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HISTORIC HYDROGRAPHIC AND METEOROLOGICAL DATA FROM THE NORTH ATLANTIC AND SOME DERIVED QUANTITIES

VON

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Summary

Historic hydrographic and meteorological data from the North Atlantic have been received from the National Oceanographic Data Center (Washington, D.C., USA) and the Woods Hole Oceanographic Institute (Woods Hole, Ma., USA), respectively. The hydrographic data have been sorted by 5- and 10-degree squares and by months and years.

Yearly averages of temperature, of temperature anomalies about the mean seasonal signal, of salinity and potential density within 5-degree squares have been compiled as well as climatological mean temperature (0 - 500 m) and potential density (0 - 5000 m) on a 5-degree grid. Brunt Väisälä frequency profiles have been computed from a 10-degree averaging of the potential density climatology, and first baroclinic mode velocity eigenfunctions were subsequently derived. Yearly time series of sub-surface temperature (250 - 500 m) on a 5-degree grid for 26 years (1948 - 1973) are also available.

The meteorological data are monthly time series (January 1948 - December 1972) of various sea level quantities averaged within 10-degree squares. Air and sea surface temperature, wind velocity and stress, sea level pressure, rainfall and ice coverage, and various heat fluxes through the sea surface are presented.

Zusammenfassung

Historische hydrographische und meteorologische Daten des Nordatlantiks wurden vom National Oceanographic Data Center (Washington, D.C., USA) bezogen. Die hydrographischen Daten wurden in 5- und 10-Grad Felder nach Monaten und Jahren unterteilt.

Erstellt wurden die Jahresmittel der Temperatur, der Anomalie der Temperatur zum saisonalen Mittel, des Salzgehaltes und der potentiellen Dichte für 5-Grad Felder, sowie Langzeitmittel der Temperatur (0 - 500 m) und der potentiellen Dichte (0 - 5000 m) auf einem 5-Grad Gitter. Profile der Brunt-Väisälä-Frequenz wurden aus den Langzeitmitteln der potentiellen Dichte aus 10-Grad Feldern berechnet, und daraus wurde die erste barokline Mode der Geschwindigkeits-Eigenfunktionen erzeugt. Jährliche Zeitreihen der Temperatur unterhalb der Deckschicht (250 - 500 m) sind auf einem 5-Grad Gitter für 26 Jahre (1948 - 1973) verfügbar.

Die meteorologischen Daten bestehen aus monatlichen Zeitreihen (Januar 1948 - Dezember 1972) verschiedener Parameter an der Meeresoberfläche in 10-Grad Feldern. Präsentiert werden Luft- und Meeresoberflächentemperatur, Windgeschwindigkeit und Windschubspannung, Luftdruck an der Meeresoberfläche, Niederschlag und Eisbedeckung sowie verschiedene Wärmeflüsse durch die Meeresoberfläche.

INTRODUCTION

In the winter of 1981, the Institut für Meereskunde (IfM), Kiel, took delivery of several full-reel magnetic tapes containing the most current, available North Atlantic hydrographic data from the National Oceanographic Data Center (NODC) in Washington, D.C., USA. This data consists of expendable bathythermograph (XBT), mechanical bathythermograph (MBT), and hydrocast data (eg. Nansen bottle casts) taken at various times and at various locations. The area of data coverage is the region (0^{o} to 70^{o}N; 0^{o} to 90^{o}W) plus a 10-degree latitude by 10-degree longitude ("10-degree square") region encompassing the western half of the Gulf of Mexico. The time interval of data coverage is from 1900 through 1978 for the hydrocasts and from 1900 through the middle of 1981 for the XBT and MBT observations.

The purpose of collecting this data was to study the large space- and time-scale temperature and density fluctuations in the North Atlantic. Thus, the data processing initially performed on these NODC tapes was the extraction of temperature, salinity and depth information and sorting by 10-degree squares, by 5-degree squares and by years and months. The original tapes have more detailed information: longitude and latitude of casts, exact calendar dates of casts, calibration of instruments information, the research ship's name and nationality, etc., as well as other observed parameters such as dissolved oxygen, silicone and nitrogen concentrations, etc.. All of this information was excluded in the initial data processing.

The user who needs this additional information must use the original NODC tapes. All other users may use the sorted temperature and salinity data, which exist on magnetic tapes for use with either the Control

Data PDP-11/VAX system at the IfM or the Control Data PDP-10 computer at Kiel University.

In addition to the above hydrographic data, a North Atlantic meteorological data set has been acquired from the Woods Hole Oceanographic Institution, USA. This data, compiled by the late Andrew Bunkers, consists of time and space averages of air and sea surface temperature, air pressure, wind velocity, rainfall, ice coverage and various sea surface heat fluxes averaged by months and 10-degree squares. The area of data coverage essentially overlaps that of the hydrographic data, but includes the zone 70^{o} - 80^{o}N and a few 10-degree squares east of the Greenwich meridian. The time interval of data coverage is from January 1948 through December 1972.

This report catalogs the various data tapes and shows the user how to read them. It also catalogs and describes some derived data fields of general interest and how to access them.

The user is urged to obtain a copy of the most current version of the Users Guide to NODC's Data Services, from the National Oceanographic Data Center, Environmental Data Service, NOAA, Washington, D.C. 20235, USA. A few copies may still be available in the Theoretische Ozeanographie, Regionale Ozeanographie, or Meeresphysik Departments. One should also request the record description information for their new XBT and MBT data formats; the XBT and MBT data formats described in the current (February, 1974) version are no longer in use. Hopefully, the next version will contain only the new formats. The record description for the hydrocasts (called "Station Data II" by NODC) in the February 1974 version are, as of this writing, still in use.

The user is also urged to obtain a copy of Archived Time-Series of Atlantic Ocean Meteorological Variables and Surface Fluxes by Andrew F. Bunker and Roger A. Goldsmith, Woods Hole Technical Report Number

WHOI-79-3, from the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543, USA. The Maritime Meteorologie department should have at least one copy of this booklet and is compiling an atlas based upon another version of this data (Bunker, 1976).

I. Original NODC Data Tapes

The original data tapes are all in ASCII code, but they could not be read directly by either the PDP-11/VAX at the institute or the PDP-10 computer on the Kiel University campus. They all had to be translated first using the IfM standard program "TRNRSX". The data on the original tapes are already geographically sorted by NODC designated ocean areas and by 10 x 10-degree squares, according to the modified Canadian system. (see the User's Guide to NODC's Data Services, revised February, 1974, Washington, D.C., USA, pages 32 and 33 and see the supplementary map, called "attachment-1"). The face of each reel has a paper label indicating in which ocean area its data was observed. The data on each tape are sequentially sorted by these 10-degree squares. It is important to note that data from the end of one tape is usually from the same 10-degree square as the data from the beginning of the next tape (the tape sequence is indicated by the order of the tape numbers presented in tables 1 - 3). It should also be noted that on the tapes containing the XBT data, data from a single 10-degree square may be found at several locations on one tape as well as being split onto two tapes as just described above. (This silliness was due to the many problems NODC had during the course of relocating into another facility with another computer, which occurred while they were processing this data for us.)

The geographic density of data coverage is presented in figure 1. The approximate base 10 logarithms of the number of hydrocasts, MBTs, and

XBTs in each 10-degree square are shown.

I.1. Original NODC Hydrocast Data Tapes

Each tape has three files. The first and third files, which the user may ignore, always contain "header" and "trailer" information, respectively. The second (middle) file always contains the data.

In the second file of the hydrocast tapes, the first 12 bytes of each physical block contain more "header" information, which may be skipped. (All this "header" and "trailer" information is for NODC internal management.) The rest of the block consists of several contiguous logical records of 80 bytes in length. The number of 80-byte records per block is variable.

Those users who only need temperature, salinity and depth information with 10- or 5-degree spatial resolution and year or month temporal resolution, need not use the original tapes. They can use the abridged version of these data, available for either the institute's PDP-11/VAX or the University's PDP-10 computer.

The abridged data are described in section II.1. .

Those users who need the information not in the abridged version (eg. water chemistry, latitudes and longitudes of the casts, calendar dates of the casts, etc.) must use the original data tapes from NODC. They must first translate the tapes needed at the IfM with the standard program [40,40] TRNRSX, specifying that the second file is to be translated, the first 12 bytes of each block are to be skipped, and that the record length is 80. The translated data may then be read using the data format described in the NODC user's guide.

There are four kinds of records. The first is the "master information" which gives the geographic location and date of the cast, the research ship's name and nationality and other information. This record is identified by a "1" in the 80th byte. The second kind is a continuation of the "master information" and contains some water chemistry, meteorological information, etc., and is identified by a "2" in the 80th byte. The third kind is the "observed depth information" and contains the observed temperature, and salinity as well as oxygen, phosphate, silicate, nitrite and nitrate concentration at the actual sample depth. It is identified by a "3" or "5" in the 80th byte. The fourth kind is the "standard depth information" and contains temperature, salinity and oxygen concentration interpolated onto the Sverdrup standard depths via the 3-point Lagrange interpolation formula. It also contains the dynamic depth anomaly computed from the interpolated temperature and salinity and is identified by a "6" or "7" in the 80th byte. Type "1" is always the first record and is always followed by type "2", which in turn is followed by the data records in no particular order, which are followed by a type "1" record for the next "batch" of observations. The 79th byte always contains the record type of the following record.

The hydrocasts are sometimes "split" into two or more "batches". Thus one "batch" of observations might have data from the surface to 500 meters, followed by a second "batch" with observations from 600 meters to 1500 meters, etc.. If it is important for the user to identify individual casts, he/she must carefully compare the information in the type "1" records as they should be almost identical for a given cast. Also it is possible that no data follows the "master information". This happens only infrequently, however.

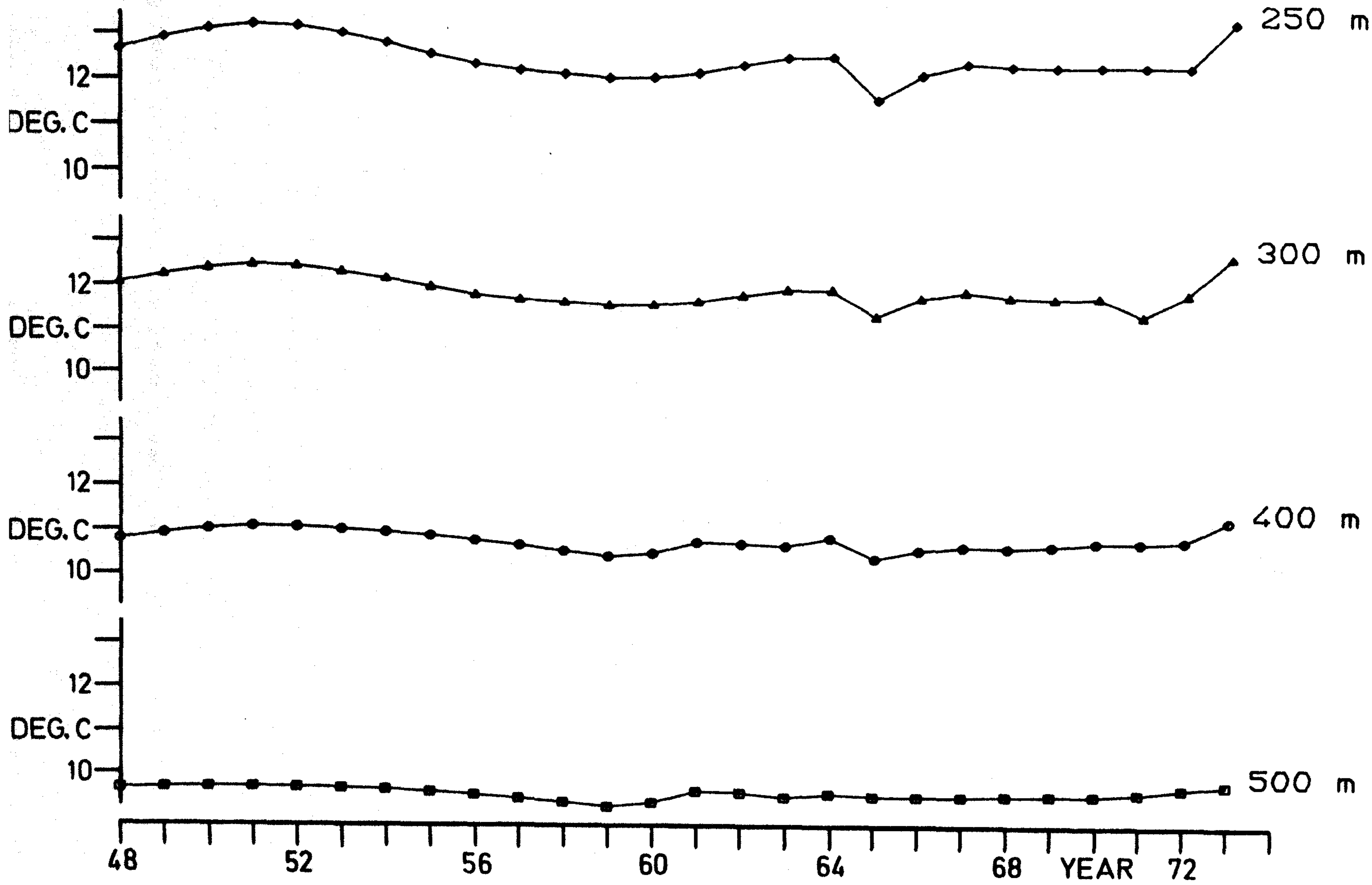
The original NODC tapes containing hydrocast data are listed in table 1 along with the 10-degree squares from where the observations were made. The 10-degree squares are identified by "modified Canadian" numbers (see Users Guide to NODC's Data Services). The sequential order of these tapes is important because the data from the end of one tape is usually continued at the beginning of the next tape. Note also that the sequence of "modified Canadian" numbers, shown in table 1, is not always monotonic. The reference letters in table 1 are used in section II.1..

Table 1:

Tape No.	Ref.	10-degree squares
006421	A	902-910; 1003-1008
006412	B	1008-1010; 1103-1110
006409	C	1110-1111; 1202-1206
006462	D	1206-1209
006486	E	1209-1210; 1303-1306
006487	F	1306-1308
006433	G	1308-1309; 1403
006470	H	1403-1408
006417	I	909-910
002988	J	1302; 1402
003011	K	1402
003976	L	1409-1410; 1502-1503
003993	M	1503-1510

NODC hydrocast tapes and regions of data coverage, indicated by "modified Canadian" 10-degree square numbers. The letters are abbreviated tape references.

TEMPERATURE AT (17.5N,22.5W)



I.2. Original NODC MBT and XBT Data Tapes

Each tape has three files. The first and third files, which the user may ignore, always contain "header" and "trailer" information, respectively. The second (middle) file always contains the data.

The record lengths in the second file are large and variable. This is a problem for the PDP-11/VAX software and is discussed later in this section.

Those users who only need temperature and depth information with a 10- or 5-degree spatial resolution and year or month temporal resolution need not use the original tapes. They can use the abridged version of these data, available for either the institute's PDP-11/VAX or the University's PDP-10 computer. The abridged data are described in section II.2..

Those users who need the information not in the abridged version (eg. calibration information, latitudes and longitudes of the casts, calendar dates of the casts, etc.) must use the original data tapes from NODC.

The record formats for the MBT and XBT observations described in the 1974 version of the <u>Users Guide to NODC's Data Services</u> are no longer in use and do not describe the data archived on these tapes. The user must consult the supplementary record documentation for the "Univac-BT" data, available from NODC (and IfM, in limited guaranties).

As mentioned above, the records are long and of variable length. The length is usually too long for the PDP-11/VAX software to handle, and the non-uniformity in length is not immediately compatible with the IfM standard program [40,40] TRNRSX, used to translate the original tapes. It is recommended that TRNRSX be used, specifying that the second file is to be translated, no bytes should be skipped, and that the record length is 100, since the first 100 bytes of each record are the cast documentation and are followed by the observations (depth-temperature pairs in fixed (A4,A4) format). The user then can either write his/her own program to extract the desired information or modify the program [40,141]MBTTEN.FTN to do the same. Program [40,141]MBTTEN.FTN was used to generate the abridged data sets but can be easily modified to extract other information from the translated data. (MBTTEN.FTN is fairly well documented in the archived source file in disc area [40,141]. A "task" file can be found in [40,40].)

> The same cautionary note given for the hydrocasts (section I.1) applies to the MBT and XBT data as well.

The user should also be aware that MBTTEN.FTN truncates the insignificant digit in the temperature. The original NODC records have temperature written in four digits. The fourth digit represents 1/100 of a degree Celsius, which is smaller than instrument error and has been truncated (not rounded-off) in the abridged MBT and XBT data for storage space economy.

The original NODC tapes containing MBT data are listed in table 2; XBT data, in table 3. The 10-degree squares from where the observations were made, identified by "modified Canadian" numbers (see <u>Users Guide to NODC Data Services</u>), are also listed. The sequential order of these tapes is important because the data from the end of one tape is usually continued at the beginning of the next tape. Note also that the sequence of the "modified Canadian" numbers in table 3 is not always monotonic. The reference letters in tables 2 and 3 are used in section II.2..

Table 2

Tape No.	Ref.	10-degree squares
002200	A	902-910; 1003-1010; 1103-1104
002459	B	1104-1110
002616	C	1110-1111; 1202-1206
002749	D	1206-1208
003717	E	1208-1209
003803	F	1209
004049	G	1209-1210
002247	H	1302-1307
002435	I	1307-1308
002449	J	1308
002498	K	1308-1309
002642	L	1309-1310; 1402-1405
002653	M	1405-1410; 1502-1509
002670	N	1509-1510

NODC MBT tapes and regions of data coverage, indicated by "modified Canadian" 10-degree square numbers. The letters are abbreviated tape references.

Table 3

Tape No.	Ref.	10-degree squares
002338	A	902-907; 909-910 1003-1010; 1103-1109; 1208
002508	B	1109-1111; 1202-1205; 1209
002738	C	1205-1209
002866	D	1209-1210; 1302-1308
003036	E	1308-1309; 1402-1409; 1502-1508

NODC XBT tapes and regions of data coverage, indicated by "modified Canadian" 10-degree square numbers. The letters are abbreviated tape references.

II. Translated and abridged data tapes

These tapes contain temperature, salinity and depth information within indicated 10- and 5-degree squares and within indicated years and months. All other information contained in the original hydrographic tapes have been deleted. They may be read directly by the PDP-11/VAX or PD-10 computer and offer an economy in data storage for the user who does not need the deleted information.

II.1. Translated and Abridged Hydrocast Data Tapes

Temperature, salinity and depth information has been extracted from the original NODC hydrocast tapes and is available on other tapes for direct use (i.e. without further translation) on the PDP-11/VAX and PDP-10 computers. The data on the PDP-10 tapes are better organized than the data on the PDP-11/VAX tapes, and, therefore, the PDP-10 tapes are recommended. The PDP-11/VAX tapes, however, are not poorly organized and can be easily used.

The following (skelleton) Fortran program may be used to read either the PDP-11/VAX or the PDP-10 tapes.

```
      DIMENSION IZ(34),IT(34),IS(34)
      OPEN (UNIT=1, ... )
   90 READ (1,100,END=500) MRSQ,IFIVE,IYR, MON, ISYMBL,ICOUNT
  100 FORMAT (I4,I1,2I2,A1,I2)
      DO 110 I=1,ICOUNT
  110 READ (1,120) IZ(I),IT(I),IS(I)
  120 FORMAT (3I4)
      .        .        .        .
      .        .        .        .
      .        .        .        .
      GO TO 90
  500 CONTINUE
      CLOSE (UNIT=1)
      .        .        .        .
      .        .        .        .
      .        .        .        .
      END
```

The variables in this routine are:

MRSQ = "modified Canadian" 10-degree square designation (eg. 1209)
See pages 32 and 33 of the NODC user's guide.

IFIVE = 5-degree subdivision of the 10-degree square. (1,2,3,or 4).
See page 34 of the NODC user's guide.

IYR = Calender year of observation (00,01,02,...,81) = (1900,...,1981)

MON = Calender month of observation (1,2,3,...,12) = (Jan.,Feb.,...,Dec.)

ISYMBL = "$" = dollar sign. This is a record identification mark.

ICOUNT = The number of (depth, temperature, salinity) triplets to follow.

IZ = depth in meters (eg. 1500). These are the Sverdrup standard depths.

IT = temperature in degrees Celsius multiplied by 100 (eg. 1426=14.26 degrees C.). Missing data is indicated by "9999".

IS = salinity (old system, ie. pre-UNESCO system) in parts per mille multiplied by 100 (eg. 3547=35.47 0/00). Missing data is indicated by "9999".

The following tables catalog the abridged hydrocast data available for use with the PDP-10 (table 4) or the PDP-11/VAX (table 5). Note that each tape file contains data from only one 10-degree square. The file names in table 5 are all of the same structure. They all begin with "SD" (station data), followed by a four digit number designating the 10-degree square from where the observations were made, followed by a file name extension containing the reference letter of the original NODC tape (table 1) from where the data was obtained. The sequence of file names is not always monotonic.

Table 4

Tape No.	File No.s	10-degree squares
360216	1-9	902-910
"	10-17	1003-1010
"	18-26	1103-1111
"	27-35	1202-1210
360217	1-8	1302-1309
"	9-17	1402-1410
360218	1-9	1502-1510

Abridged hydrocast data available on the PDP-10. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers.

Table 5

Tape No.	File No.s	File Names
MTH157	1-9	SD 902.00A, SD 903.00A,..., SD 910.00A (note the blank after each "SD")
"	10-15	SD1003.00A, SD1004.00A,..., SD1008.00A
"	16-18	SD1008.00B, SD1009.00B, SD1010.00B
"	19-26	SD1103.00B, SD1104.00B, SD1110.00B
"	27-28	SD1110.00C, SD1111.00C
"	29-33	SD1202.00C, SD1203.00C,.., SD1206.00C
"	34-37	SD1206.00D, SD1207.00D,..., SD1209.00D
MTH158	1-2	SD1209.00E, SD1210.00E
"	3-6	SD1303.00E, SD1304.00E,..., SD1306.00E
"	7-8	SD1306.00F, SD1307.00F
"	9-11	(useless files - skip these files)
"	12-13	SD1307.00F, SD1308.00F
"	14-15	SD1308.00G, SD1309.00G
"	16	SD1403.00G
"	17-22	SD1403.00H, SD1404.00H,..., SD1408.00H
MTH159	1-2	SD 909.00I, SD 910.00I (note the blank after each "SD")
"	3	SD1302.00J
"	4-5	SD1402.00J, SD1402.00K
"	6-7	SD1409.00L, SD1410.00L
"	8-9	SD1502.00L, SD1503.00L
"	10-17	SD1503.00M, SD1504.00M,... SD1510.00M

Abridged hydrocast data available on the PDP-11/VAX. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers, incorporated within the file names between "SD" and the file name extensions. The letters in the file name extension indicate the original NODC tapes (table 1) from where the data was obtained.

The PDP-10 tapes are in the standard blocksize of 640 bytes per block. The PDP-11/VAX tapes were written in 512 bytes per block.

There are copies of the PDP-10 tapes 360216, 360217, and 360218; they are 360219, 360220, and 360221, respectively.

II.2. Translated and Abridged MBT and XBT Data Tapes

Temperature and depth information has been extracted from the original NODC MBT and XBT tapes and is available on other tapes for direct use (ie. without further translation) on the PDP-11/VAX and PDP-10 computers.

As mentioned in section I.2., the original NODC data has temperature written in four figures, where the last digit represents 1/100 of a degree Celsius. Since this is smaller than instrument error and since an economy in storage space was needed, the last digit was truncated (not rounded-off).

The truncation produced some high-latitude temperature records that, at first glance, look erroneous. Sometimes three blanks appear or two blanks preceding a minus sign. The user should not worry about these strange-looking records, because both the PDP-10 and PDP-11/VAX computers will appropriately interpret such records as representing temperatures of zero degrees.

The following (skelleton) Fortran program may be used to read either the PDP-11/VAX or the PDP-10 tapes.

```
      DIMENSION IZ(500),IT(500)
      OPEN(UNIT=1,...)
   90 READ(1,100,END=500)MRSQ,ISYMBL,IFIVE,IYR,MON,ICOUNT
  100 FORMAT(I4,A1,I1,2I2,I4)
      DO 110 I=1,ICOUNT
  110 READ(1,120)IZ(I),IT(I)
  120 FORMAT(I4,I3)
      .        .        .        .
      .        .        .        .
      .        .        .        .
      GO TO 90
  500 CONTINUE
      CLOSE(UNIT=1)
      .        .        .        .
      .        .        .        .
      .        .        .        .
      END
```

The variables in this routine are described in section II.1. but with the following modifications.

ICOUNT = the number of (depth, temperature) pairs to follow.

IZ = depth in meters (eg. 1565). These are not necessarily Sverdrup standard depths.

IT = temperature in degrees Celsius multiplied by 10 (eg. 142 = 14.2 degrees C.).

The following tables catalog the abridged MBT and XBT data available for use with the PDP-10 (tables 6 and 7) or the PDP-11/VAX (tables 8 and 9). Note that each tape file contains data from only one 10-degree square. The file names in tables 8 and 9 are all of same structure. They all begin with "SD" (station data), followed by a four digit number designating the 10-degree square from where the observations were made, followed by a file name extension containing the reference letter of the original NODC tape (tables 2 and 3) from where the data was obtained. The sequence of file names is not always monotonic. This is especially true of the XBT tapes, where data from a single 10-degree square may be found in several files.

Table 6

Tape No.	File No.s	10-degree Squares
360271	1-9	902-910
"	10-17	1003-1010
"	18-19	1103-1104
360272	1-7	1104-1110
360273	1-2	1110-1111
"	3-7	1202-1206
360274	1-3	1206-1208
360264	1-2	1208-1209
360265	1	1209
360266	1-2	1209-1210
"	3-8	1302-1307
360267	1-2	1307-1308
360268	1	1308
360269	1-2	1308-1309
360275	1-2	1309-1310
"	3-6	1402-1405
360276	1-6	1405-1410
"	7-14	1502-1509
"	15-16	1509-1510

Abridged MBT data available on the PDP-10. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers.

Table 7

Tape No.	File No.s	10-degree Squares
360277	1-6	902-907
"	7-8	909-910
"	9-16	1003-1010
"	17-23	1103-1109
"	24-27	1108,1109,1108,1109
"	28-31	1108,1208,1108,1208
"	32-33	1108,1109
360278	1-2	1109,1209
"	3-5	1109,1110,1111
"	6-9	1202-1205
360279	1-5	1205-1209
"	6-9	1208,1209,1208,1209
"	10-13	1208,1209,1210,1209
360280	1-2	1209,1210
"	3-9	1302-1308
360281	1-2	1308-1309
"	3-10	1402-1409
"	11-17	1502-1508

Abridged XBT data available on the PDP-10. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers.

Table 8

Tape No.	File No.s	File Names
MTH161	1-9	SD0902.00A, SD0903.00A,..., SD0910.00A
"	10-17	SD1003.00A, SD1004.00A,..., SD1010.00A
"	18-19	SD1103.00A, SD1104.00A
MTH162	1-7	SD1104.00B, SD1105.00B,..., SD1110.00B
MTH163	1-2	SD1110.00C, SD1111.00C
"	3-7	SD1202.00C, SD1203.00C,..., SD1206.00C
MTH164	1-3	SD1206.00D, SD1207.00D, SD1208.00D
MTH165	1-2	SD1208.00E, SD1209.00E
MTH166	1	SD1209.00F
MTH167	1-2	SD1209.00G, SD1210.00G
"	3-8	SD1302.00H, SD1303.00H,..., SD1307.00H
MTH171	1-2	SD1307.00I, SD1308.00I
MTH168	1	SD1308.00J
MTH169	1-2	SD1308.00K, SD1309.00K
MTH170	1-2	SD1309.00L, SD1310.00L
"	3-6	SD1402.00L, SD1403.00L,..., SD1405.00L
MTH172	1-6	SD1405.00M, SD1406.00M,..., SD1410.00M
"	7-14	SD1502.00M, SD1503.00M,..., SD1509.00M
"	15-16	SD1509.00N, SD1510.00N

Abridged MBT data available on the PDP-11/VAX. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers, incorporated within the file names between "SD" and the file name extensions. The letters in the file name extensions indicate the original NODC tapes (table 2) from where the data were obtained.

Table 9

Tape No.	File No.s	File Names
MTH173	1-6	SD0902.00A, SD0903.00A,..., SD0907.00A
"	7-8	SD0909.00A, SD0910.00A
"	9-16	SD1003.00A, SD1004.00A,..., SD1010.00A
"	17-23	SD1103.00A, SD1104.00A,..., SD1109.00A
"	24-27	SD1108.00A, SD1109.00A, SD1108.00A, SD1109.00A
"	28-31	SD1108.00A, SD1208.00A, SD1108.00A, SD1208.00A
"	32-33	SD1108.00A, SD1109.00A
MTH174	1-2	SD1109.00B, SD1209.00B
"	3-5	SD1109.00B, SD1110.00B, SD1111.00B
"	6-9	SD1202.00B, SD1203.00B,..., SD1205.00B
MTH175	1-5	SD1205.00C, SD1206.00C,..., SD1209.00C
"	6-9	SD1208.00C, SD1209.00C, SD1208.00C, SD1209.00C
"	10-13	SD1208.00C, SD1209.00C, SD1210.00C, SD1209.00C
MTH176	1-2	SD1209.00D, SD1210.00D
"	3-9	SD1302.00D, SD1303.00D,..., SD1308.00D
MTH177	1-2	SD1308.00E, SD1309.00E
"	3-10	SD1402.00E, SD1403.00E,..., SD1409.00E
"	11-17	SD1502.00E, SD1503.00E,..., SD1508.00E

Abridged XBT data available on the PDP-11/VAX. The regions of data coverage are indicated by "modified Canadian" 10-degree square numbers, incorporated within the file names between "SD" and the file name extensions. The letters in the file name extensions indicate the original NODC tapes (table 3) from where the data were obtained.

The PDP-10 tapes are in the standard block size of 640 bytes per block. The PDP-11/VAX tapes were written in 2048 bytes per block with the single exception of tape MTH161, which was written in 512 bytes per block.

III. Quantitities derived from Hydrocast Data

Numerous physical quantities (eg. potential density, Väisälä frequency, etc.) were derived from the National Oceanographic Data Center (NODC) hydrocast data (I.1. and II.1.) for the purpose of studying large space- and time-scale temperature and density fluctuations in the North Atlantic. Some of the more generally useful of these are presented in this section and are available on PDP-10 magnetic tapes.

III.1. Yearly Averages of Temperature, Temperature Anomalies, Salinity and Potential Density

Yearly averages of temperature, salinity, and potential density (sigma-theta) were computed for the years 1944 through 1977, from observations within each 5-degree x 5-degree square in a sub-field of the original data field (fig. 2), ie. a space- and time-averaging without editing was performed. The sub-field is bounded by the 10^{o}N and 60^{o}N parallels. Potential density was first computed from the individual (depth, temperature, salinity) triplets using the NODC empirical formulae (U.S. Dept. of Commerce, 1974) and then averaged within years and 5-degree squares. These mean quantities and standard deviations have been computed at the Sverdrup standard depths for the entire water column.

In addition, yearly averages of temperature anomalies about a mean seasonal signal within 5-degree squares have been computed at the Sverdrup standard depths for the upper 500 meters, and for the years 1944 through 1977. The mean seasonal signal was computed by averaging all the Januaries, all the Februaries, ..., and all the Decembers from 1900 through 1978, at each Sverdrup standard depth, 0-500 m, within each 5-degree square. (This field is available separately, along with its standard deviations and the numbers of observations averaged.) Then, the mean seasonal signal was subtracted from the individual temperature observations to produce temperature anomalies. A positive temperature anomaly corresponds to a temperature warmer than the seasonal mean. Then, the anomalies within 5-degree squares and within one-year partitions were averaged to produce the anomaly field.

The following (skelleton) program can be used to access the first data field described above, on a year by year basis.

```
      DIMENSION TAVG(4,34),TSD(4,34),NT(4,34)
      DIMENSION SAVG(4,34),SSD(4,34),NS(4,34)
      DIMENSION DAVG(4,34),DSD(4,34),ND(4,34)
      OPEN   (UNIT=1,...)
   90 READ (1,100,END=500) MRSQ,IYR,ISYMBL
  100 FORMAT (I4,I2,A1)
      DO   110   IFIVE=1,4
      I=IFIVE
```

```
    READ (1,120) (TAVG(I,J),TSD(I,J),NT(I,J),J=1,34)
    READ (1,120) (SAVG(I,J),SSD(I,J),NS(I,J),J=1,34)
110 READ (1,120) (DAVG(I,J),DSD(I,J),ND(I,J),J=1,34)
120 FORMAT (34(2F5.2,I5))
      .    .    .    .
      .    .    .    .
      .    .    .    .
    GO TO 90
500 CONTINUE
    CLOSE (UNIT=1)
      .    .    .    .
      .    .    .    .
      .    .    .    .
    END
```

The variables in this routine are:

TAVG = average temperature in degrees Celsius
TSD = standard deviation of temperature in degrees Celsius
NT = number of temperature observations averaged
SAVG = average salinity in parts per mille
SSD = standard deviation of salinity in parts per mille
NS = number of salinity observations averaged
DAVG = average sigma-theta in kg m^{-3}
DSD = standard deviation of sigma-theta in kg m^{-3}
ND = number of sigma-theta observations averaged

The absence of data is indicated by zero number of obersvations, and the mean and standard deviation will also be zero. Variables

"MRSQ", "IYR", "ISYMBL", and "IFIVE" are defined in section II.1.. The averaging was done within the 5-degree square indicated by "IFIVE" and within the year indicated by "IYR". The index "J" in the "110" DO-LOOP indicates the Sverdrup standard depths with J=1,2,...,34 corresponding to depths 0, 10, ..., 9000 meters, respectively.

Data from each 10-degree square (identified by "MRSQ") resides in one tape file, as shown in table 10 below.

The following (skelleton) program can be used to access the anomaly and seasonal mean temperature fields described above, on a year by year basis.

```
      DIMENSION TAVG(4,14),TSD(4,14),NT(4,14)
      DIMENSION X(4,14,12),XSD(4,14,12),NX(4,14,12)
      OPEN   (UNIT=1,...)
      DO 500 IYEAR=1,34
      READ (1,100) MRSQ,IYR,ISYMBL
  100 FORMAT (I4,I2,A1)
      DO 110 IFIVE=1,4
      I=IFIVE
  110 READ (1,120) (TAVG(I,J),TSD(I,J),NT(I,J),J=1,14)
  120 FORMAT (14(2F5.2,I5))
        .       .       .       .
        .       .       .       .
        .       .       .       .
  500 CONTINUE
      READ (1,510) MRSQ,ISYMBL
  510 FORMAT (I4,13X,A1)
      DO 520 IFIVE=1,4
      I=IFIVE
        DO 520 J=1,14
  520 READ (1,120) (X(I,J,K),XSD(I,J,K),NX(I,J,K),K=1,12)
      CLOSE  (UNIT=1)
        .       .       .       .
        .       .       .       .
        .       .       .       .
      END
```

The variables in this routine are:

TAVG = averaged temperature anomalies in degrees Celsius
TSD = standard deviation of temperature anomalies in degrees Celsius
NT = number of temperature anomalies averaged
X = mean seasonal temperature in degrees Celsius
XSD = the corresponding standard deviation in degrees Celsius
NX = number of temperatures averaged to obtain X

The absence of data is indicated by zero number of obersvations, and the mean and standard deviation will also be zero. The index "IYEAR" runs through the 34 years: 1944 - 1977. The variables "MRSQ", "IYR", "ISYMBL", and "IFIVE" are defined in section II.1.. The averaging was done within the 5-degree square indicated by "IFIVE" and within the year indicated by "IYR".

The index "J" in the "110" and "520" DO-LOOPS indicates the Sverdrup standard depths with J=1,2,...,14 corresponding to depths 0,10,...,500 meters, respectively. Index "K" in the "520" DO-LOOP indicates the calendar months with K=1,2,...,12 corresponding to January, February, ..., December.

Data from each 10-degree square (identified by "MRSQ") resides in one tape file, as shown in table 11 below.

Two identical tapes containing the data described in this section are available for use on the PDP-10. They bear the tape numbers 360222 and 360224, and their files are documentated in tables 10 and 11.

Table 10

File No.s	10-degree Squares
1-9	1103-1111
10-17	1003-1010
18-26	1202-1210
27-34	1302-1309
35-40	1402-1407

Yearly averages of temperature, salinity and sigma-theta from 1944-1977, within 5-degree squares. Each file contains data from only one 10-degree square region designated by a "modified Canadian" number. This file documentation applies to both 360222 and 360224 magnetic tapes.

Table 11

File No.s	10-degree Squares
41-48	1003-1010
49-57	1103-1111
58-66	1202-1210
67-74	1302-1309
75-80	1402-1407

Yearly averages of temperature anomalies about the seasonal mean, from 1944-1977, within 5-degree squares. The seasonal mean follows the 1977 anomalies. Each file contains data from only one 10-degree square region designated by a "modified Canadian" number. This file documentation applies to both 360222 and 360224 magnetic tapes.

III.2. Temperature and Potential Density Climatologies

Temperature observations in the upper 500 m from hydrocasts made from 1900 through 1978 in the North Atlantic (10 N to 60 N) were horizontally averaged within 5-degree squares to produce a temperature climatology. Potential densities were computed from temperature and salinity observations in the entire water column from the same hydrocasts using the NODC empirical formulae (U.S. Dept. of Commerce, 1974). Then, the potential densities were horizontally averaged within 5-degree squares to produce a potential density (sigma-theta) climatology.

The following (skelleton) program can be used to access the temperature climatology, which resides in file number 6 of PDP-10 tape 360225 and of PDP-10 tape 360226.

```
      DIMENSION T(10,18,14)
      OPEN(UNIT=1)
      DO 100 I=1,10
         DO 100 J=1,18
  100 READ(1,110)IX,JX,(T(I,J,K),K=1,14)
  110 FORMAT(1X,2(I2,1X),14(F5.2,1X))
      CLOSE(UNIT=1)
      .         .         .         .
      .         .         .         .
      .         .         .         .
      END
```

The first two indices of array "T" (temperature) indicate the geographic centers of the 5-degree squares in which the temperatures were averaged. North latitude is indicated by the first index: "I"=1,2,3,...10 corresponds to 57.5°N,52.5°N,47.5°N,..., 12.5°N respectively, and west longitude is indicated by the second index: "J"=1,2,3,...,18 corresponds to 87.5^{o}W,82.5^{o}W,77.5^{o}W, ...,2.5^{o}W respectively. The third index indicates the Sverdrup standard depths with "K"=1,2,...,14 corresponding to 0,10,...,500 meters respectively. "IX" and "JX" are record identifiers and should always be equal to "I" and "J" respectively.

Note that the data grid overlaps land and shallow shelf areas. Land and the absence of data are indicated by zeros in the array "T".

In passing, it may be noted that the temperature climatology can be derived from the mean seasonal temperature, described in the previous section, by a weighted averaging of the 12 months according to the number of observations in each month. The associated standard deviations can be similarly computed.

The following (skelleton) program can be used to access the potential density (sigma-theta) climatology, which resides in file number 10 of PDP-10 tape 360225 and of PDP-10 tape 360226.


```
      DIMENSION PD(10,18,34)
      OPEN(UNIT=1)
      DO 100 I=1,10
         DO 100 J=1,18
  100 READ(1,110)IX,JX,(PD(I,J,K),K=1,34)
  110 FORMAT(1X,2(I2,1X),34(F6.3,1X))
      CLOSE(UNIT=1)
      .          .          .          .
      .          .          .          .
      .          .          .          .
      END
```

the indices of array "PD" (sigma-theta), and "IX" and "JX" are the same as those for the temperature climatology, with the exception that the third index of "PD" extends through the entire water column. Thus "K"=1,2,...,34 and corresponds to the Sverdrup standard depths 0,10,...,9000 meters respectively. Land and the absence of data are also indicated by array values of zero. The "F6.3" format used should have been an "F5.2" format, because there are only four significant figures in the sigma-theta values. Disregard the last digit.

III.3. Potential Density, Brunt-Väisälä Frequency, and First Baroclinic Mode Velocity Eigenfunctions

The potential density (sigma-theta) climatology, described in section III.2., was horizontally averaged within overlapping 10-degree squares to produce a smoothed density climatology from which squared Brunt-Väisälä frequency profiles were computed. Then, first baroclinic Rossby-wave velocity modes were derived by numerical integration of the following equation.

$$\frac{d^2W}{dz^2} + \lambda^2 N^2 W = 0$$

with the "rigid lid" boundary conditions

$$W = 0 \quad \text{at} \quad z = 0;H$$

and where:

- W = vertical velocity amplitude
- z = vertical coordinate, positive downward
- λ = eigenvalue
- N = Brunt-Väisälä frequency
- H = depth of water column (the mean ocean depth under each 10-degree square was used)

The N^2 profile was derived from the smoothed density field by computing finite central differences and linearly interpolating densities between depths instead of using a reference density (ie. the Boussinesg approximation was not used or needed).

The first derivative dW/dz was also computed.

The following (skelleton) program can be used to access the potential density (sigma-theta) climatology and squared Brunt-Väisälä frequencies, which reside in file number 11 of PDP-10 tape 360225 and of PDP-10 tape 360226. The data are read in on a profile by profile basis.

```
      DIMENSION IZPD(34),PD(34),IZBV2(35),BV2(35)
      OPEN(UNIT=1,...)
   90 READ(1,100,END=500)IX,JX,KX,LAT,TINRTL,G,NPD
  100 FORMAT(1X,I1,2(1X,I2),1X,I2,2X,F6.3,1X,F6.4,1X,I2)
      LON=90-5*JX
      DO 110 I=1,NPD
  110 READ(1,120)LX,IZPD(I),PD(I),MX
  120 FORMAT(1X,I2,2X,I4,5X,F6.3,2X,I1)
      READ(1,130)NBV2
  130 FORMAT(1X,I2)
      DO 140 I=1,NBV2
  140 READ(1,150)IZBV2(I),BV2(I)
  150 FORMAT(1X,I4,1X,1PE12.5)
      .     .     .     .
      .     .     .     .
      .     .     .     .
      GO TO 90
  500 CONTINUE
      CLOSE(UNIT=1)
      .     .     .     .
      .     .     .     .
      .     .     .     .
      END
```

The variables "IX","JX","KX","LX" and "MX" were useful to the author but may be safely ignored by the user. "LAT" and "LON" are the northern latitude and western longitude of the center of the 10-degree square in which the density climatology was averaged.

TINRTL = inertial period in hours
G = gravitational acceleration in ms^{-2}
NPD = number of (depth, sigma-theta) pairs
IZPD = depth in meters, (the last depth in the array will be the mean depth of the ocean within the 10-degree square)
PD = potential density (sigma-theta), (the last value in the array is an extrapolated value if its MX=0)
NBV2 = number of (depth, N^2) pairs
IZBV2 = depth in meters, (the last depth in the array will be the mean depth of the ocean within the 10-degree square)
BV2 = Brunt-Väisälä frequency squared in s^{-2}, (the surface and bottom values were arbitrarily set equal to the 5-meter and next-to-the-bottom values, respectively)

The precision indicated for sigma-theta and N^2 in format statements 120 and 150 above are a little too optimistic, but were useful in program testing.

The following (skelleton) program can be used to access the first baroclinic mode velocity eigenfunctions and associated eigenvalues, which reside in file 12 of PDP-10 tape 360225 and of PDP-10 tape 360226. The data are read in on a profile by profile basis.

```
      DIMENSION Z(201),W(201),WP(201)
      DIMENSION ISTRT(8),ISTOP(8),LAT(70),LON(70)
      DATA ISTRT/8,8,5,4,3,3,4,5/
      DATA ISTOP/5*16,15,2*14/
C
C     COMPUTE LATITUDES AND LONGITUDES
C     LOCATING THE 70 EIGENMODE PROFILES
C     AND STORE THEM IN ARRAYS LAT AND LON
C
```

```
      INDEX=0
      DO    50    I=2,8
      ITOP=ISTRT(I-1)
      IBOT=ISTRT(I)
      JSTRT=MAX0(ITOP,IBOT)
      ITOP=ISTOP(I-1)
      IBOT=ISTOP(I)
      JSTOP=MINO(ITOP,IBOT)-1

          DO   50   J=JSTRT,JSTOP
          INDEX=INDEX+1
          LAT(INDEX)=50-5*(I-2)
          LON(INDEX)=90-5*J
   50 CONTINUE
C
C        READ IN THE EIGENVALUES AND EIGENMODES
C
      OPEN (UNIT=1,...)
   90 READ (1,100,END=500)INDEX,IX,NTRPS
  100 FORMAT (3G)
      READ (1,110)JX,EGNVL2
  110 FORMAT(2G)
      DO   120   I=1,NTRPS
  120 READ (1,100)Z(I),W(I),WP(I)
      LATX=LAT(INDEX)
      LONX=LON(INDEX)
        .     .     .     .
        .     .     .     .
        .     .     .     .
      GO  TO  90
  500 CONTINUE
      CLOSE (UNIT=1)
        .     .     .     .
        .     .     .     .
        .     .     .     .
      END
```

The "50" DO-LOOP computes the north latitudes "LAT" and west longitudes "LON" of the centers of the 10-degree squares from which the "smoothed" density profiles were derived. The eigenmodes were computed from these profiles. Arrays "LAT" and "LON" are organized by "INDEX", which appears again in statement "90" in order to give the geographic location of the eigenmodes and associated eigenvalues.

NTRPS = number of (Z,W,WP) triplets
EGNVL2 = squared first baroclinic mode eigenvalue in s^2m^{-2}
Z = depth in meters; 50-meter steps were chosen
W = first baroclinic vertical velocity eigenmode
WP = dW/dz, the first derivative
LATX=LAT = north latitude of profile
LONX=LON = west longitude of profile.

All the other variables were used for organizational purposes, and the user need not be further concerned with them. However, the user might make use of the fact that "INDEX" in this program is the same as "KX" in the previous program.

III.4. Time Series of Subsurface Temperature

Yearly time series of temperature on a 5-degree grid at depths: 250m; 300m; 400m; and 500m were compiled for the 26 years: 1948-1973 inclusive. The yearly averages of temperature anomalies about a mean seasonal signal (III.1.) were added to the temperature climatology (III.2.) to produce a temperature field with the seasonal signal removed. Subsurface temperature inversions were smoothed to produce monotonic profiles, and subsurface data gaps were removed via linear and cubic spline interpolation in space and time.

The reader is cautioned that the original data density was very sparce south of 30°N, between 60°W and the African coast (fig. 1). In general, processes with time scales shorter than 4 years and/or length scales shorter than 1000 km are probably not manifest in these time series.

Plots of the time series are presented in the appendix.

The following (skelleton) program can be used to access the time series, which reside in file 19 of PDP-10 tape 360225 and of PDP-10 tape 360226.

```
      DIMENSION X(10,18,4,34),T(26)
      DIMENSION ISTRT(8),ISTOP(8),IZ(4)
      DATA ISTRT/8,8,5,4,3,3,4,5/
      DATA IZ/250,300,400,500/
C
C     READ IN DATA ARRAY X
C
      OPEN (UNIT=1,...)
      DO   100   I=1,10
         DO   100   J=1,18
            DO   100   K=1,4
  100 READ (1,110)(X(I,J,K,L),L=1,34)
  110 FORMAT (34F5.2)
      CLOSE (UNIT=1)
C
C     EXTRACT TIME SERIES AND STORE
C     THEM IN ARRAY T, COMPUTE THE CORRESPONDING
C     LATITUDES, LONGITUDES AND DEPTHS
C
      DO   250   I=2,9
      JSTRT=ISTRT(I-1)
      JSTOP=ISTOP(I-1)
      XLAT=57.5-5.0*(I-1)
        DO   250   J=JSTRT,JSTOP
        XLON=87.5-5.0*(J-1)
```

```
            DO    250       K=1,4
            IDEPTH=IZ(K)
                  DO    200       L=5,30
200               T(L-4)=X(I,J,K,L)
      .           .              .            .
      .           .              .            .
      .           .              .            .
250 CONTINUE
      .           .              .            .
      .           .              .            .
      .           .              .            .
    END
```

The temperature time series are a subset of the array X(I,J,K,L), whose indices (I,J,K,L) represent latitude, longitude, depth and time, respectively. The geographic area covered brackets the time series grid to the north and south with extra data and to the west and east by land (fig.2). X also contains data from four years before 1948 and four after 1973. Land and remaining data graps in the bracketing region (ie. not in the time series) are indicated by values of zero in X. The time series T, therefore, are extracted from X by truncating the range of the indices I,J, and L (but not K), as is done in the "200" and "250" DO-LOOPs, above. "XLAT" and "XLON" are the north latitudes and west longitudes locating the various time series. Depths in meters are given by "IDEPTH". The temperatures T (in degrees Celsius) run from 1948 (T(1)) through 1973 (T(26)).

IV. Meteorological Time Series

Monthly time series of various meteorological parameters over the North Pacific and of various surface fluxes, on a 10-degree grid, from January 1948 through December 1972 were compiled by Bunker and Goldsmith (1979).

The various surface flux computations are described in Bunker (1976). Observations within 10-degree squares from the equator to 80°N and within months were averaged to produce the 300 months long time series.

Data density north of 60°N is very sparce. Several 10-degree squares have less than 50% coverage in time, and a few have less than 80%.

The physical quantities herein presented are: sea level air temperature, mixing ratio, sea surface temperature, air-sea temperature difference (full precision), cloud and ice cover, wind stress and velocity, rainfall, sea level air pressure, effective incident radiation at the sea surface, infrared radiation, radiation exchange, latent and sensible heat fluxes, and net heat gain by the ocean. Many of these quantities are only rough estimates, known to within large uncertainties and/or precision. However, the data set offers synoptic coverage over a couple of decades and, like the temperature time series previously described offers the possibility to study the long length- and time-scale processes.

It should be noted that the meteorological and subsurface temperature time series overlap considerably in space and time. One can also make mixed-layer time series from the yearly temperature averages (III.1.).

IV. 1. Original Meteorological Data

The meteorological data described herein came from the Woods Hole Oceanographic Institution (WHOI). A special data report (Bunker and Goldsmith, 1979) describes the original (EBCDIC, not ASCII) data tape, and, therefore, only a few comments will be made in this section. The reader is urged to obtain a copy of this report.

The original data tape bears the WHOI identification number FT#CL2A and was translated from EBCIDIC by the standard program "TRNRSX" on the institute's PDP-11 computer. The original WHOI tape also bears the PDP-10 tape number 36073A. The tape containing the ASCII translation is the PDP-10 tape 360163. The first file on the original tape has redundant, administrative information and is followed by 67 data files (files 2-68). Program "TRNRSX" skipped over the first file in the original tape and sequentially translated files 2-68. These are files 1-67, respectively, on tape 360163. Each data file contains the time series from one 10-degree square (table 12).

CAUTION: There is an error in the WHOI report on page 18, in table 3. The formats indicated for parameters "TAUX" and "TAUY" are F5.1 and F5.1 but should be F5.2 and F5.2.

