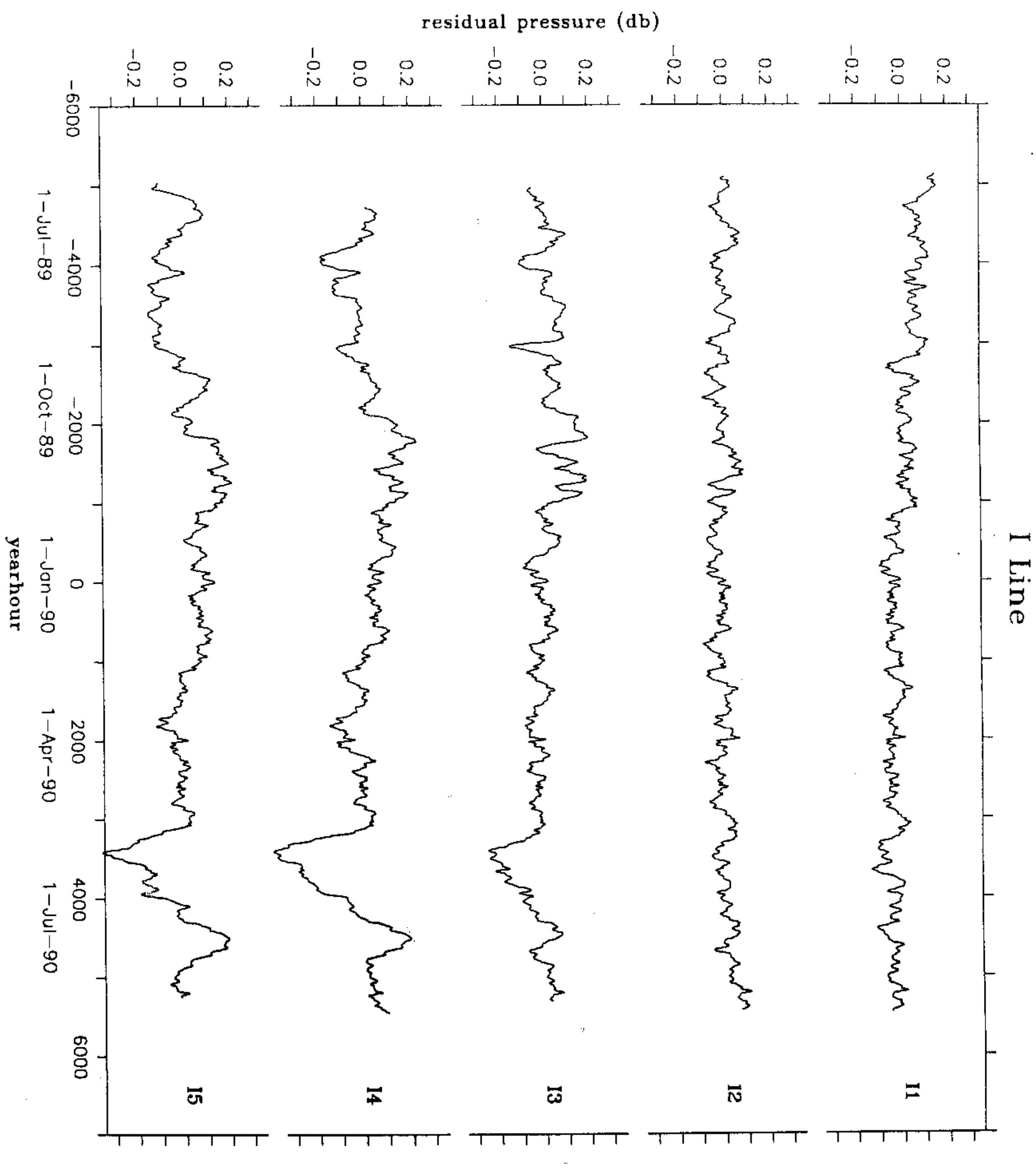


Figure 17.3: 40HRLP Residual Bottom Pressure. I line

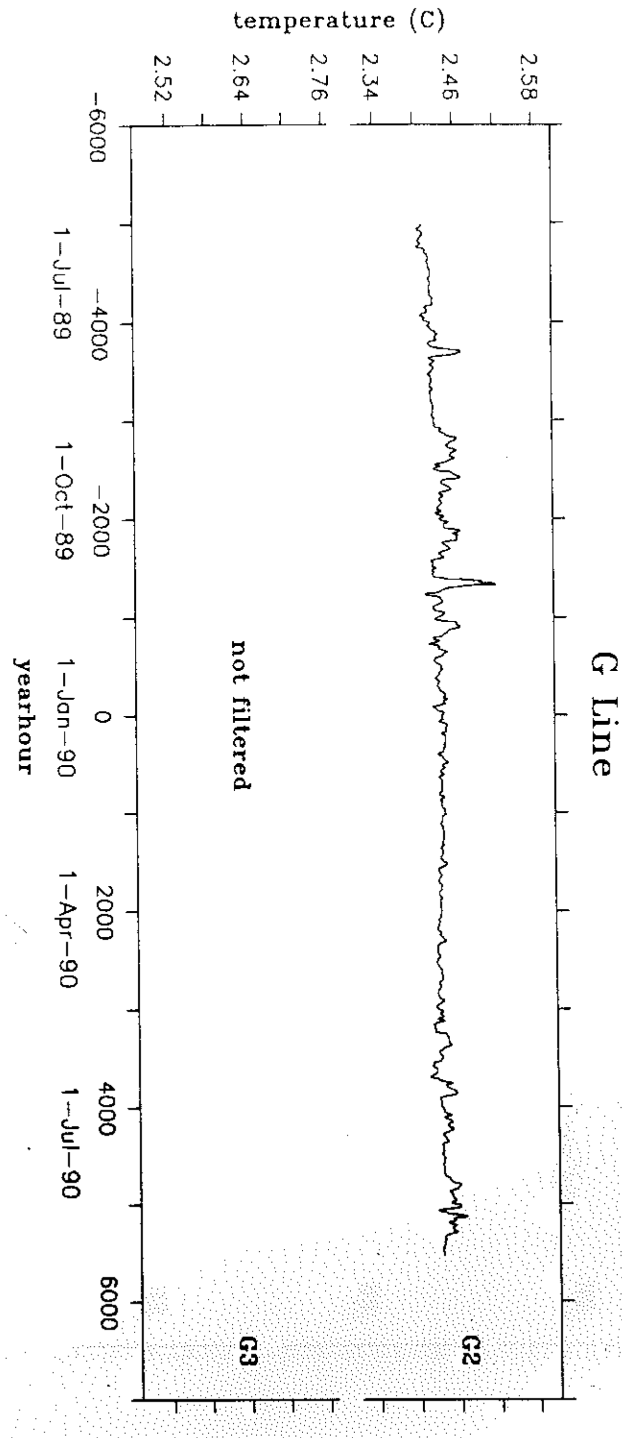