Table 12

tape 36073A file no.s	tape 360163 file no.s	"Marsden" square numbers	"modified Canadian" numbers
2-7	1-6	1-6	902-907
8	7	8	909
9	8	36	901
10-17	9-16	38-45	1003-1010
18-26	17-25	74-82	1103-1111
27-35	26-34	109-117	1202-1210
36-43	35-42	145-152	1302-1309
44-49	43-48	181-186	1402-1407
50	49	216	1401
51-57	50-56	217-223	1502-1508
58-59	57-58	251-252	1500-1501
60-61	59-60	253-254	1602-1603
62-64	61-63	258-260	1607-1609
65-66	64-65	285-286	1634-1635
67-68	66-67	287-288	1600-1601

File numbers of PDP-10 tapes containing the original meteorological data and the corresponding 10-degree square designation numbers. The "Marsden" and "modified Canadian" numbers are shown in the NODC user's guide.

IV.2. Selected Time Series of Meteorological Data

Twenty of the original meteorological parameters were selected and incorporated into IfM-formatted data files for use with the institute's standard programs. Table 13 lists the parameters (using the variable names in the WHOI report) in the order in which they appear in the data cycles. The IfM format used was the old format which was in use from 1978 through 1981. (As of this writing, the institute's standard programs will still accept the old format.) Each data file contains data from only one 10-degree square. That square is identified in the "informations block" by the variable "NMOORG" (mooring number), which contains the "Marsden" square number identification (see NODC user's guide). The first three characters of "NMOORG" are always MSQ and are followed by the "Marsden" square number, eg. MSQ216 contains data from Marsden square number 216.

These data files are the first 67 files of PDP-10 tape 360167 and of PDP-10 tape 360223. Their file documentation is identical to that of files 1-67 of tape 360163 in table 12.

The data from latitudes greater than 60°N is very sparse and no further use was made of them.

For the purpose of making a quick visual inspection of the data, the few data gaps in the lower latitudes (0° - 50°N) were replaced with linearly interpolated values, and the time series were plotted on a CALCOMP plotter. The "de-gapped" time series (IfM formatted) are on the PDP-10 tapes 360167 and 360223 (table 14), and the plots are available for inspection in the Theoretische Ozeanographie Department, IfM. The interpolated values can be recognized by a zero value in the variable "NOBS" (number of observations). (When data is missing for one variable in a data cycle, all the other variables in the data cycle are also data gaps.)

Table 13

number	name	units	description
1	NOBS	-	number of observations
2	TAIR	^{o}C	air temperature
3	MIXR	g/kg	mixing ratio
4	TSEA	^{o}C	sea surface temperature
5	TASD	^{o}C	air-sea temperature difference
6	WIND	m/s	wind speed
7	EAST	m/s	east component of wind speed
8	NORT	m/s	north component of wind speed
9	RAIN	-	ratio of rain to total observation
10	PRES	Pa/100	sea level air pressure
11	ICER	-	ratio of sea ice coverage
12	QSUR	W/m^2	effective radiation at surface
13	IRED	W/m^2	infrared radiation
14	REXB	W/m^2	radiation exchange
15	OHGB	W/m^2	heat gain of ocean (Budyko)
16	LATI	W/m^2	latent heat flux
17	SENI	W/m^2	sensible heat flux
18	HGBI	W/m^2	heat gain by ocean (observation)
19	TAUX	Pa	east wind stress component
20	TAUY	Pa	north wind stress component

Selected meteorological variables, numbered according to their position in the IFM data format data cycles. A more complete description of the variables is in Bunker and Goldsmith (1979).

Table 14

File No.s	"Marsden" square numbers	"modified Canadian" numbers
68-73	1-6	902-907
74	8	909
75	36	901
76-83	38-45	1003-1010
84-92	74-82	1103-1111
93-101	109-117	1202-1210
102-109	145-152	1302-1309
110-115	181-186	1402-1407
116	216	1401

Data files containing IFM-formatted time series of de-gapped meteorological data residing on the PDP-10 tapes 360167 and 360223.

The final working data set is the lower latitude data with spikes, data gaps and the mean seasonal signal removed. First, obtuse data spikes were removed from variables 2-20 (table 13). Mean seasonal signals were computed by averaging all the January values, all the February values, etc. for each series. The mean seasonal signals were subtracted and the anomalies averaged. Any datum whose anomaly was 4 or more standard deviations from its respective mean was eliminated. (A 2.5- or 3-standard deviation filter often rejected too much data that looked realistic on the plots.) The ice ratio "ICER", however, could not reasonably be edited in this manner. A visual inspection of the time series revealed no spikes, and, consequently, all the data were retained.

A second mean seasonal signal was computed by the same process from the de-spiked values. A second anomaly set was then computed (a positive anomaly represents a value greater than the seasonal mean). All the data gaps and eliminated spikes were replaced by linearly interpolating between neighbouring months in the (second) anomaly time series set. The resultant time series were IfM-formatted and the (second) seasonal signal was appended to the end of the last data cycle.

The following (skelleton) program may be used to access the data. Data from one 10-degree square are read in at a time. The data reside on PDP-10 tapes 360167 and 360223 (table 15).

```
      DIMENSION ANOMAL(20,300),SEASON(20,12)
      OPEN    (UNIT=1,...)
   90 READ (1,100,END=500) MRSQ
  100 FORMAT (45X,I3)
      DO 110   I=1,6
  110 SKIP RECORD 1
      DO 120 I=1,300
  120 READ (1,130)IX,(ANOMAL(J,I),J=1,20)
  130 FORMAT (I6,F7.0,F5.1,F4.0,2F5.1,
     &         3F4.0,F4.2,F6.0,F4.2,7F6.1,2F5.2)
      DO   140   I=1,12
  140 READ (1,130)IX,(SEASON(J,I),J=1,20)
        .       .        .        .
        .       .        .        .
        .       .        .        .
      GO TO 90
  500 CONTINUE
      CLOSE (UNIT=1)
        .       .        .        .
        .       .        .        .
        .       .        .        .
      END
```

The array "ANOMAL" contains the anomalies about the seasonal mean, which is stored in "SEASON". The first index of both these arrays indicates the various variables numbered in table 13. The second index of "ANOMAL" chronologically indicates the month in the time series from January 1948 through December 1972, while the second index of "SEASON" sequentially represents the calendar months from January (index=1) through December (index=12). "MRSQ" designates the 10-degree square for which the data are representative averages. The designation is a "Marsden" (not "modified Canadian") square number.

This program can also be used to access the other IfM-formatted meteorological data by removing the "140" DO-LOOP.

The user should note that some of the IfM standard programs will not run with the seasonal signal appended at the end. In those cases, just delete the seasonal signal with the text editor.

No comprehensive series of plots of the anomalies were made. However, to give the reader some visual presentation of the interannual variability of the anomaly field, time series (Δt=3 months) of air and sea temperature (TAIR and TSEA) and of the net heat gain by the ocean (OHGB) at Marsden square number 113 (30°-40°N; 40°-50°W) is presented in figure 3.

Table 15

File No.s	"Marsden" square numbers	"modified Canadian" numbers
166 - 171	1 - 6	902 - 907
172	8	909
173	36	901
174 - 181	38 - 45	1003 - 1010
182 - 190	74 - 82	1103 - 1111
191 - 199	109 - 117	1202 - 1210
200 - 207	145 - 152	1302 - 1309
208 - 213	181 - 186	1402 - 1407
214	216	1401

Data files containing IfM-formatted time series of the anomalies (about the seasonal mean) of the various meteorological data with the seasonal mean appended to the end of the file. These all reside on the PDP-10 tapes 360167 and 360223.

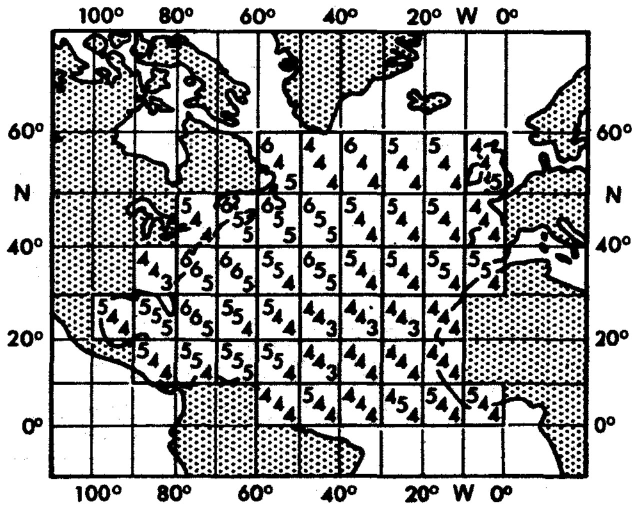


Fig. 1: The approximate base 10 log of the total number of MBT (upper left), XBT (center), and hydrocast observations (lower right) in each 10-degree square.

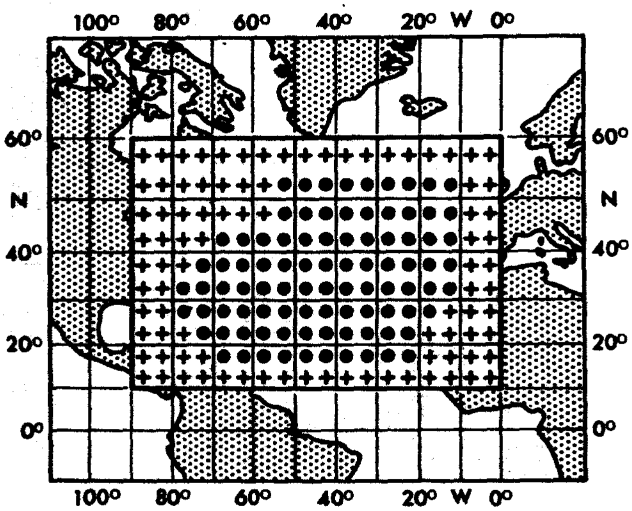


Fig. 2: Temperature time series data grid, indicated by (●) and the bracketing area (used to interpolate for missing data) indicated by (+).

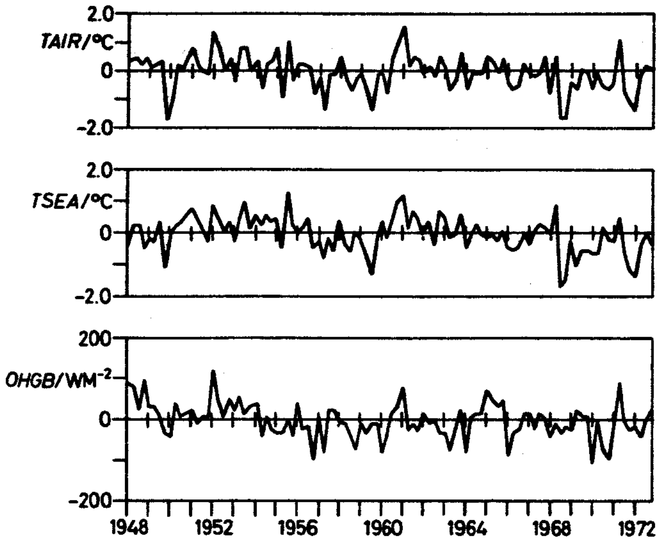


Fig. 3: Anomalies (about the seasonal mean) of air temperature at the sea surface (TAIR), sea surface temperature (TSEA), and the net heat gain of the ocean (OHGB) every 3 months from January 1948 - October 1972 at Marsden square number 113 (30°-40°N; 40°-50°W).

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Bunker, A.F. and R.A. Goldsmith, 1979: Archived Time-Series of Atlantic Ocean Meteorological Variables and Surface Fluxes. Woods Hole Oceanographic Institution technical report WHOI-79-3, 27 pp.

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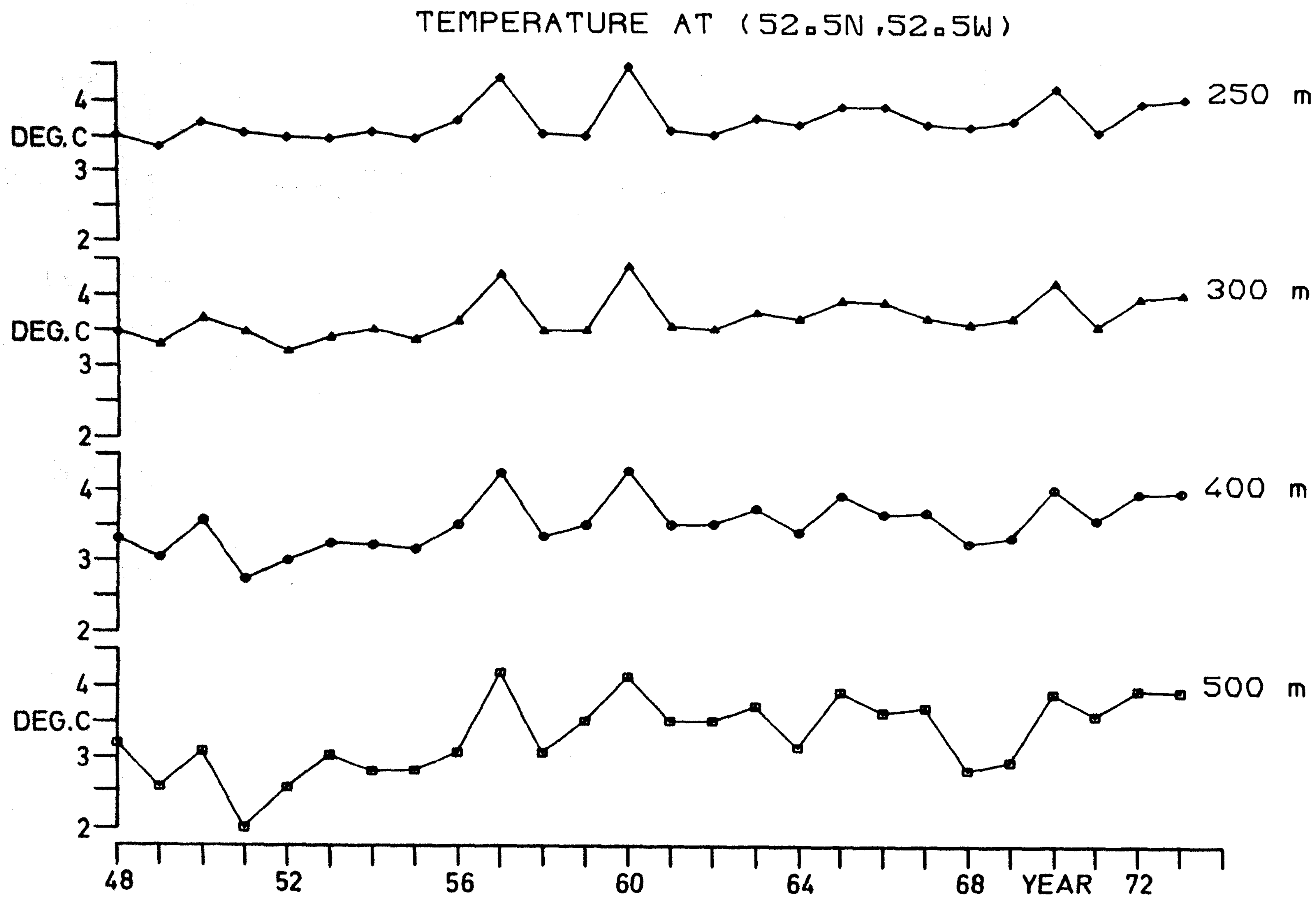
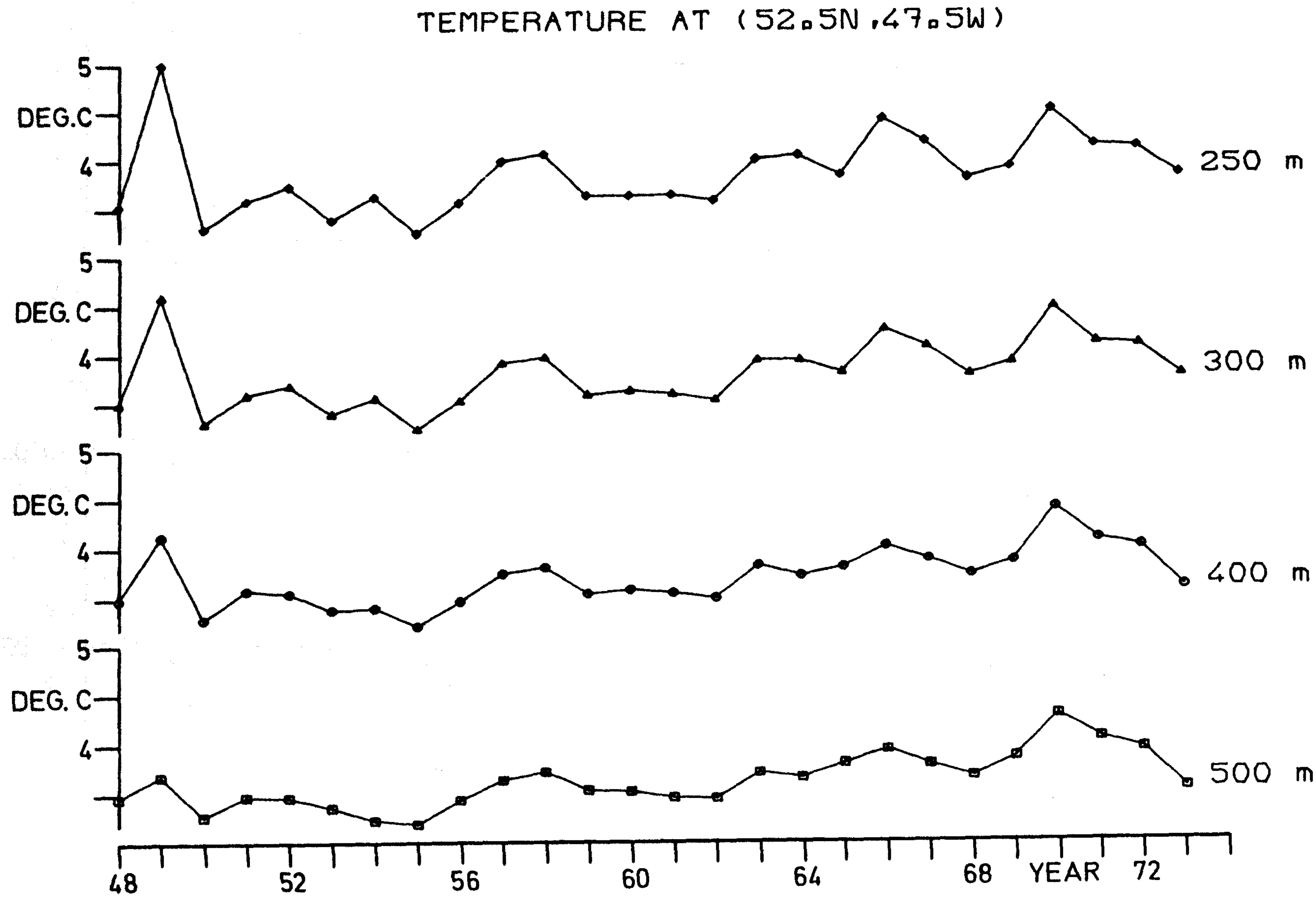
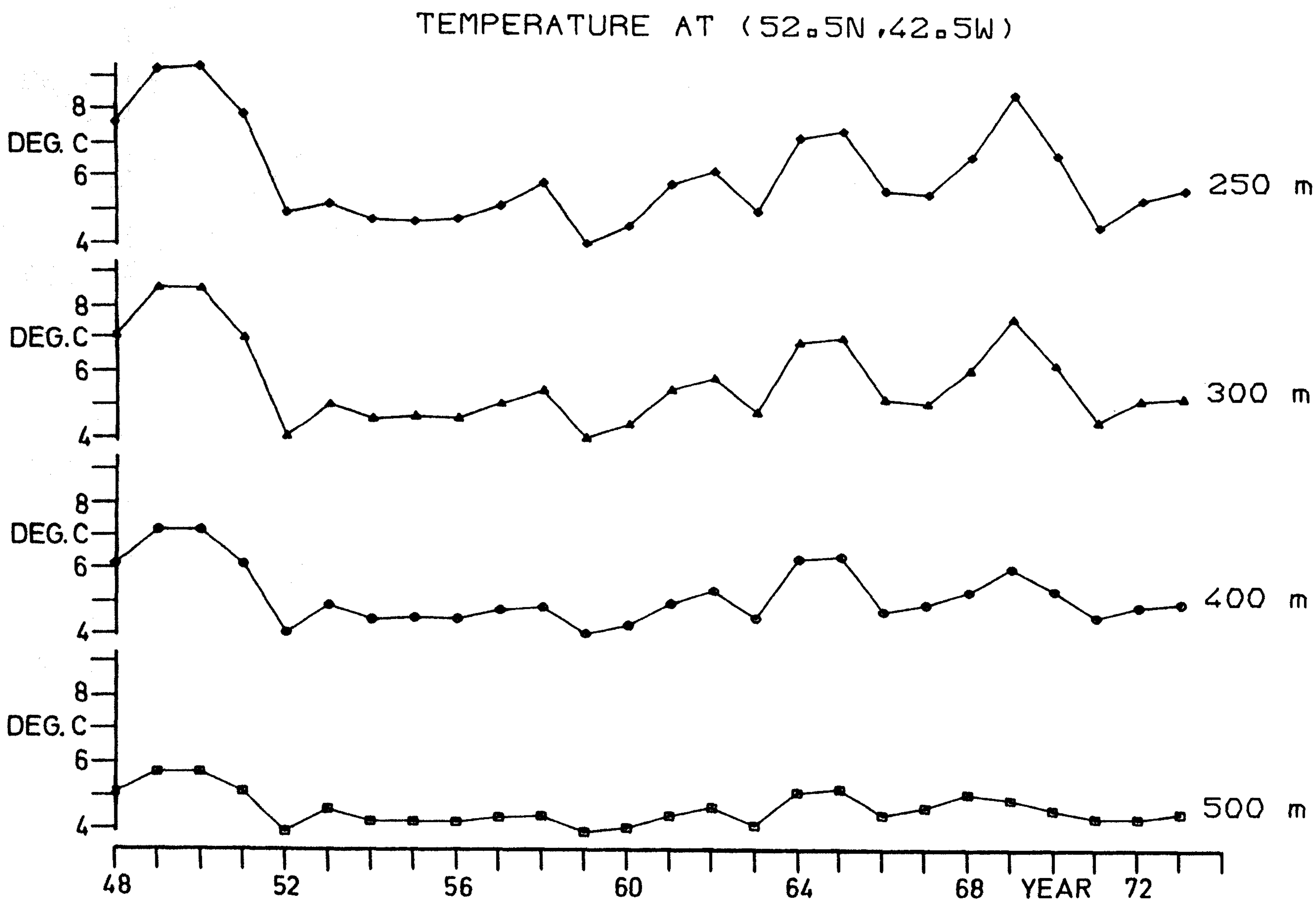
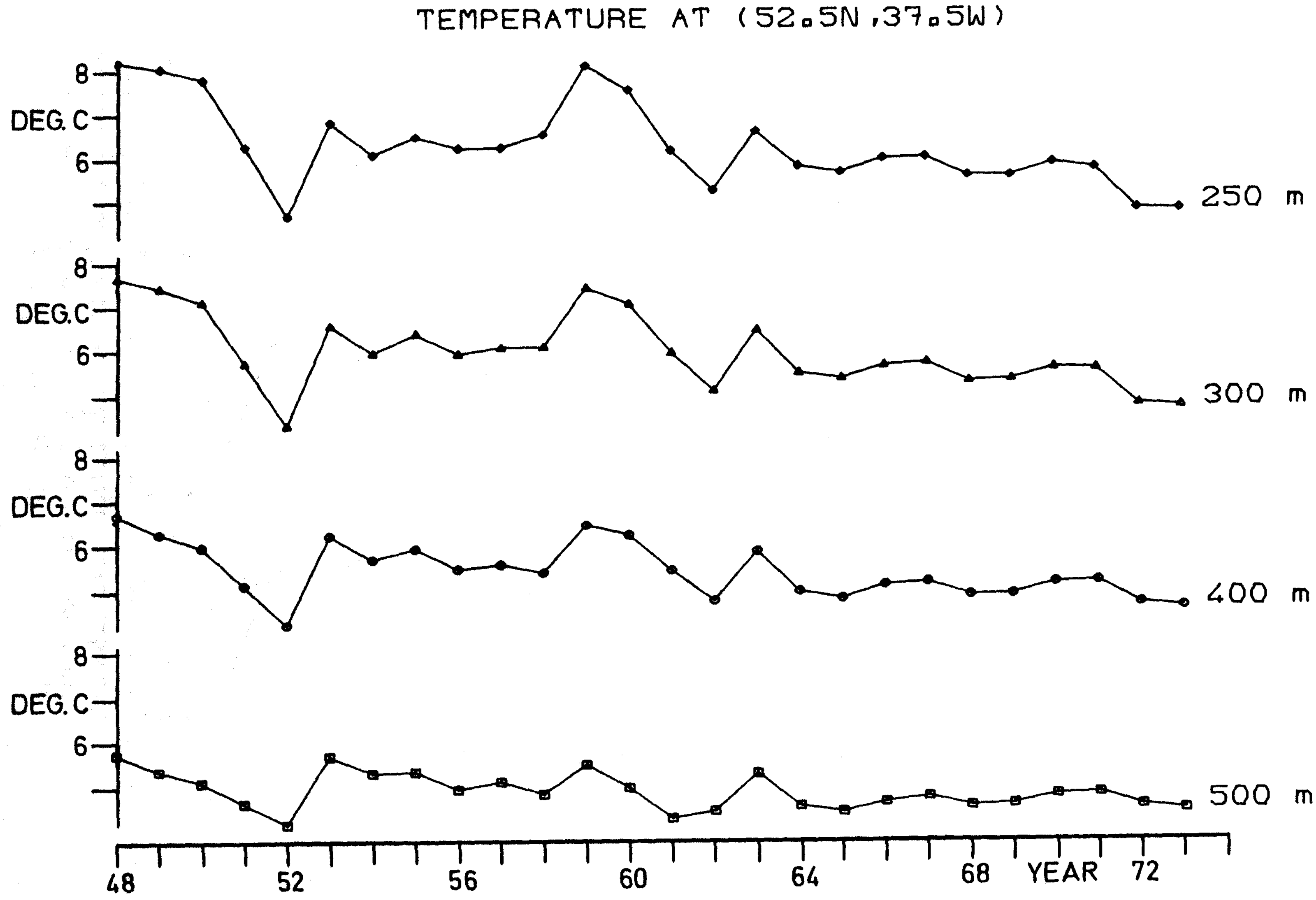
Appendix

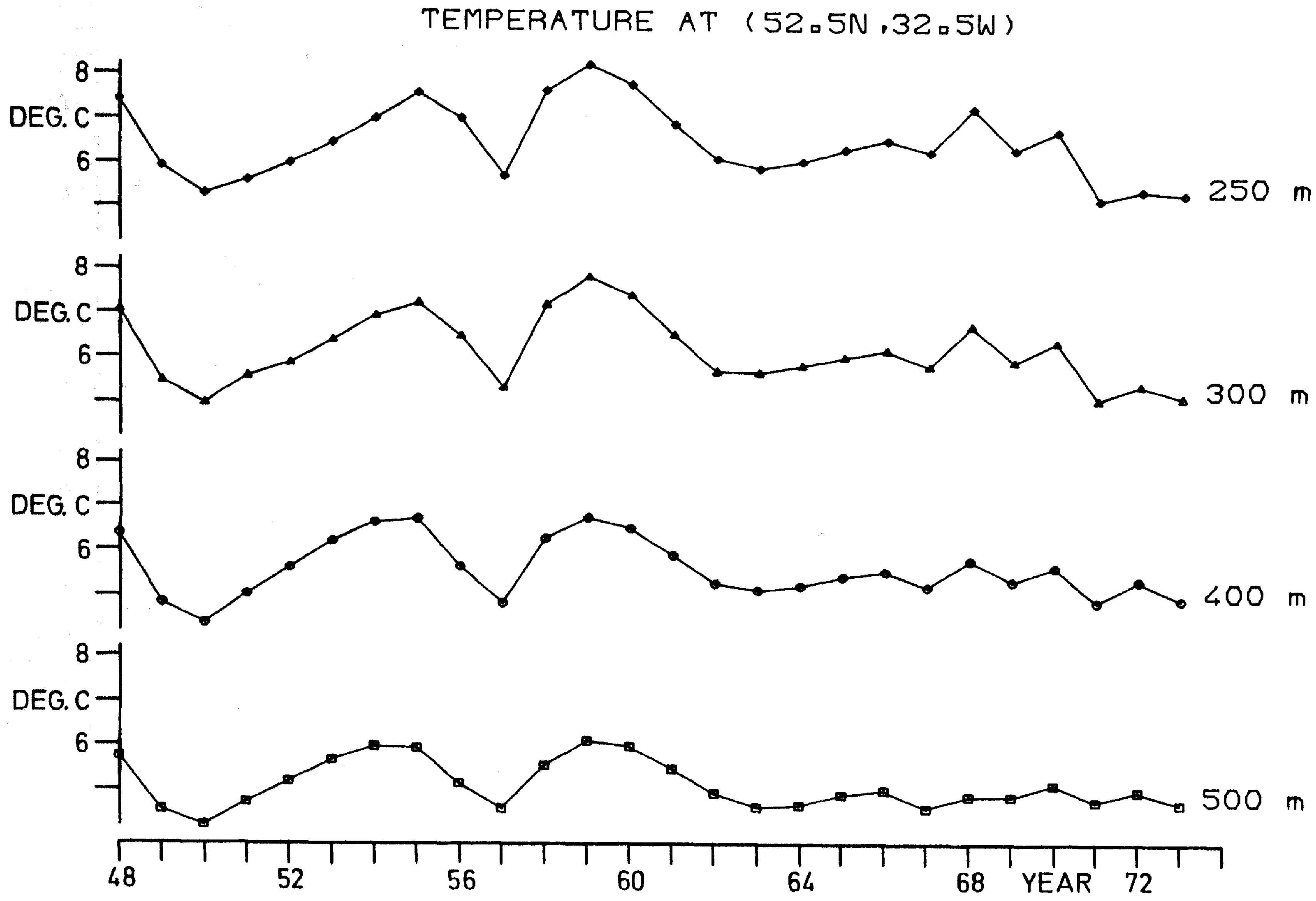
The following are 26 years long time series of subsurface temperature at various grid point locations in the North Atlantic (III.4.).

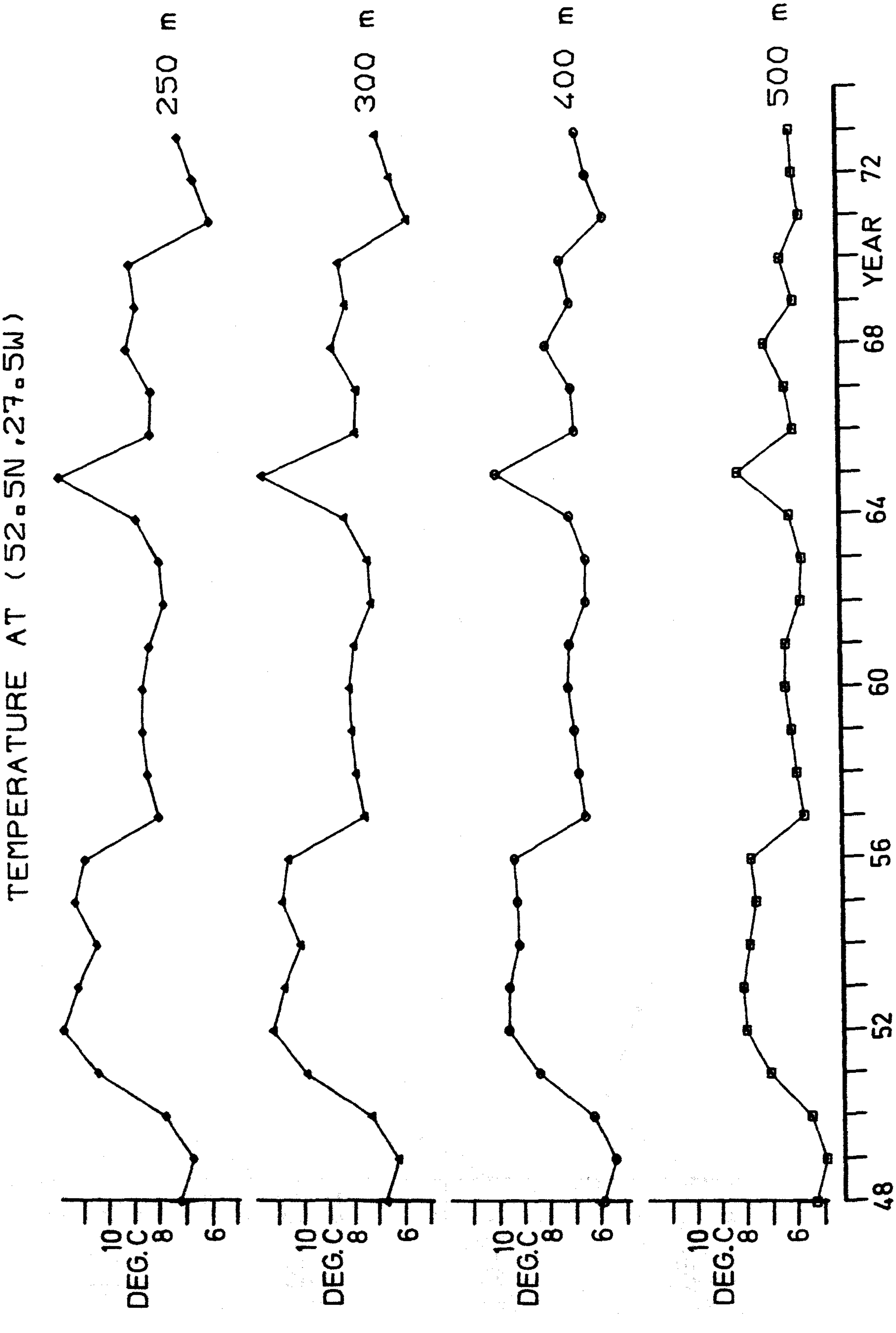

TEMPERATURE AT (52.5N,52.5W)
250 m
300 m
400 m
500 m
DEG.C
DEG.C
DEG.C
4
3
2
48
52
56
60
64
68
YEAR
72

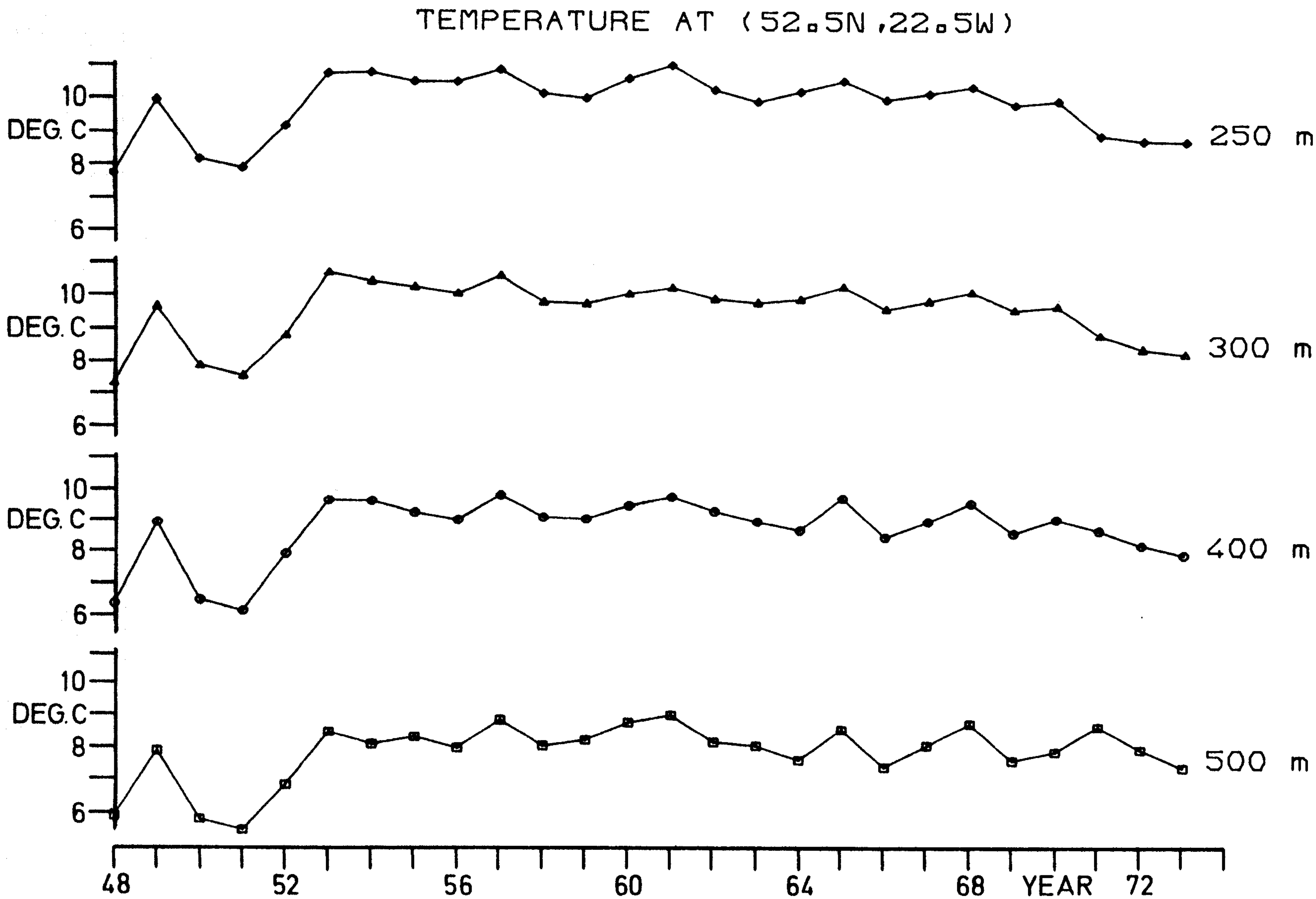

TEMPERATURE AT (52.5N,47.5W)
250 m
300 m
400 m
500 m
DEG.C
5
4
48
52
56
60
64
68
72
YEAR

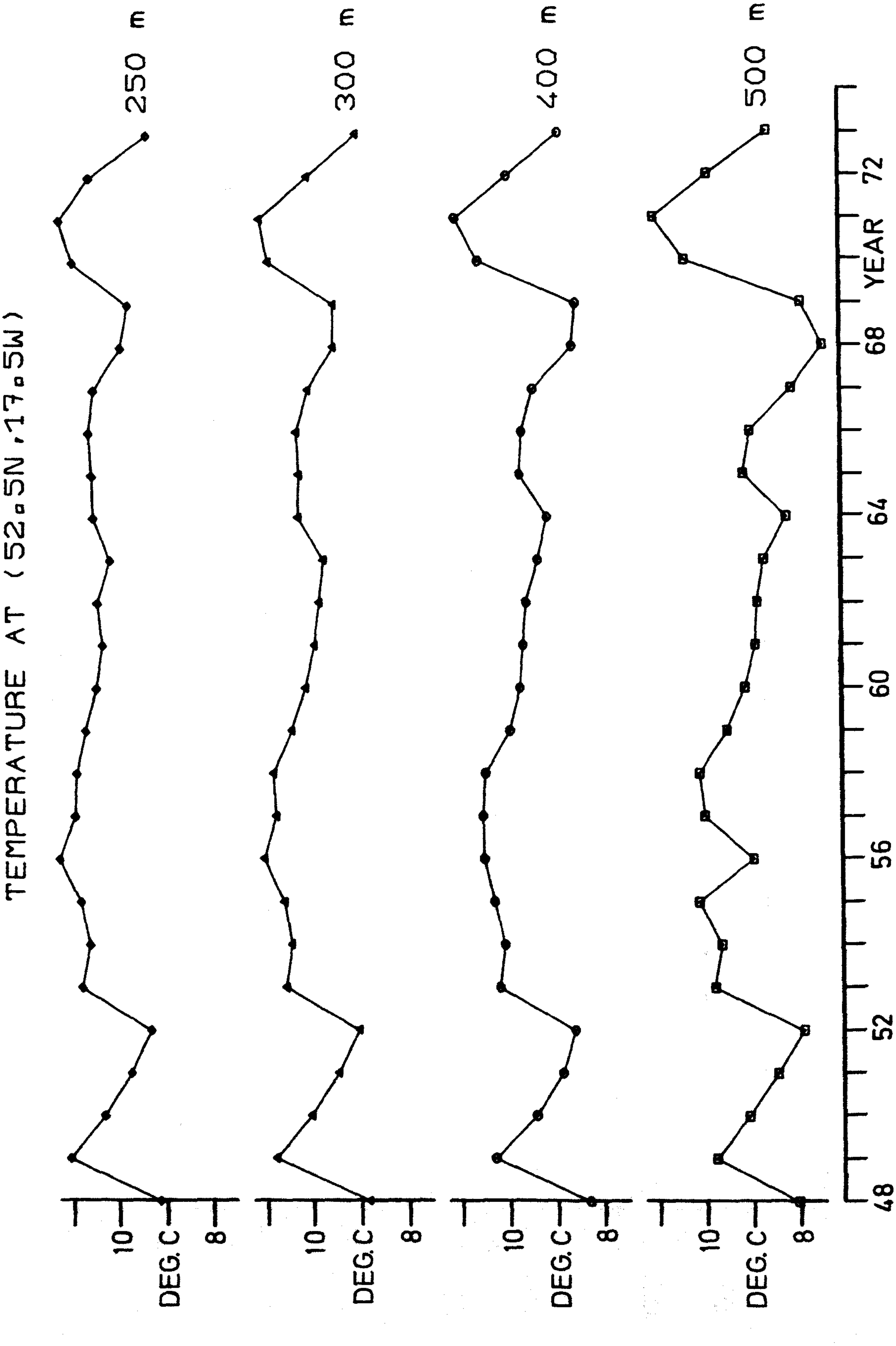

TEMPERATURE AT (52.5N,42.5W)
DEG. C
8
6
4
250 m
300 m
400 m
500 m
48
52
56
60
64
68
72
YEAR

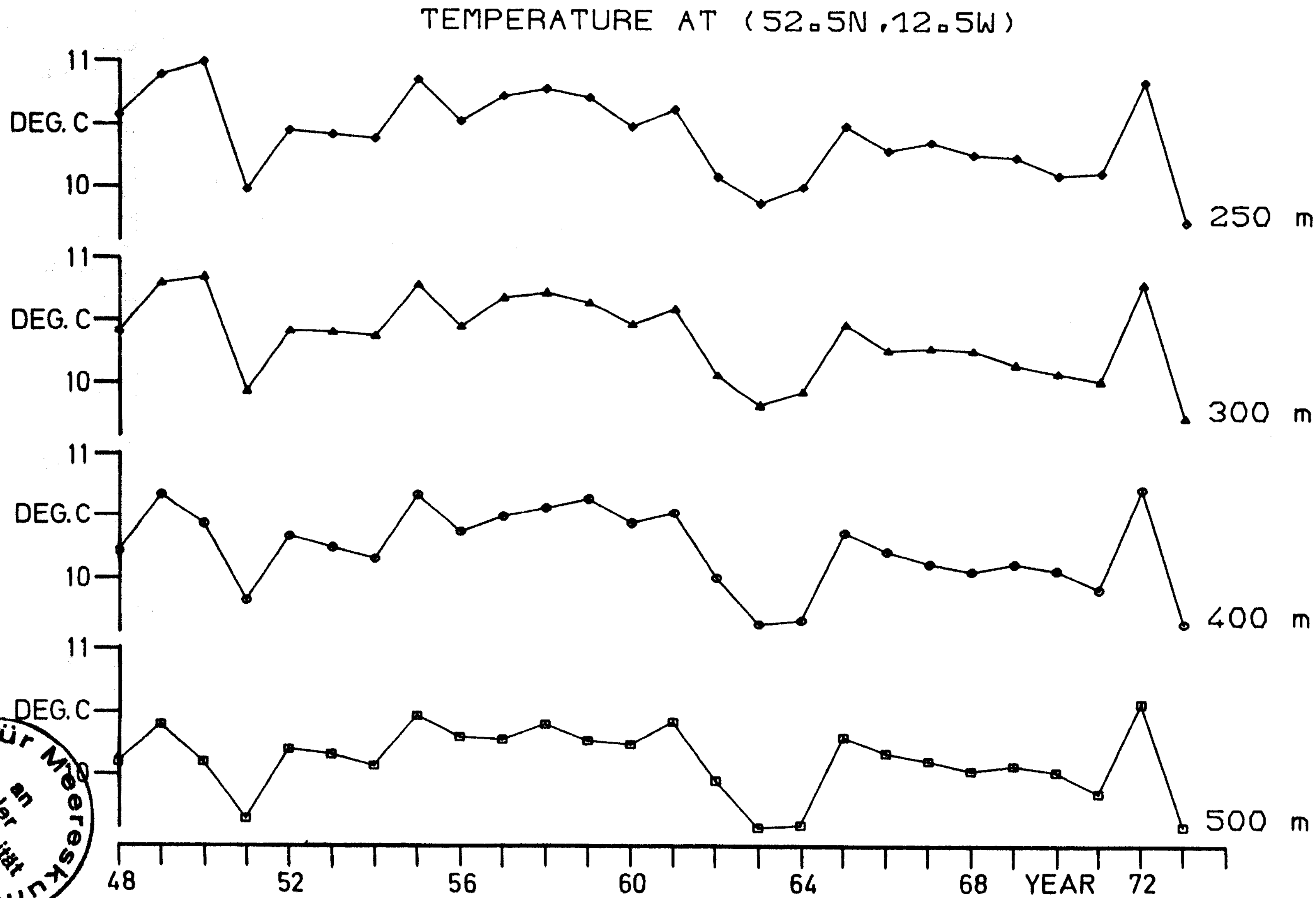

TEMPERATURE AT (52.5N,37.5W)
DEG.C
8
6
250 m
DEG.C
8
6
300 m
DEG.C
8
6
400 m
DEG.C
8
6
500 m
48
52
56
60
64
68
YEAR
72

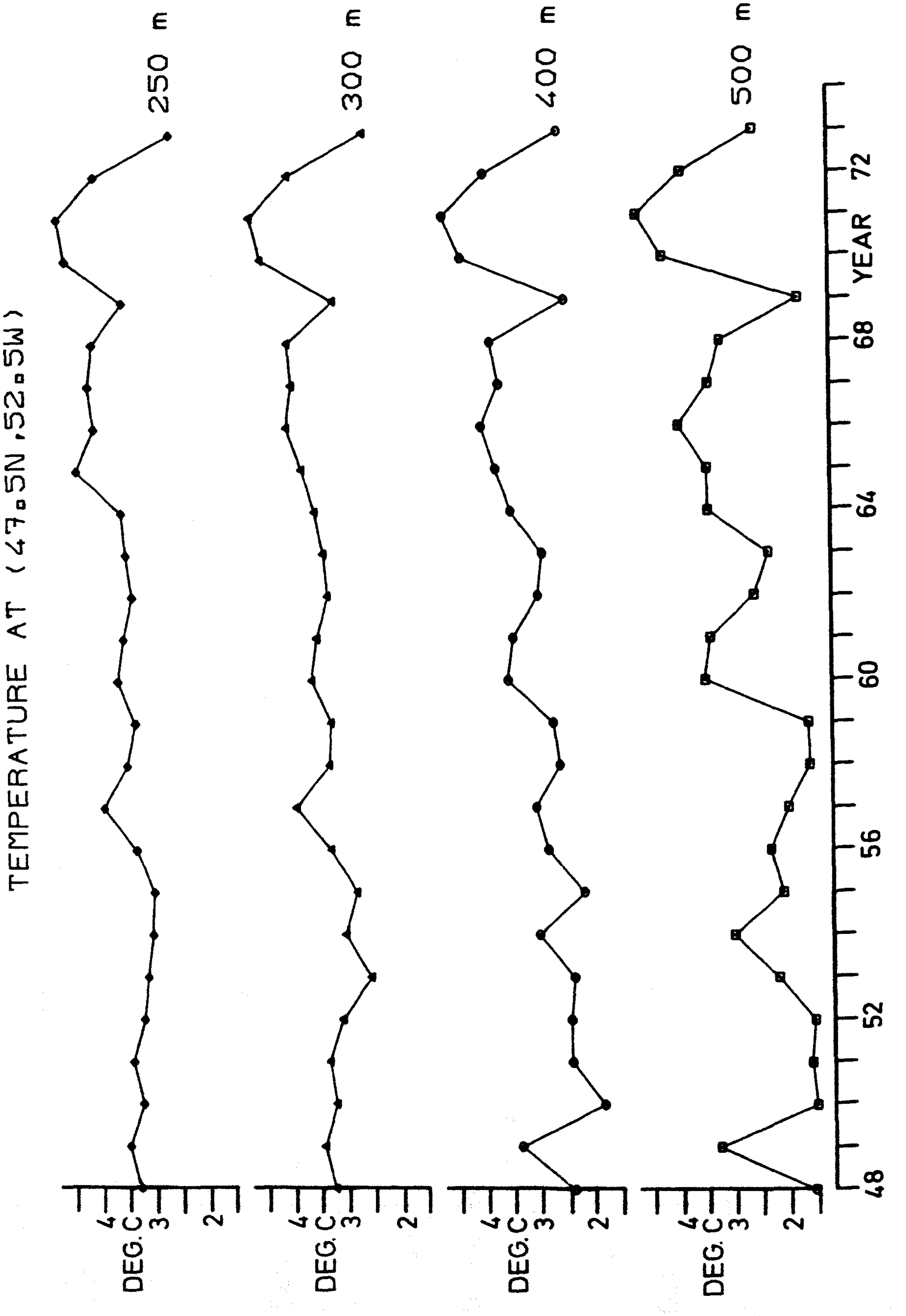

TEMPERATURE AT (52.5N,32.5W)
8
DEG. C
6
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

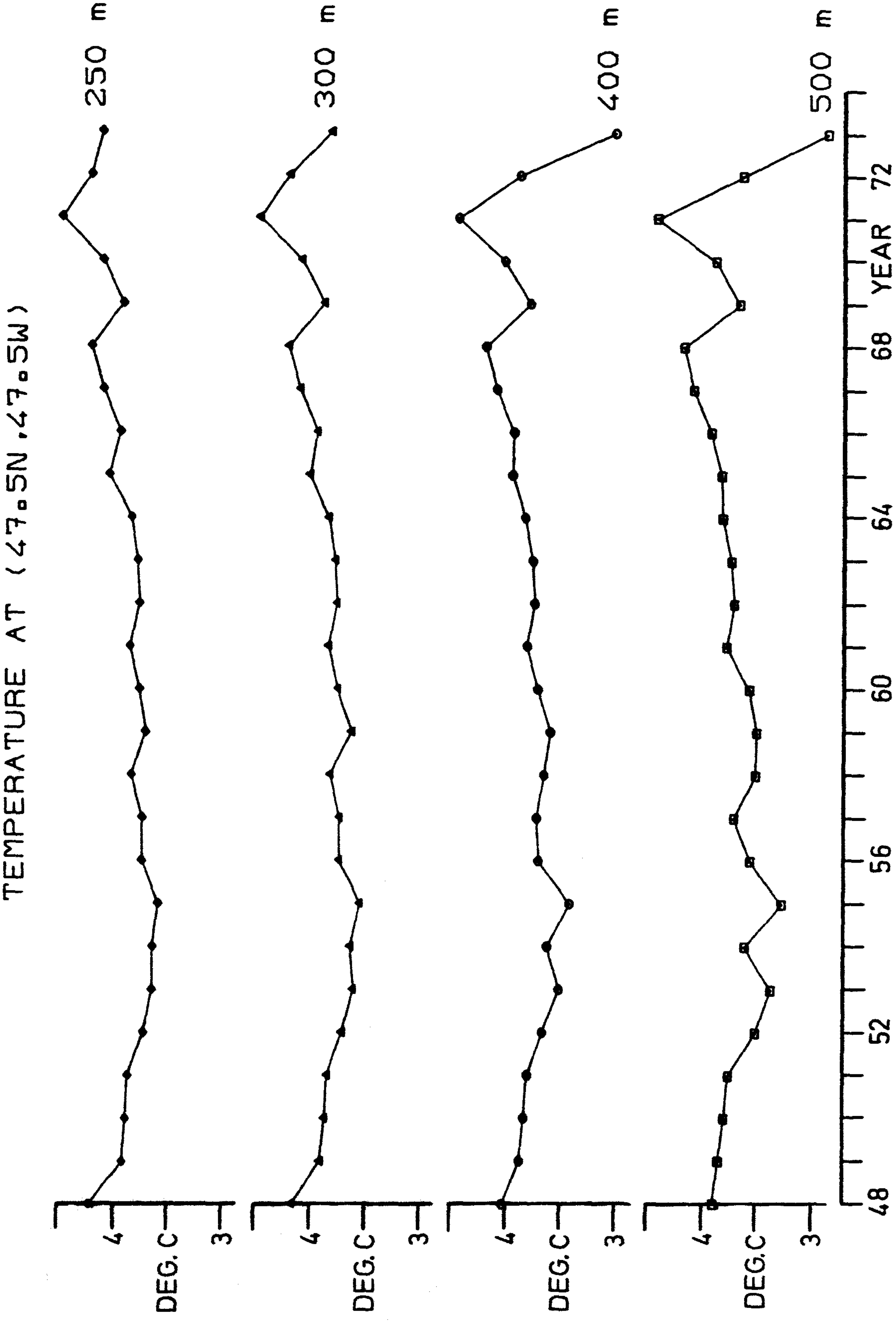

TEMPERATURE AT (52.5N,27.5W)
250 m
300 m
400 m
500 m
DEG.C
10
8
6
YEAR
48
52
56
60
64
68
72


TEMPERATURE AT (52.5N,22.5W)
10
DEG. C
8
6
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

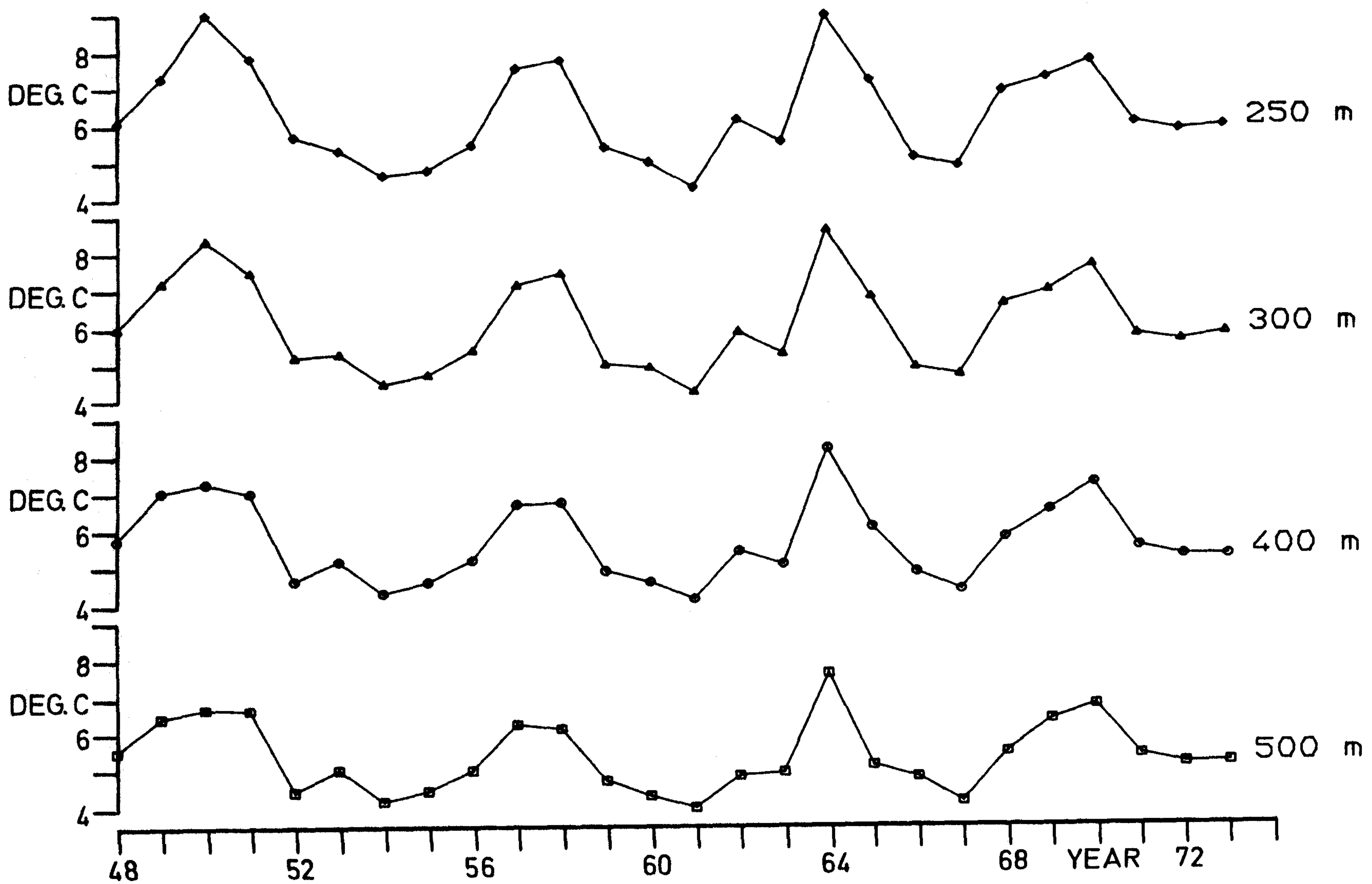

TEMPERATURE AT (52.5N,17.5W)
250 m
300 m
400 m
500 m
DEG.C
10
8
YEAR
48
52
56
60
64
68
72

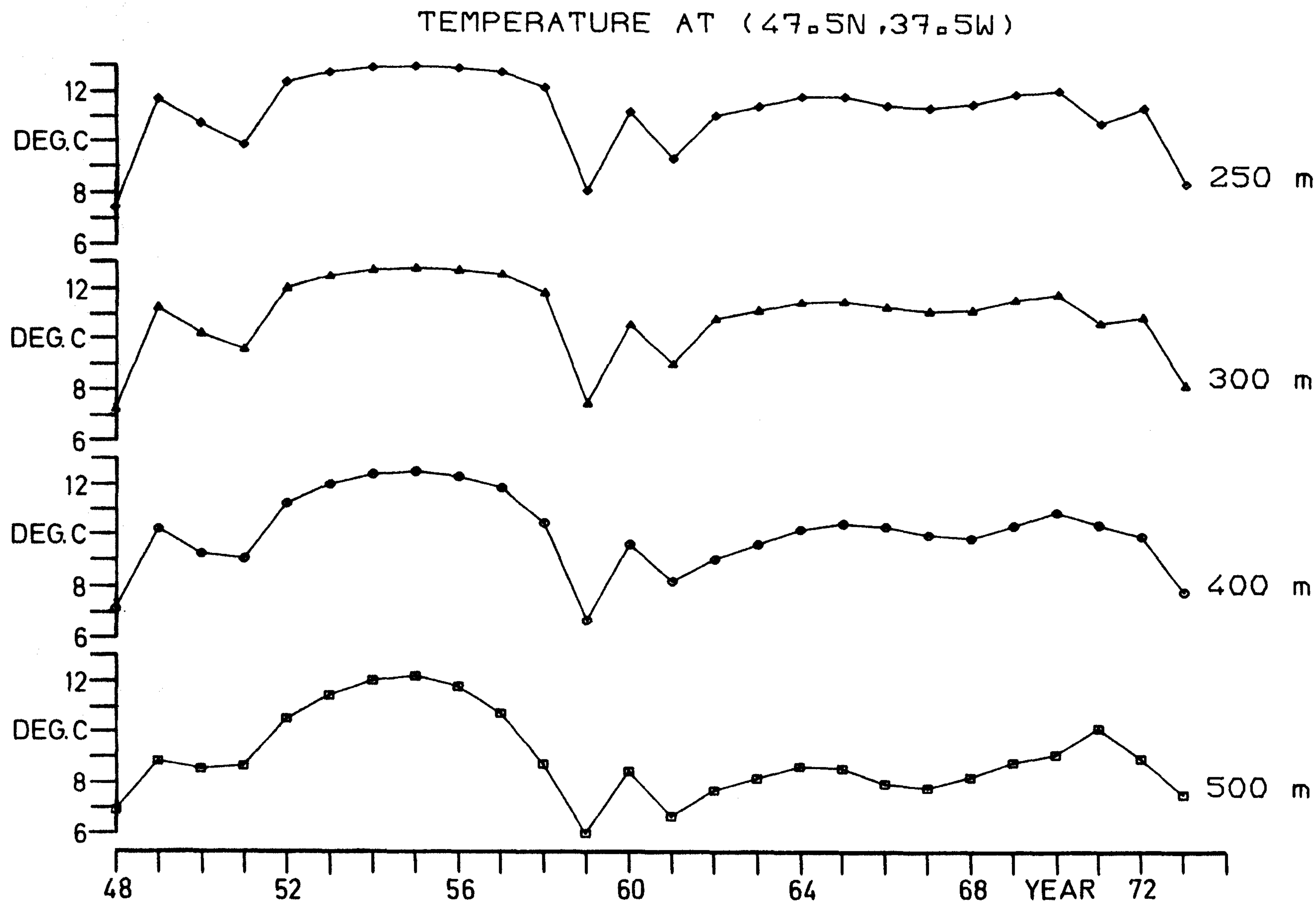

TEMPERATURE AT (52.5N,12.5W)
11
DEG. C
10
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

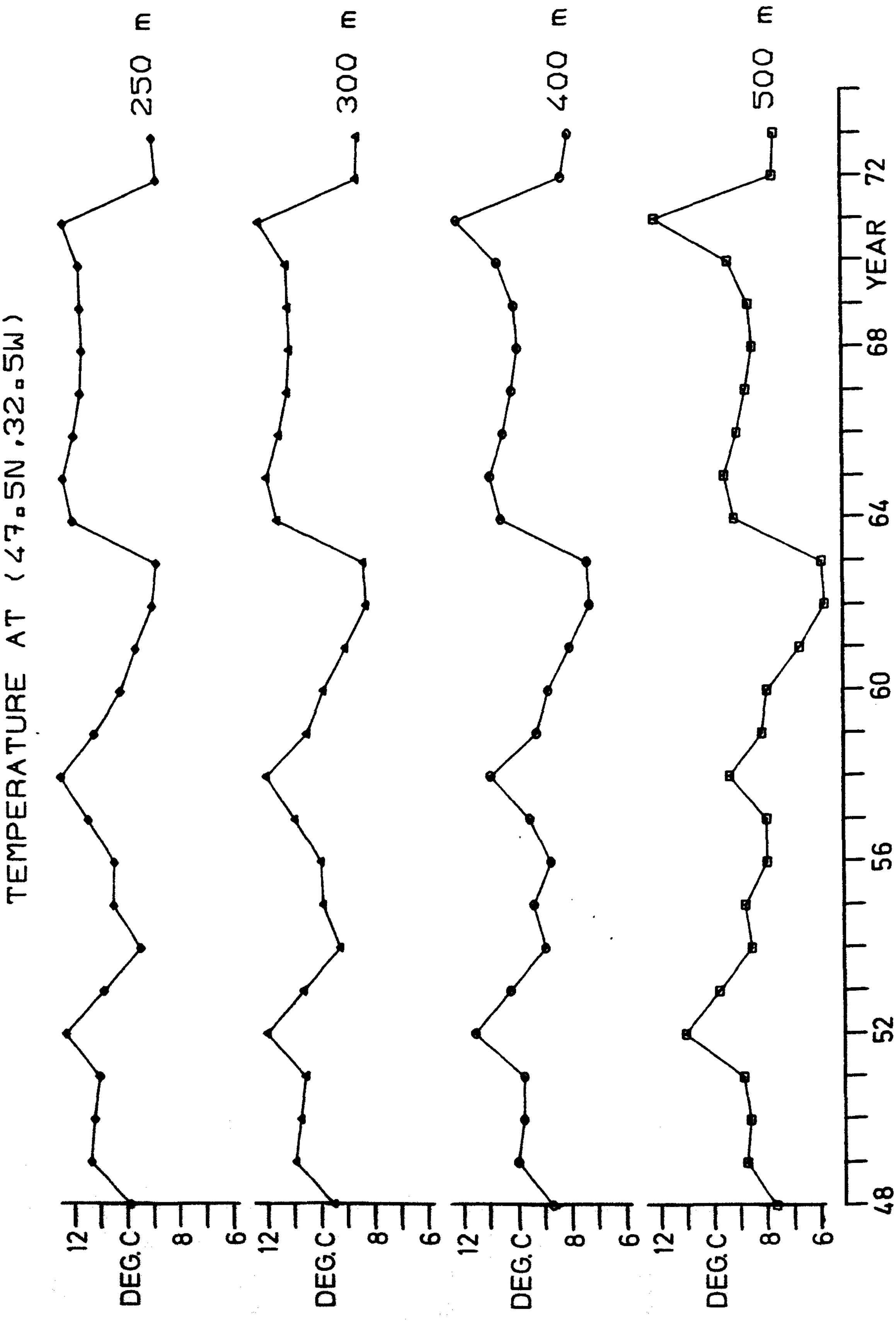

TEMPERATURE AT (47.5N,52.5W)
250 m
300 m
400 m
500 m
DEG.C
4
3
2
YEAR
48
52
56
60
64
68
72

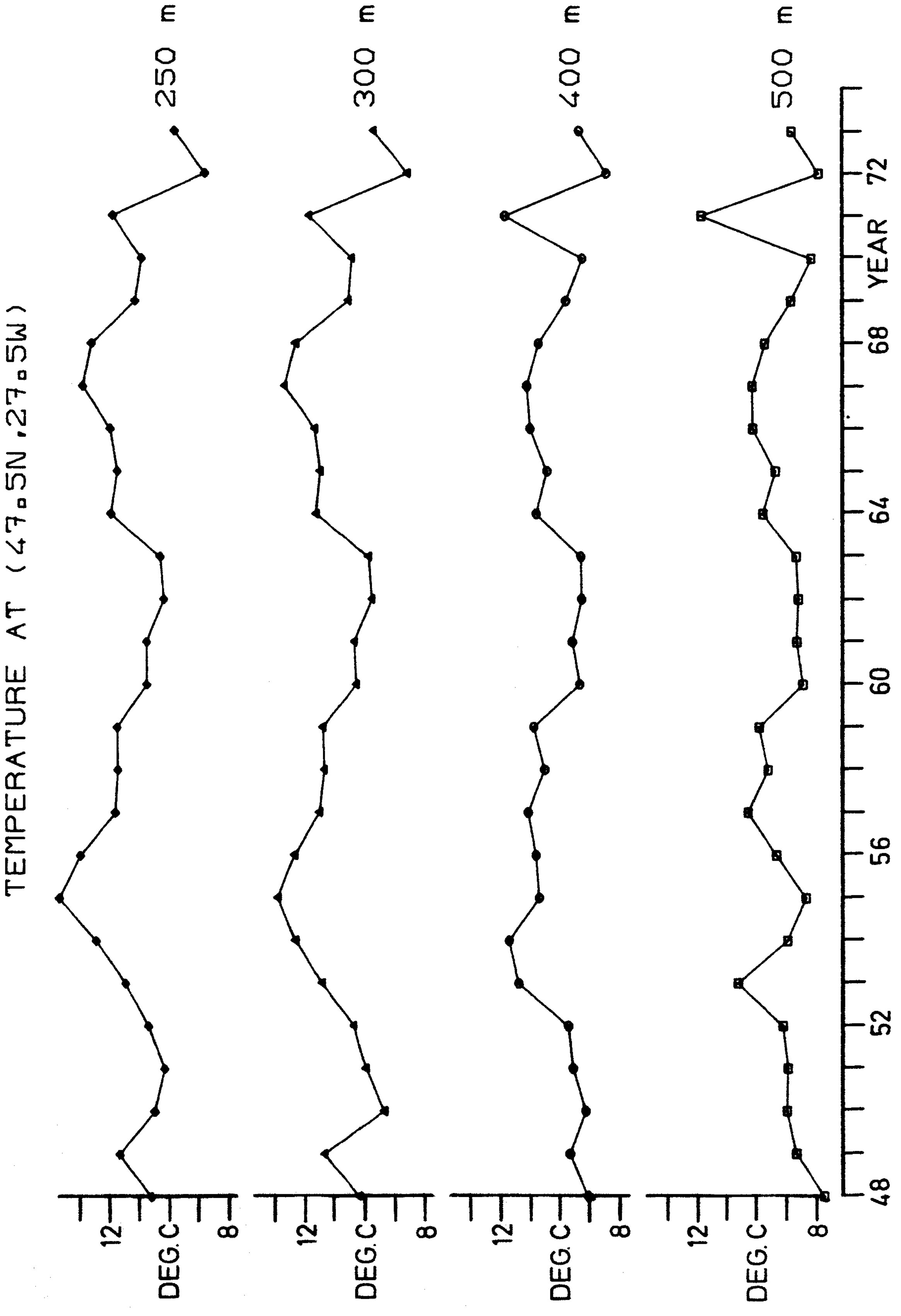

TEMPERATURE AT (47.5N,47.5W)
250 m
300 m
400 m
500 m
DEG.C
DEG.C
DEG.C
DEG.C
4
3
YEAR
48
52
56
60
64
68
72

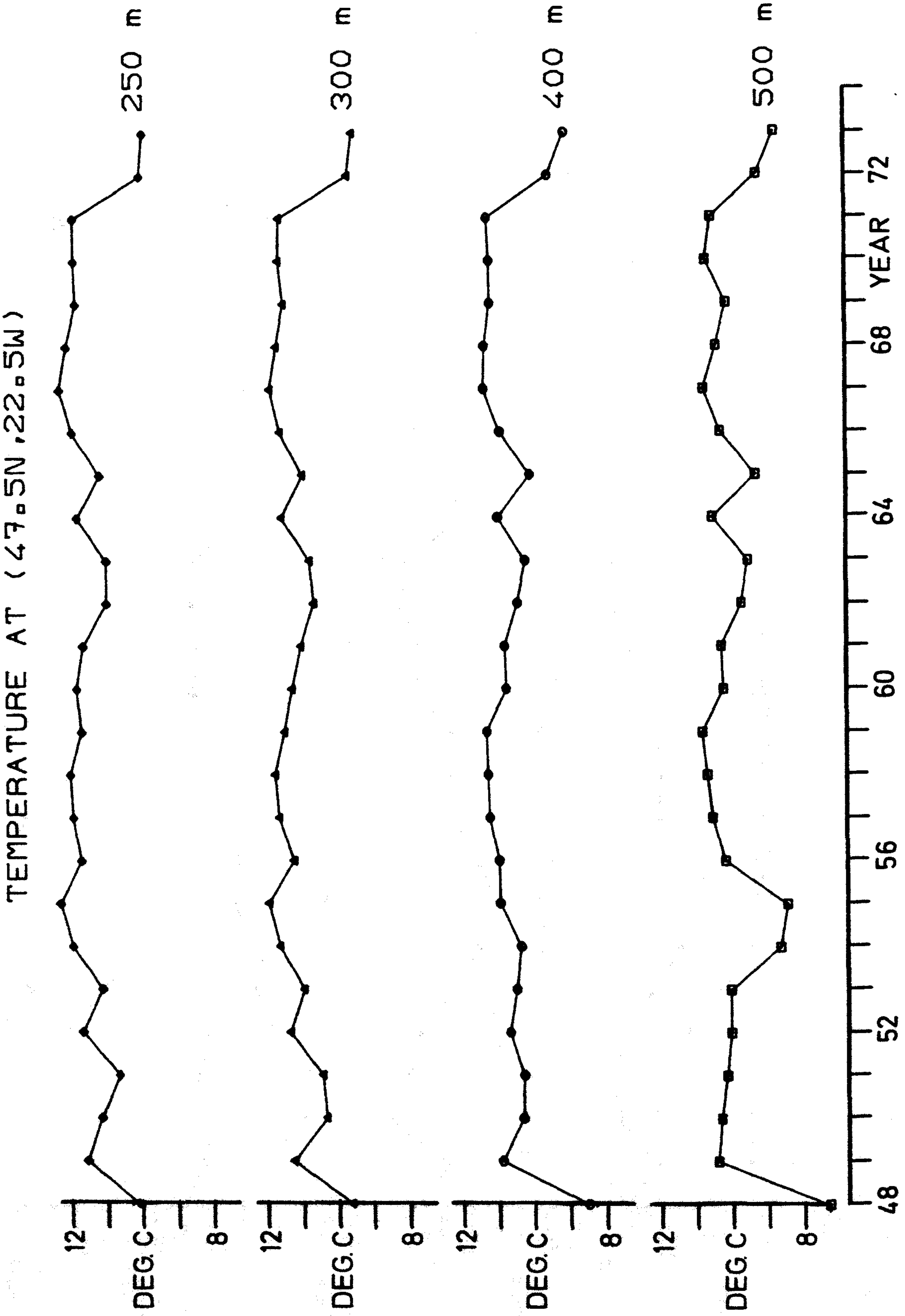
TEMPERATURE AT (47.5N,42.5W)

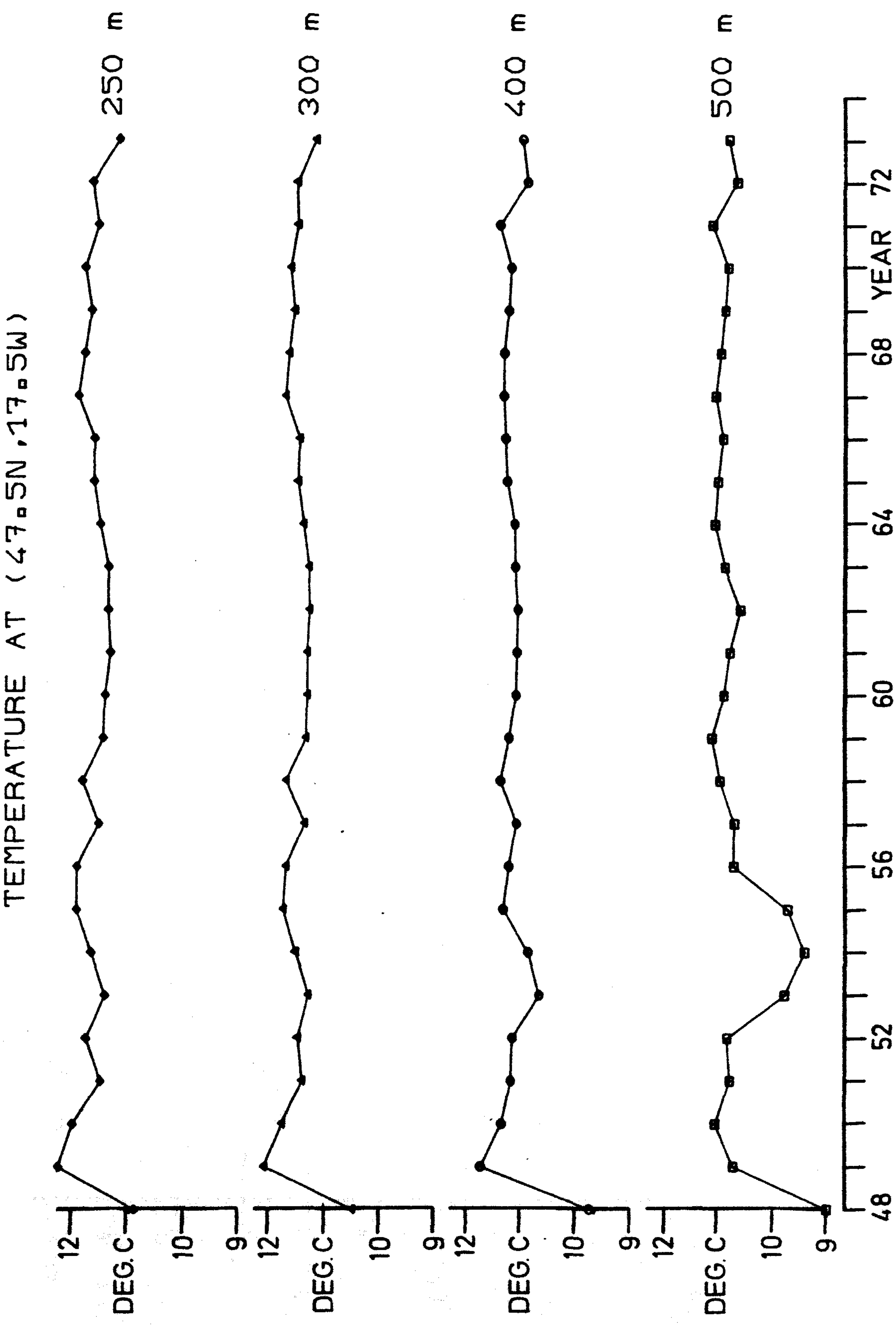



TEMPERATURE AT (47.5N,37.5W)
DEG.C
12
8
6
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

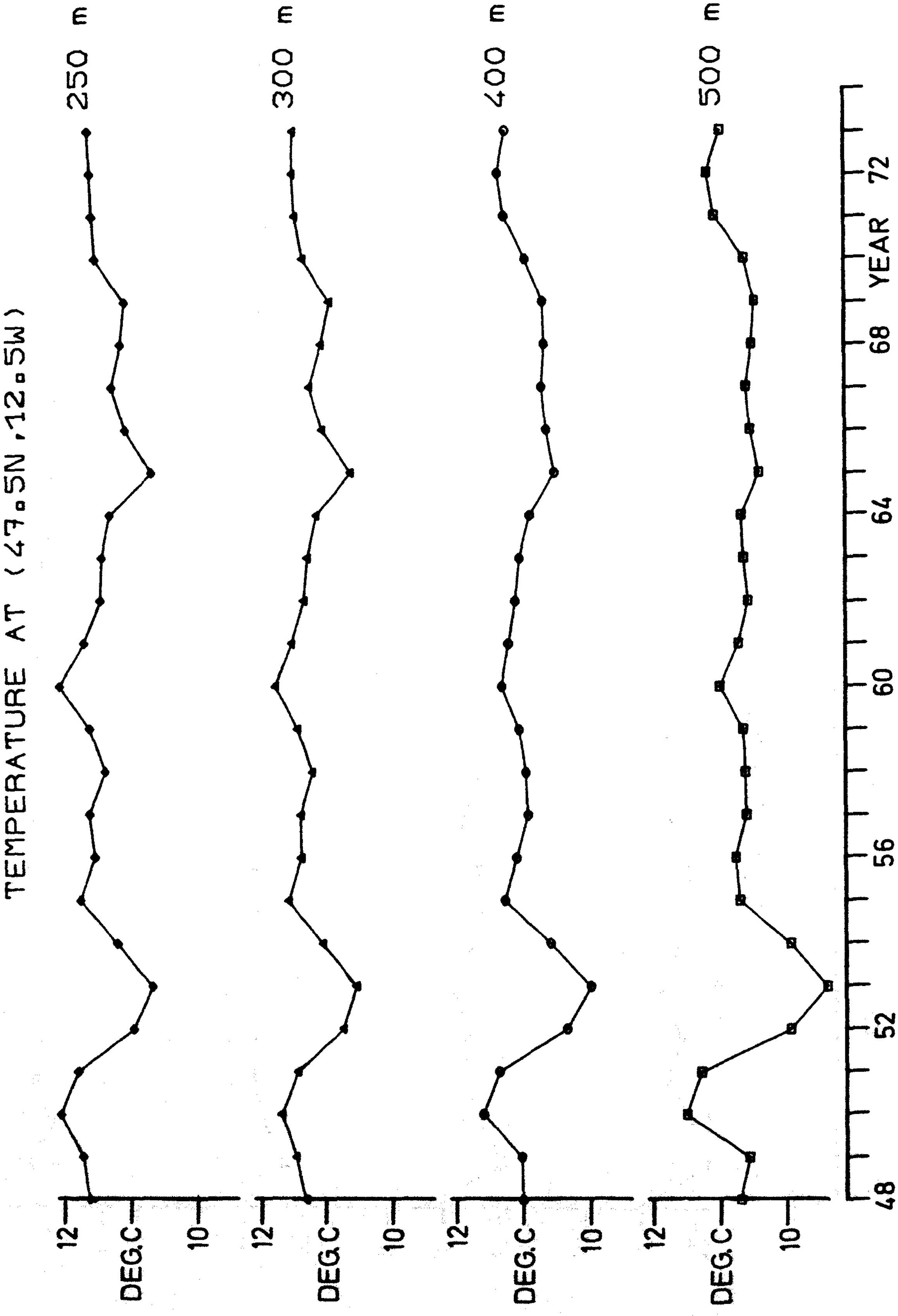

TEMPERATURE AT (47.5N,32.5W)
250 m
300 m
400 m
500 m
DEG.C
12
8
6
YEAR
48
52
56
60
64
68
72

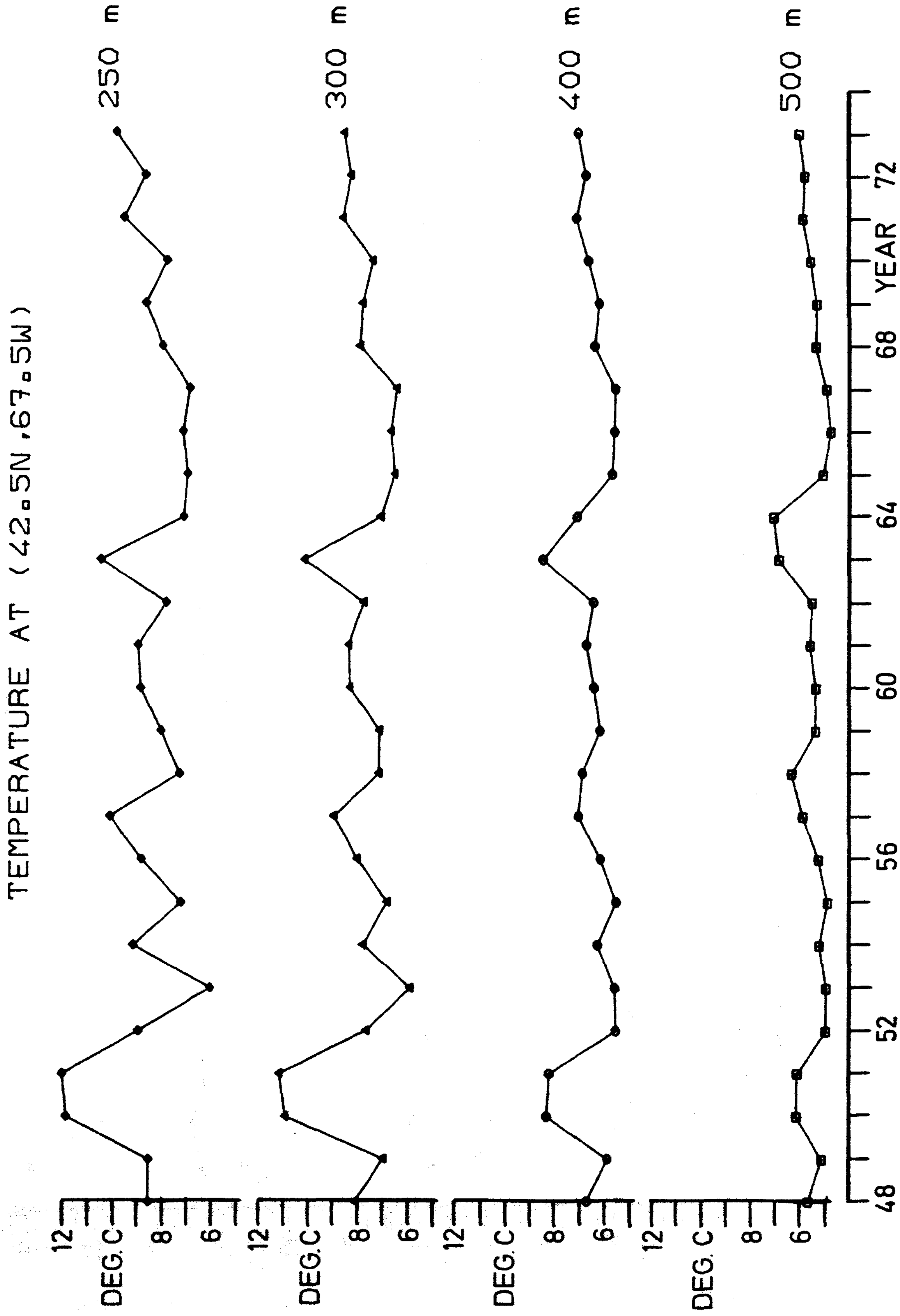

TEMPERATURE AT (47.5N, 27.5W)
250 m
300 m
400 m
500 m
DEG.C
12
8
YEAR
48
52
56
60
64
68
72


TEMPERATURE AT (47.5N, 22.5W)
250 m
300 m
400 m
500 m
DEG.C
12
8
YEAR
48
52
56
60
64
68
72

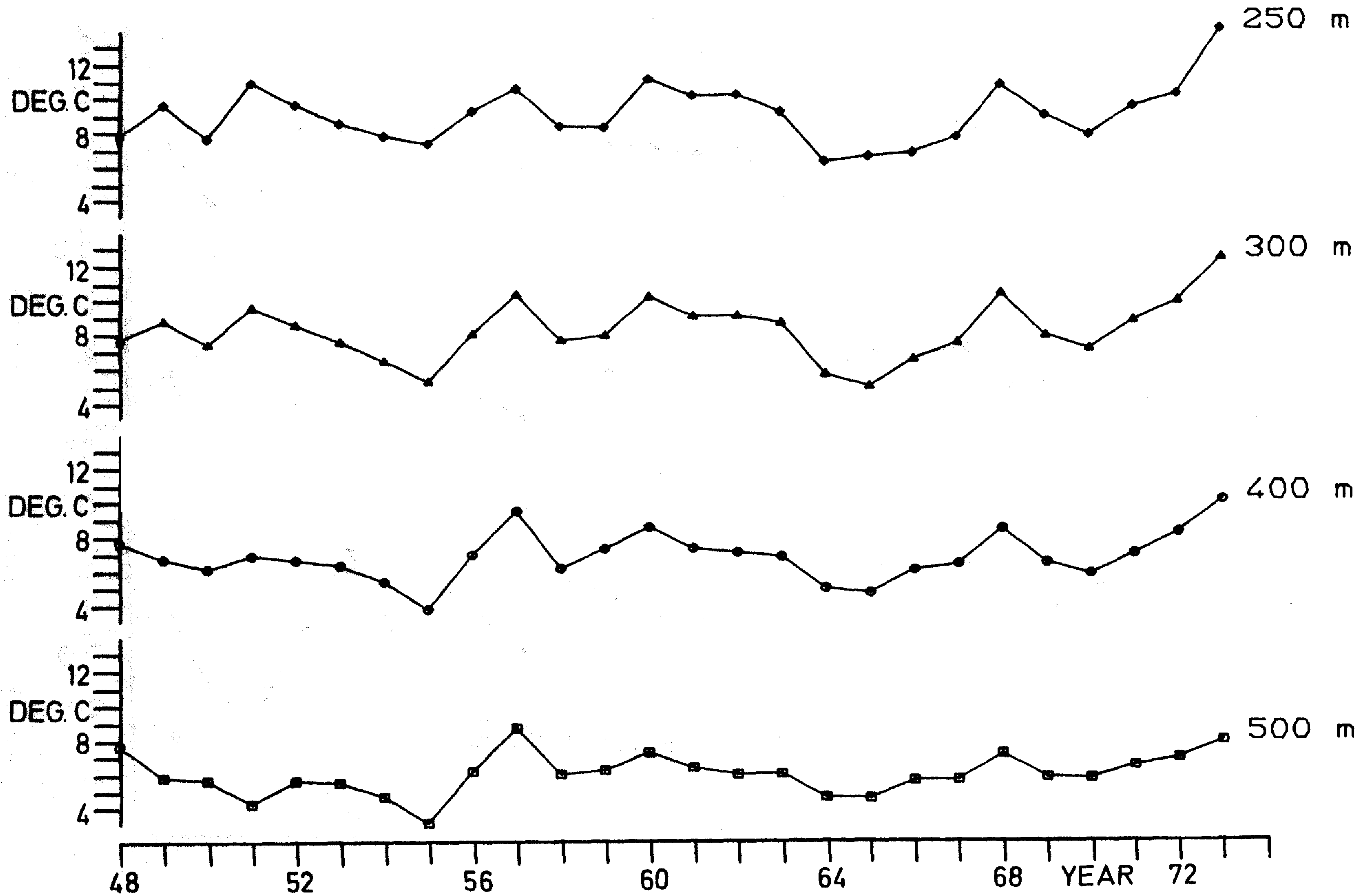


TEMPERATURE AT (47.5N,17.5W)
250 m
300 m
400 m
500 m
DEG.C
12
10
9
YEAR
48
52
56
60
64
68
72

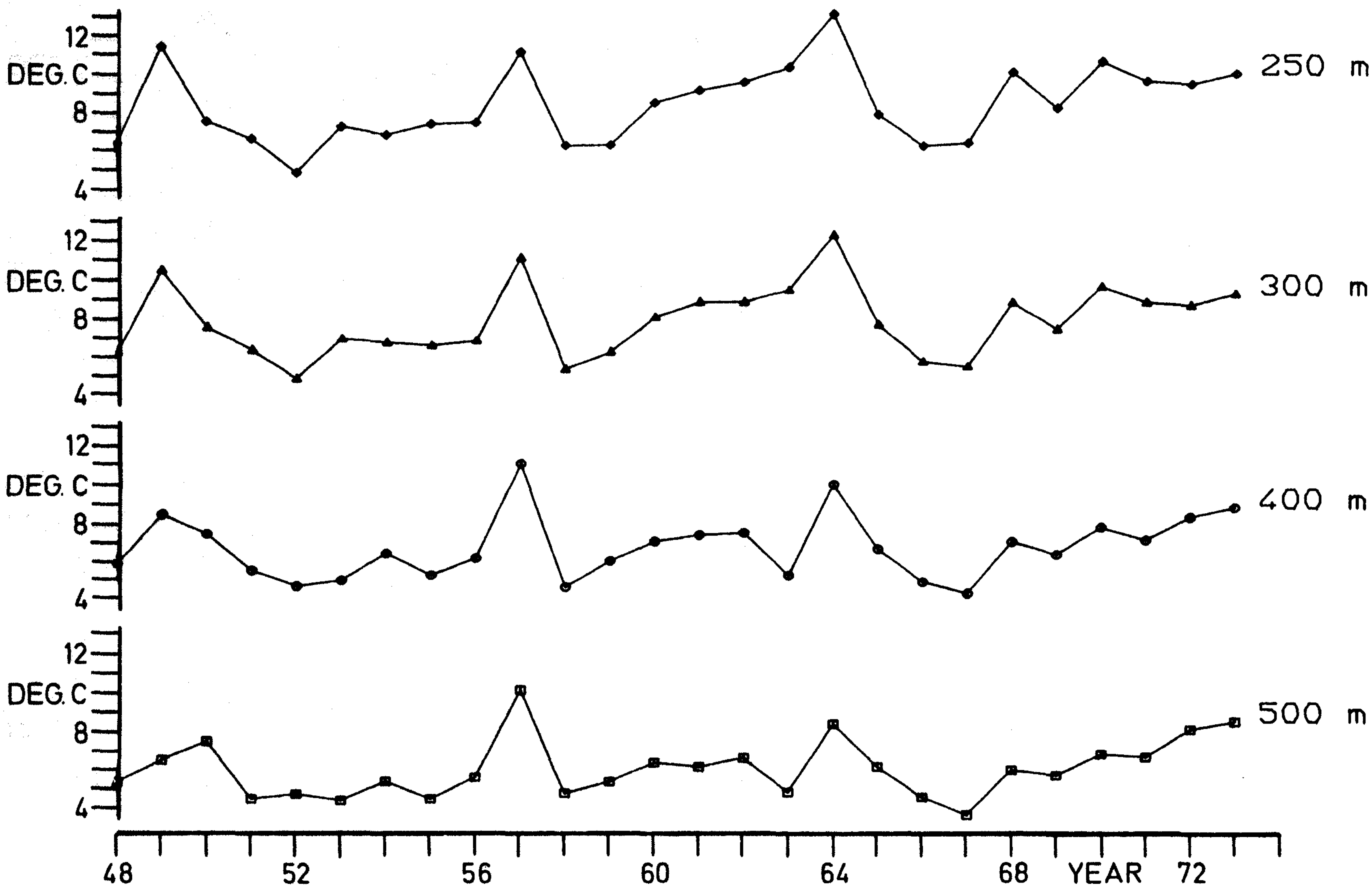

TEMPERATURE AT (47.5N,12.5W)
250 m
300 m
400 m
500 m
DEG.C
12
10
YEAR
48
52
56
60
64
68
72

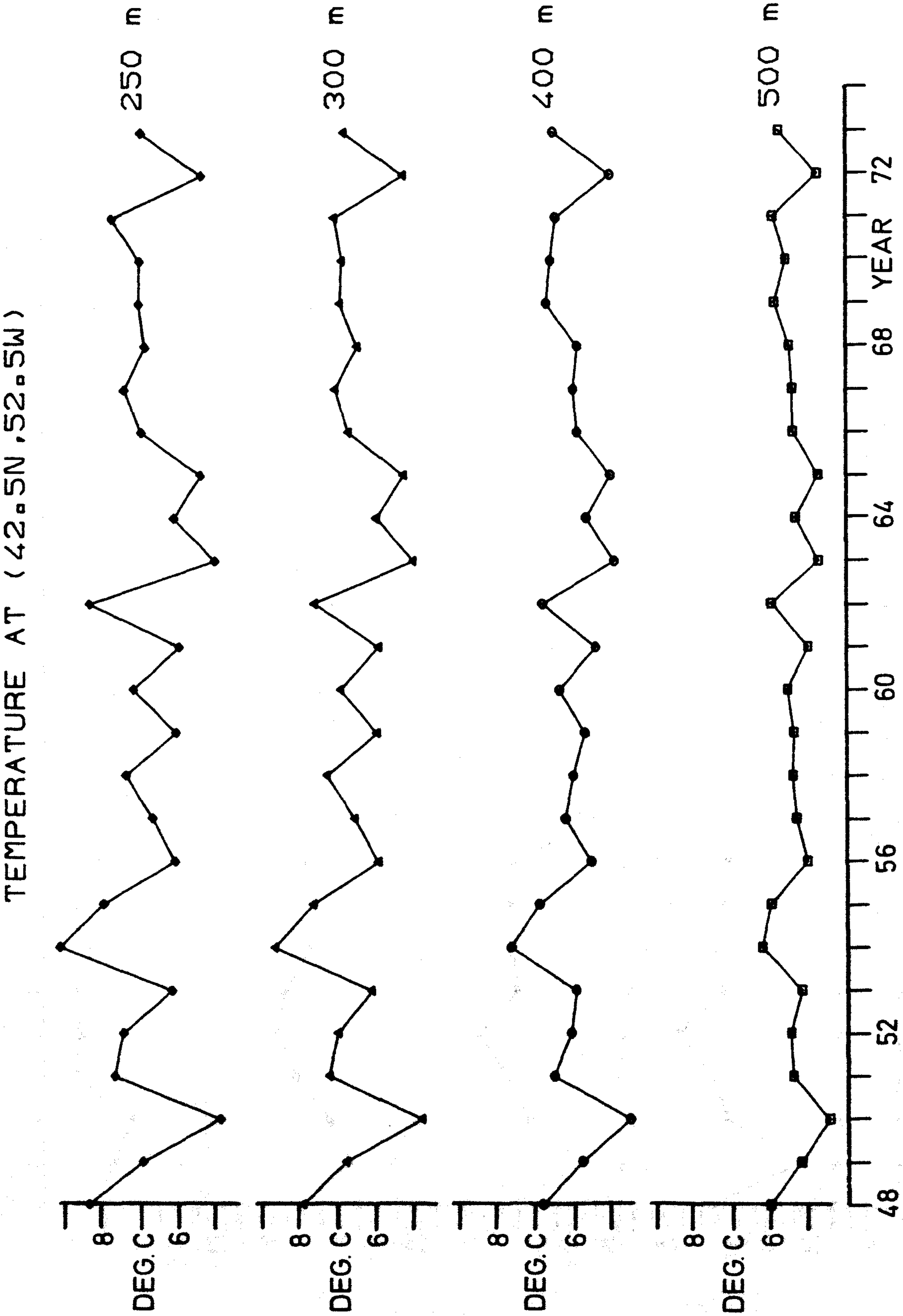

TEMPERATURE AT (42.5N,67.5W)
250 m
300 m
400 m
500 m
DEG.C
DEG.C
DEG.C
DEG.C
12
8
6
YEAR
48
52
56
60
64
68
72

TEMPERATURE AT (42.5N,62.5W)

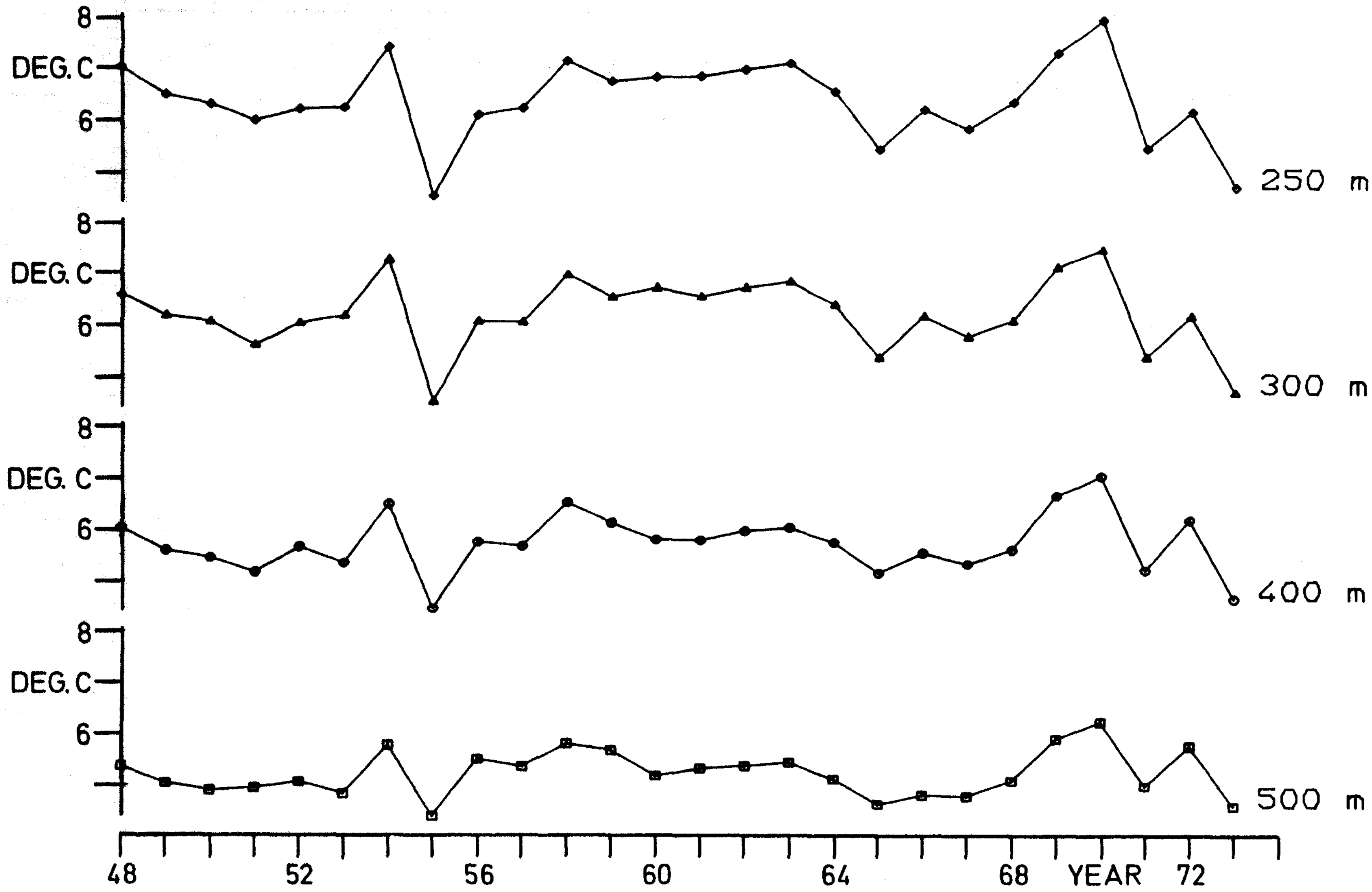


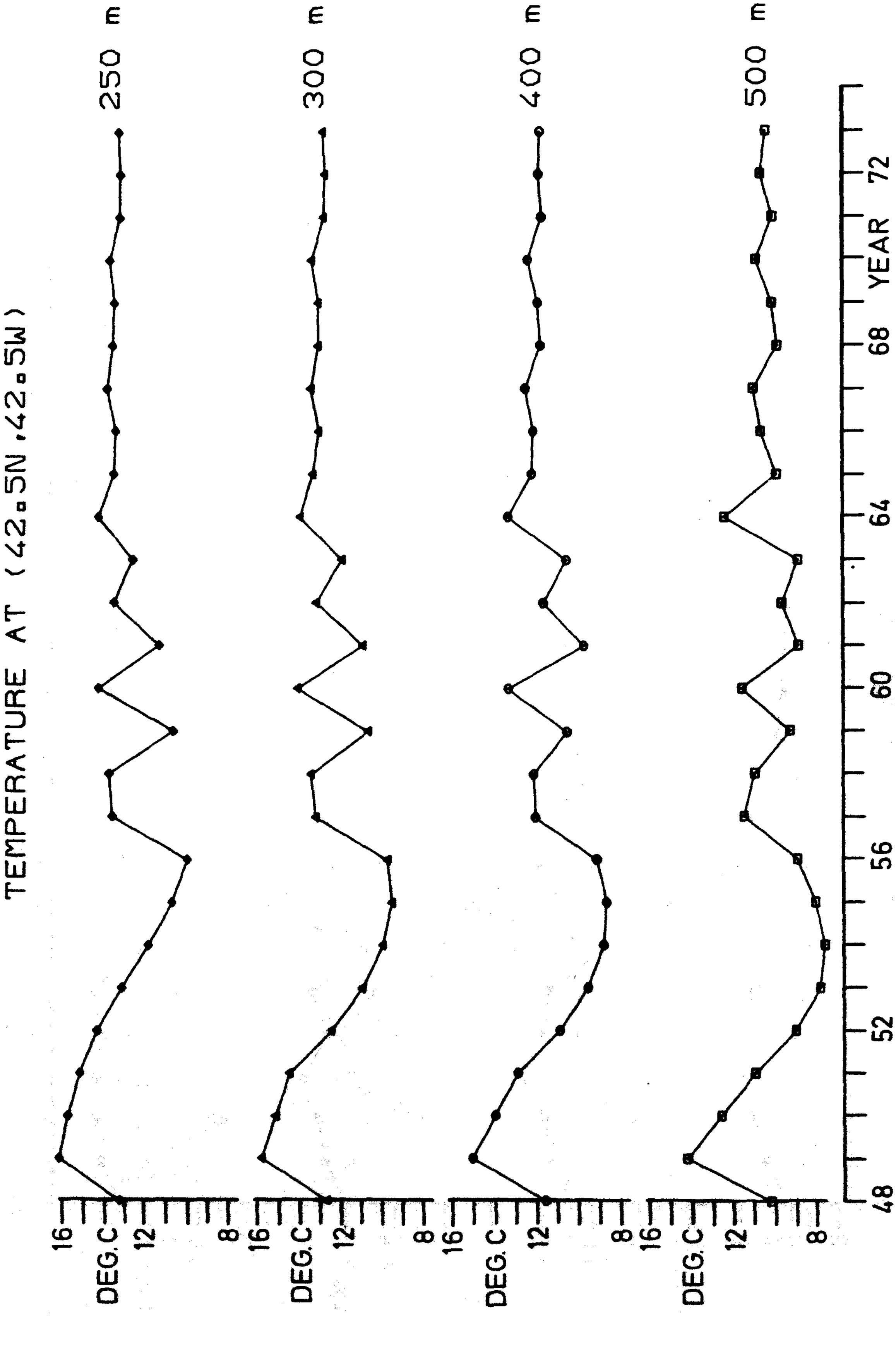
TEMPERATURE AT (42.5N,57.5W)