Figure 18.1: 40HRLP Temperature. G line

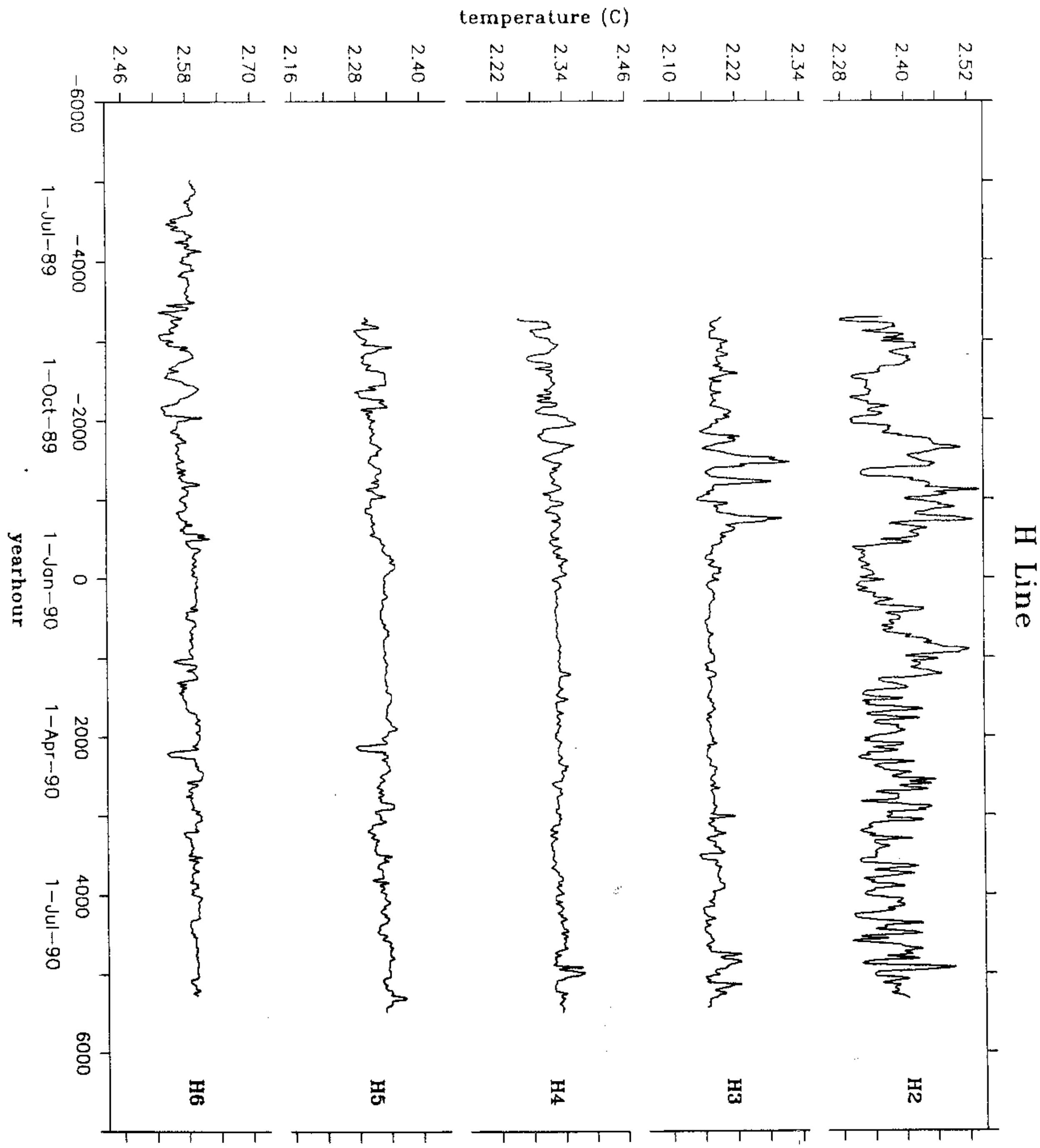


Figure 18.2: 40HRLP Temperature. H line