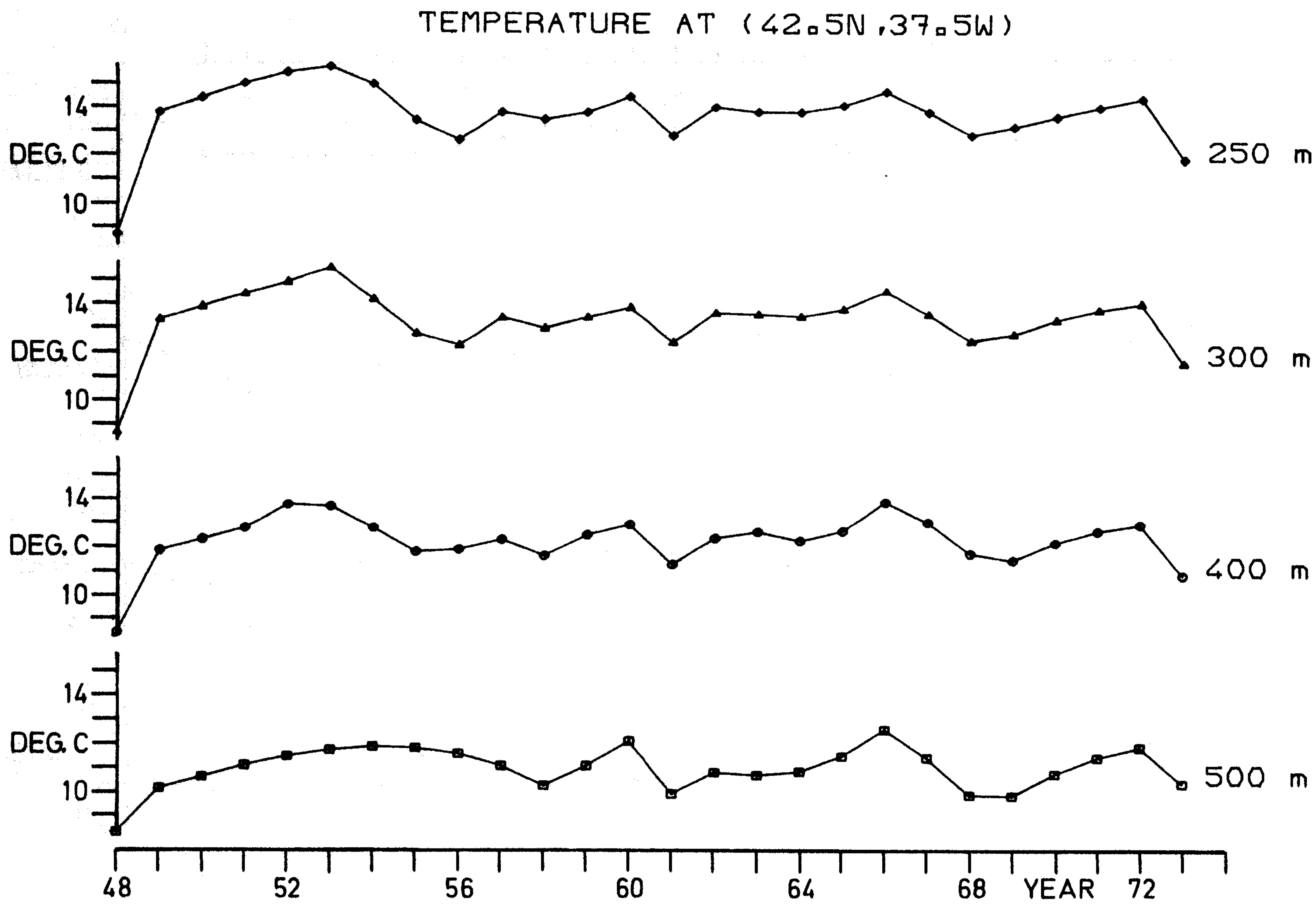

TEMPERATURE AT (42.5N,52.5W)
250 m
300 m
400 m
500 m
DEG.C
8
6
DEG.C
8
6
DEG.C
8
6
DEG.C
8
6
48
52
56
60
64
68
72
YEAR

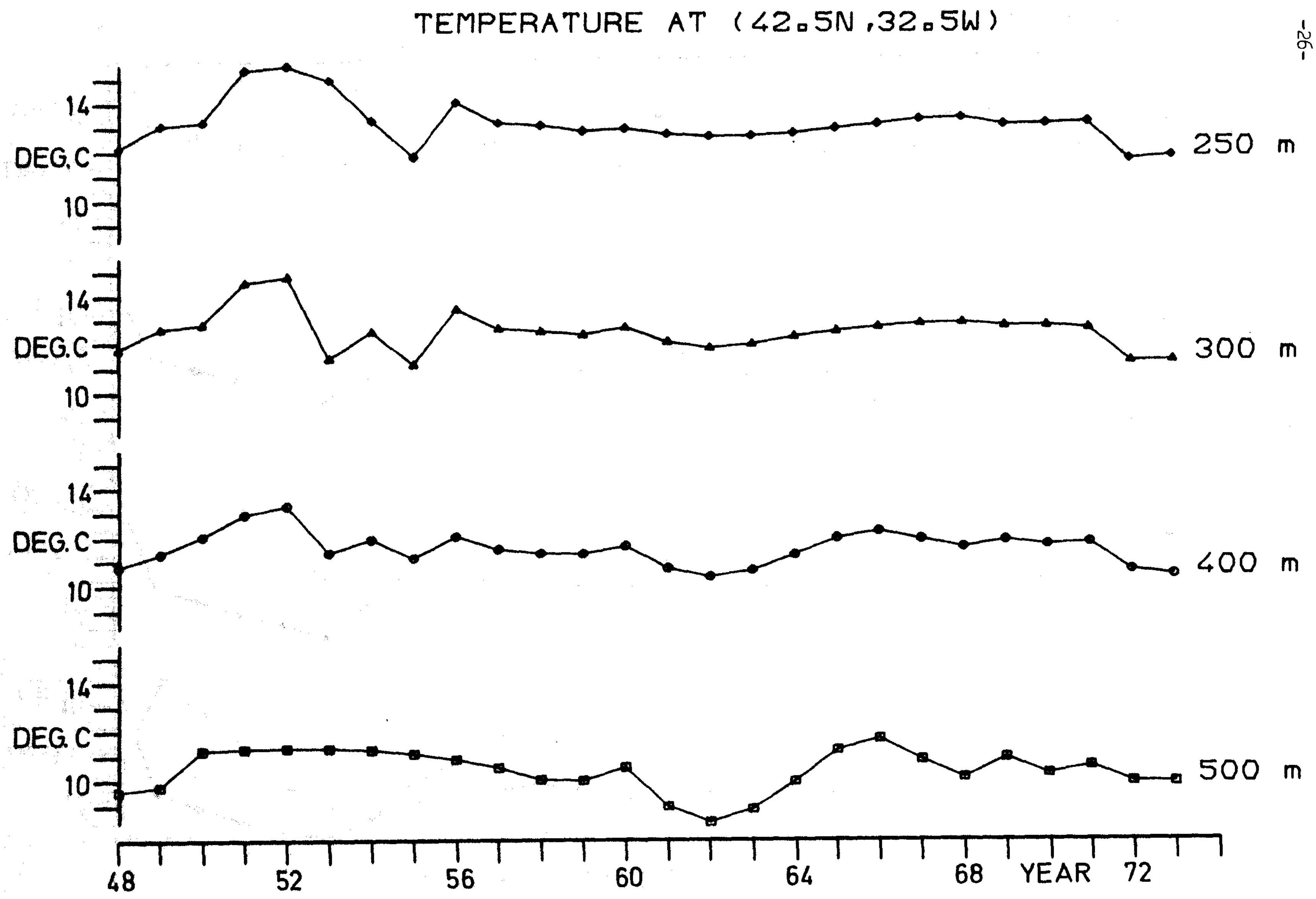
TEMPERATURE AT (42.5N, 47.5W)



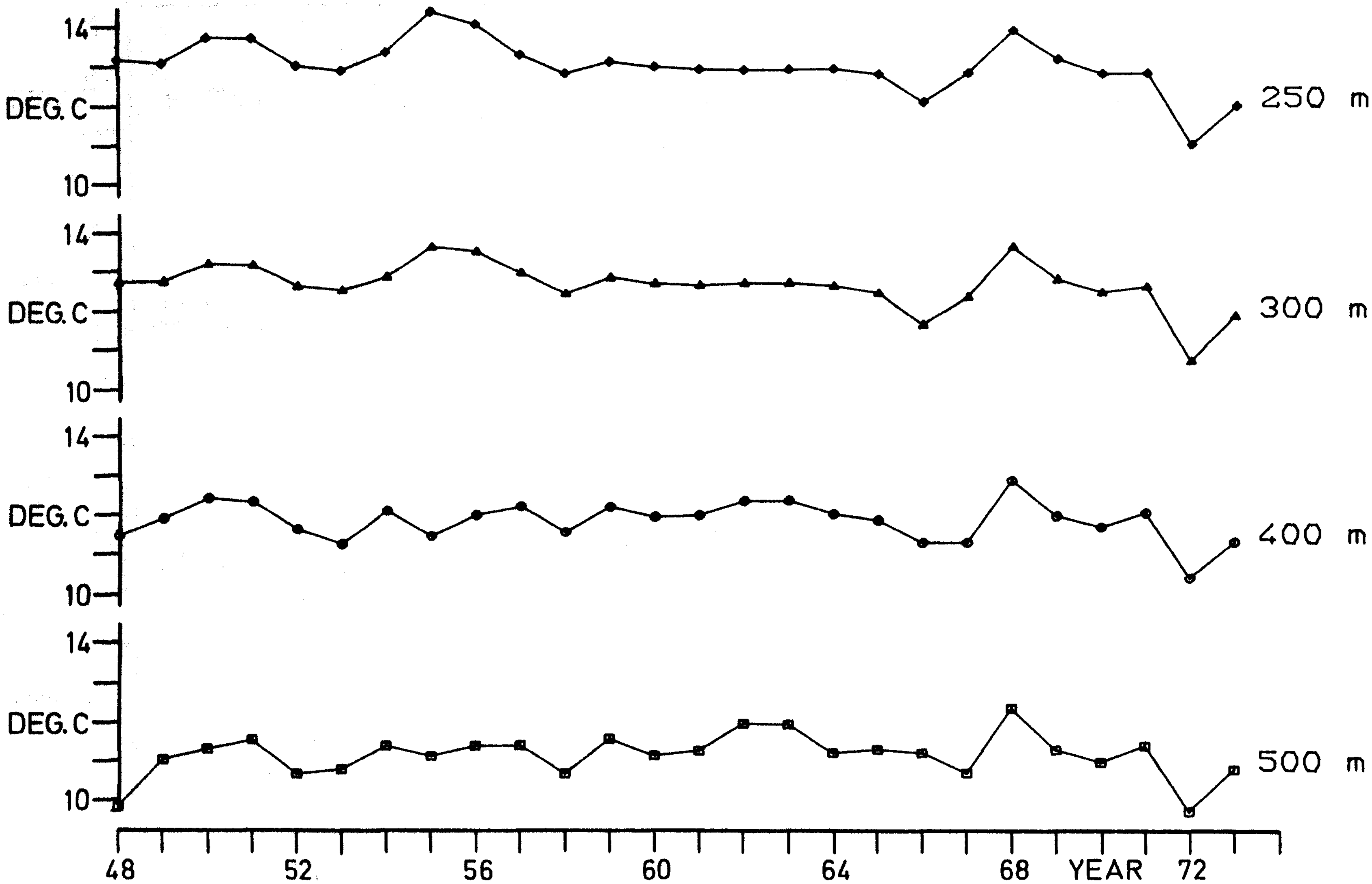


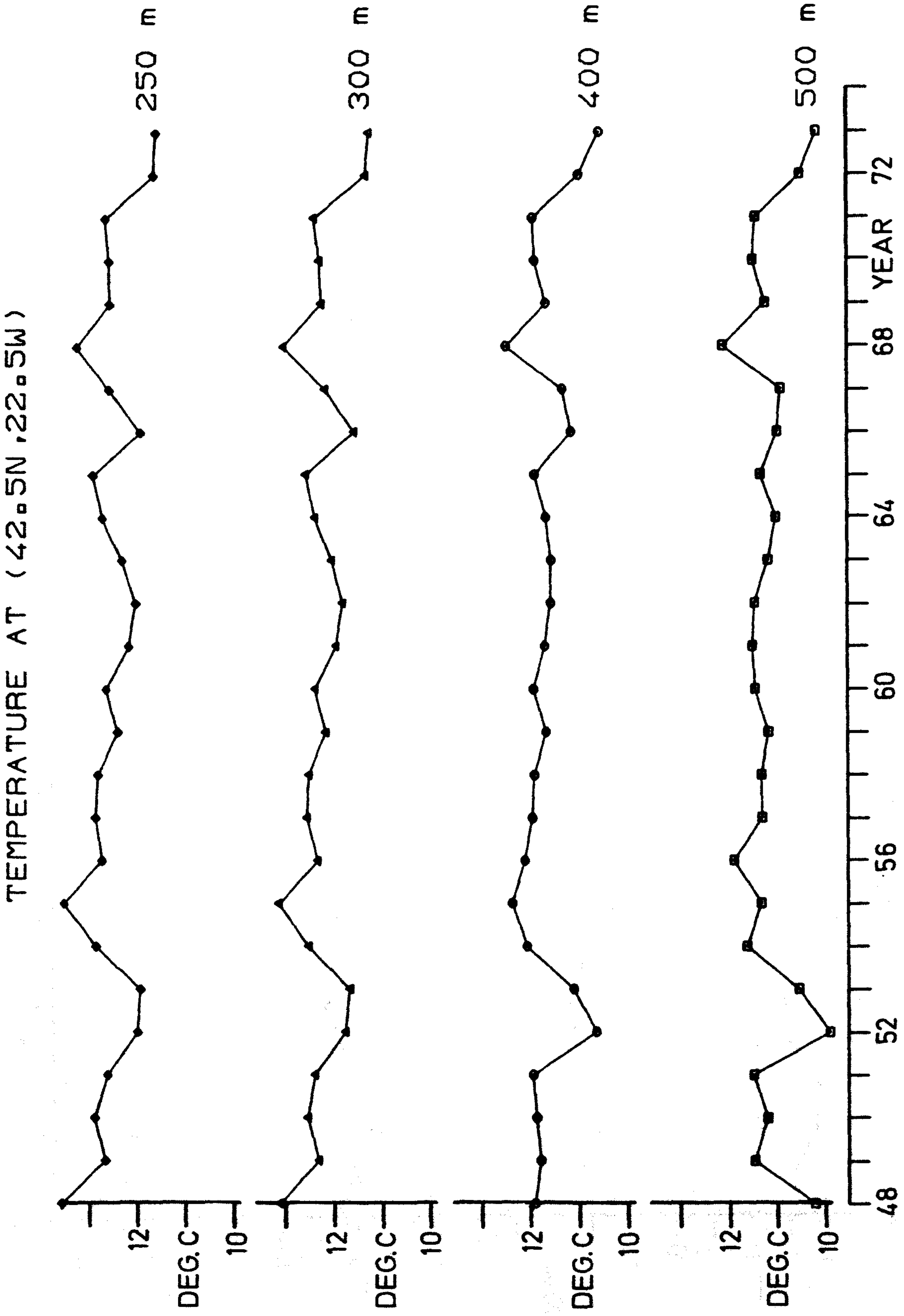
TEMPERATURE AT (42.5N,42.5W)
250 m
300 m
400 m
500 m
DEG.C
16
12
8
YEAR
48
52
56
60
64
68
72

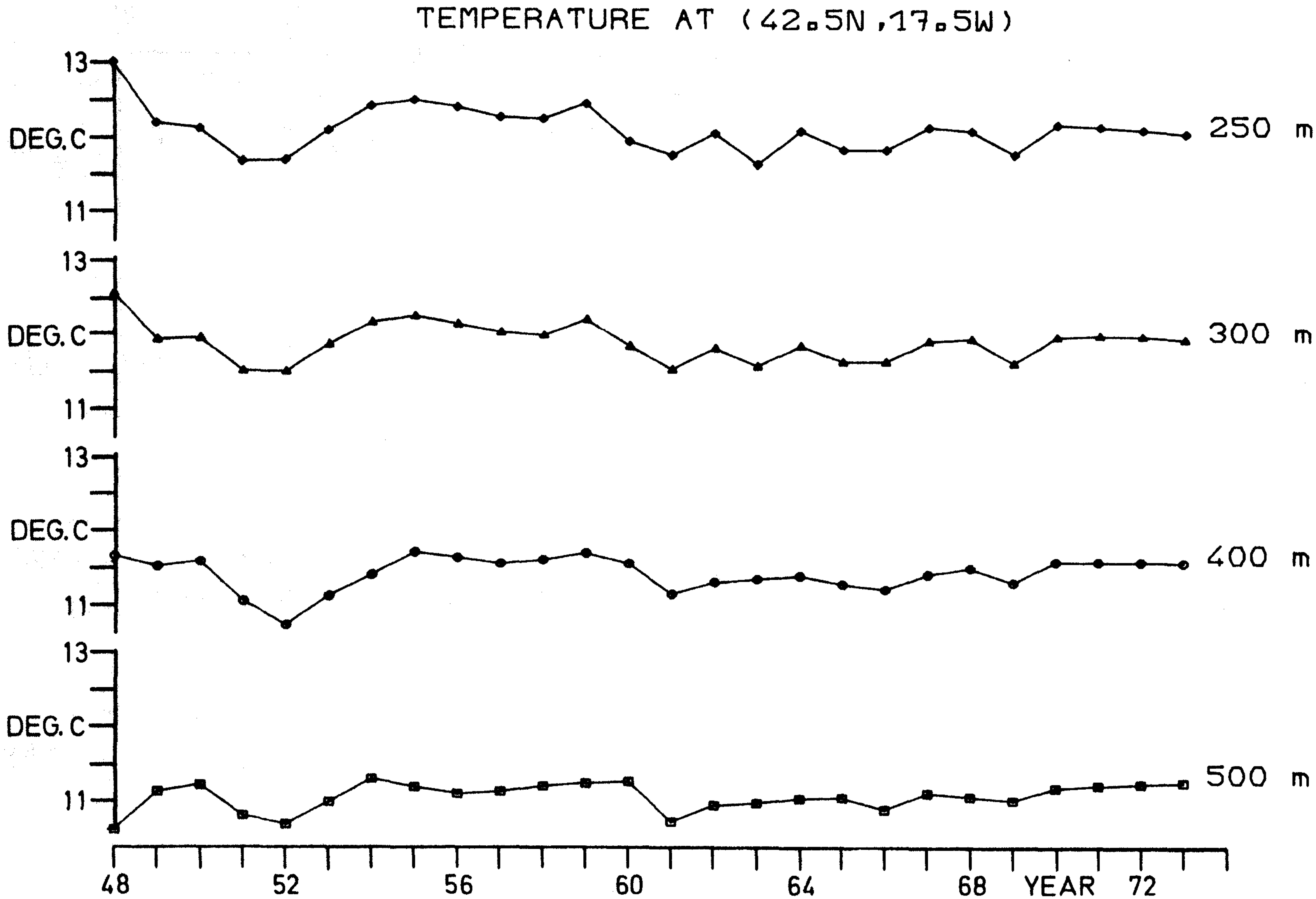

TEMPERATURE AT (42.5N,37.5W)
14
DEG. C
10
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

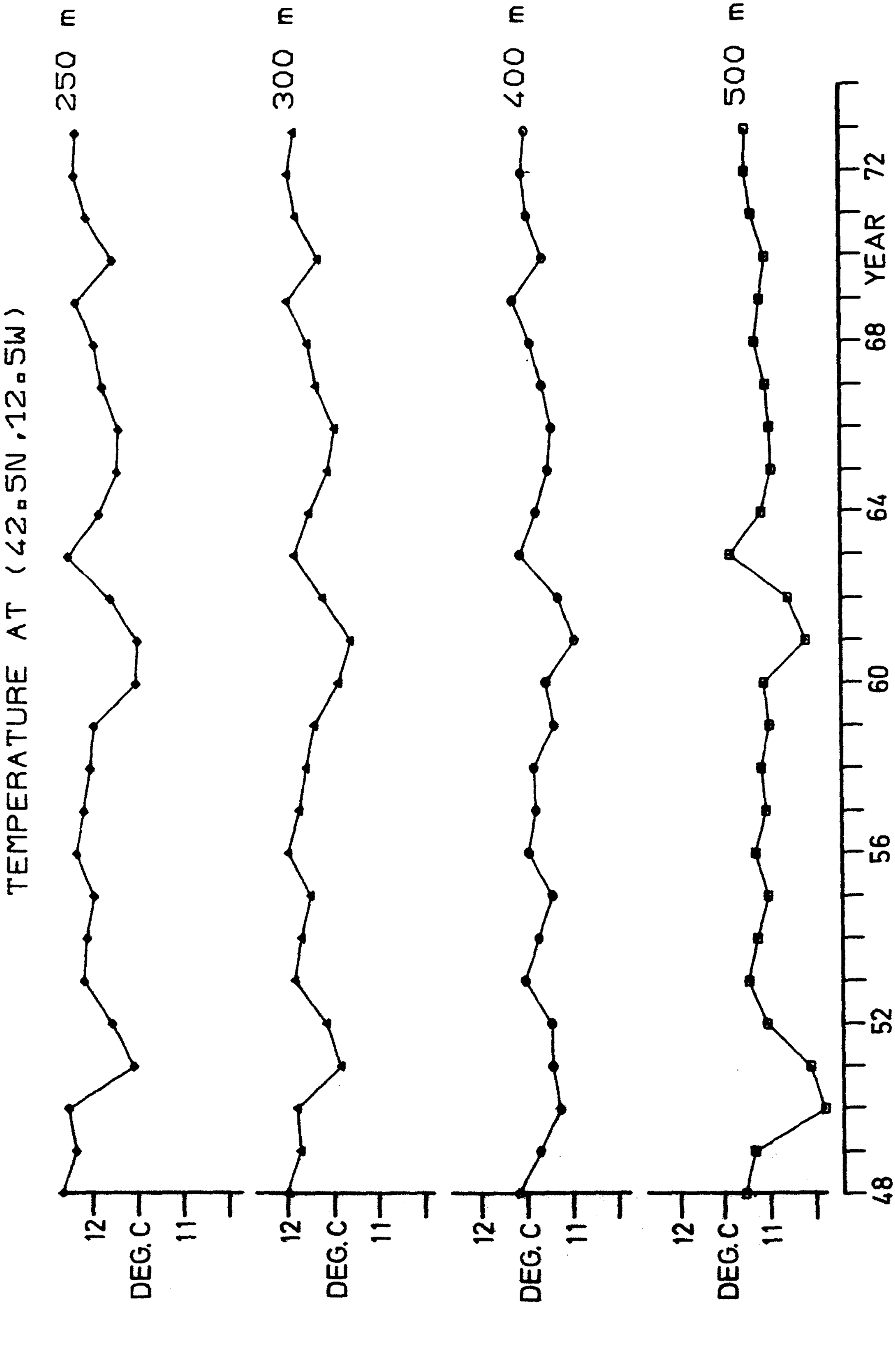

TEMPERATURE AT (42.5N,32.5W)
250 m
300 m
400 m
500 m
DEG.C
14
10
YEAR
48
52
56
60
64
68
72

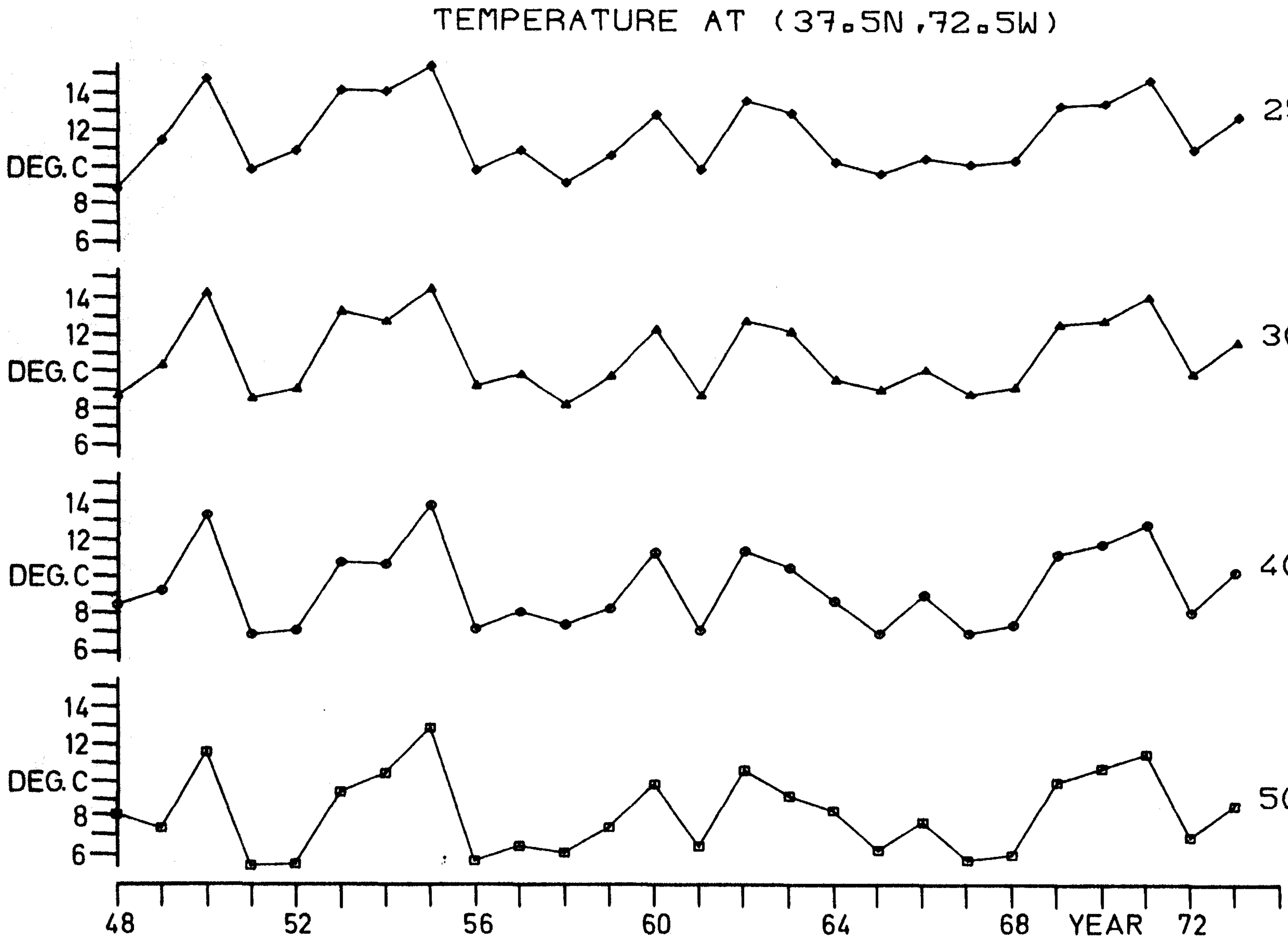
TEMPERATURE AT (42.5N, 27.5W)




TEMPERATURE AT (42.5N,22.5W)
250 m
300 m
400 m
500 m
DEG.C
12
10
YEAR
48
52
56
60
64
68
72

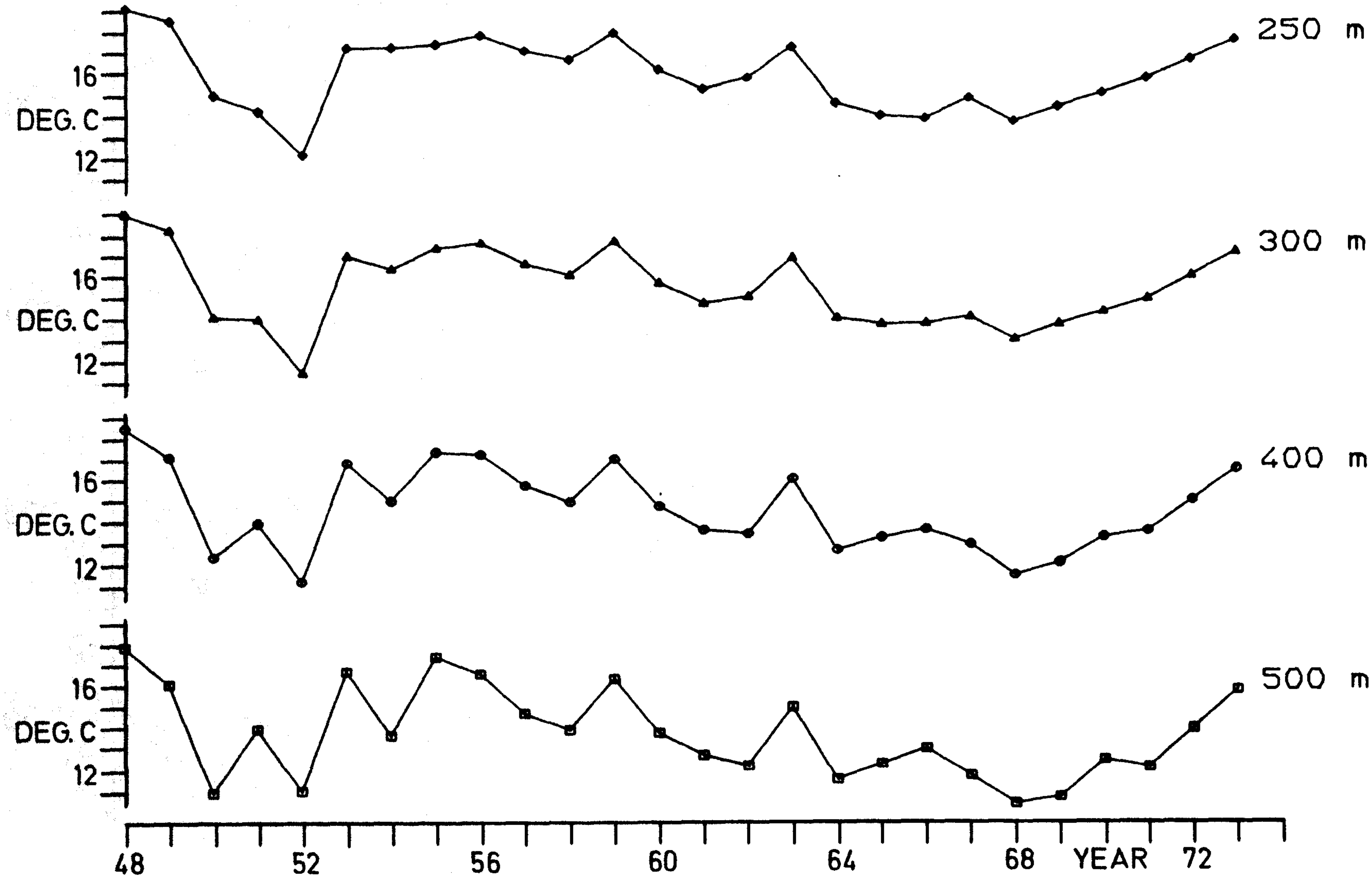

TEMPERATURE AT (42.5N,17.5W)
13
DEG.C
11
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72


TEMPERATURE AT (42.5N,12.5W)
250 m
300 m
400 m
500 m
DEG.C
12
11
YEAR
48
52
56
60
64
68
72

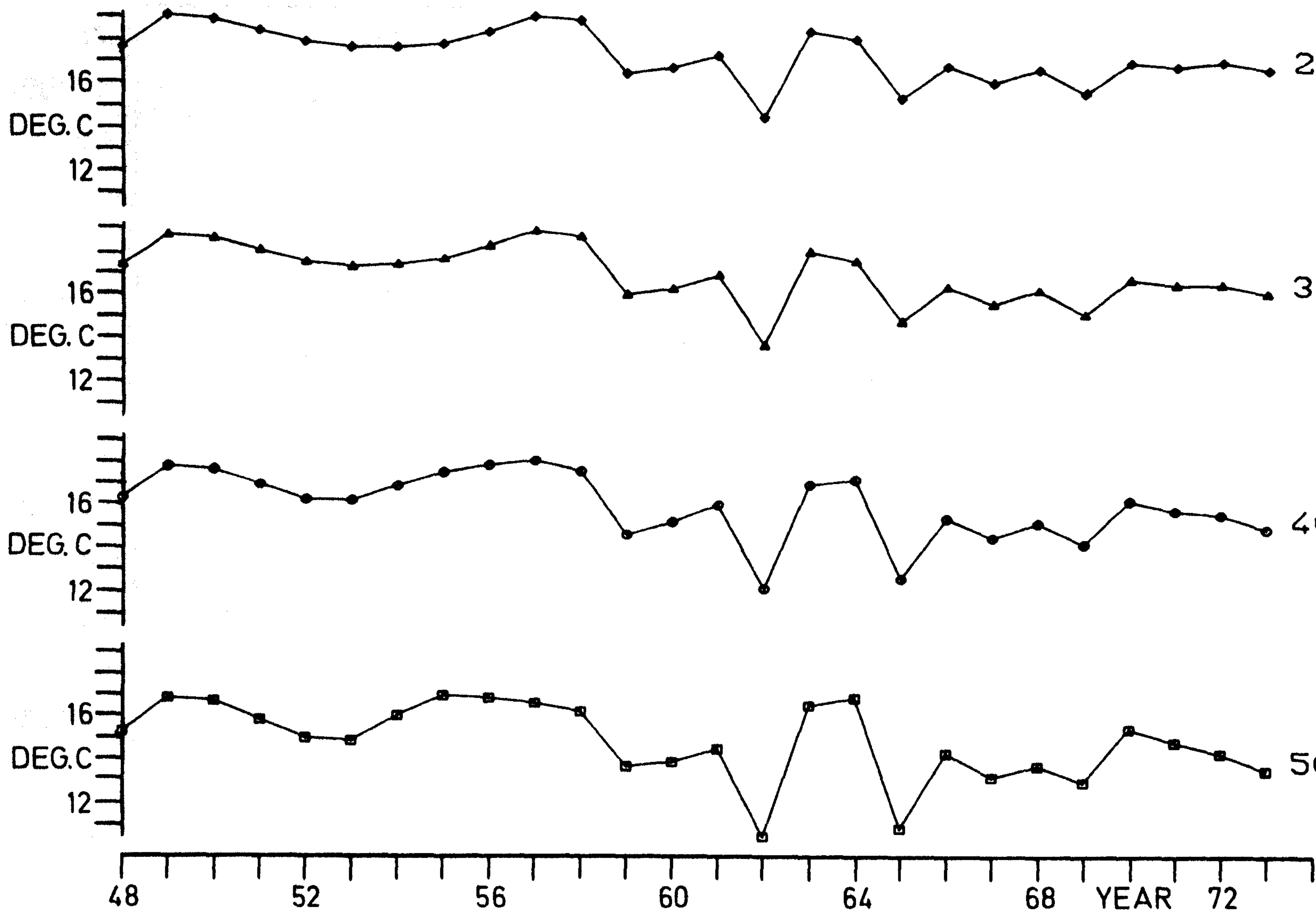


TEMPERATURE AT (37.5N,72.5W)
250 m
300 m
400 m
500 m
DEG.C
14
12
8
6
48
52
56
60
64
68
YEAR
72

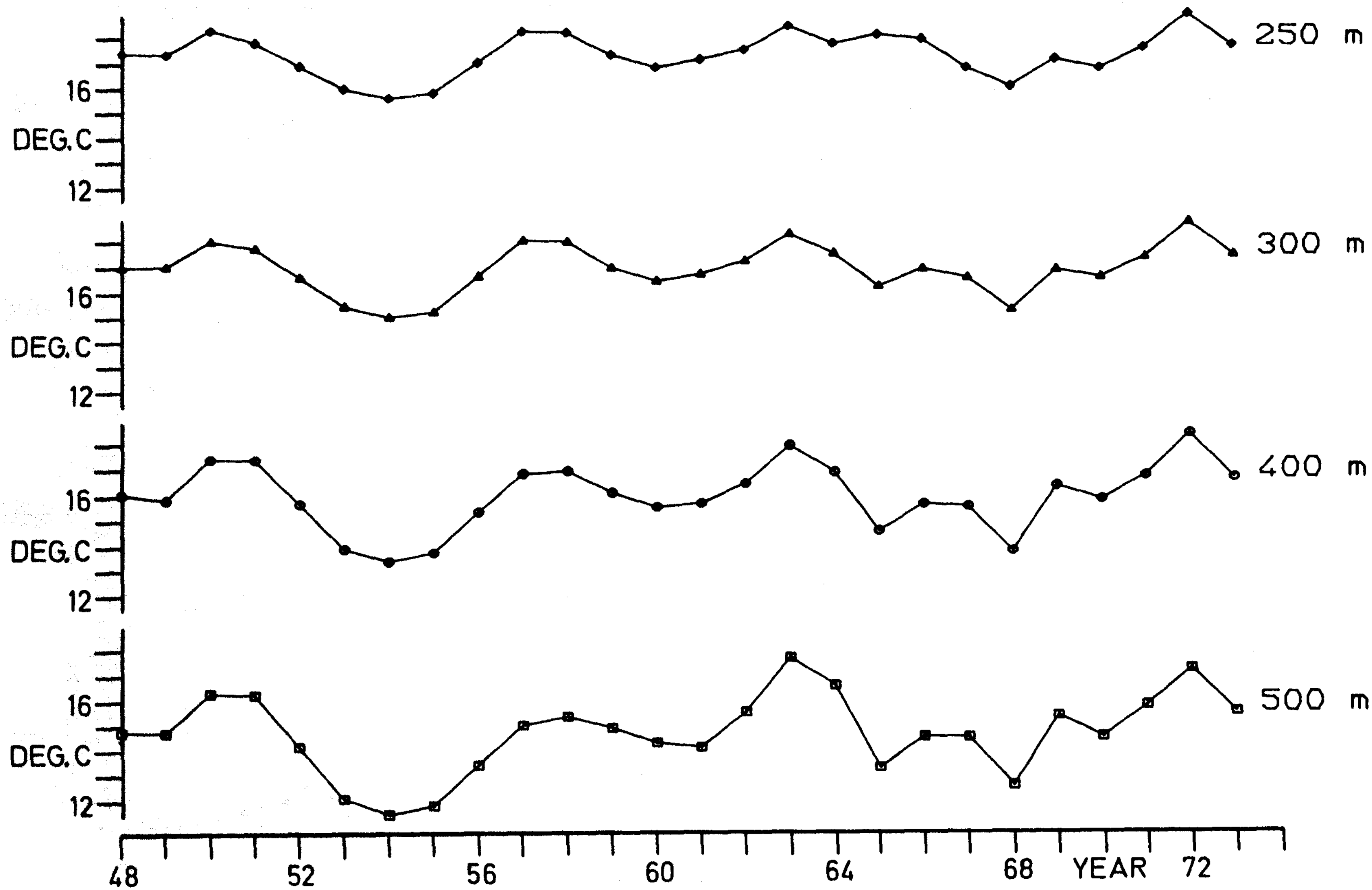
TEMPERATURE AT (37.5N,67.5W)



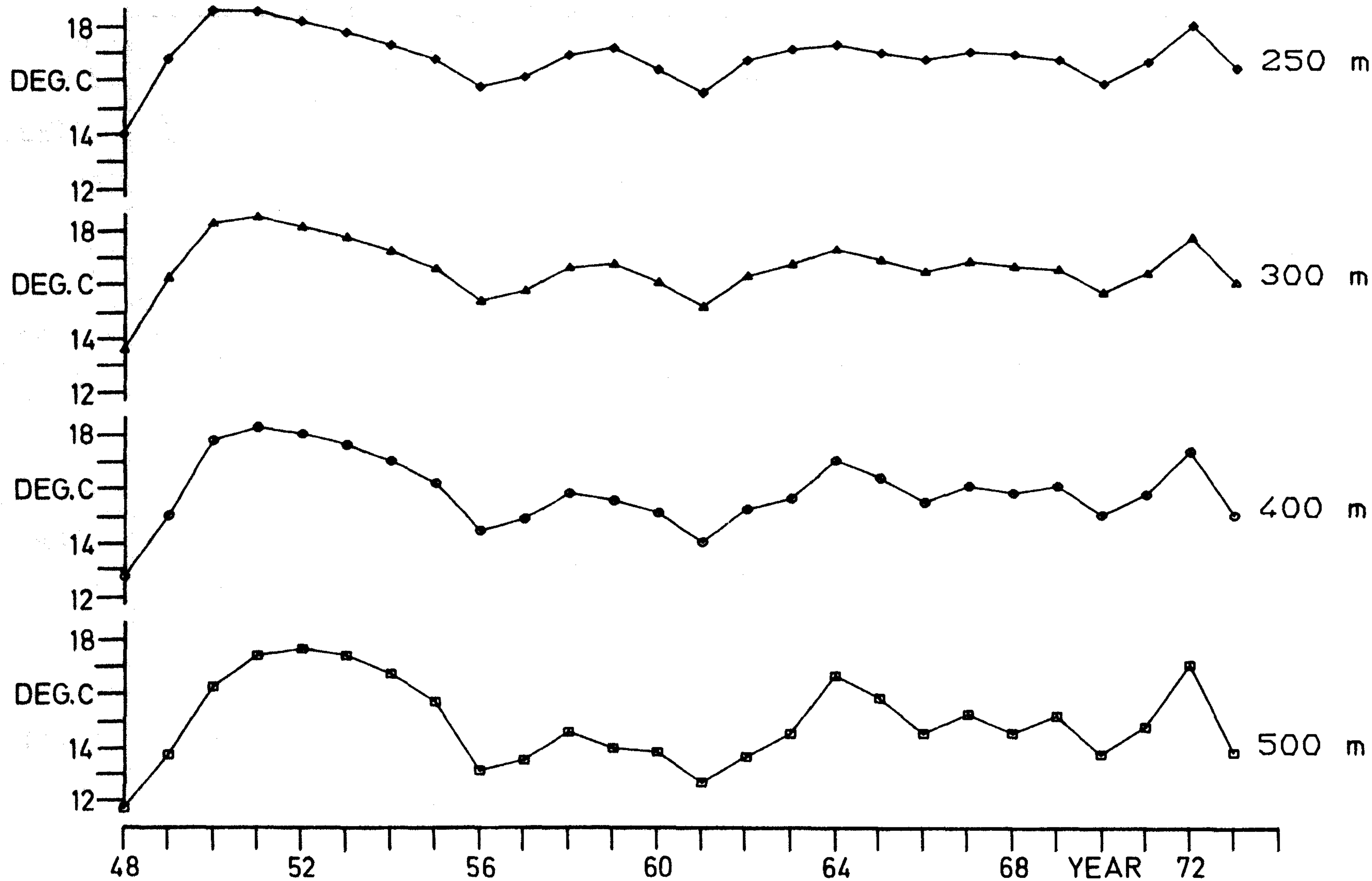
TEMPERATURE AT (37.5N,62.5W)



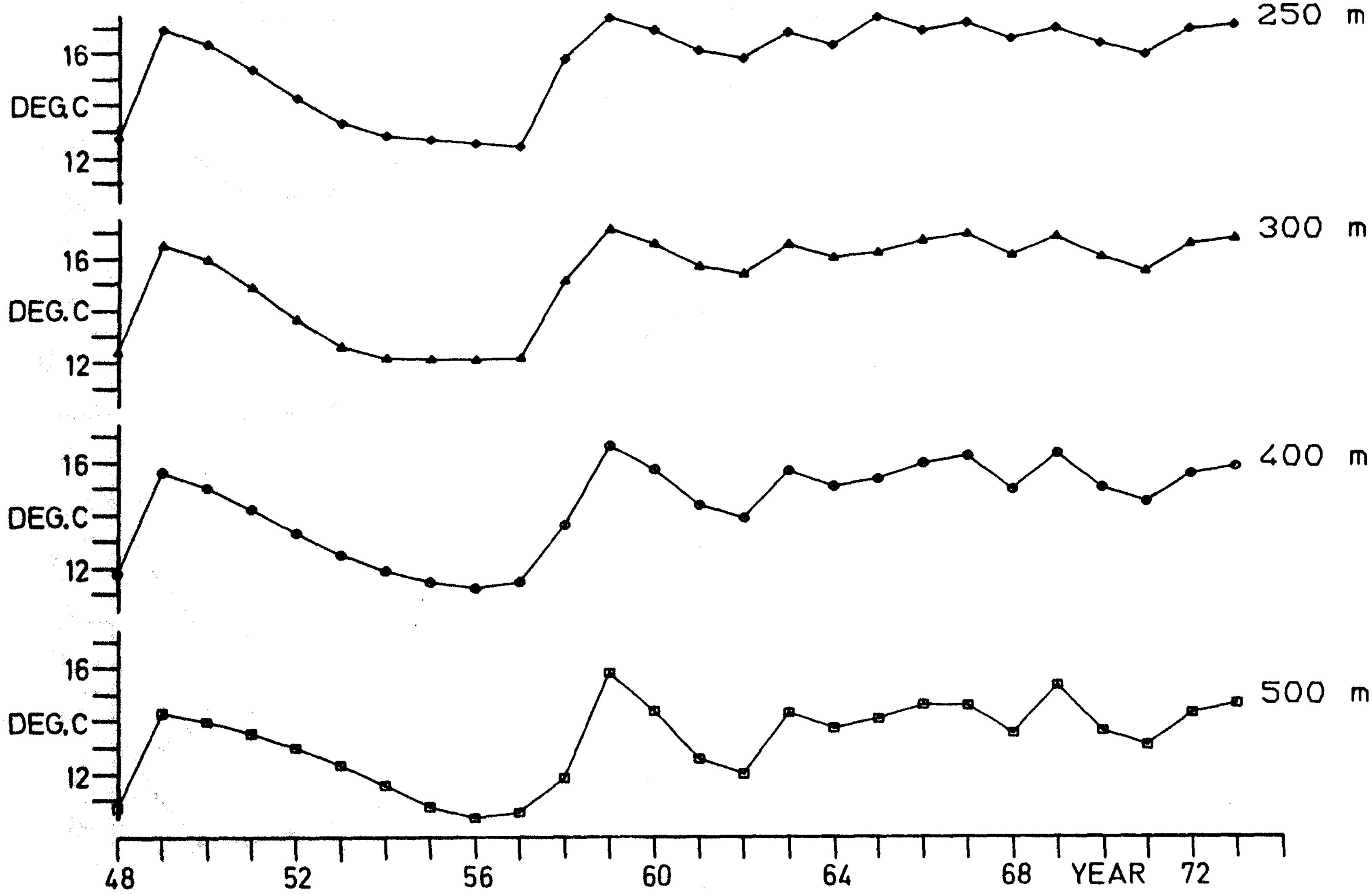
TEMPERATURE AT (37.5N,57.5W)

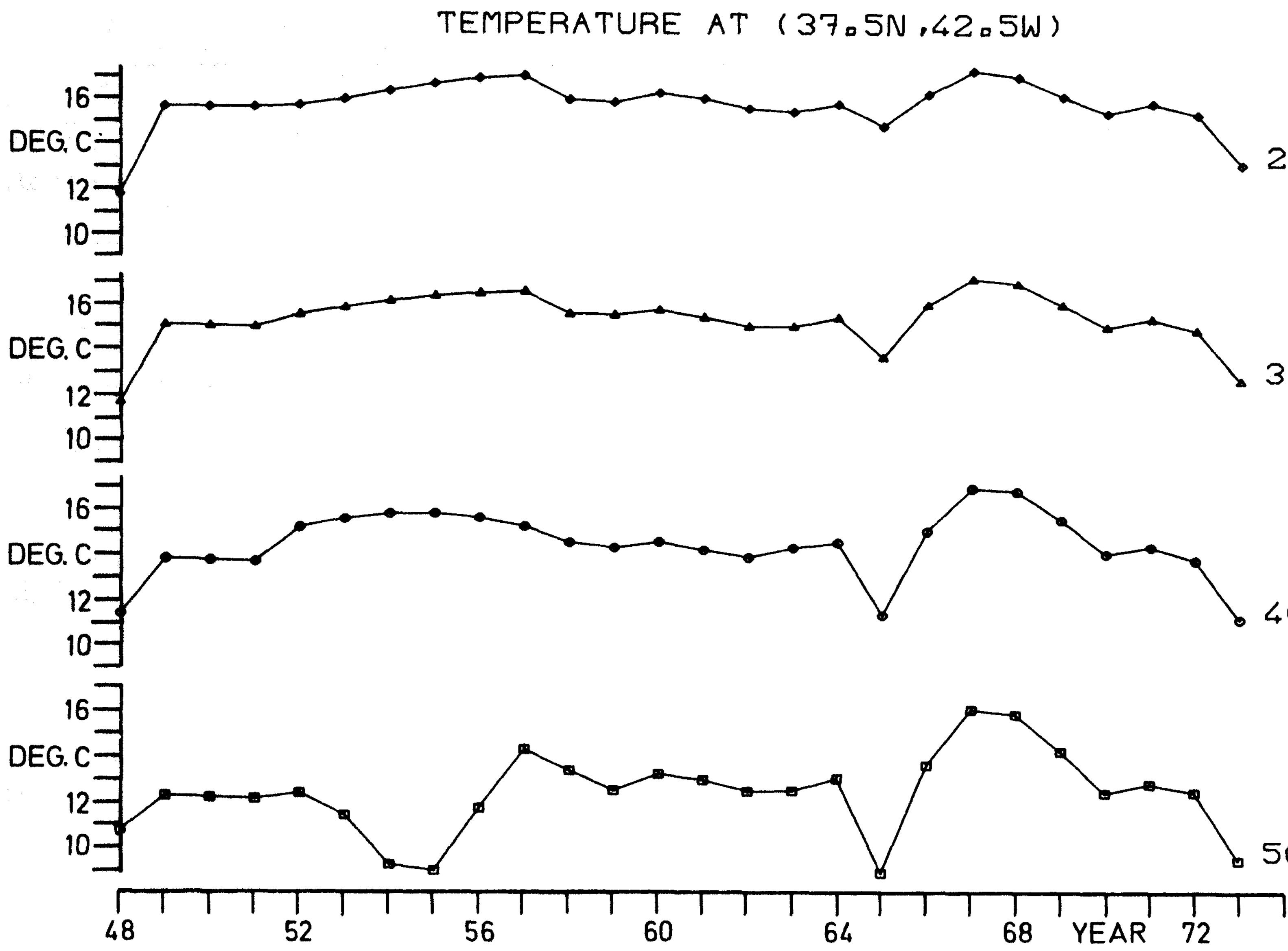


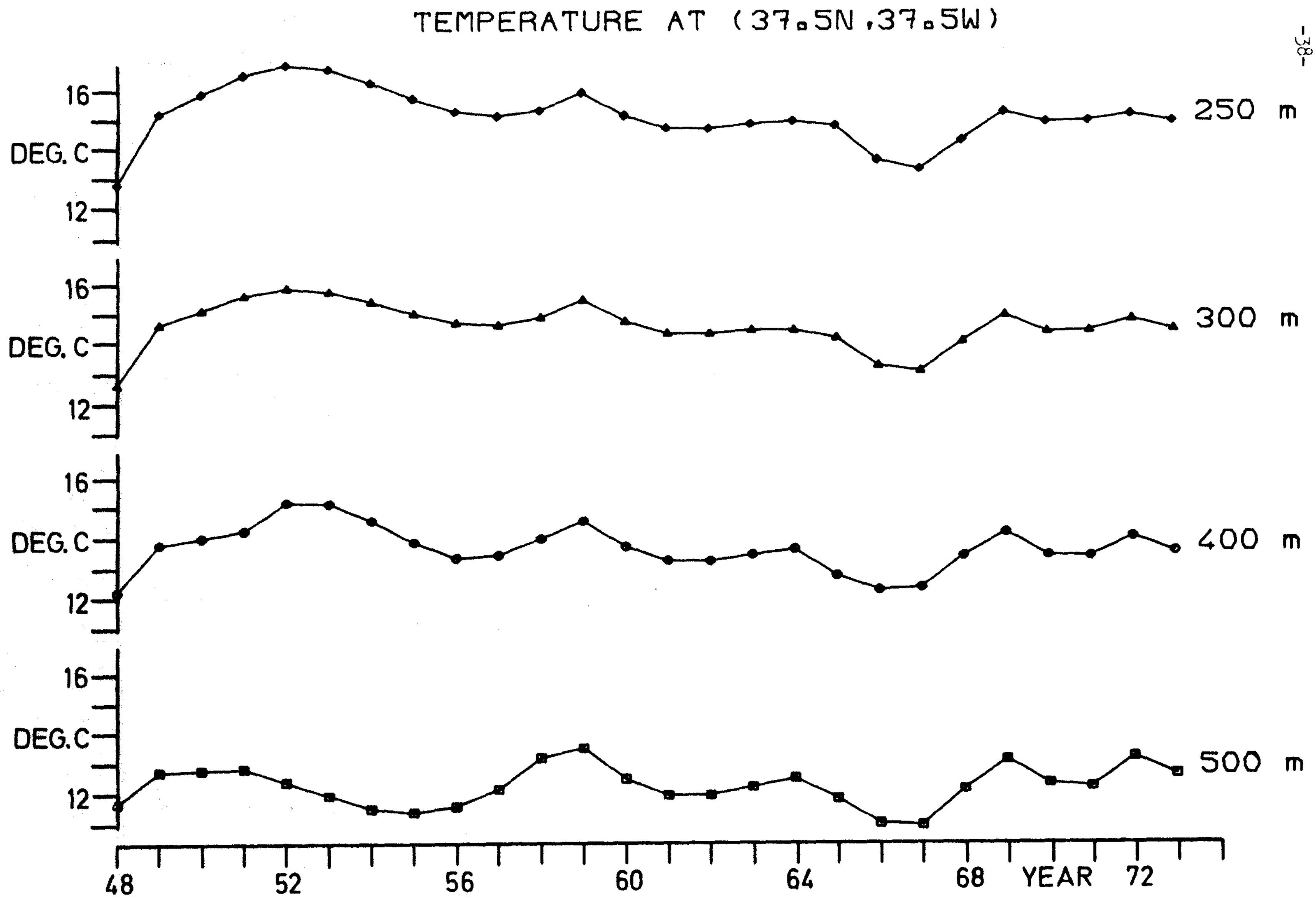
TEMPERATURE AT (37.5N,52.5W)



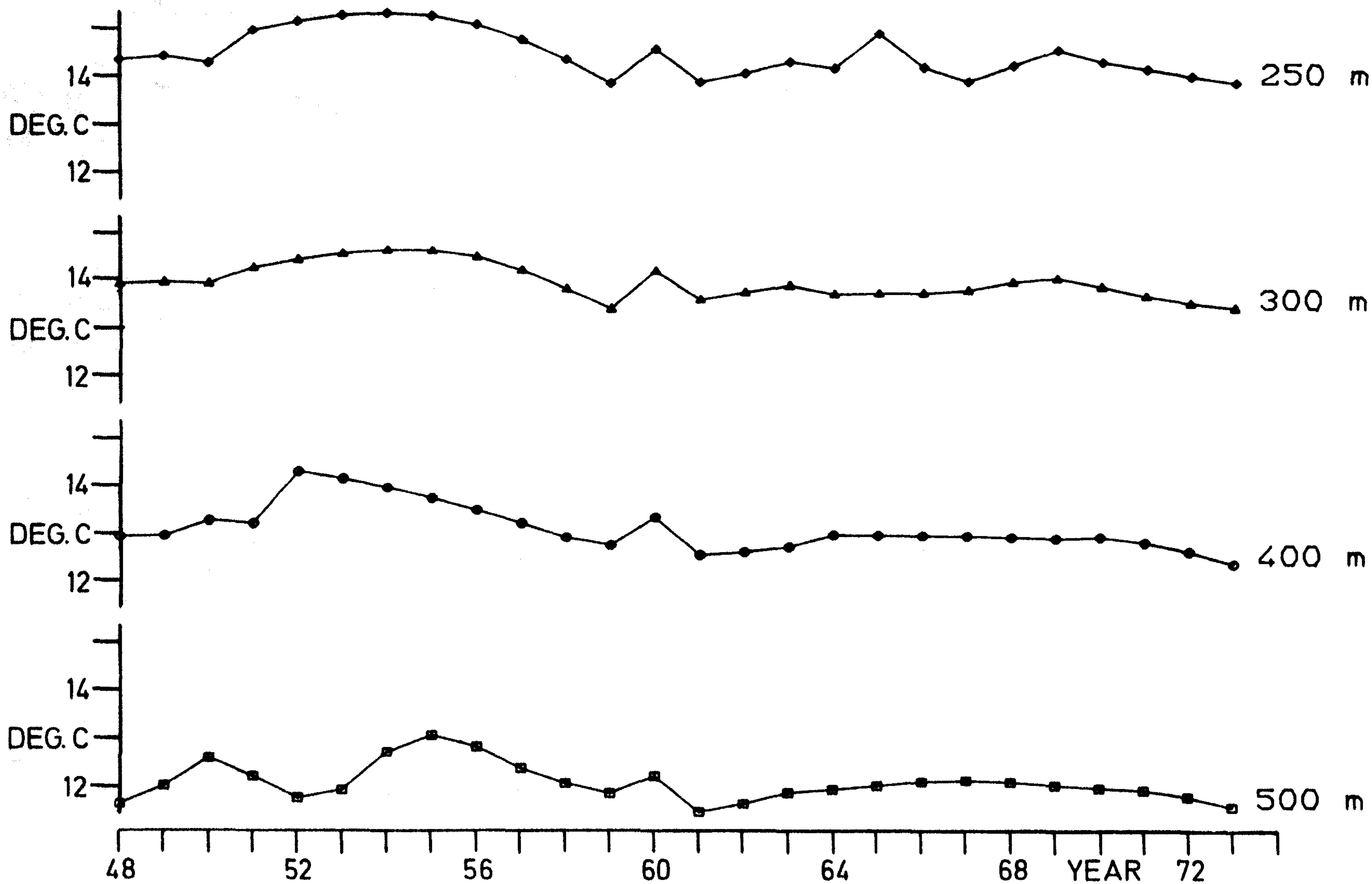
TEMPERATURE AT (37.5N,47.5W)

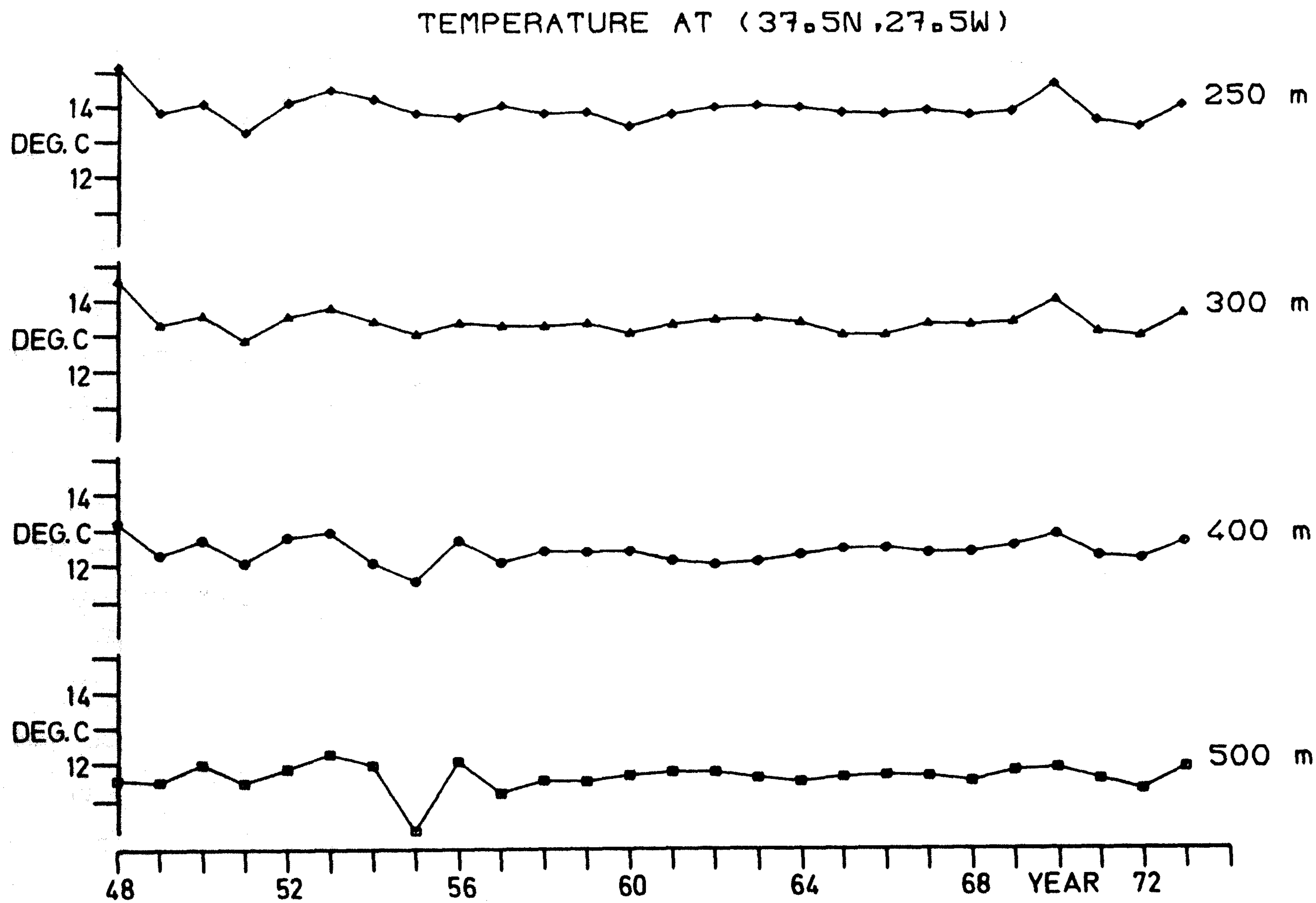



TEMPERATURE AT (37.5N,42.5W)
DEG. C
16
12
10
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

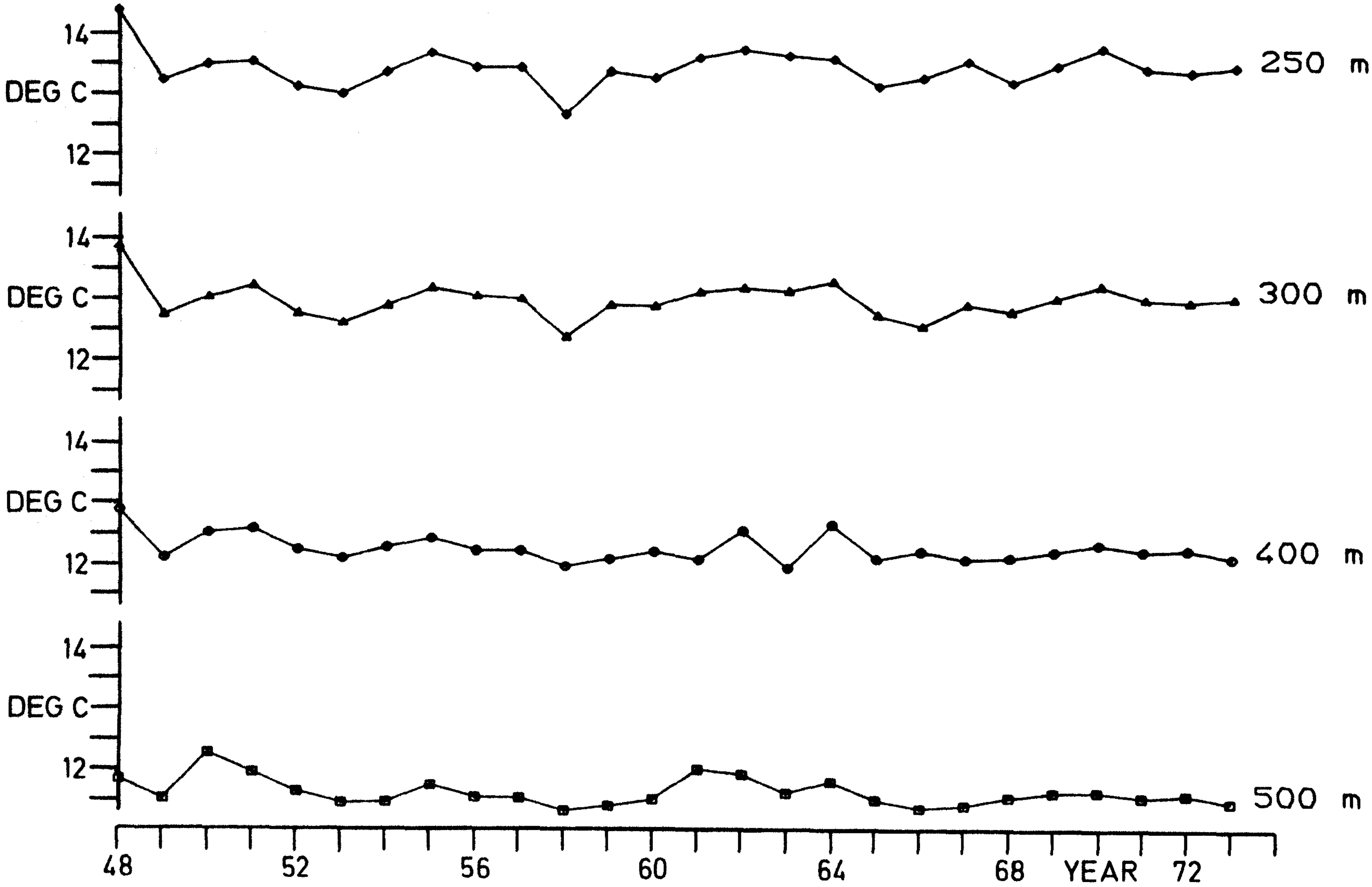

TEMPERATURE AT (37.5N,37.5W)
16
DEG. C
12
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

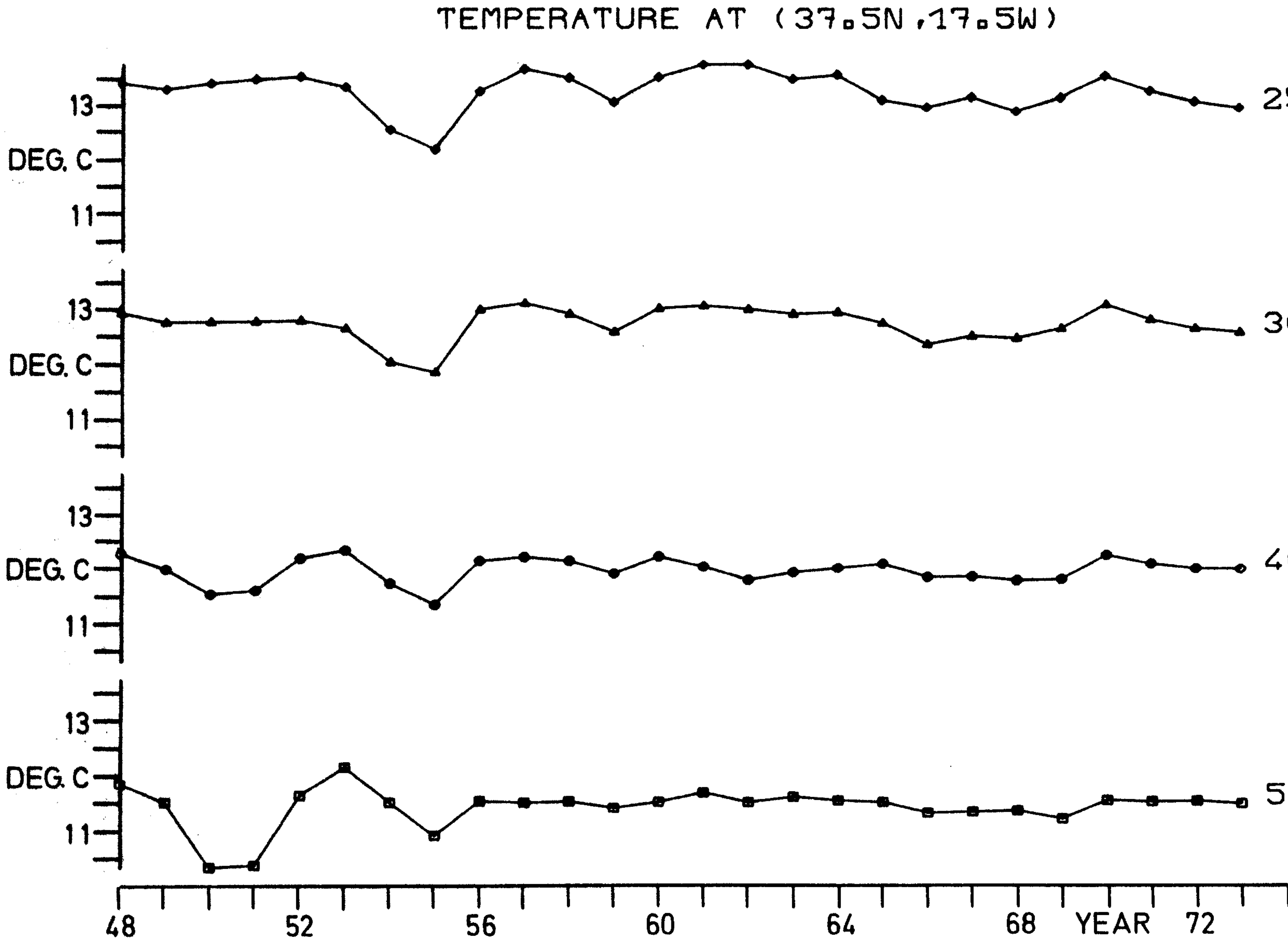
TEMPERATURE AT (37.5N,32.5W)



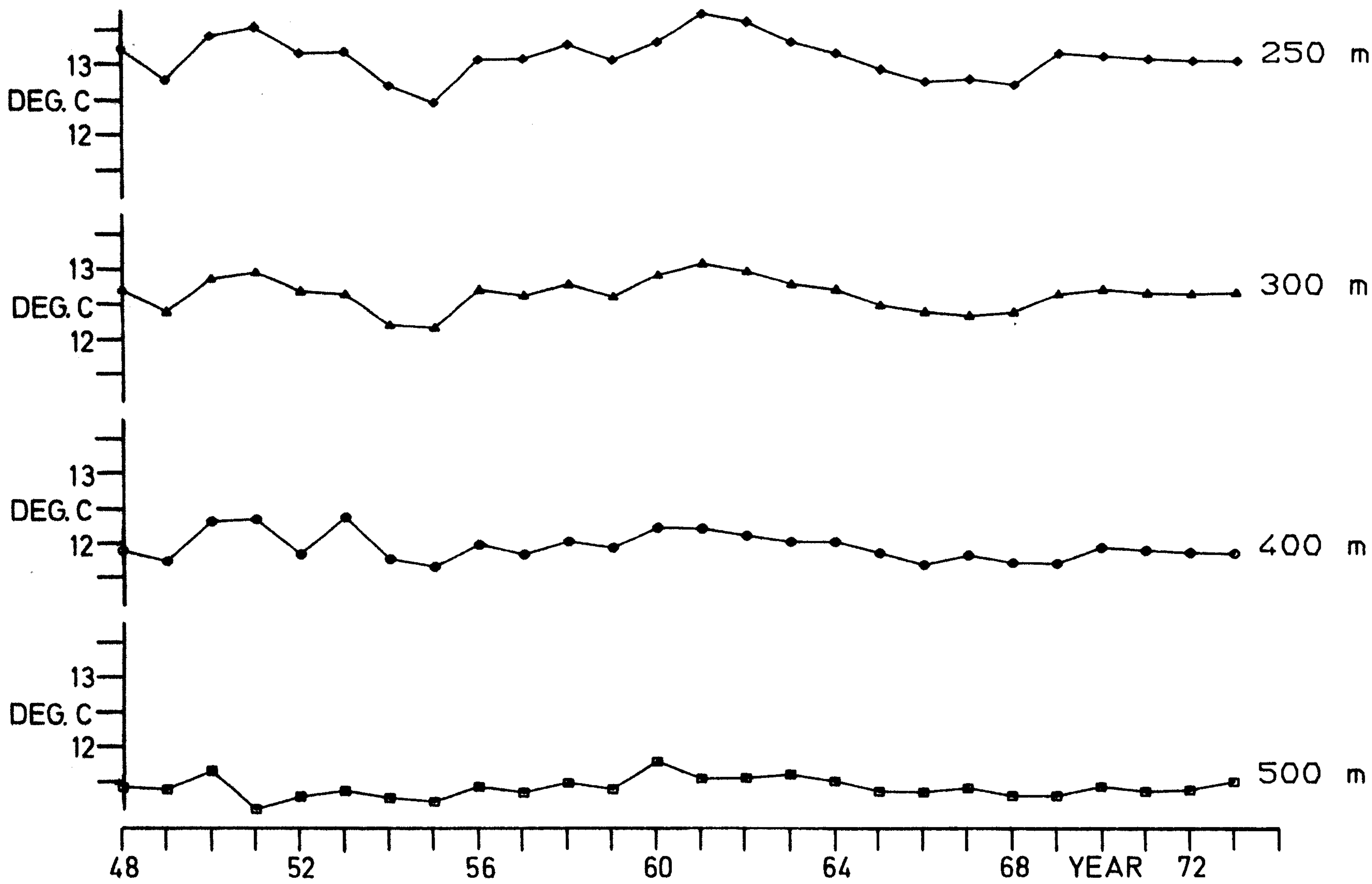

TEMPERATURE AT (37.5N,27.5W)
250 m
300 m
400 m
500 m
14
DEG. C
12
48
52
56
60
64
68
YEAR
72

TEMPERATURE AT (37.5N,22.5W)

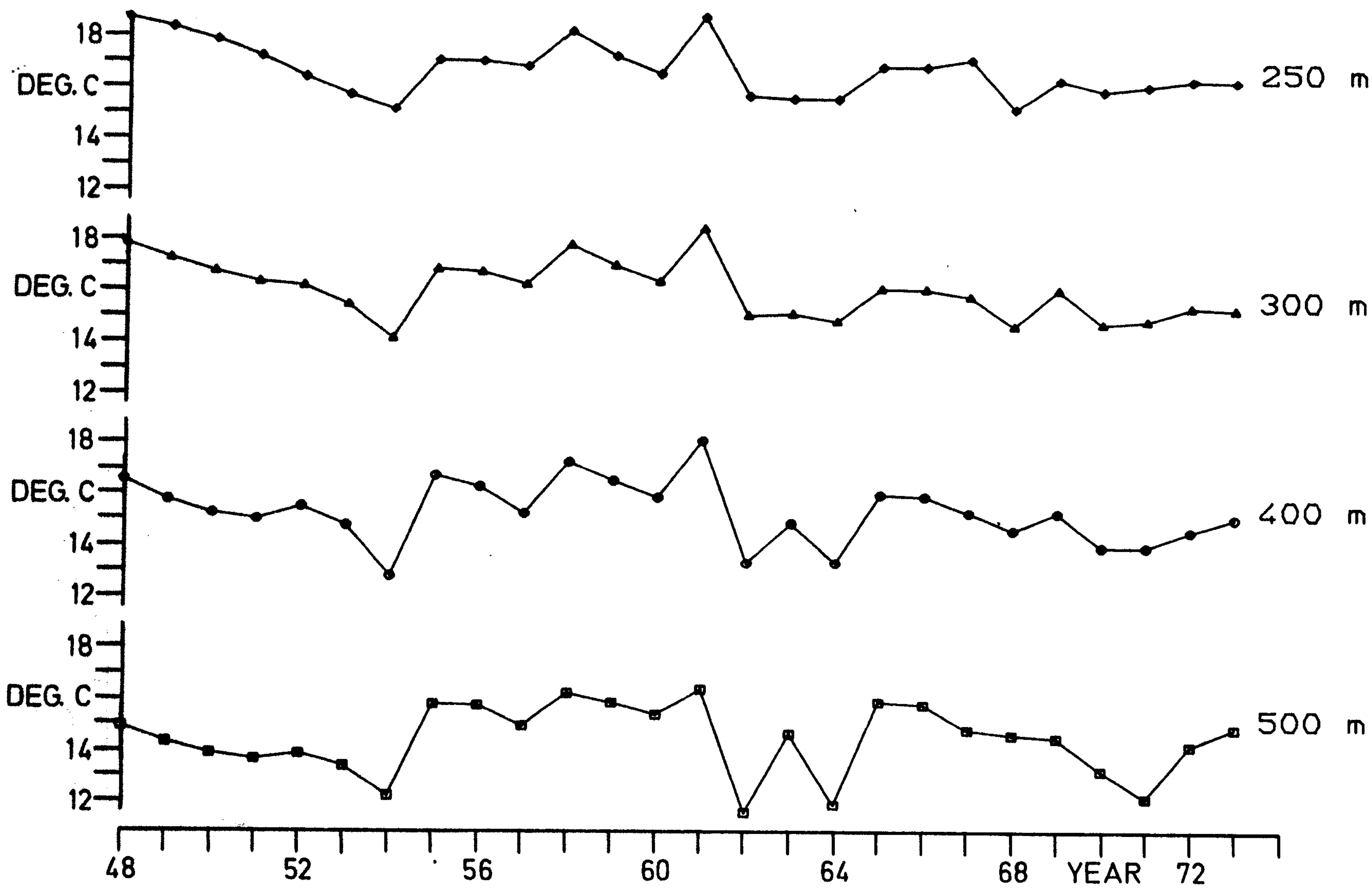


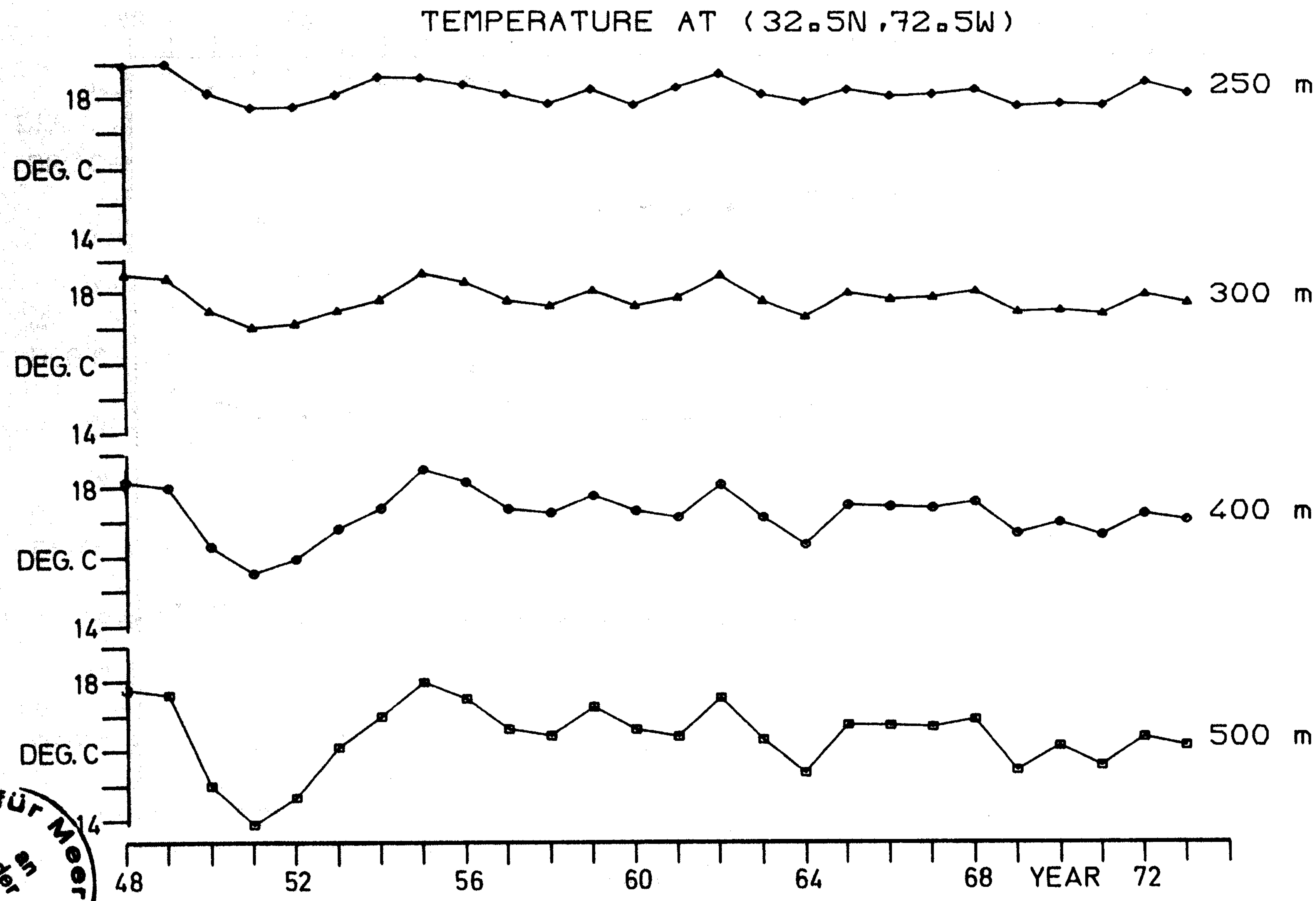

TEMPERATURE AT (37.5N,17.5W)
250 m
300 m
400 m
500 m
13
DEG. C
11
48
52
56
60
64
68
YEAR
72

TEMPERATURE AT (37.5N,12.5W)



TEMPERATURE AT (32.5N,77.5W)





TEMPERATURE AT (32.5N,72.5W)
250 m
300 m
400 m
500 m
18
DEG. C
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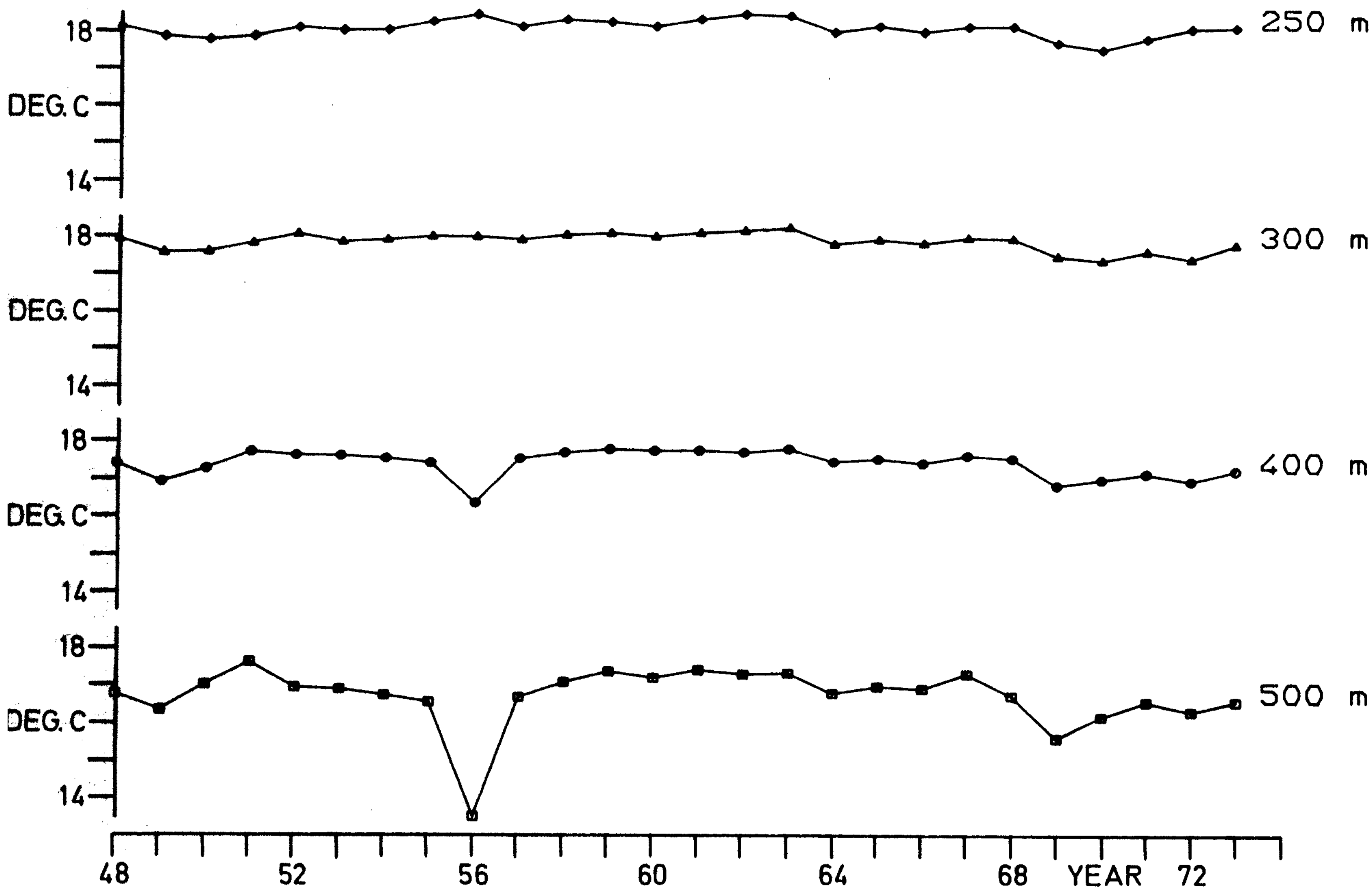
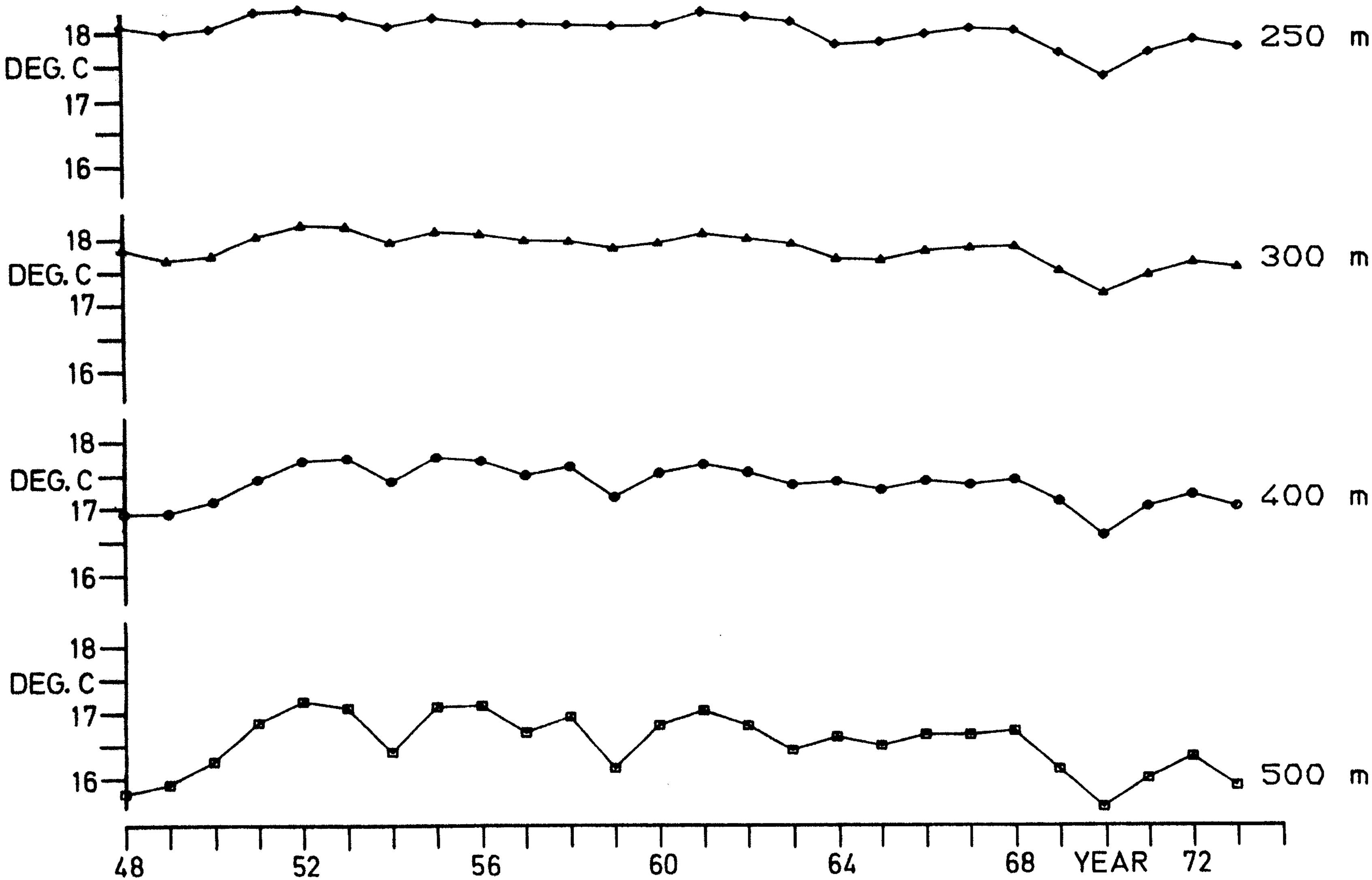
48
52
56
60
64
68
YEAR
72

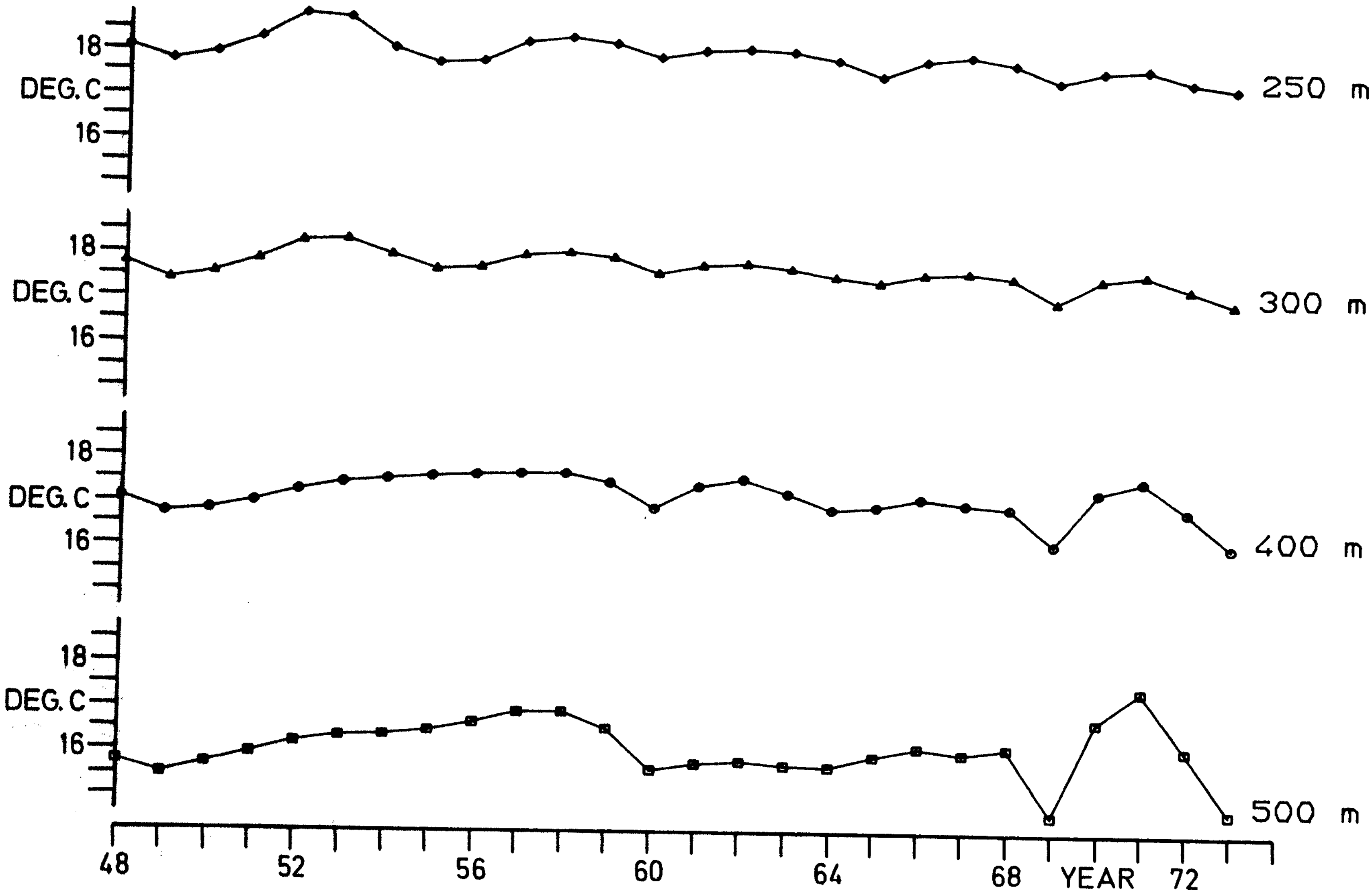
TEMPERATURE AT (32.5N,67.5W)



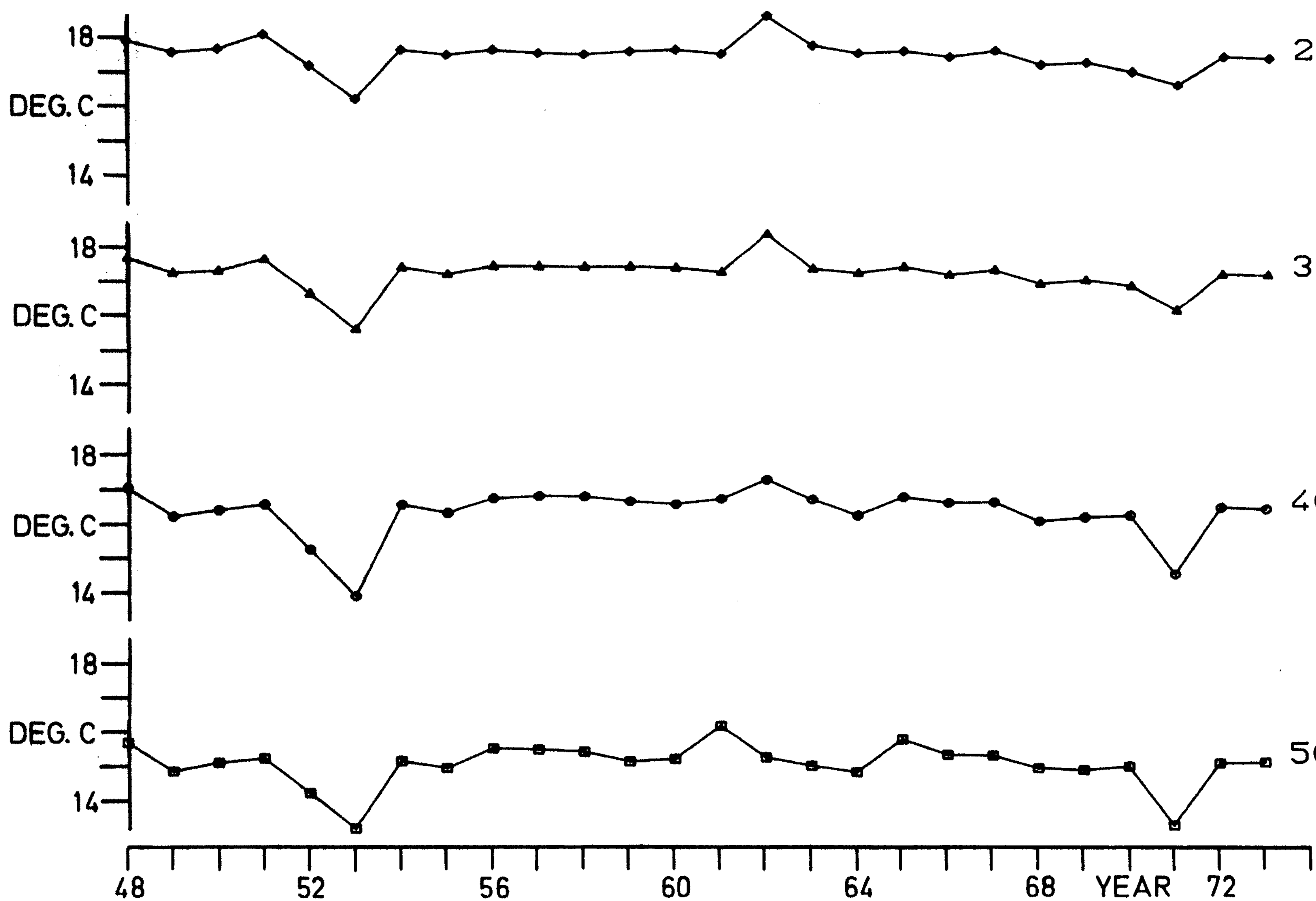
TEMPERATURE AT (32.5N,62.5W)



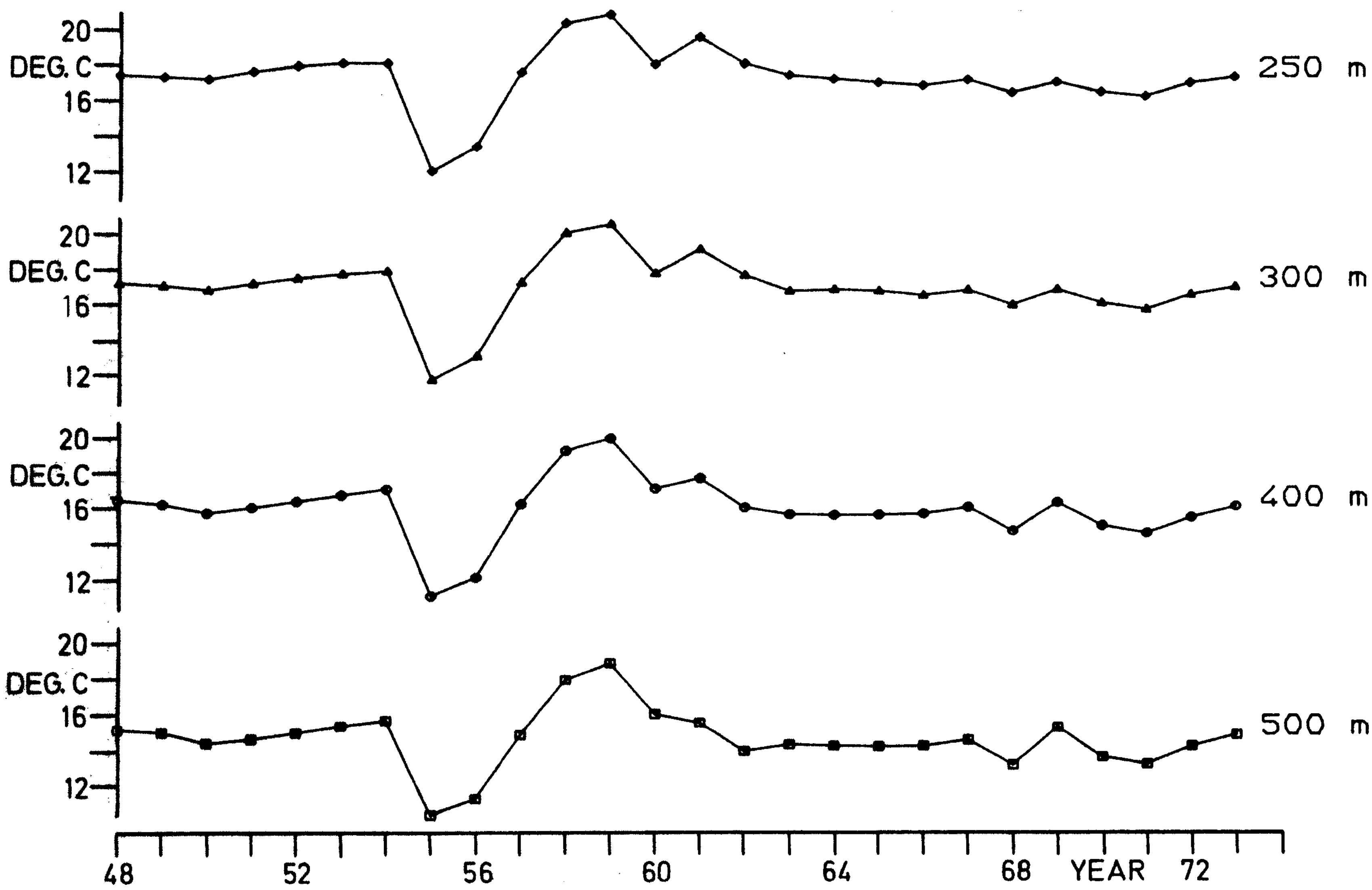
TEMPERATURE AT (32.5N,57.5W)