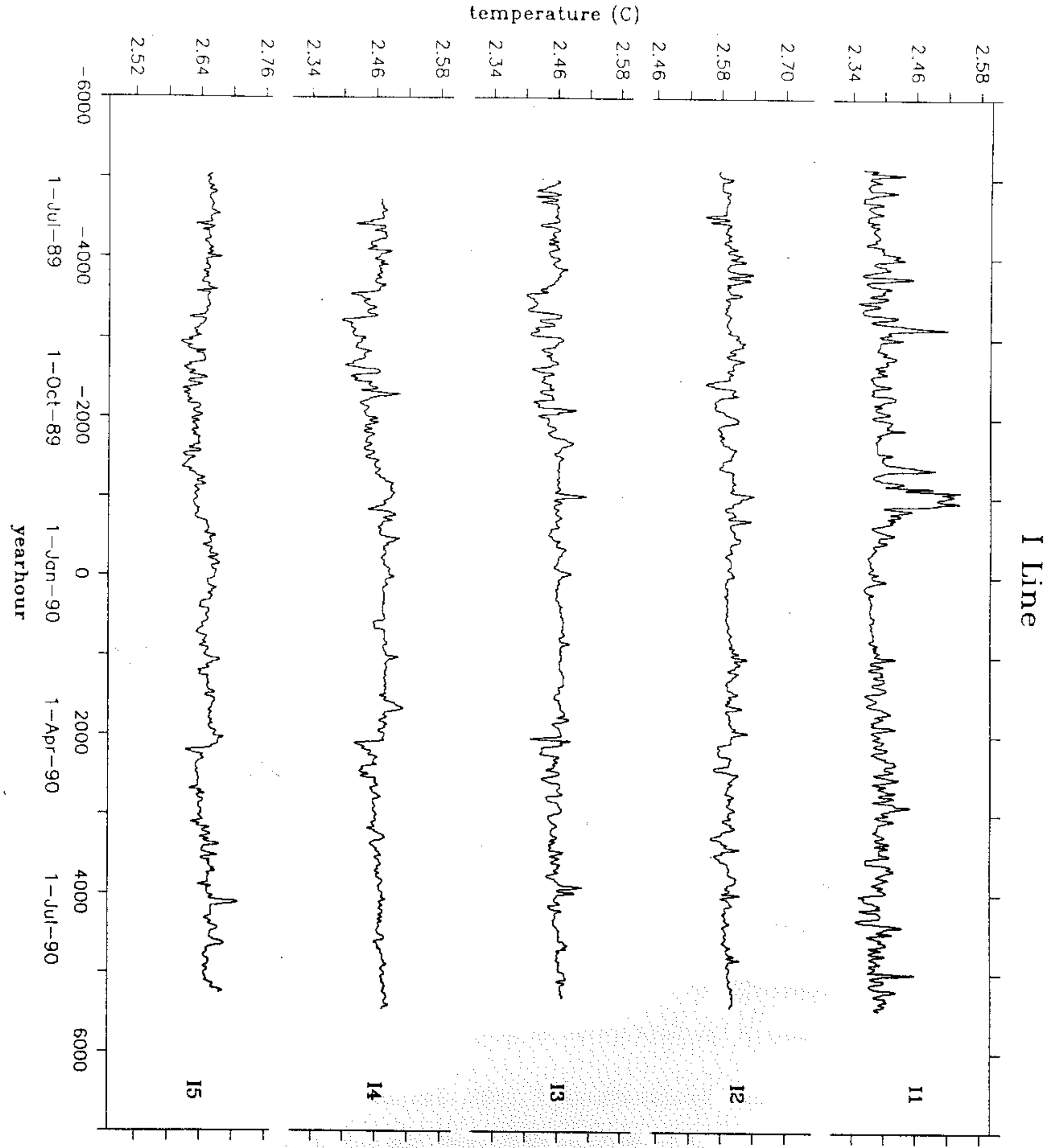


Figure 18.3: 40HRLP Temperature. I line

Acknowledgments

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