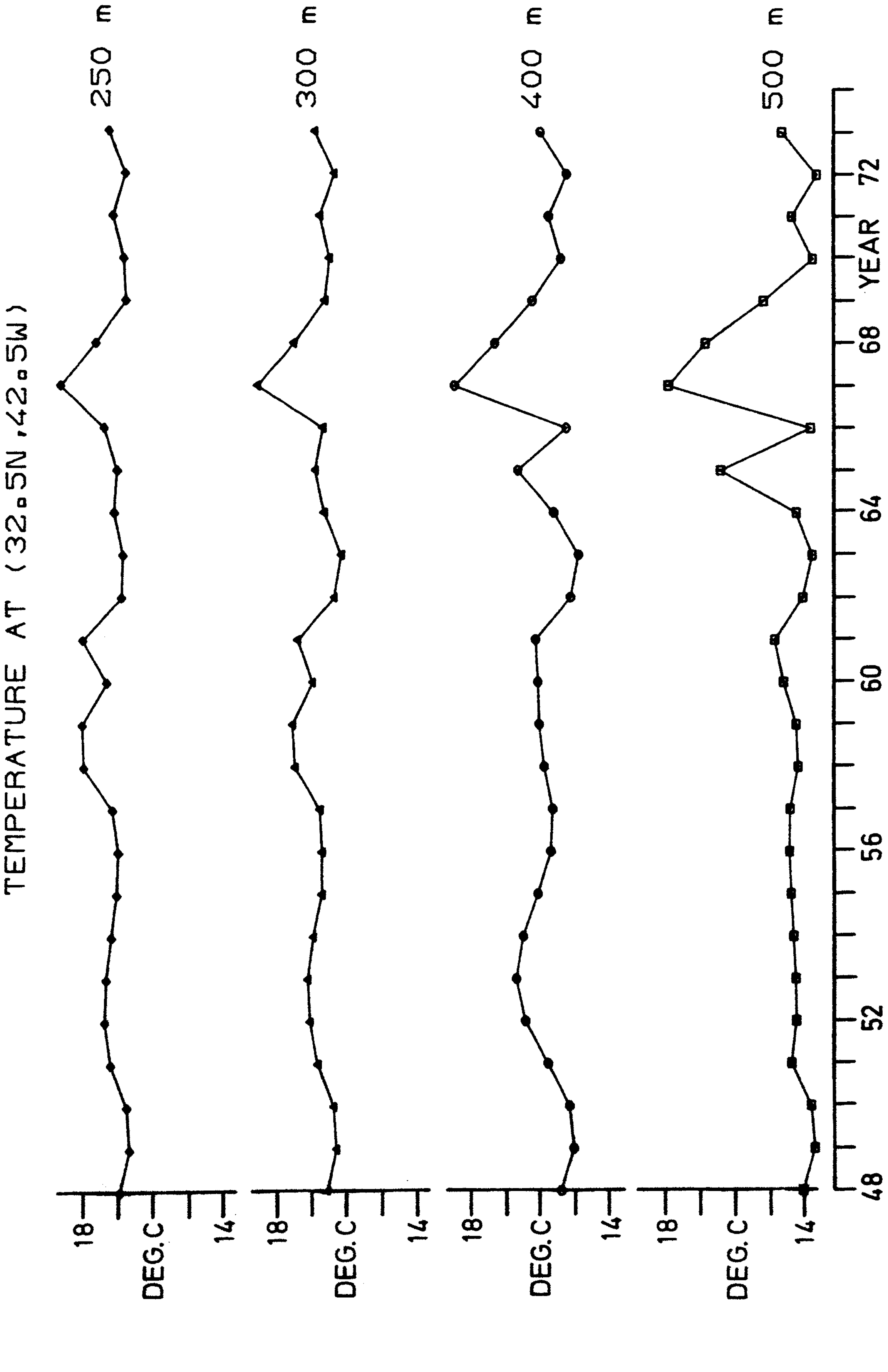


TEMPERATURE AT (32.5N,52.5W)



TEMPERATURE AT (32.5N,47.5W)




TEMPERATURE AT (32.5N, 42.5W)
250 m
300 m
400 m
500 m
18
DEG.C
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YEAR
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52
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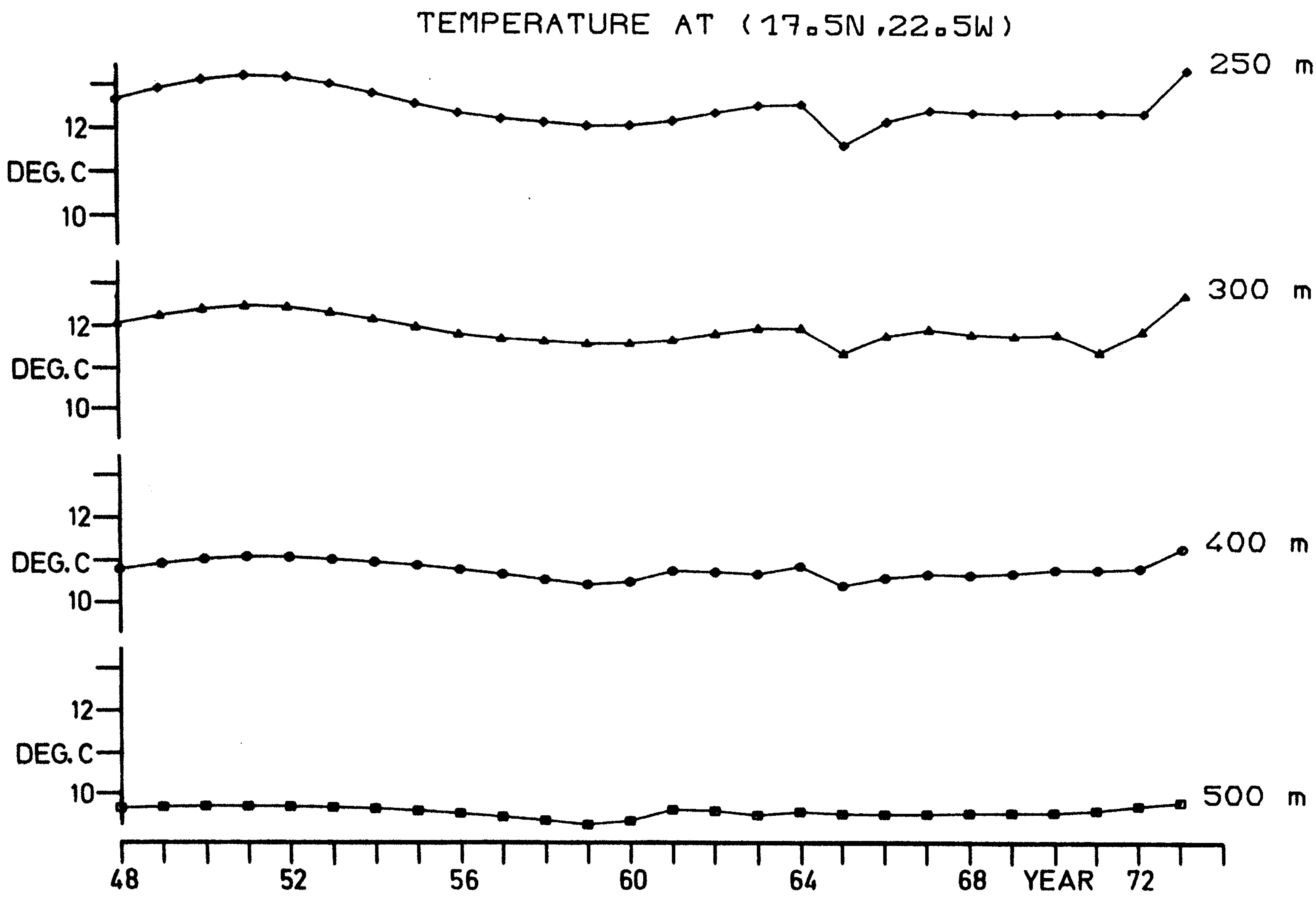
68
72


TEMPERATURE AT (17.5N,22.5W)
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300 m
400 m
500 m
12
DEG.C
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48
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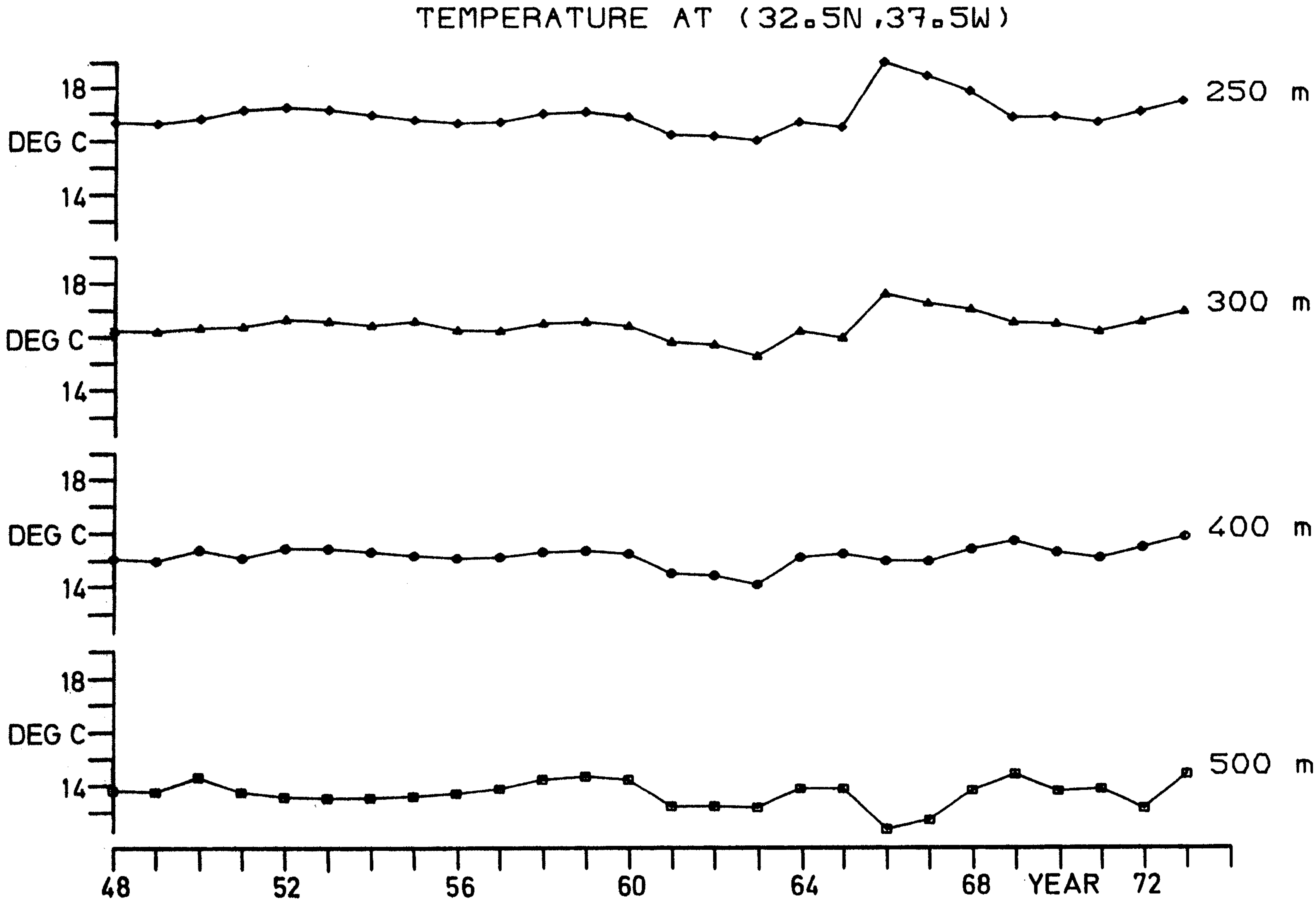
56
60
64
68
YEAR
72


TEMPERATURE AT (32.5N,37.5W)
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DEG C
14
250 m
300 m
400 m
500 m
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68
YEAR
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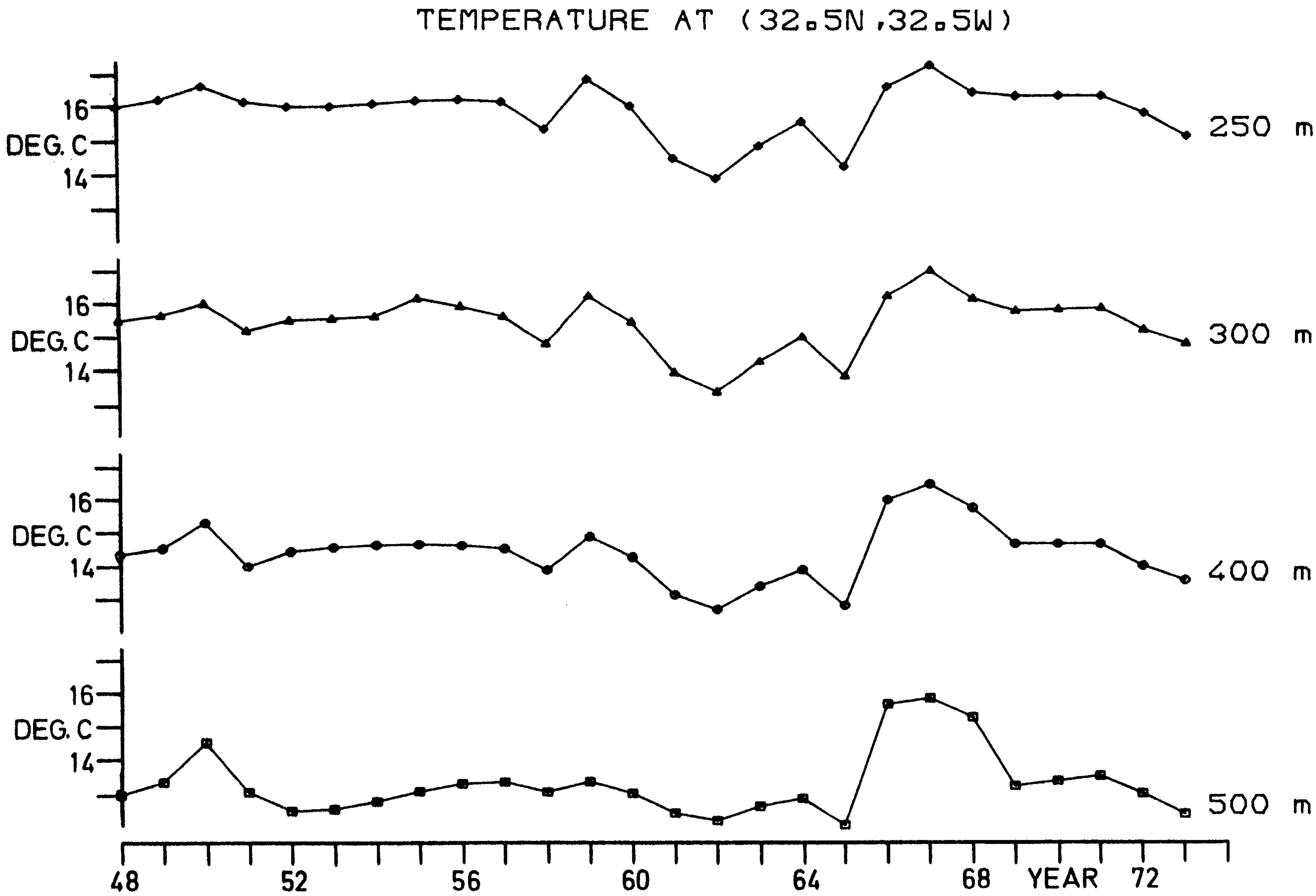
TEMPERATURE AT (32.5N,32.5W)
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DEG. C
14
250 m
300 m
400 m
500 m
48
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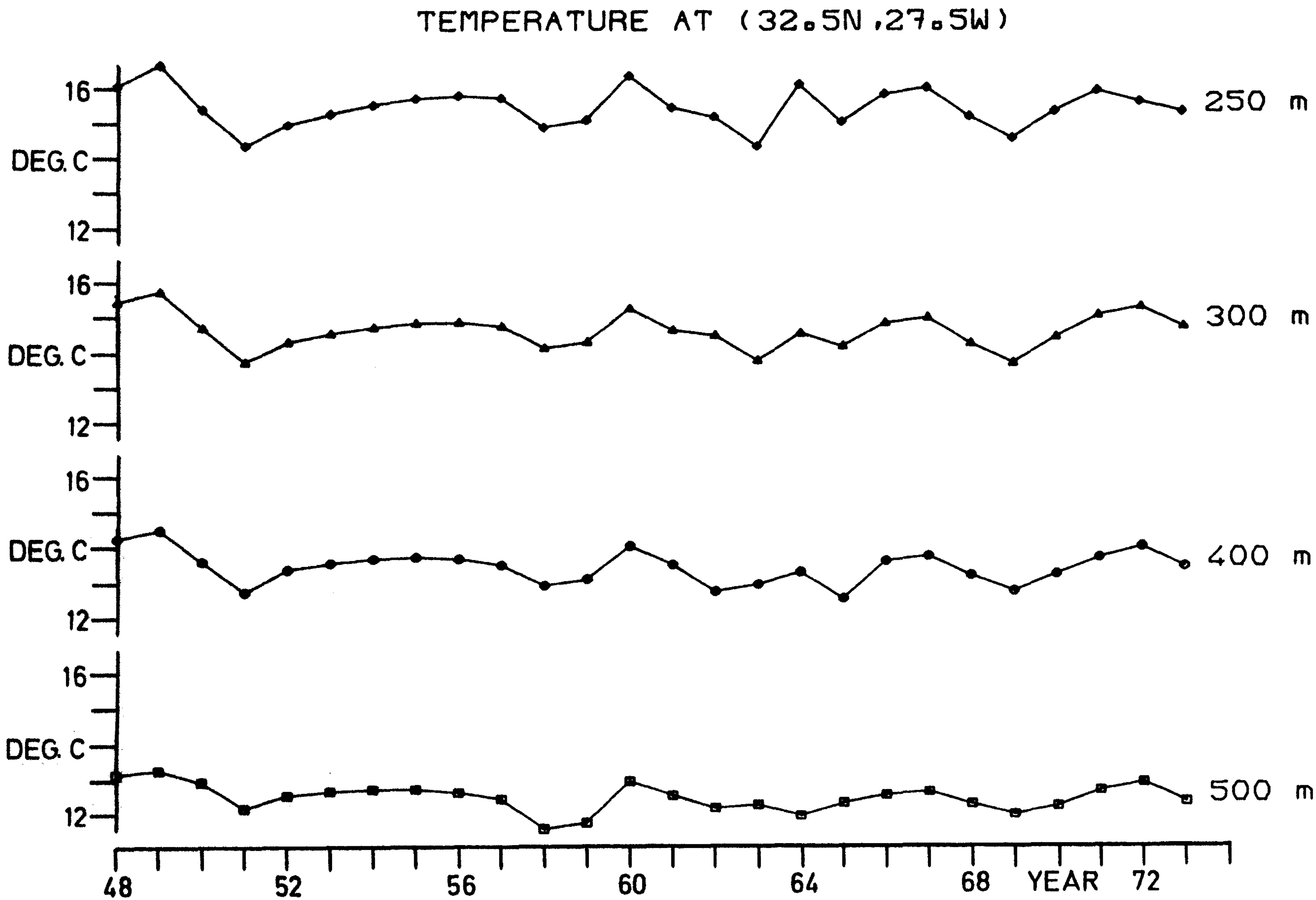
56
60
64
68
YEAR
72


TEMPERATURE AT (32.5N,27.5W)
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DEG. C
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250 m
300 m
400 m
500 m
48
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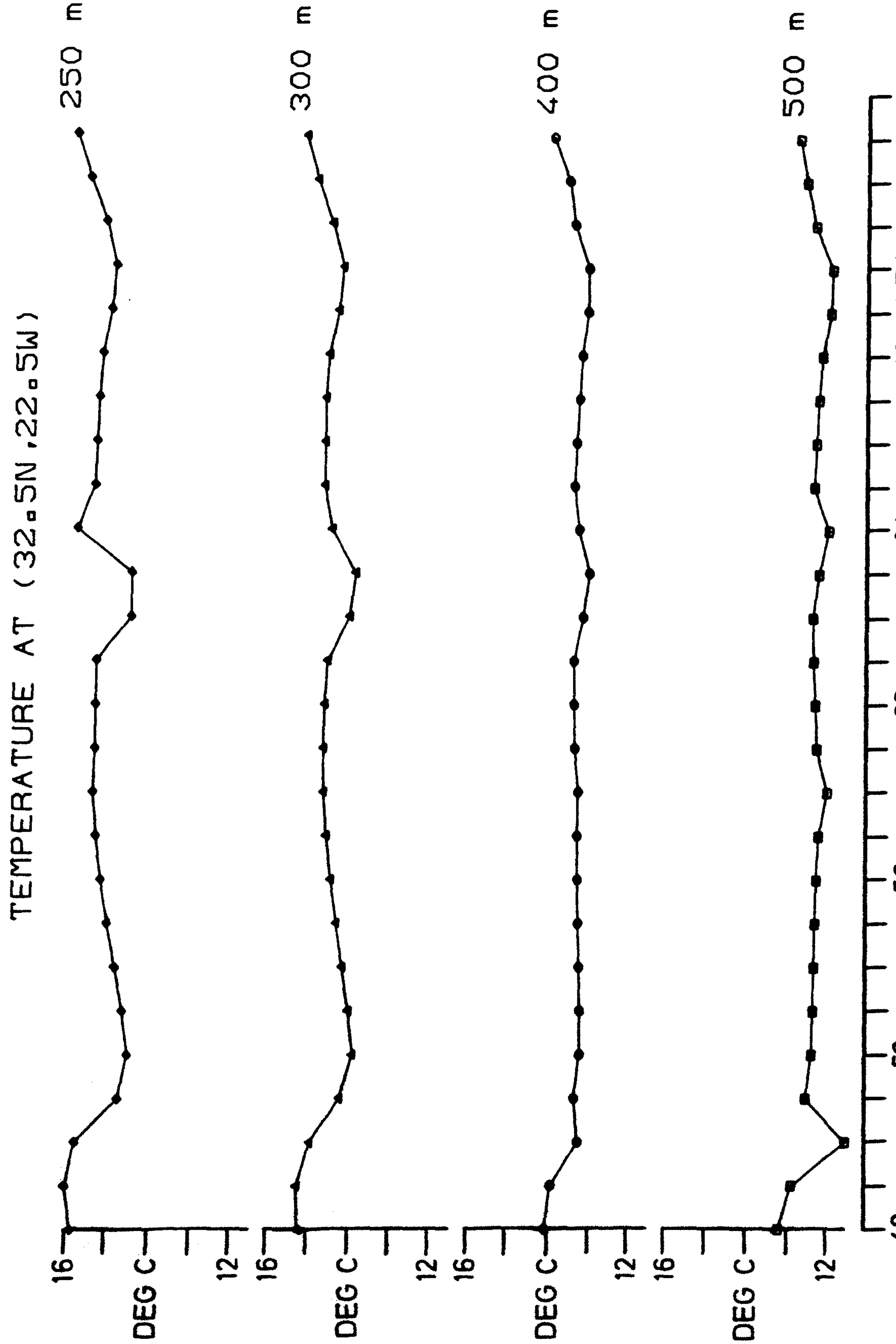
56
60
64
68
YEAR
72


TEMPERATURE AT (32.5N, 22.5W)
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300 m
400 m
500 m
DEG C
16
12
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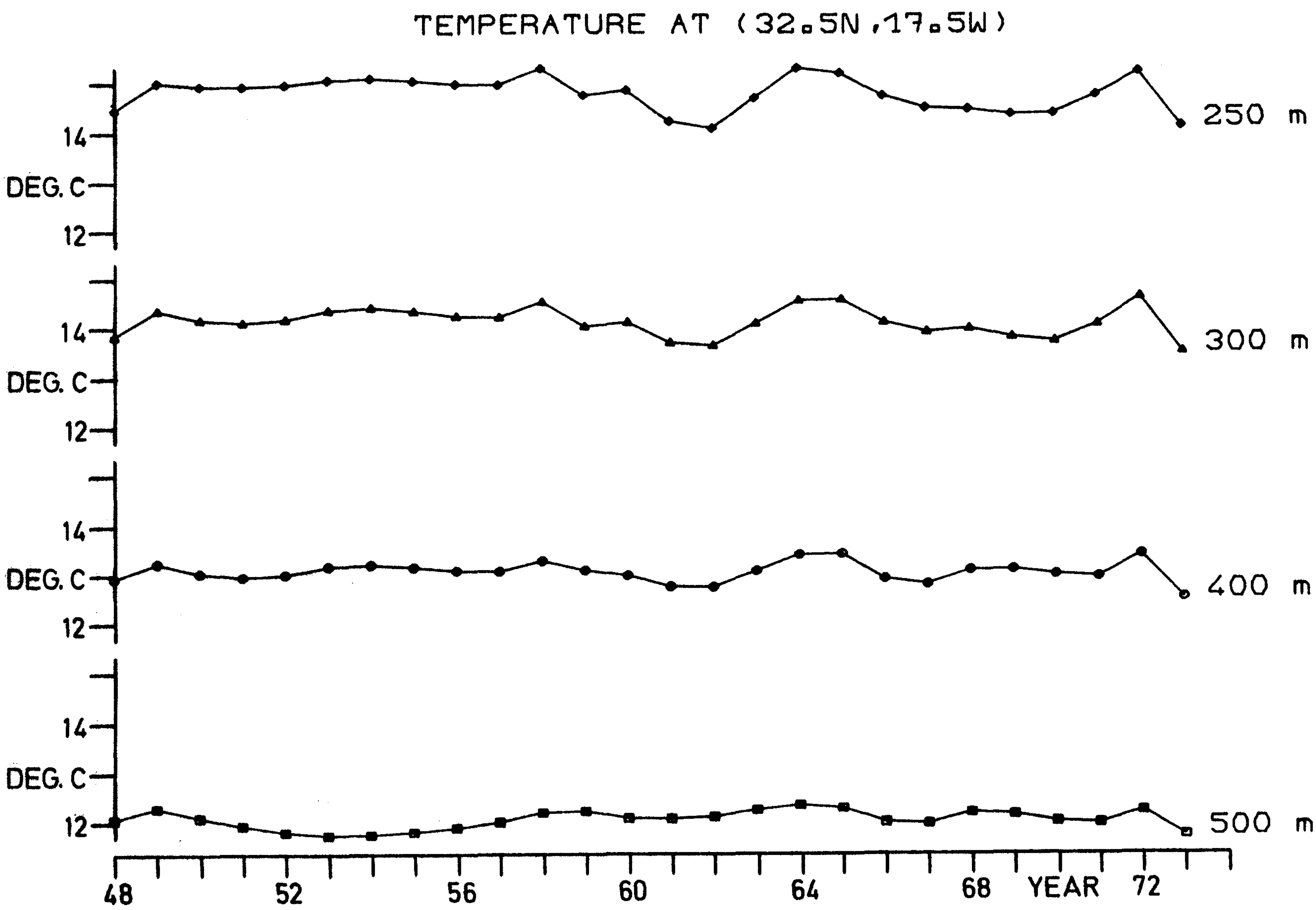
56
60
64
68
72
YEAR


TEMPERATURE AT (32.5N,17.5W)
250 m
300 m
400 m
500 m
14
DEG. C
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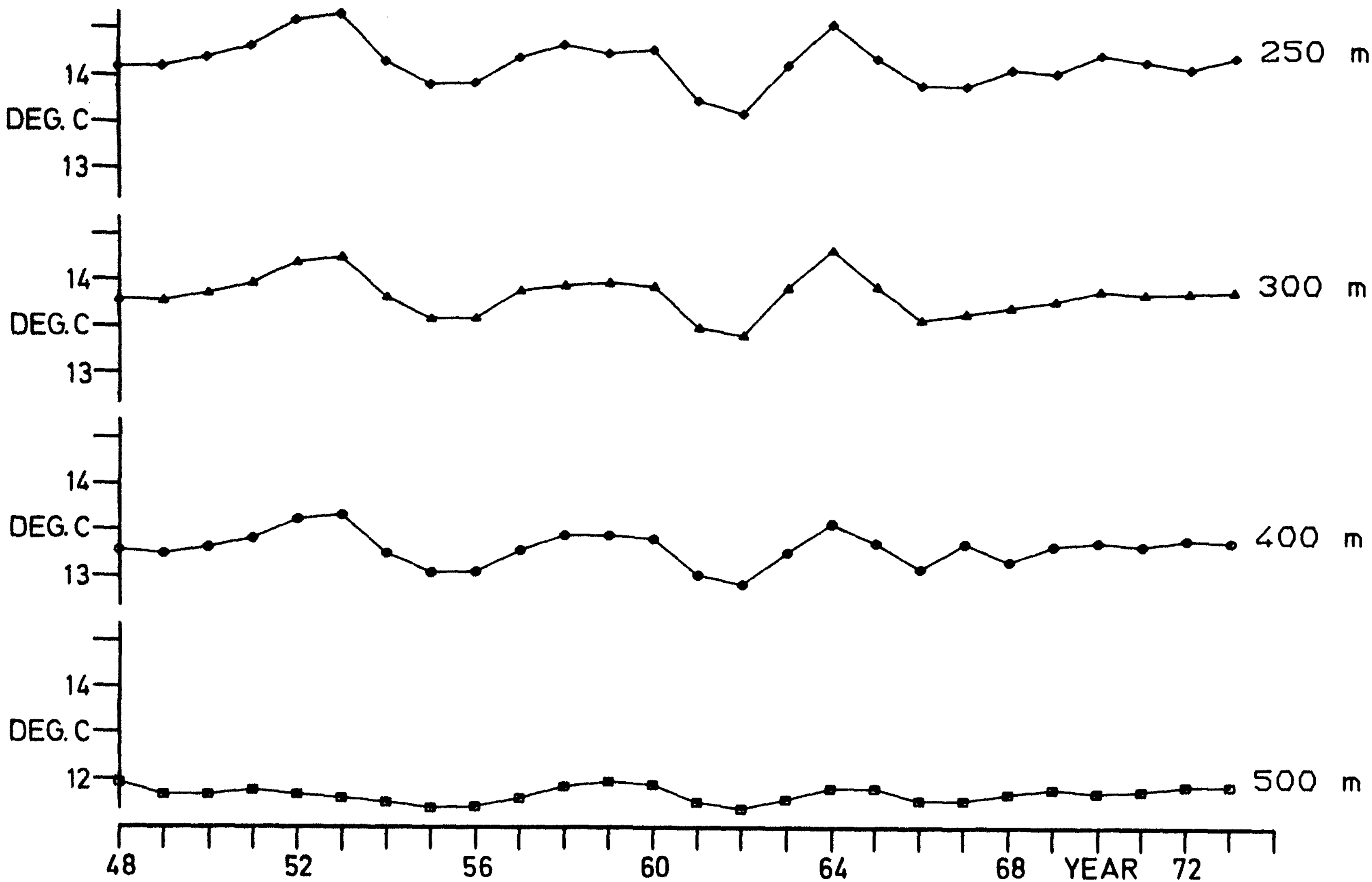
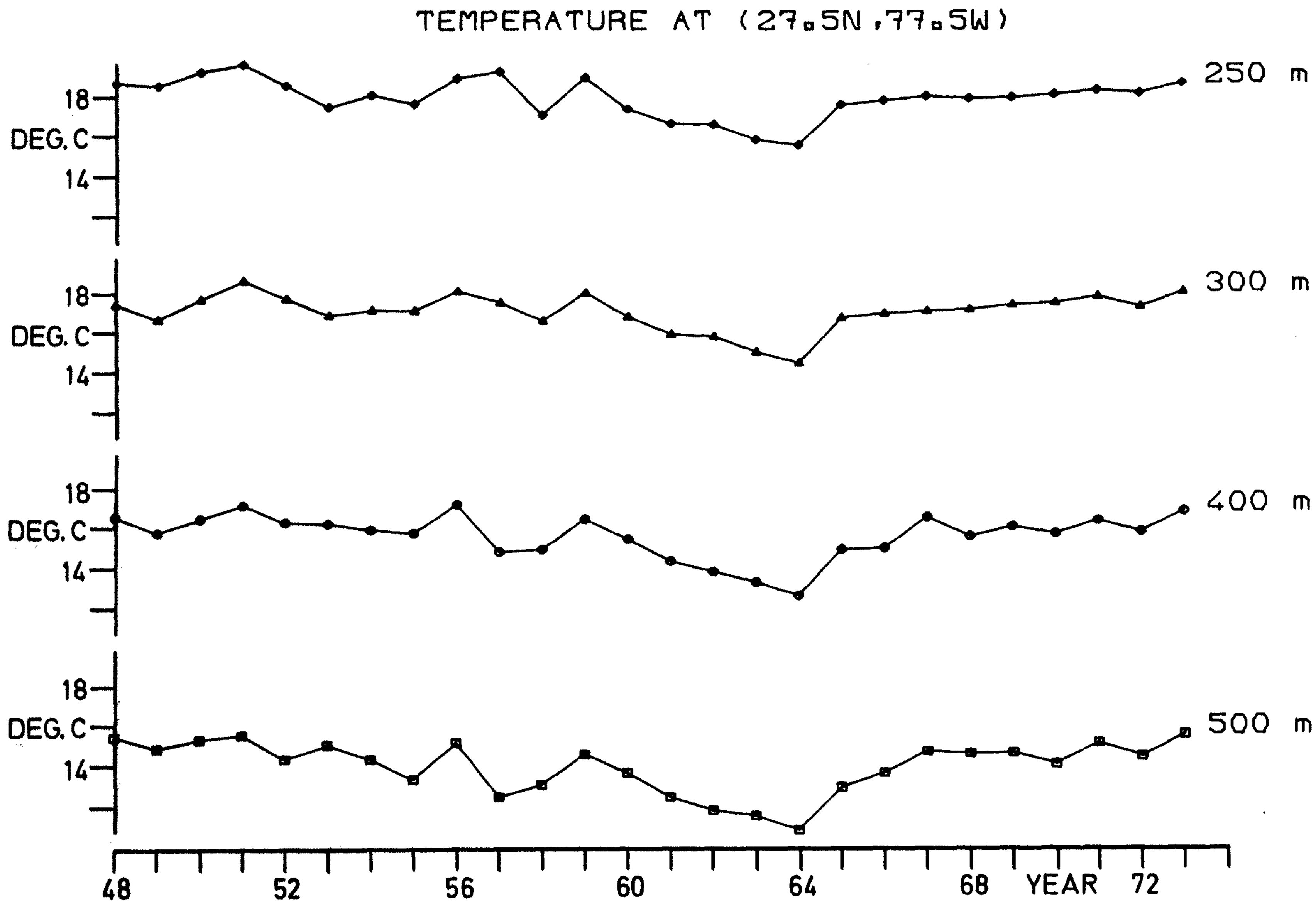
48
52
56
60
64
68
YEAR
72

TEMPERATURE AT (32.5N,12.5W)




TEMPERATURE AT (27.5N, 77.5W)
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300 m
400 m
500 m
18
DEG. C
14
48
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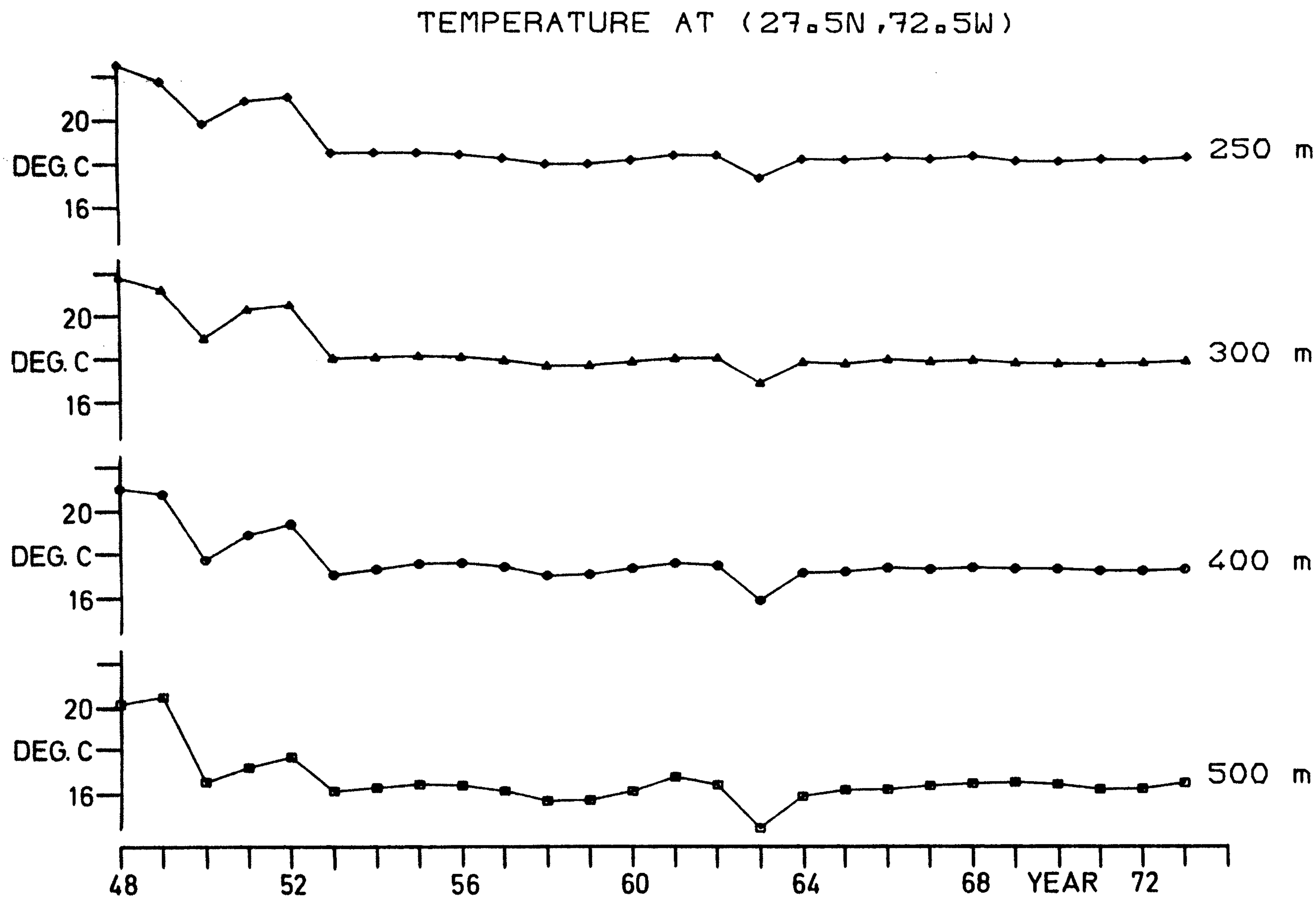
56
60
64
68
YEAR
72


TEMPERATURE AT (27.5N,72.5W)
250 m
300 m
400 m
500 m
DEG. C
20
16
48
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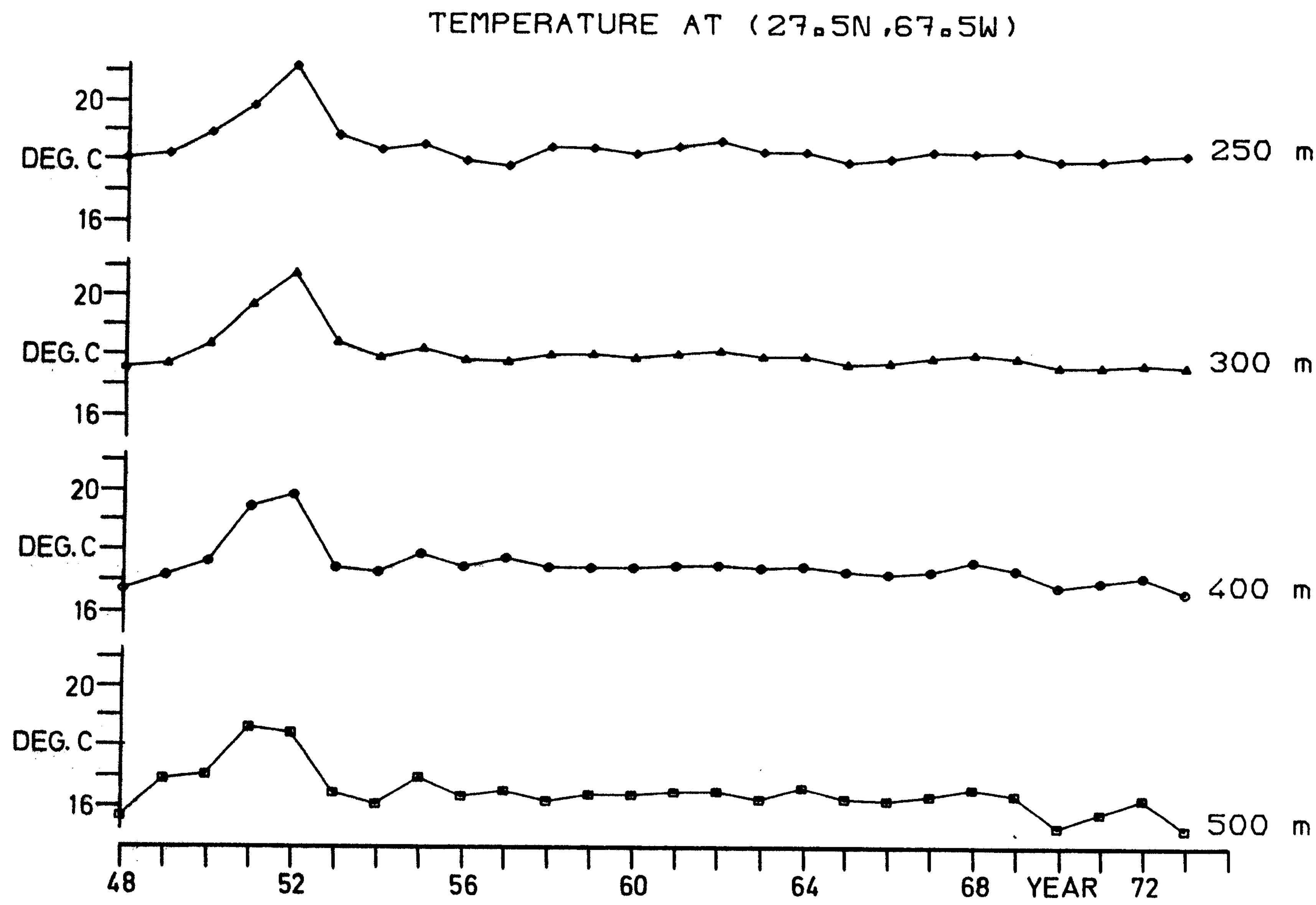
56
60
64
68
YEAR
72


TEMPERATURE AT (27.5N,67.5W)
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DEG. C
16
250 m
300 m
400 m
500 m
48
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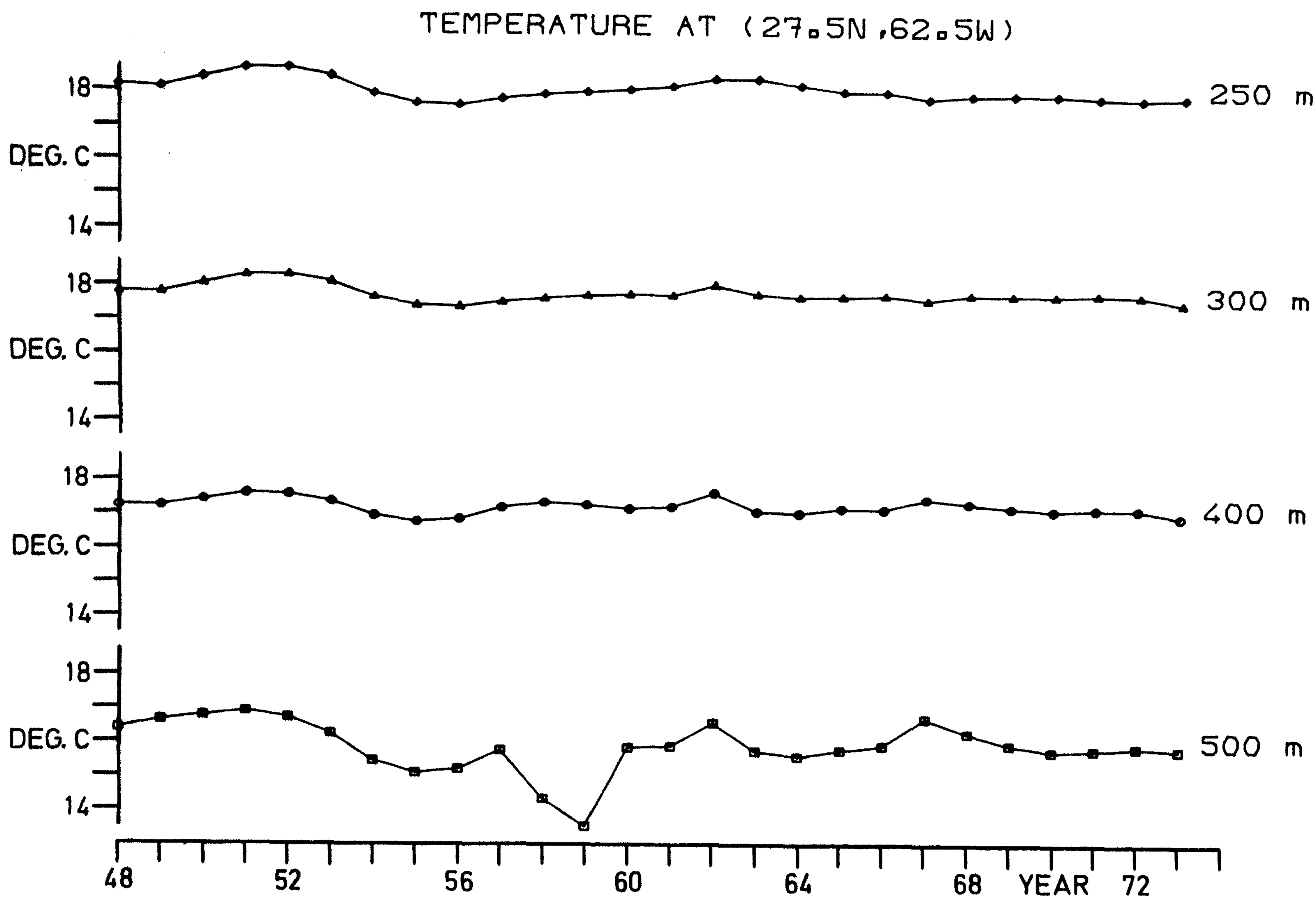
56
60
64
68
YEAR
72


TEMPERATURE AT (27.5N, 62.5W)
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DEG. C
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300 m
400 m
500 m
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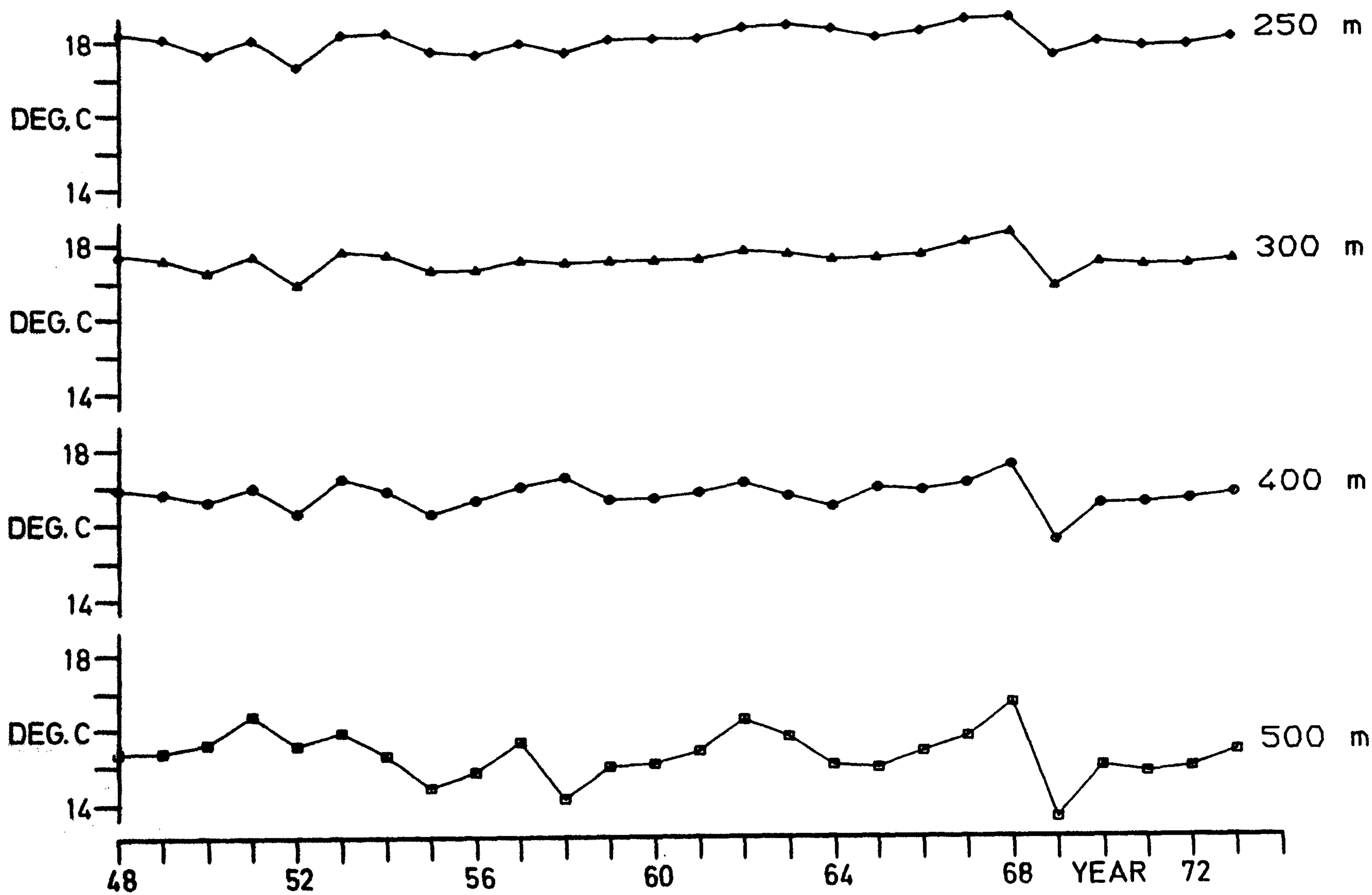
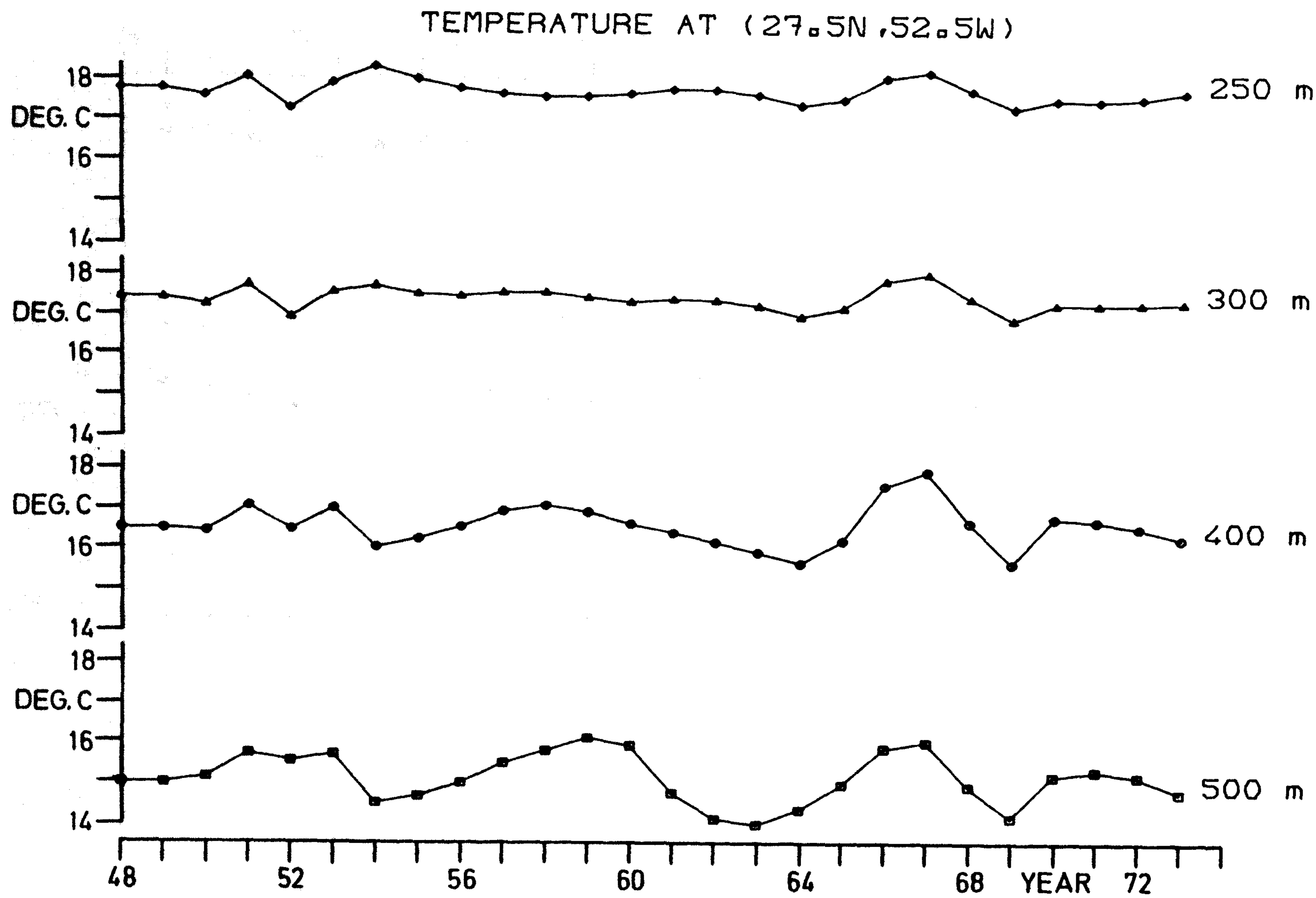
64
68
YEAR
72

TEMPERATURE AT (27.5N,57.5W)




TEMPERATURE AT (27.5N,52.5W)
18
DEG. C
16
14
250 m
18
DEG. C
16
14
300 m
18
DEG. C
16
14
400 m
18
DEG. C
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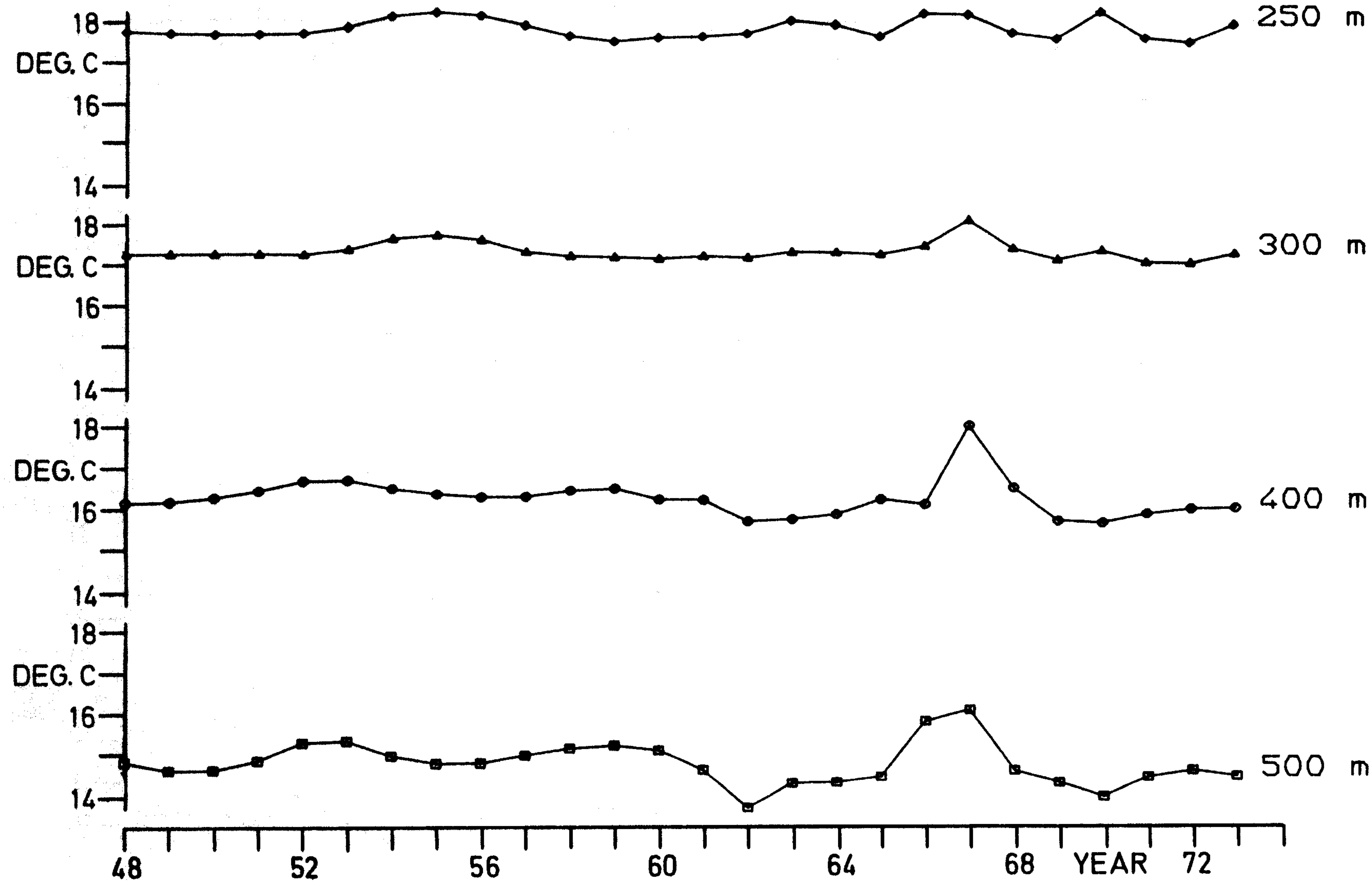
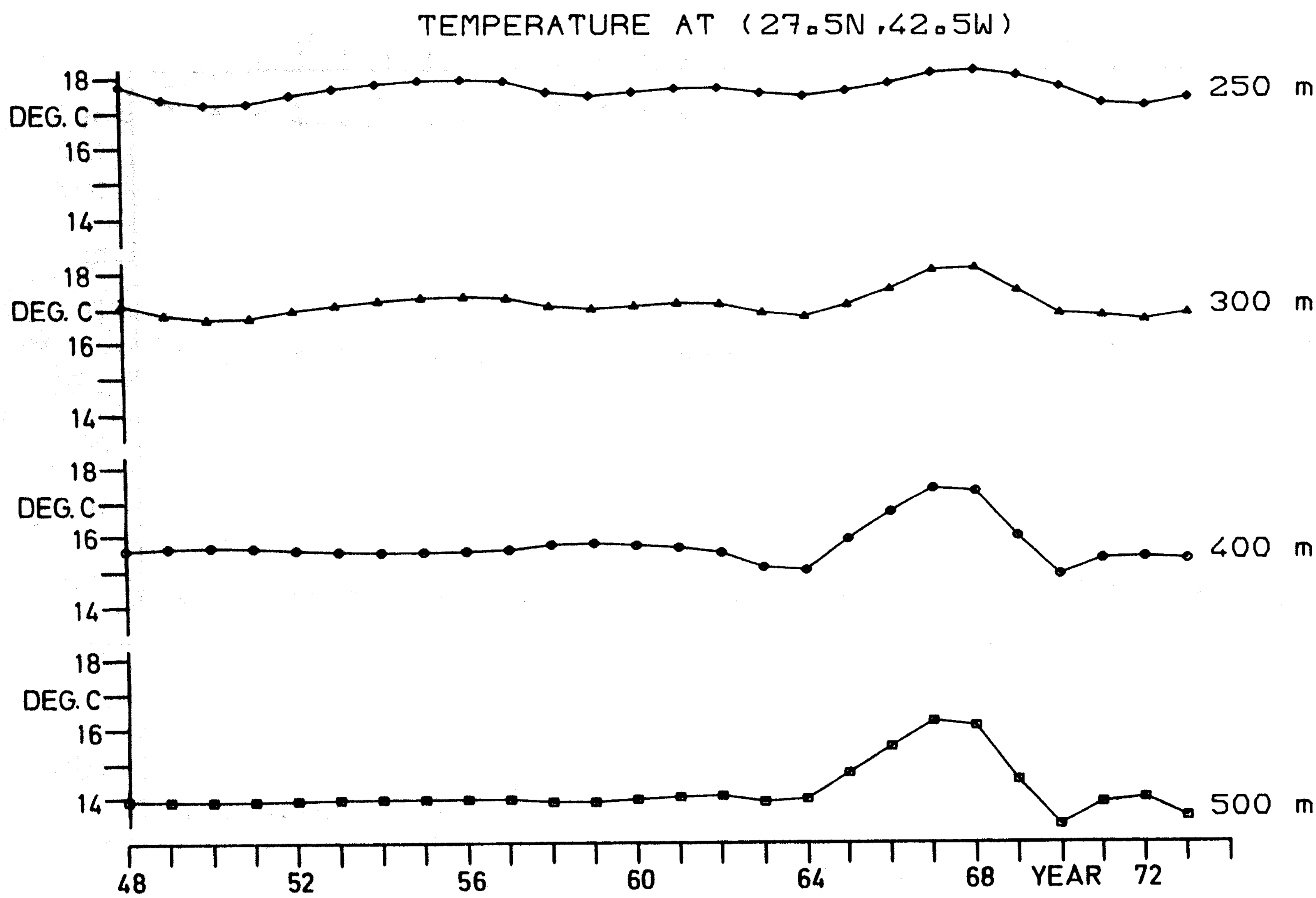
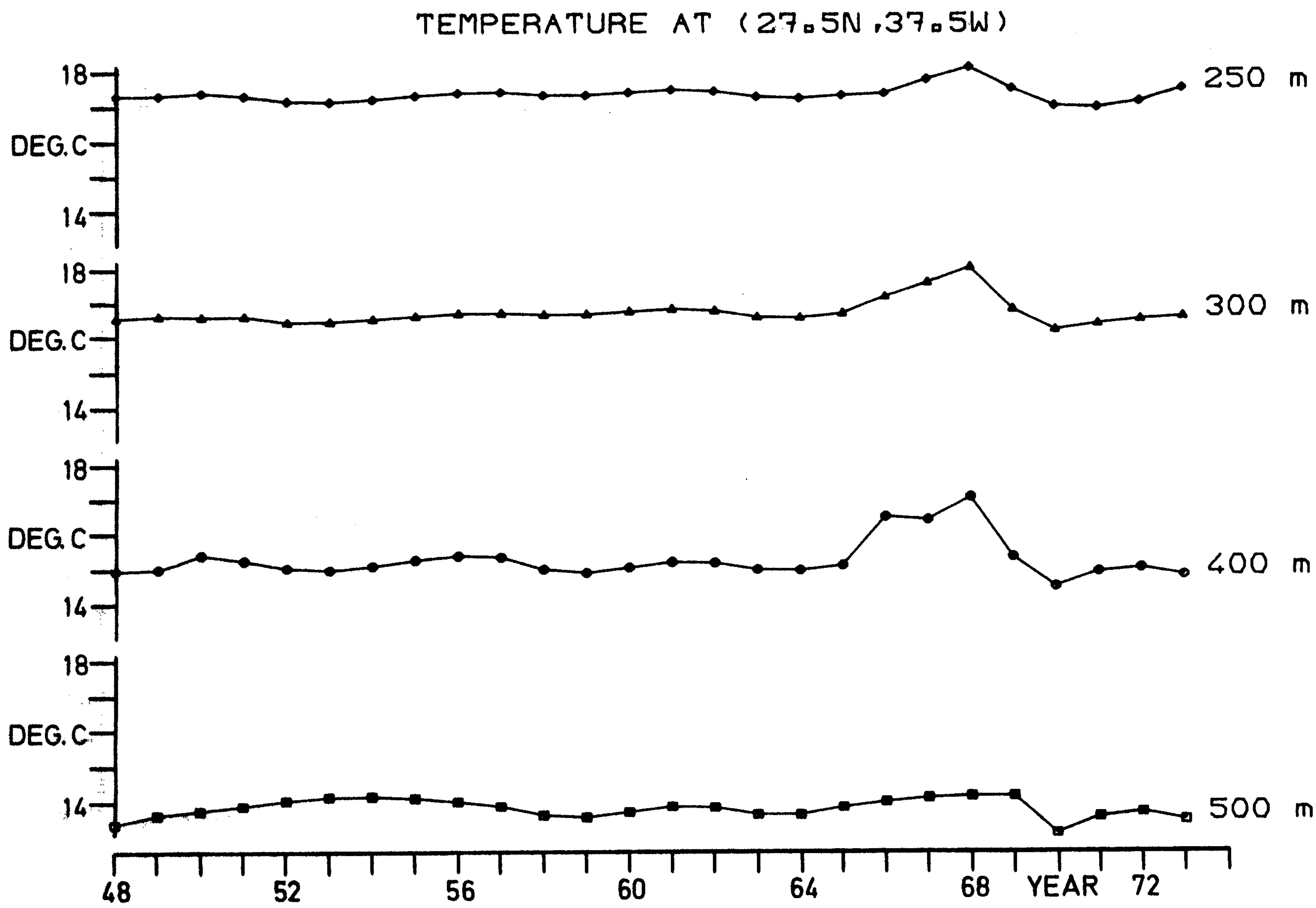
14
500 m
48
52
56
60
64
68
YEAR
72

TEMPERATURE AT (27.5N, 47.5W)




TEMPERATURE AT (27.5N, 42.5W)
18
DEG. C
16
14
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72


TEMPERATURE AT (27.5N, 37.5W)
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300 m
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DEG. C
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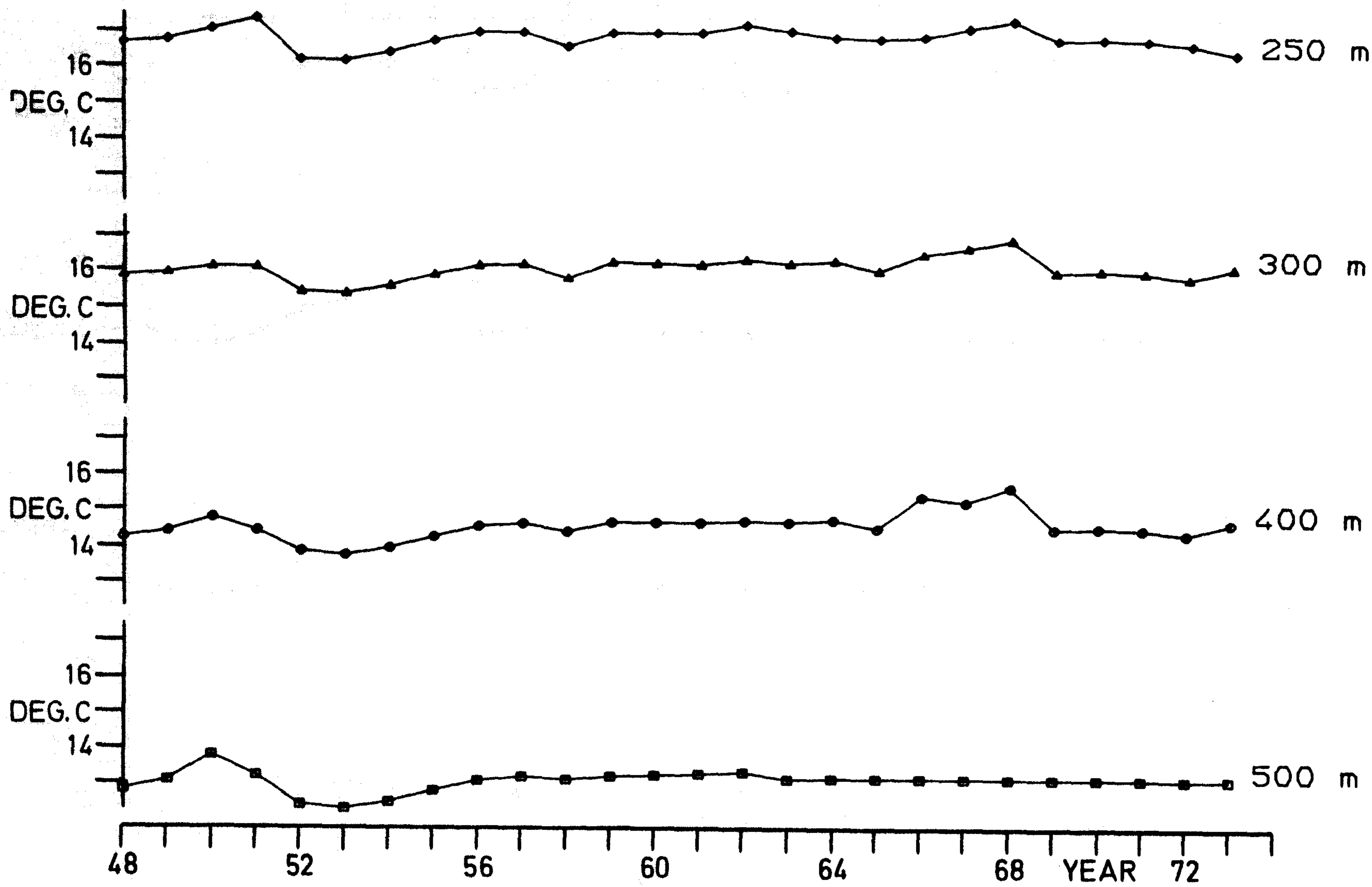
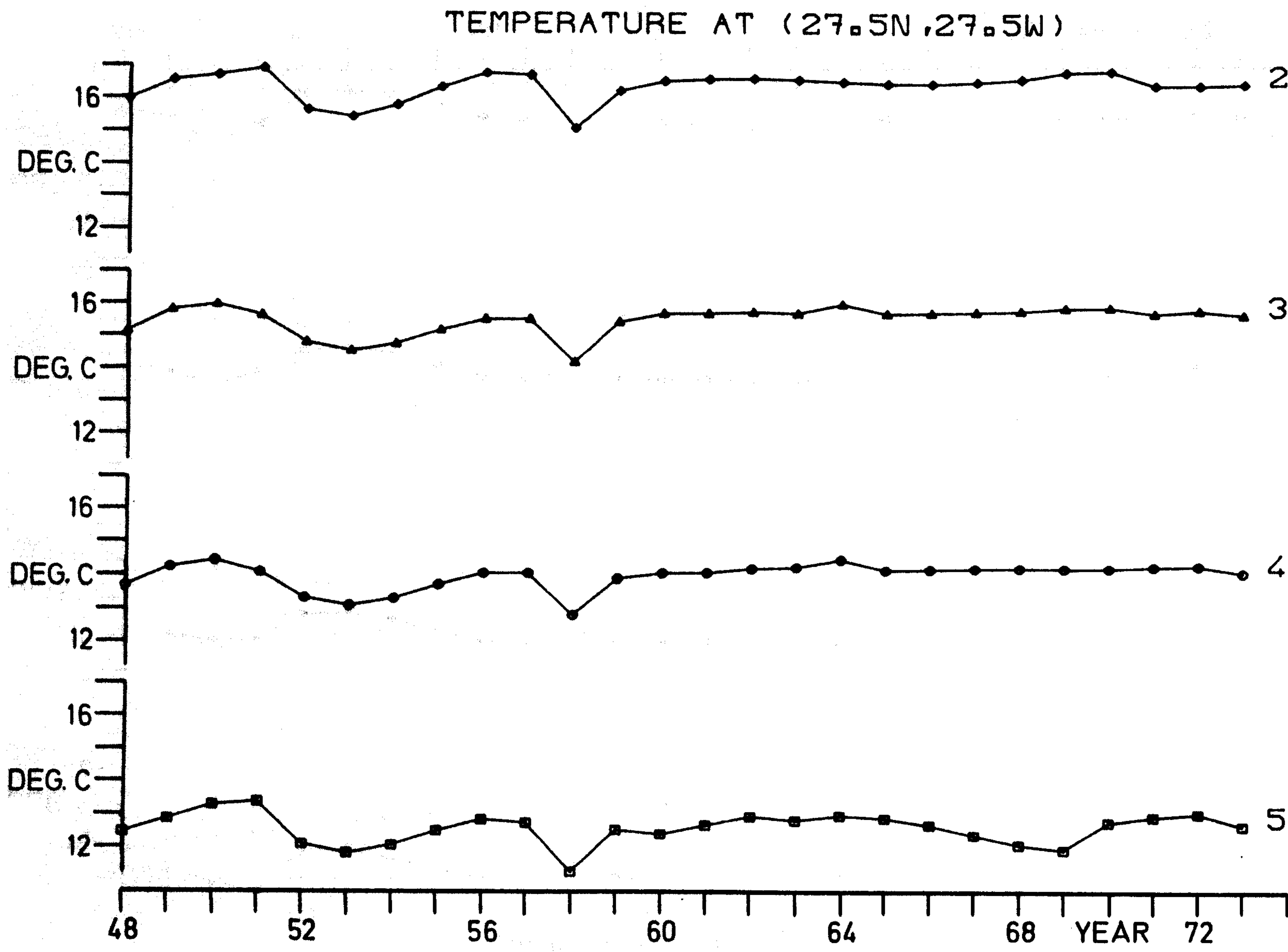
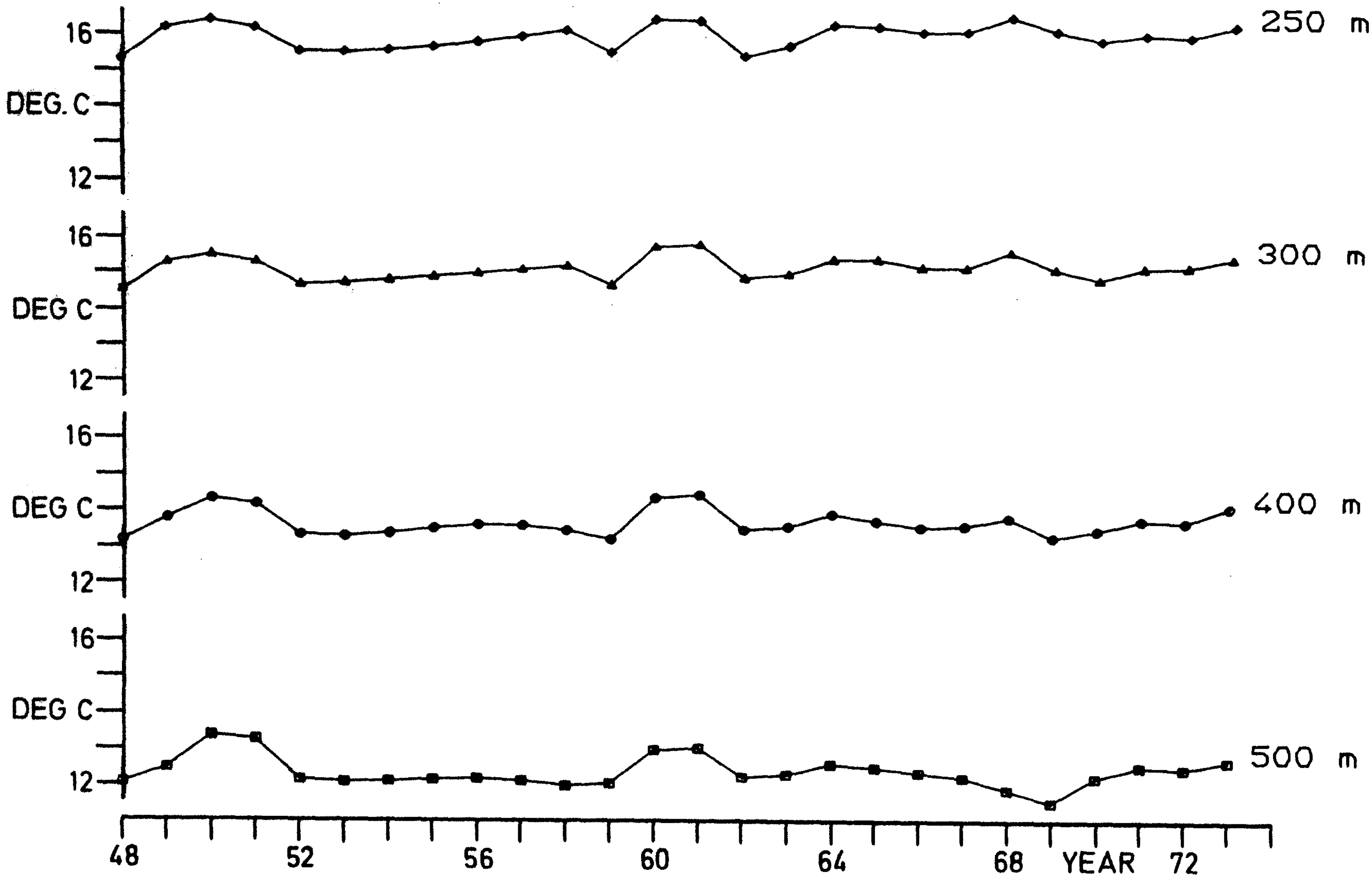
52
56
60
64
68
YEAR
72

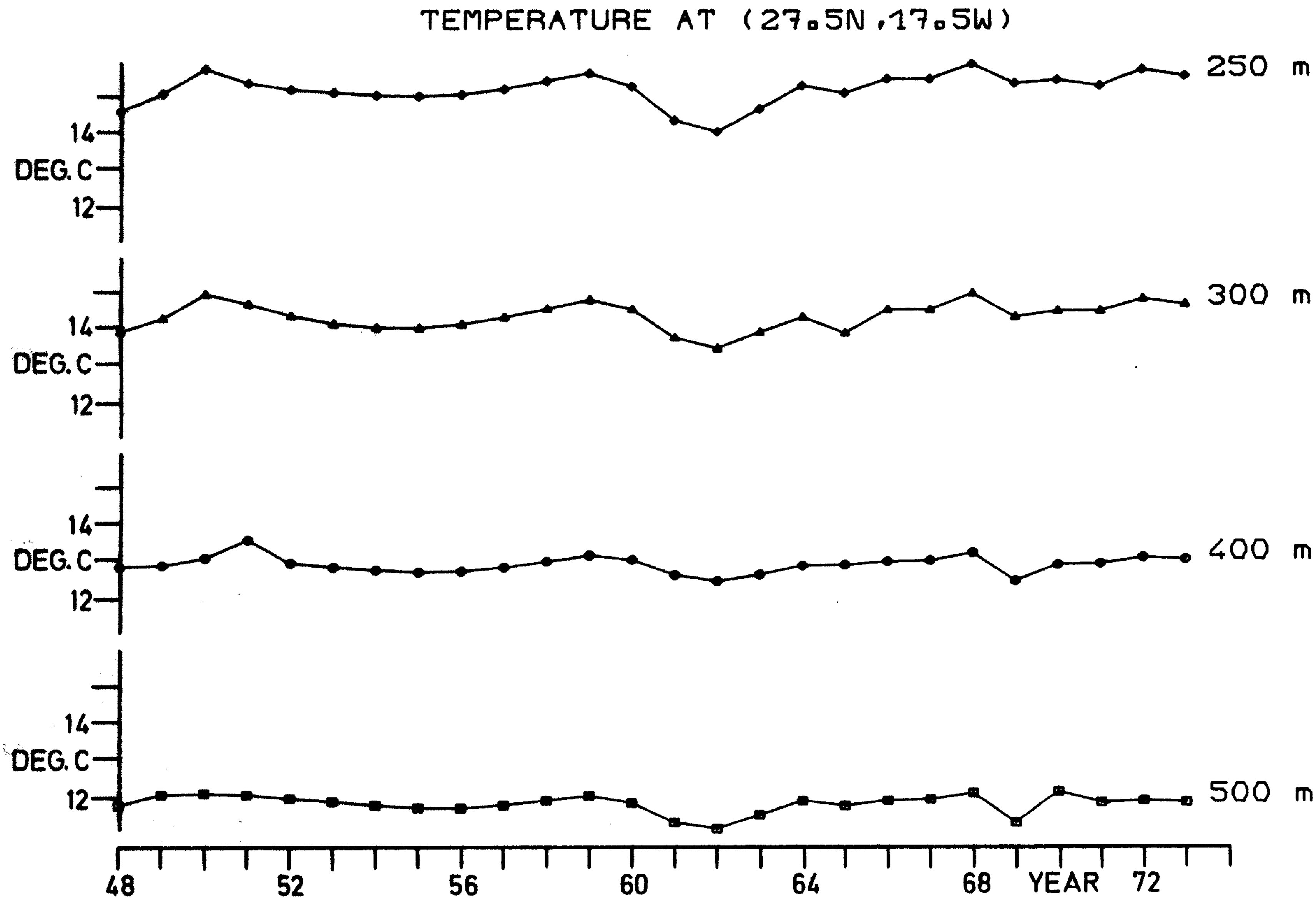
TEMPERATURE AT (27.5N,32.5W)




TEMPERATURE AT (27.5N,27.5W)
250 m
300 m
400 m
500 m
DEG. C
16
12
48
52
56
60
64
68
72
YEAR

TEMPERATURE AT (27.5N,22.5W)




TEMPERATURE AT (27.5N, 17.5W)
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DEG. C
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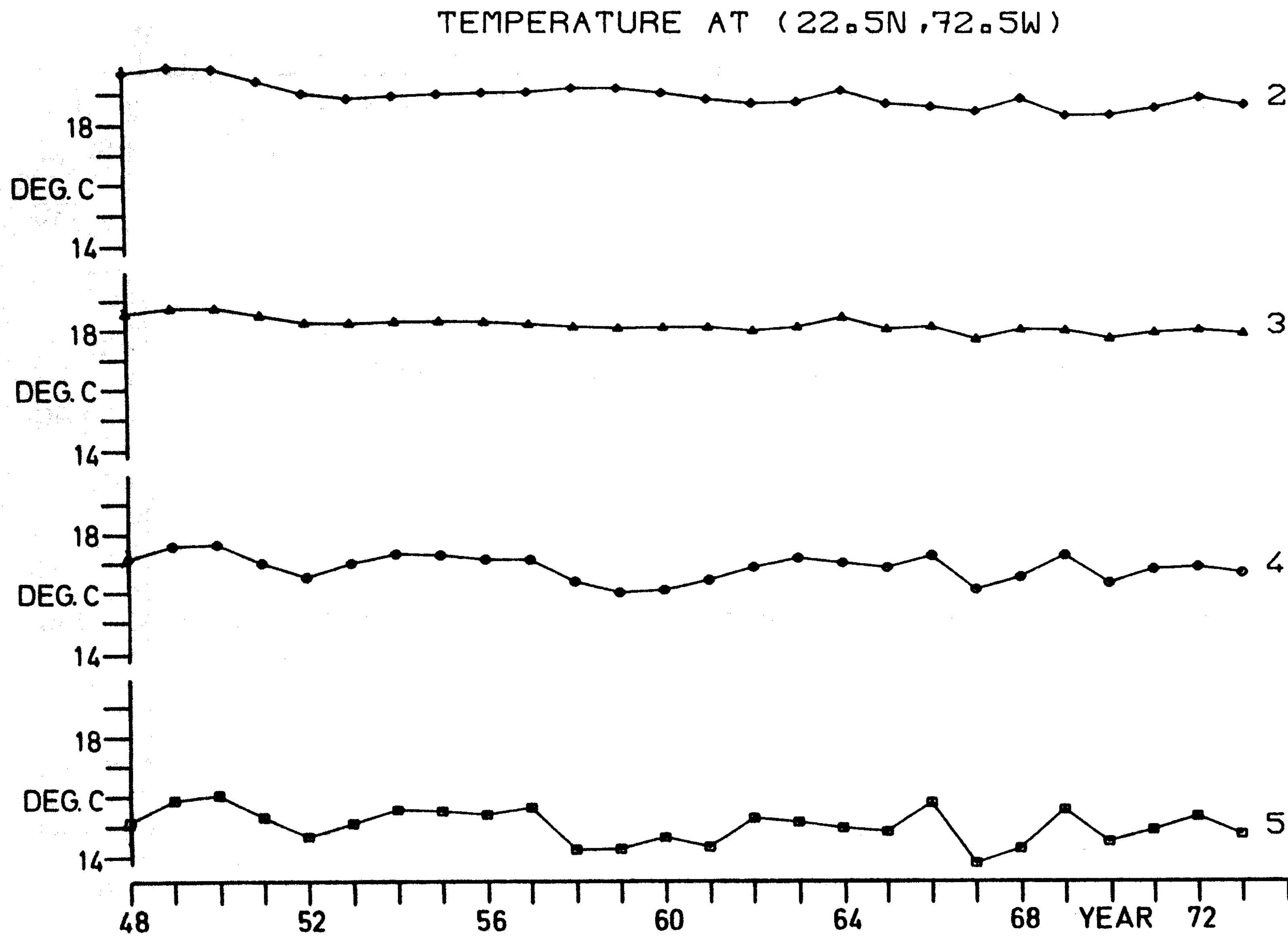
YEAR
72


TEMPERATURE AT (22.5N,72.5W)
250 m
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DEG. C
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48
52
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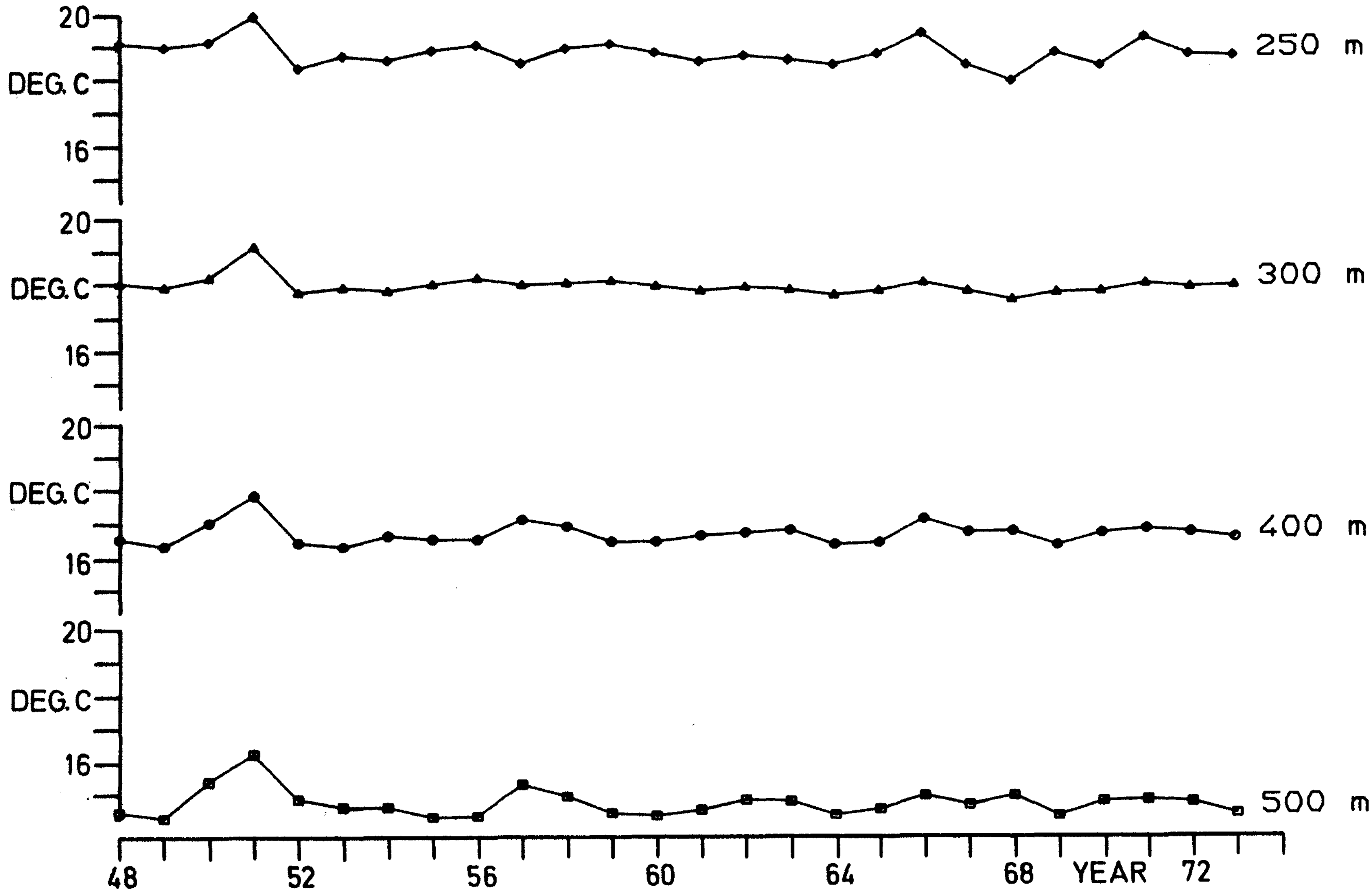
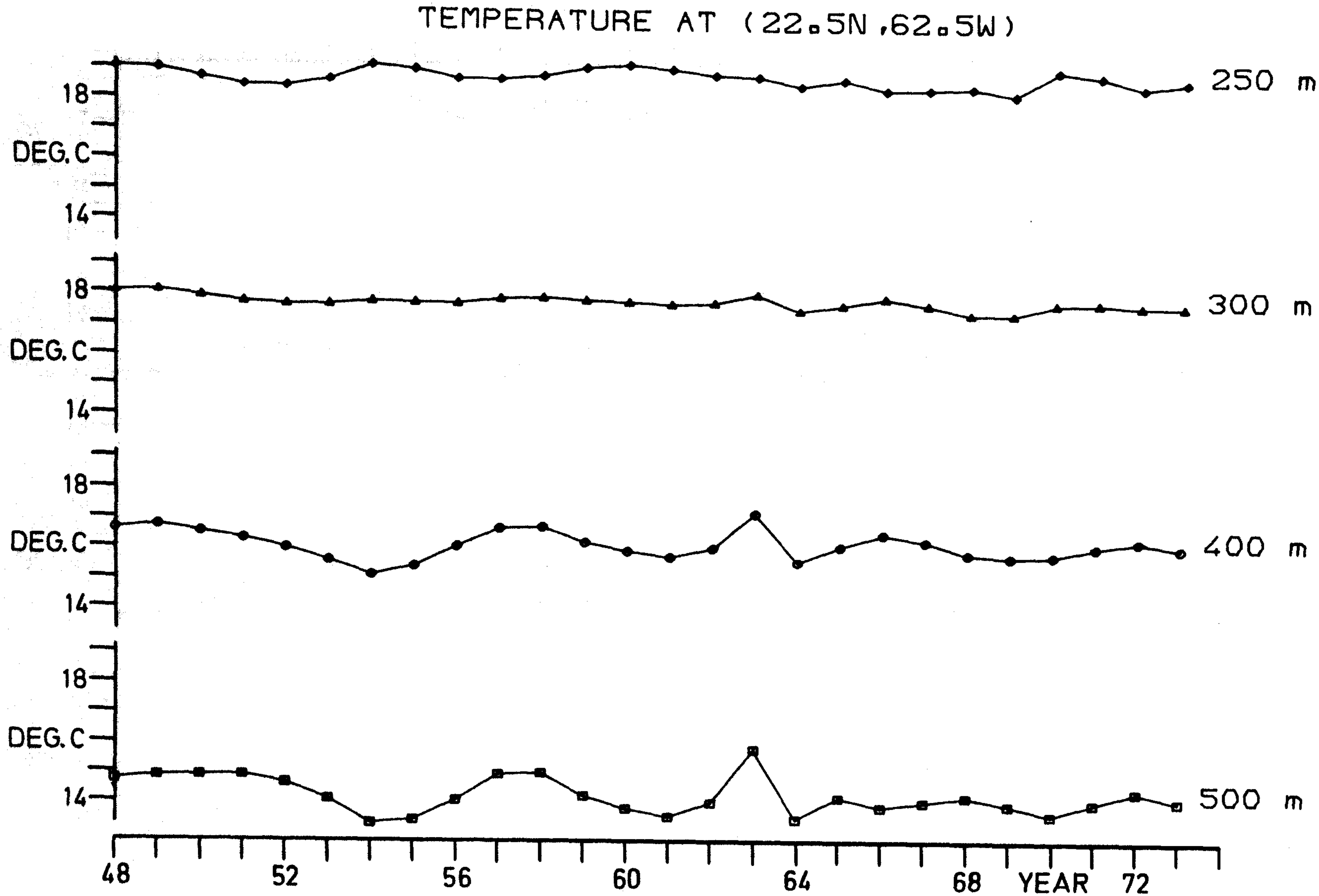
64
68
YEAR
72

TEMPERATURE AT (22.5N,67.5W)




TEMPERATURE AT (22.5N,62.5W)
250 m
300 m
400 m
500 m
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DEG.C
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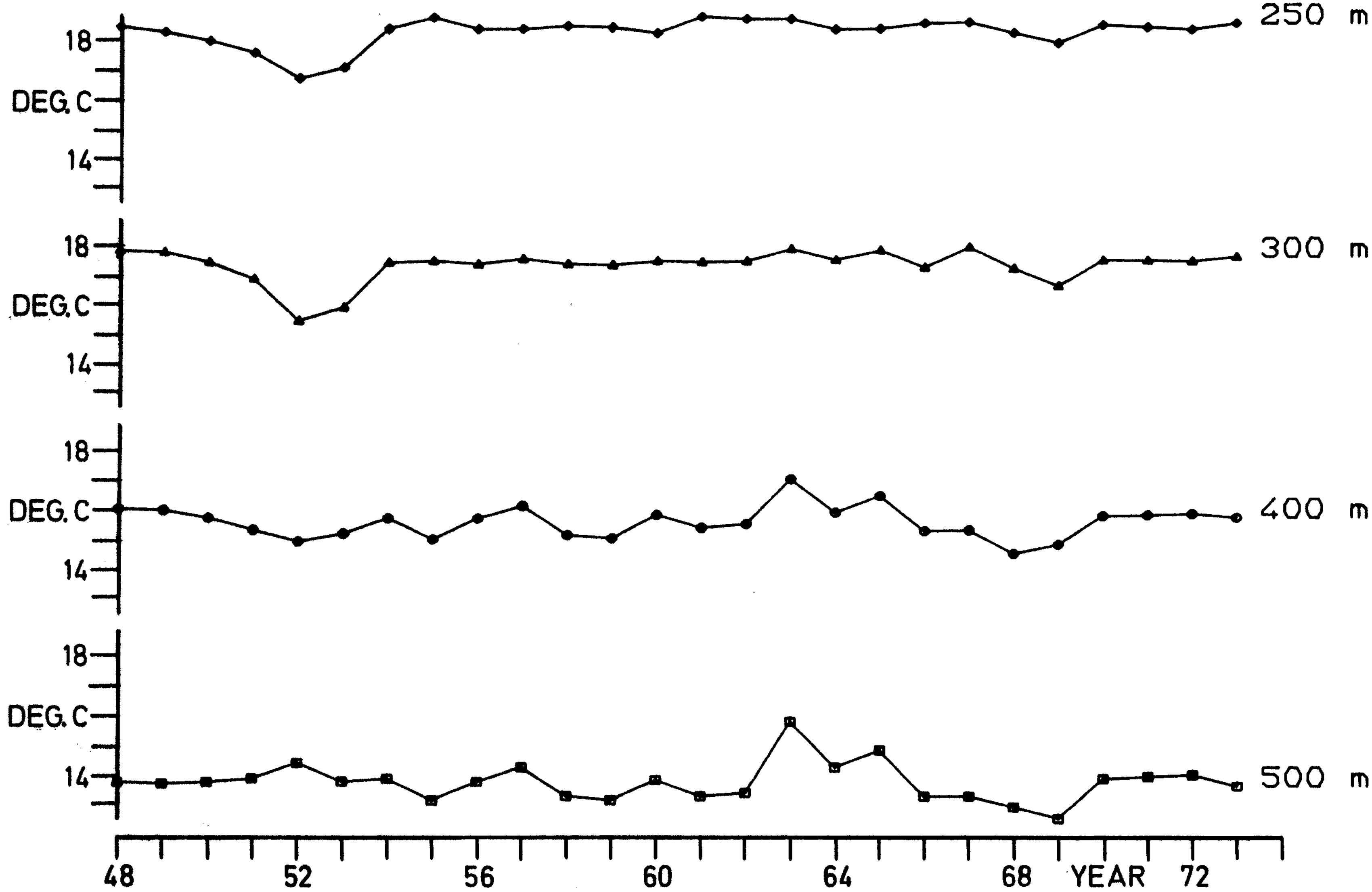
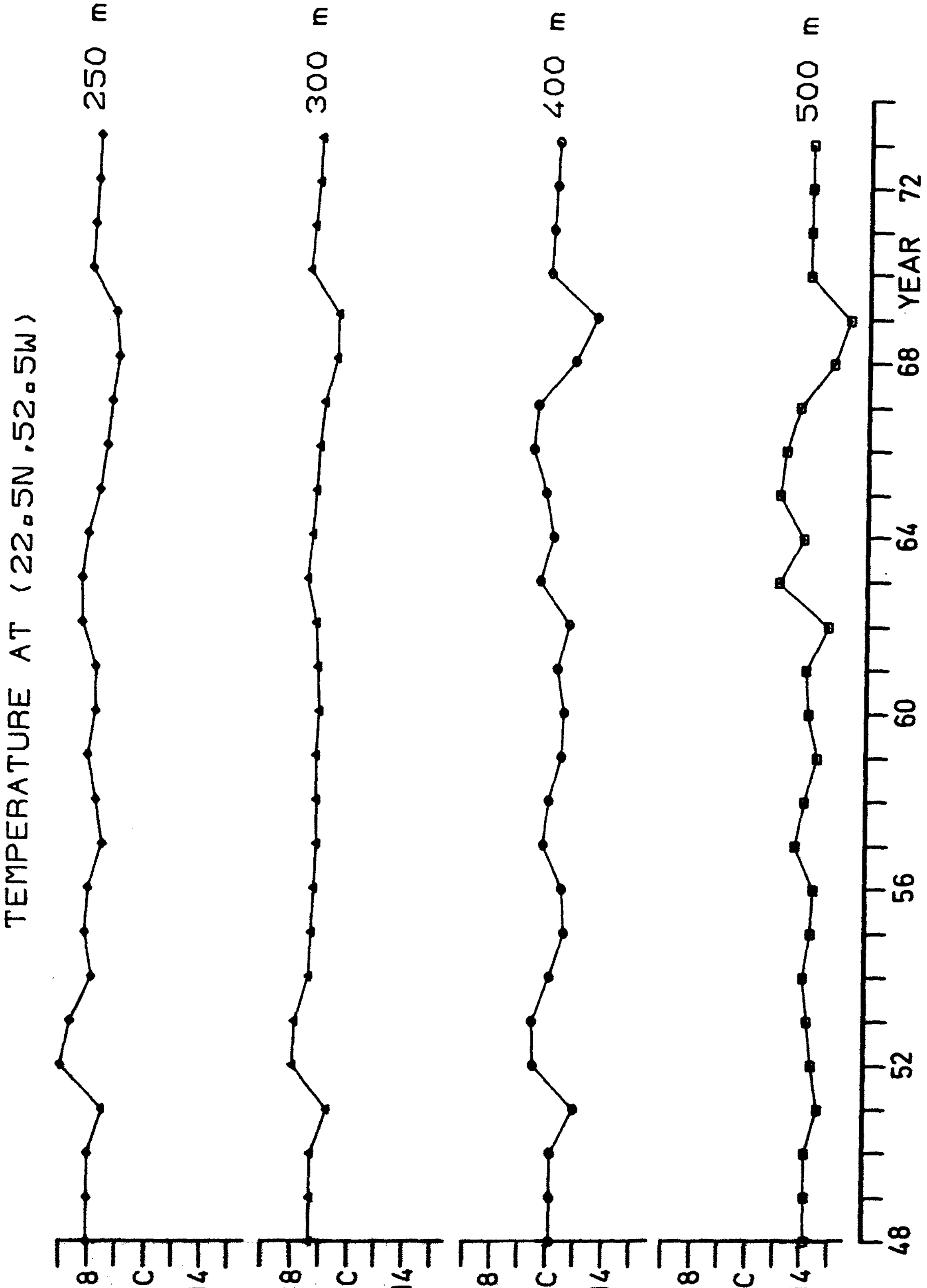
56
60
64
68
YEAR
72

TEMPERATURE AT (22.5N,57.5W)




TEMPERATURE AT (22.5N,52.5W)
250 m
300 m
400 m
500 m
DEG.C
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YEAR
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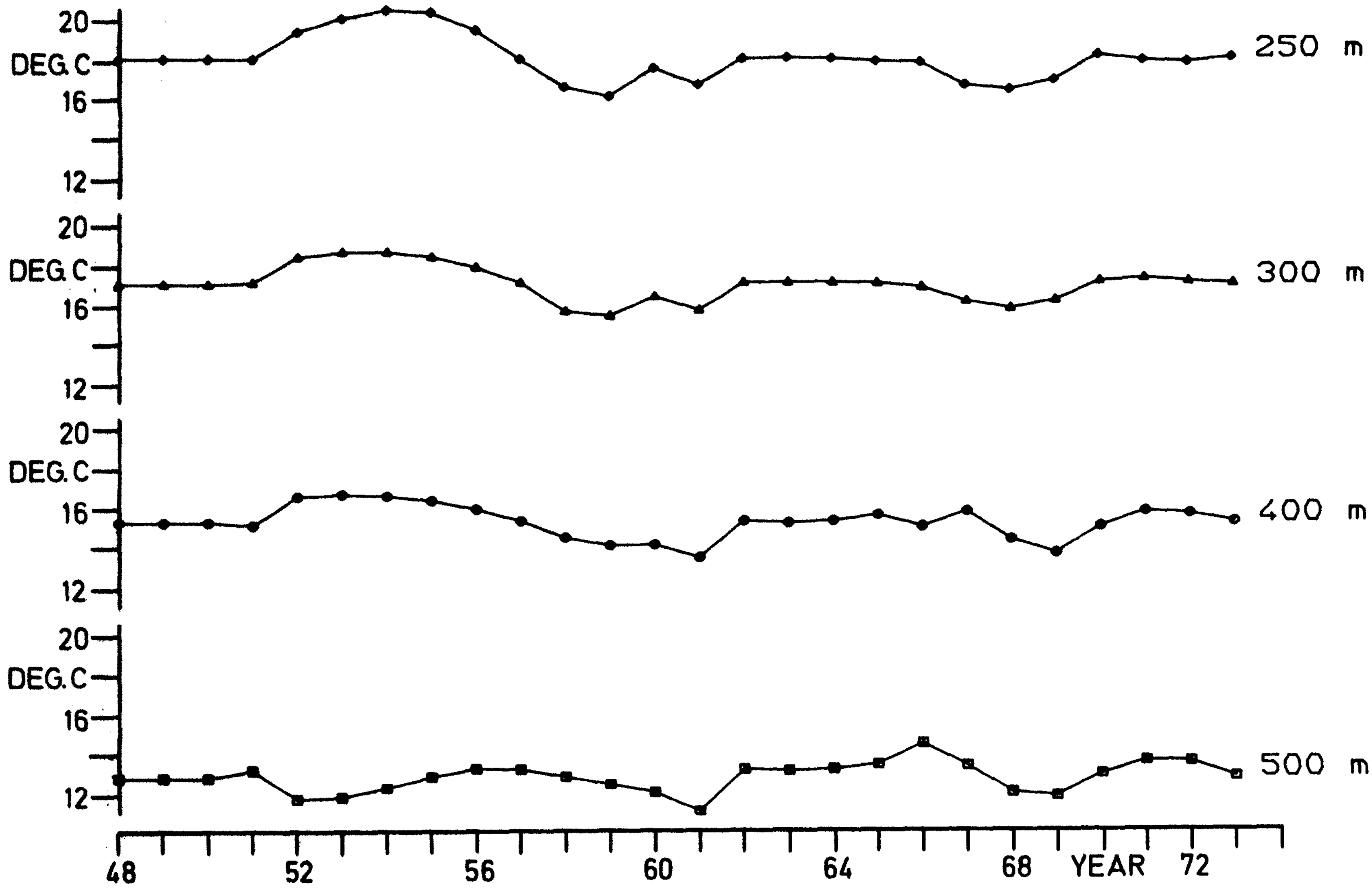
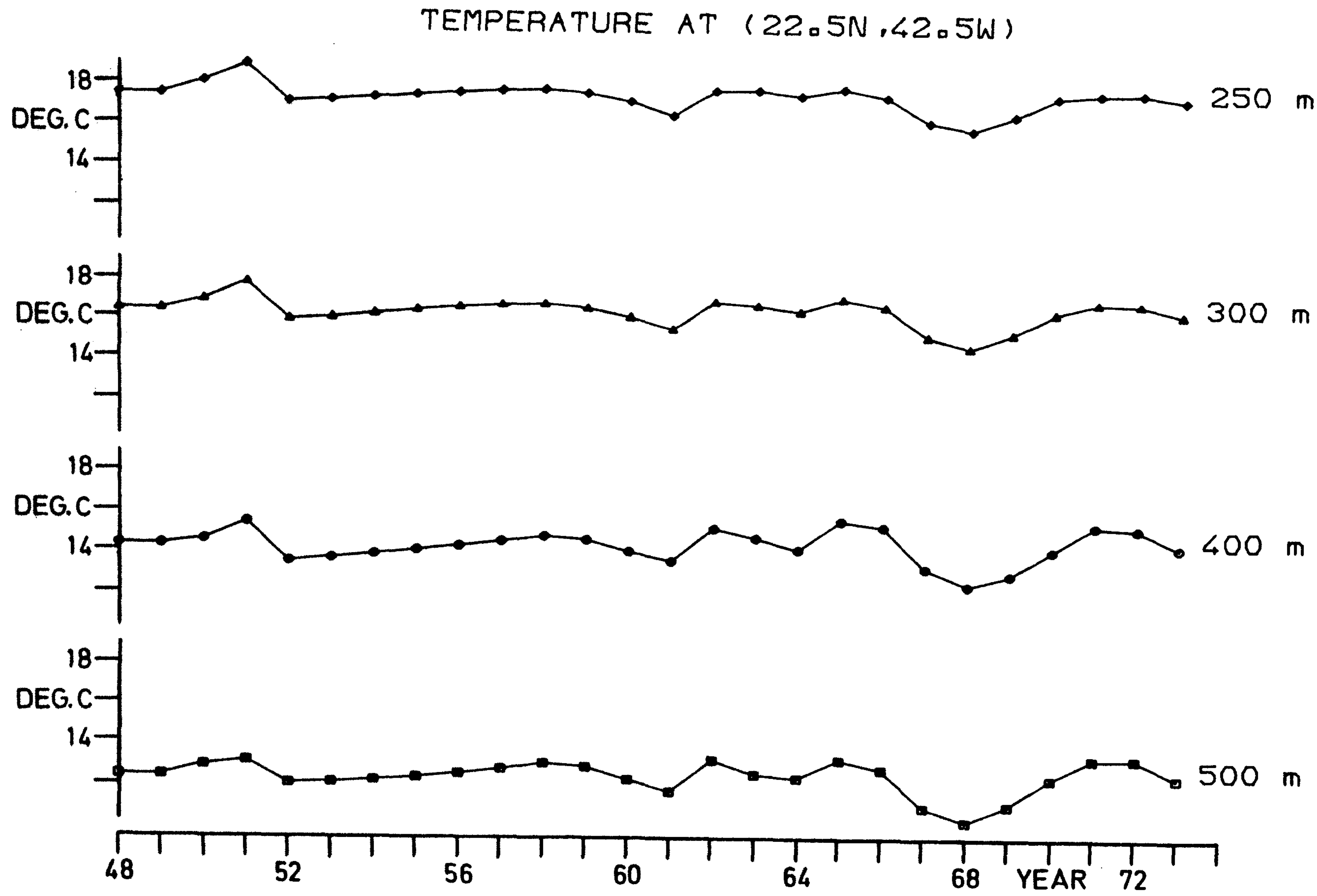
56
60
64
68
72

TEMPERATURE AT (22.5N,47.5W)




TEMPERATURE AT (22.5N,42.5W)
250 m
300 m
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500 m
DEG.C
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YEAR
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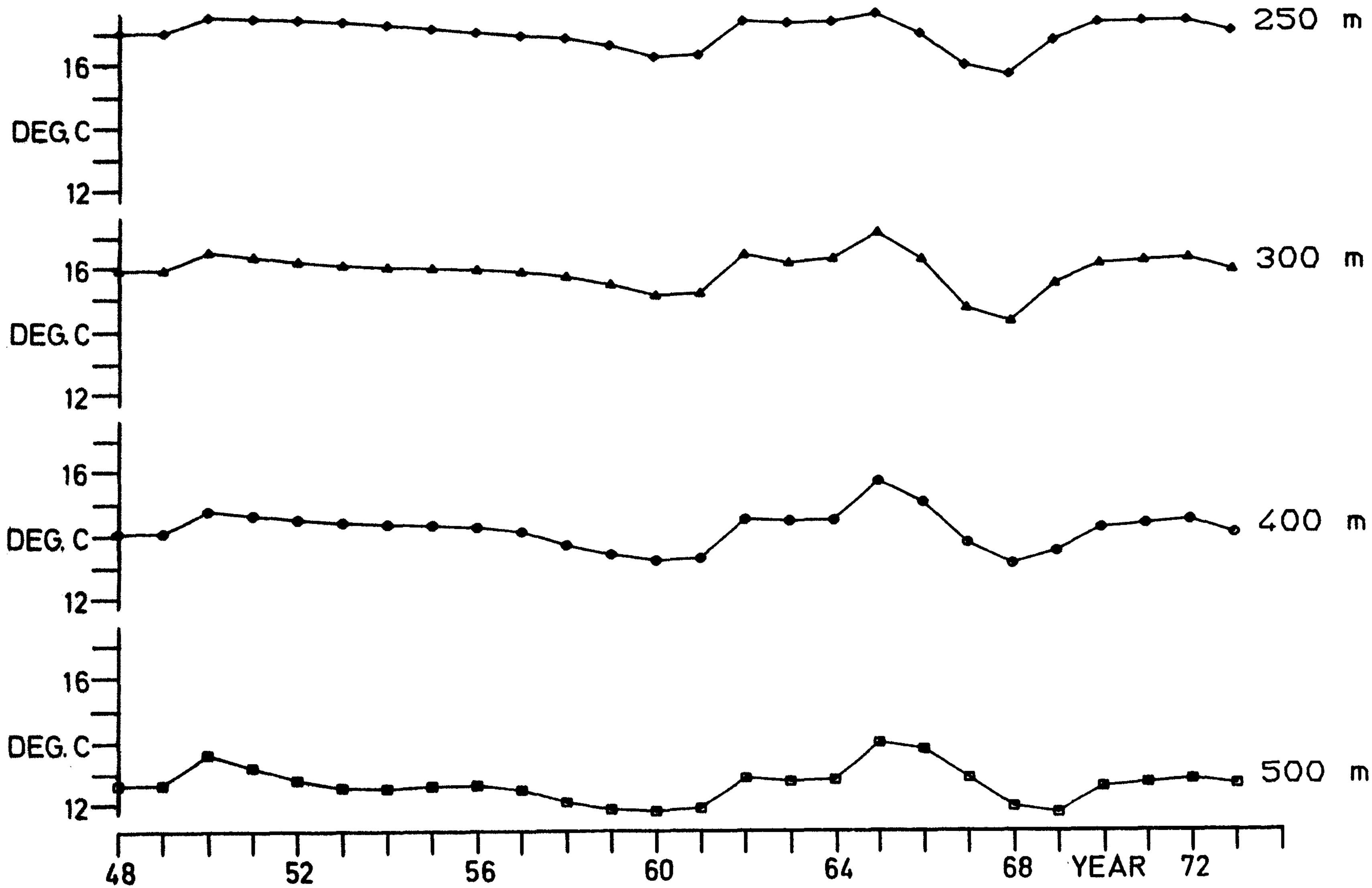
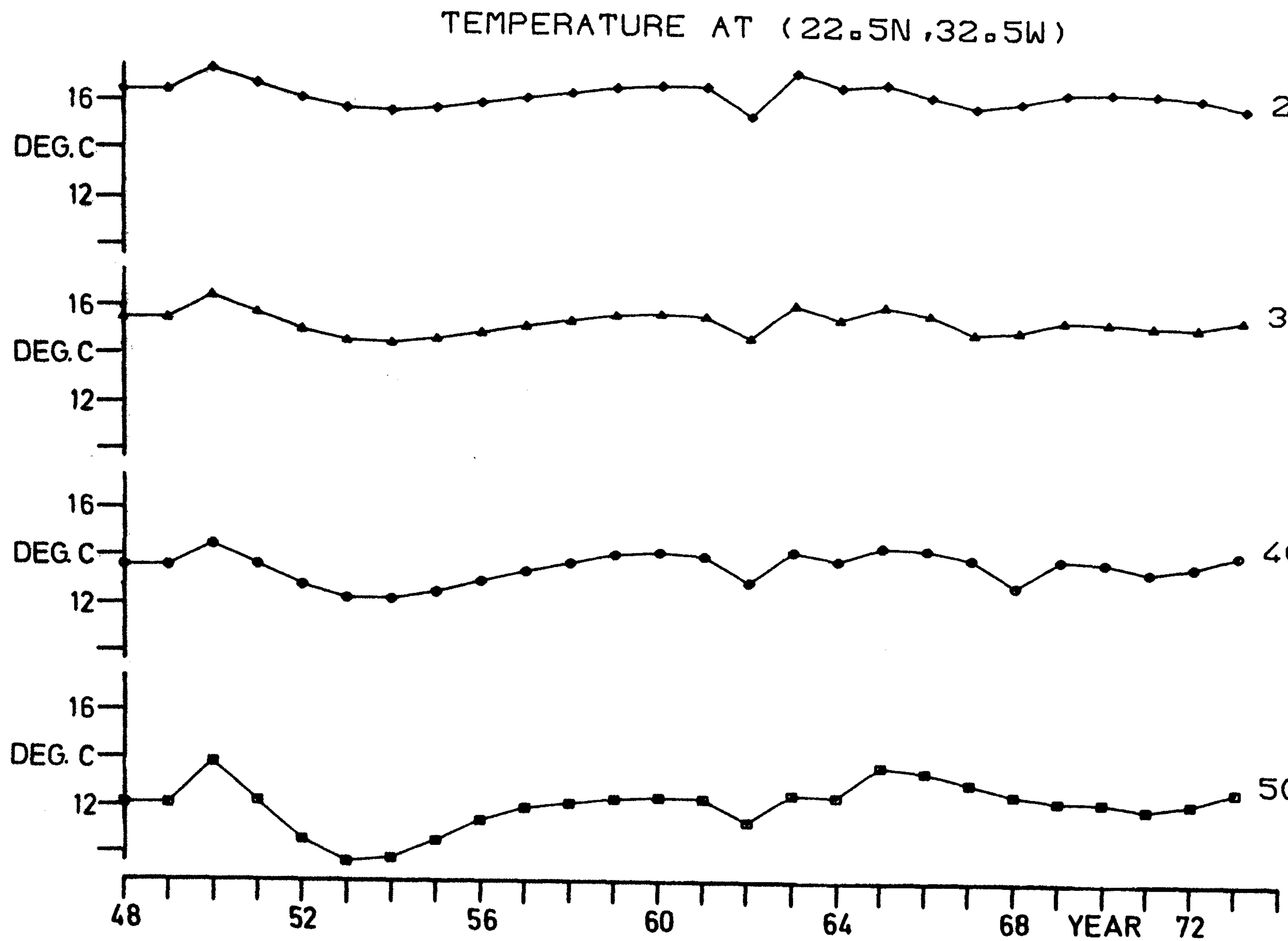
68
72

TEMPERATURE AT (22.5N, 37.5W)




TEMPERATURE AT (22.5N,32.5W)
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300 m
400 m
500 m
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DEG.C
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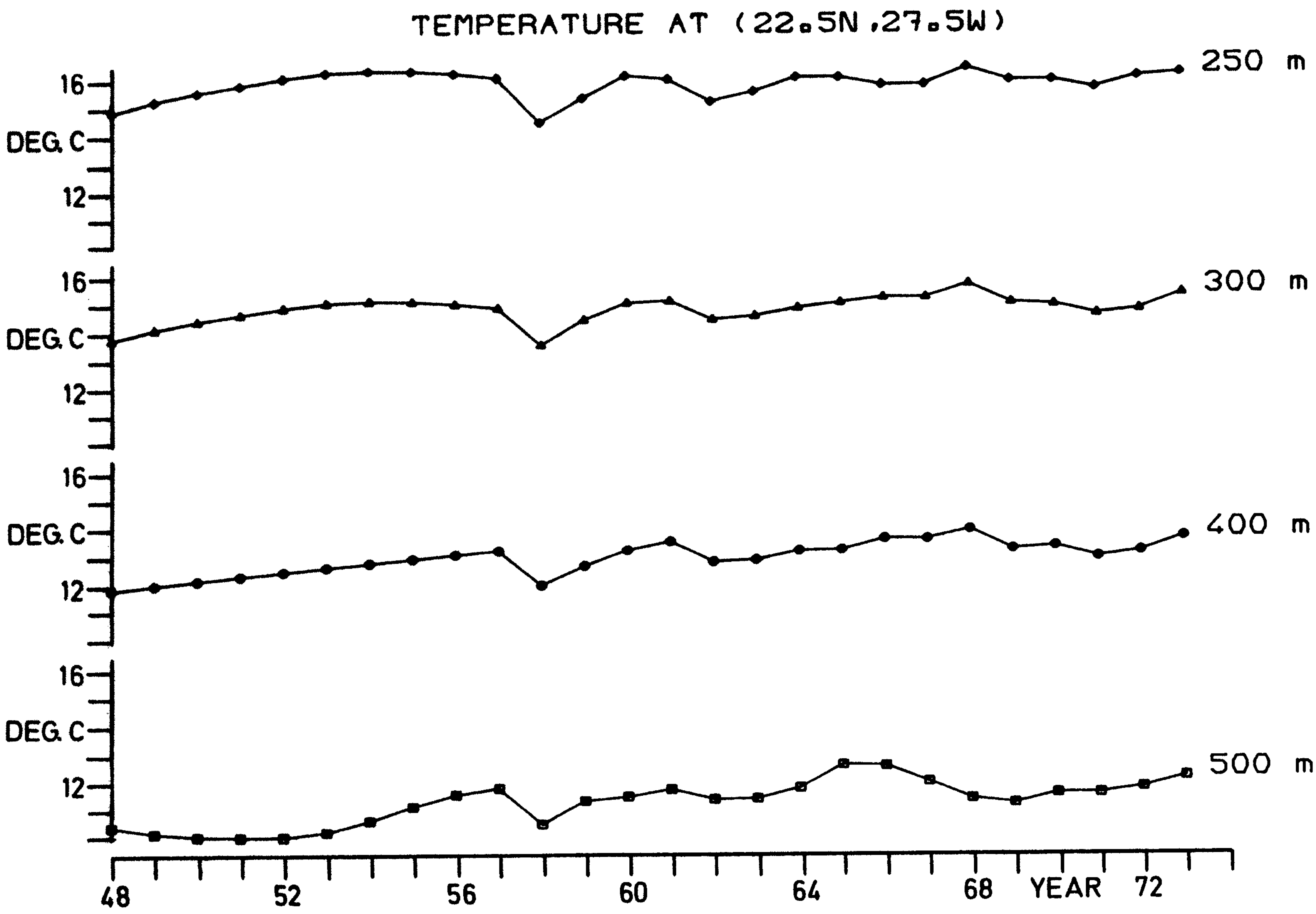
YEAR
72


TEMPERATURE AT (22.5N,27.5W)
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400 m
500 m
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DEG. C
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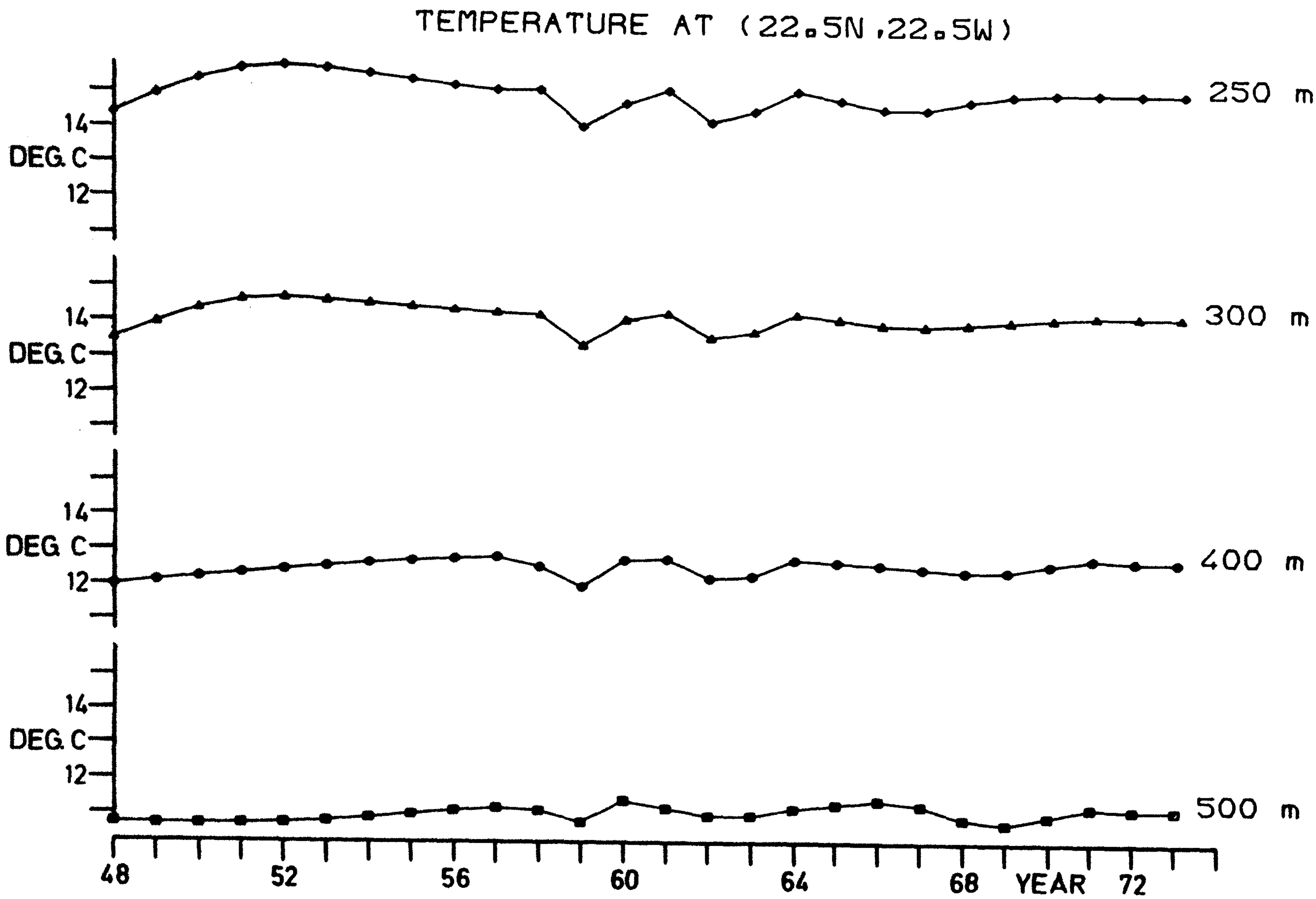
68
YEAR
72


TEMPERATURE AT (22.5N,22.5W)
250 m
300 m
400 m
500 m
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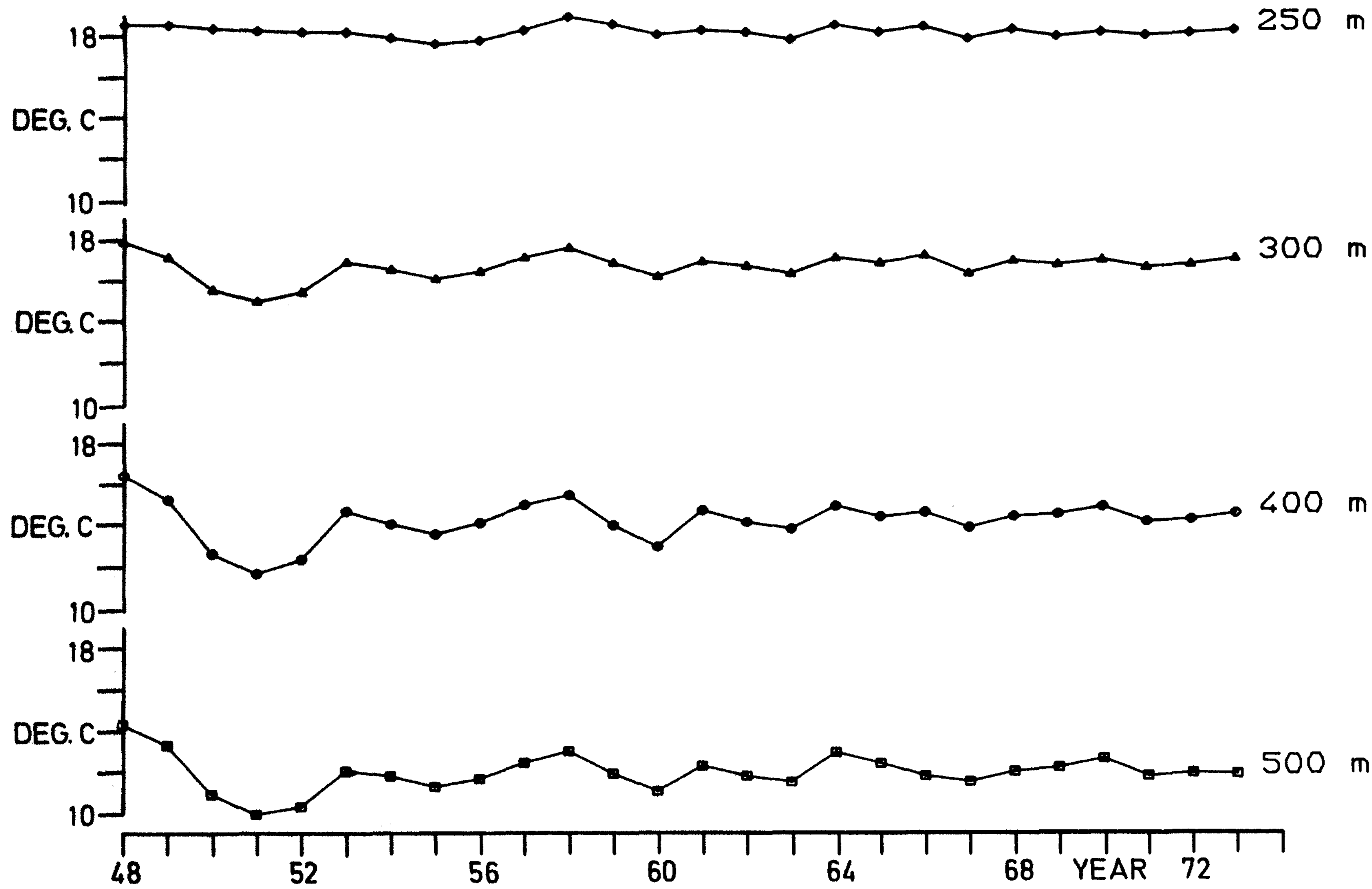
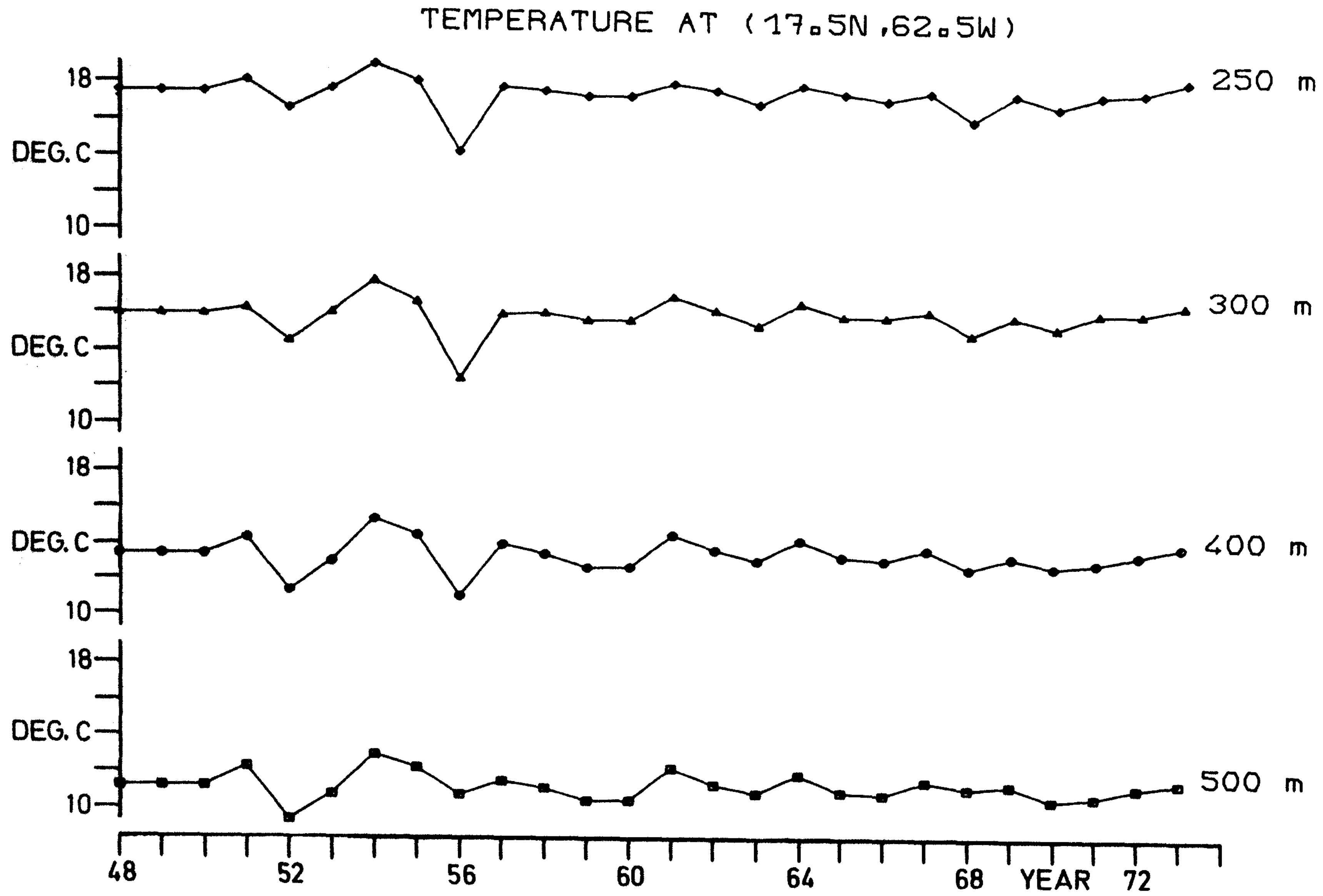
DEG C
12
48
52
56
60
64
68
YEAR
72

TEMPERATURE AT (17.5N,67.5W)




TEMPERATURE AT (17.5N,62.5W)
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DEG. C
10
250 m
300 m
400 m
500 m
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56
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68
YEAR
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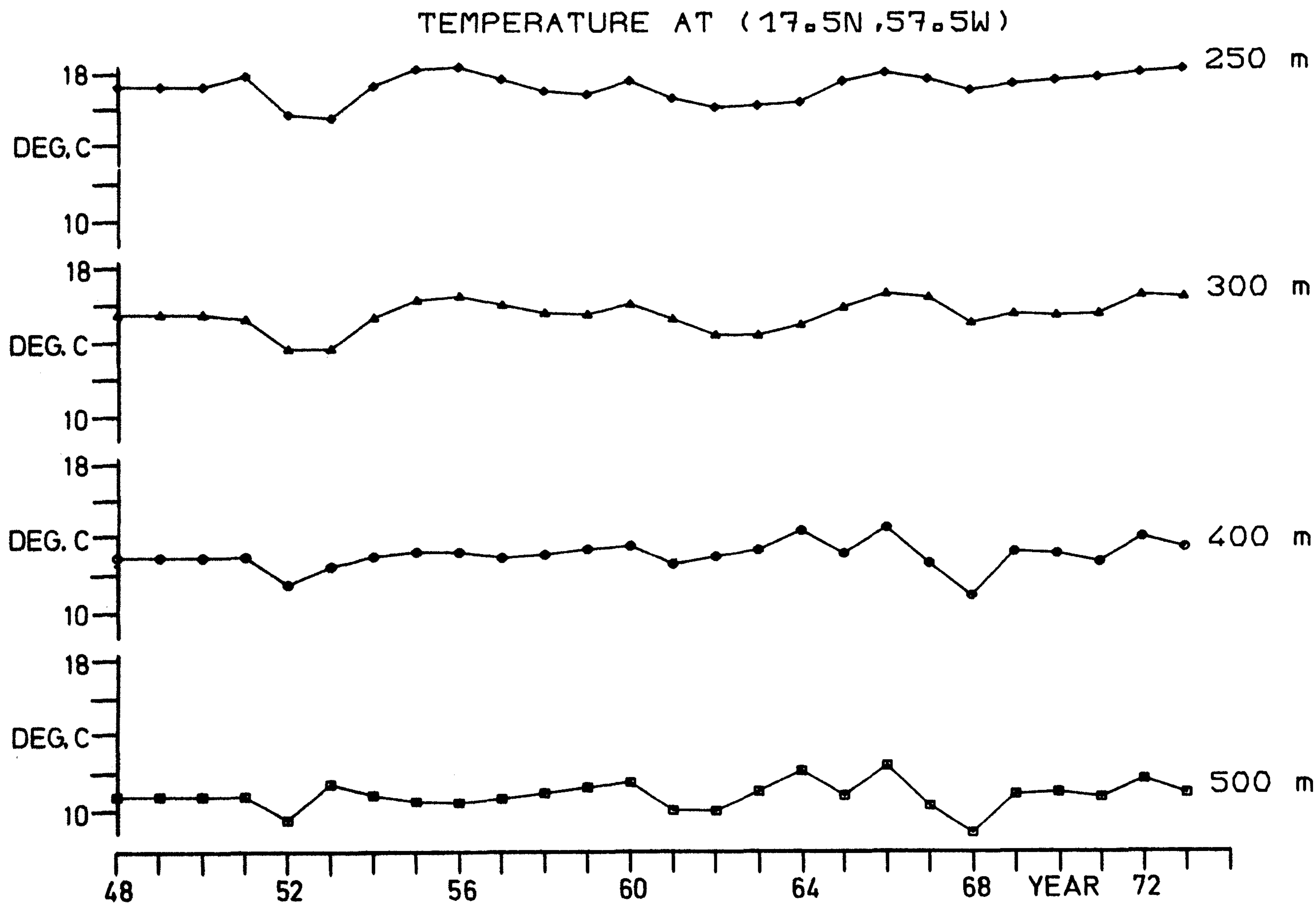
TEMPERATURE AT (17.5N,57.5W)
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400 m
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DEG. C
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YEAR
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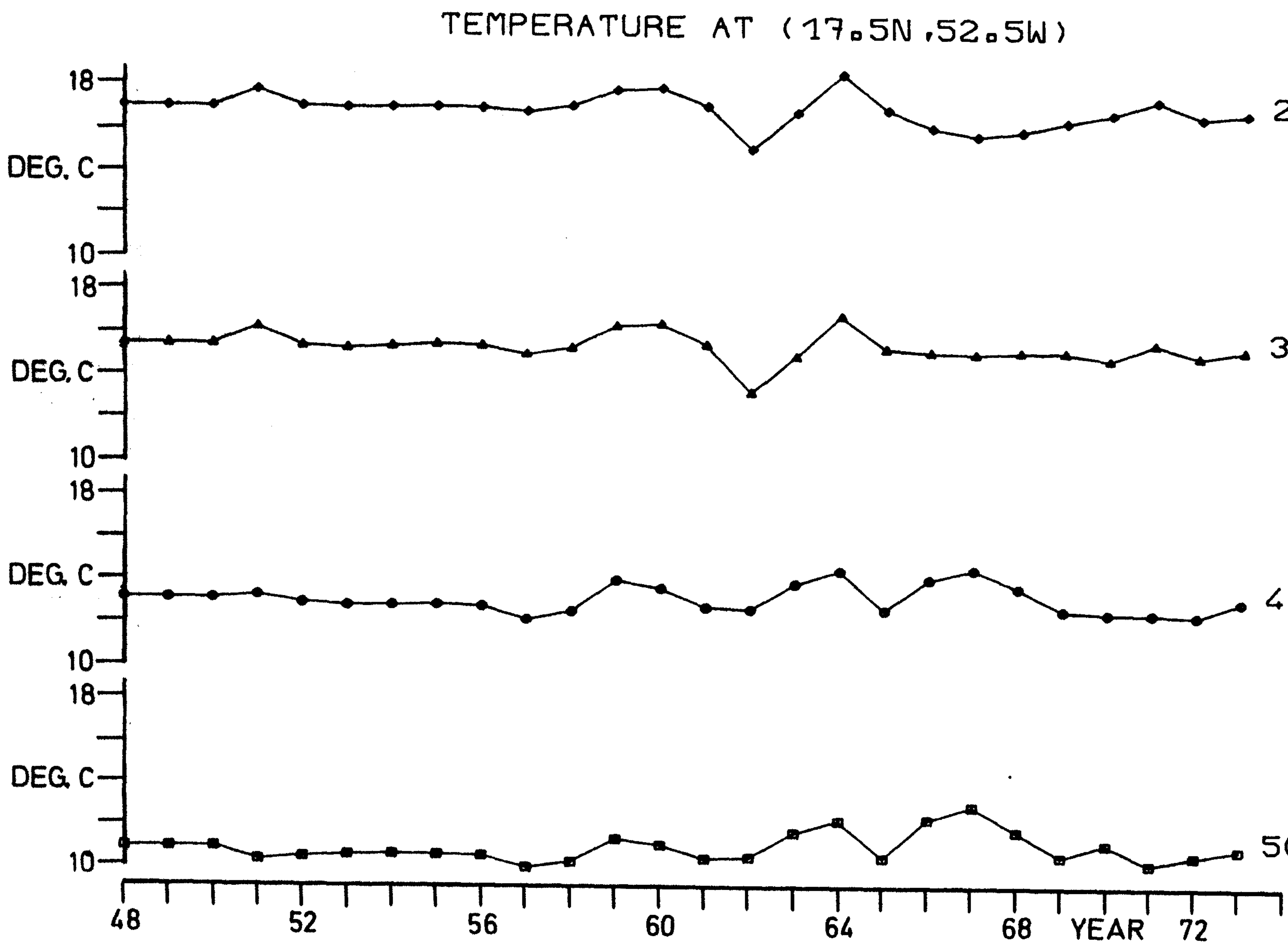
TEMPERATURE AT (17.5N,52.5W)
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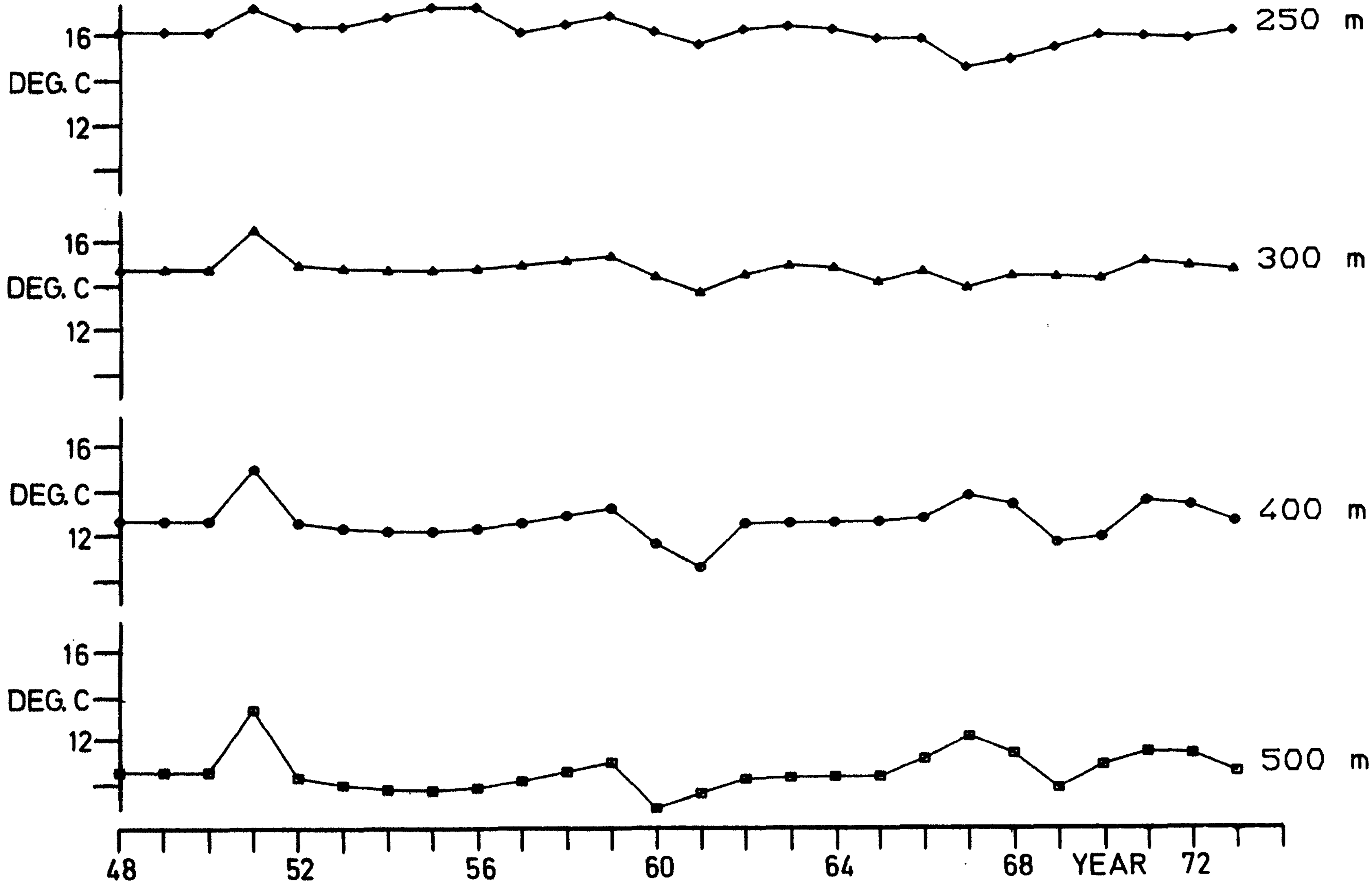
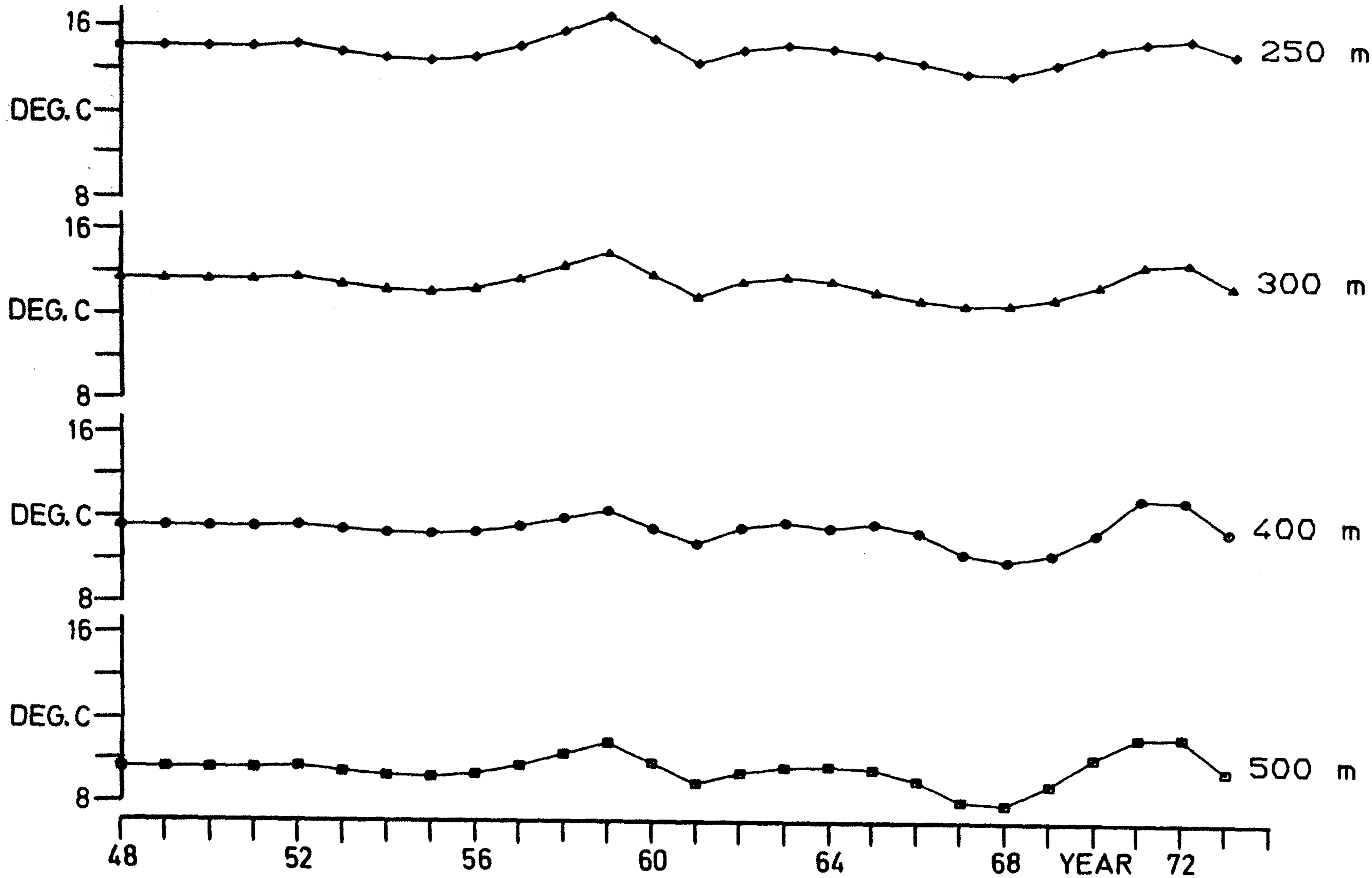
DEG. C
10
250 m
300 m
400 m
500 m
48
52
56
60
64
68
YEAR
72

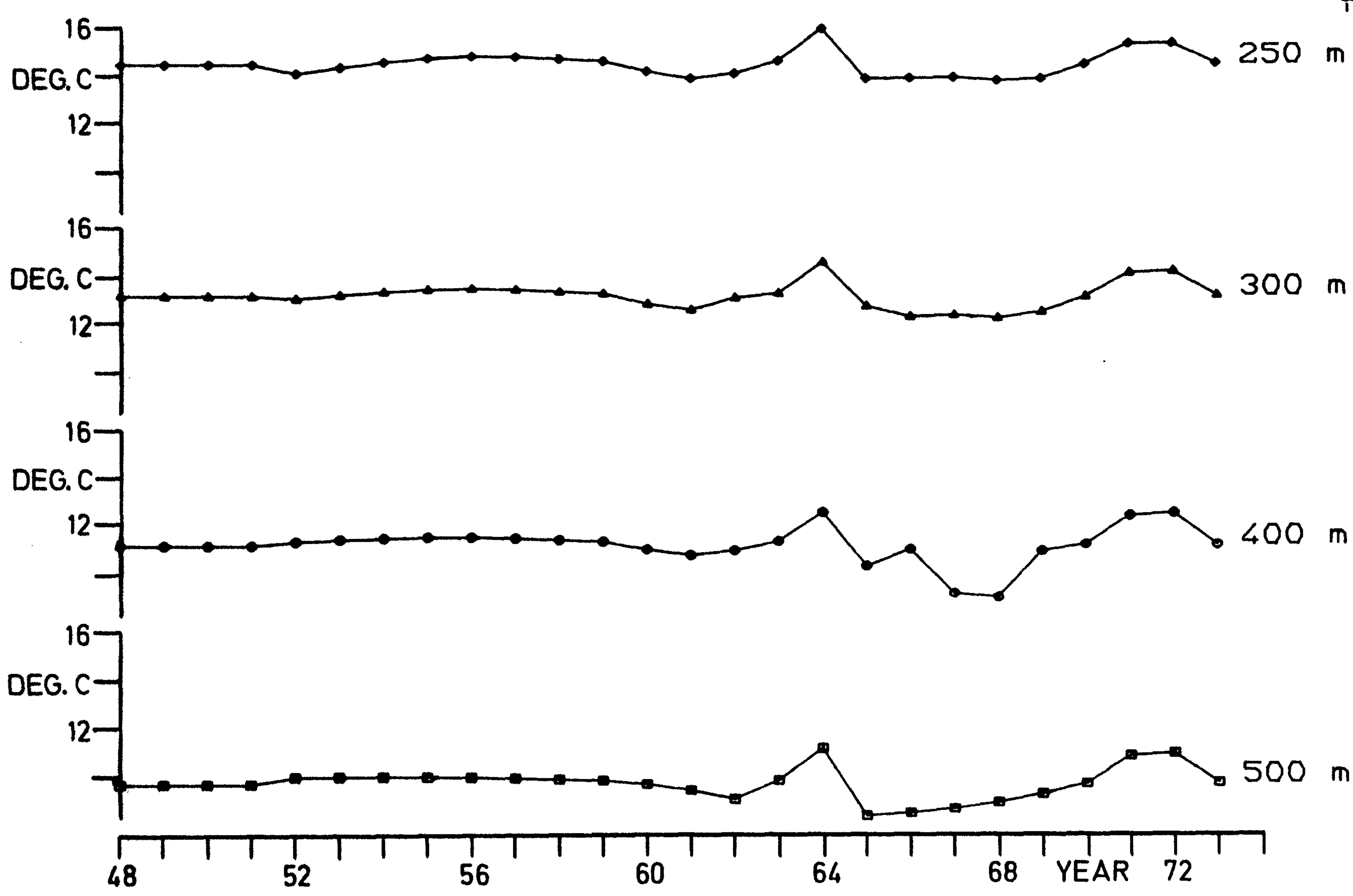
TEMPERATURE AT (17.5N,47.5W)

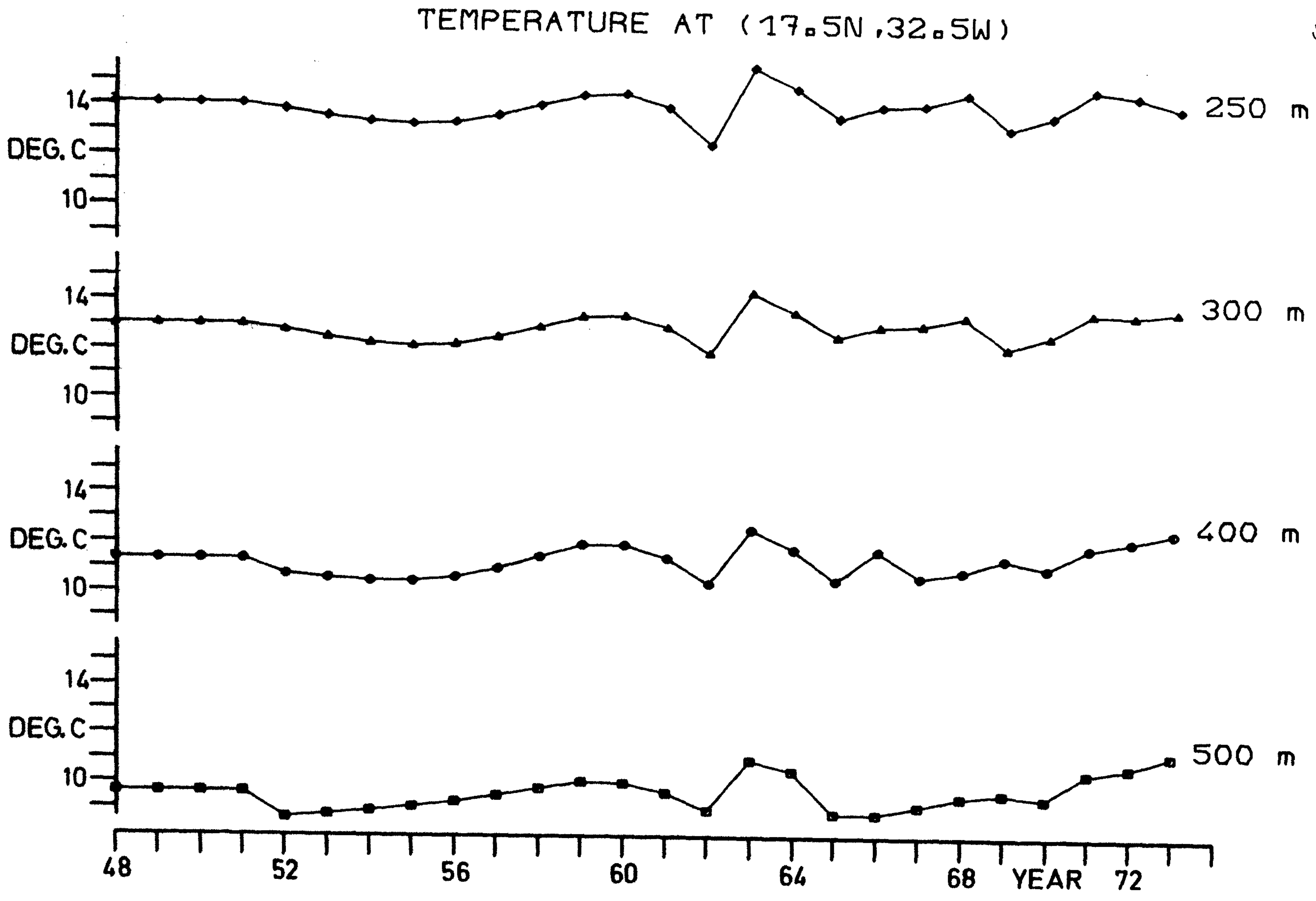


TEMPERATURE AT (17.5N,42.5W)

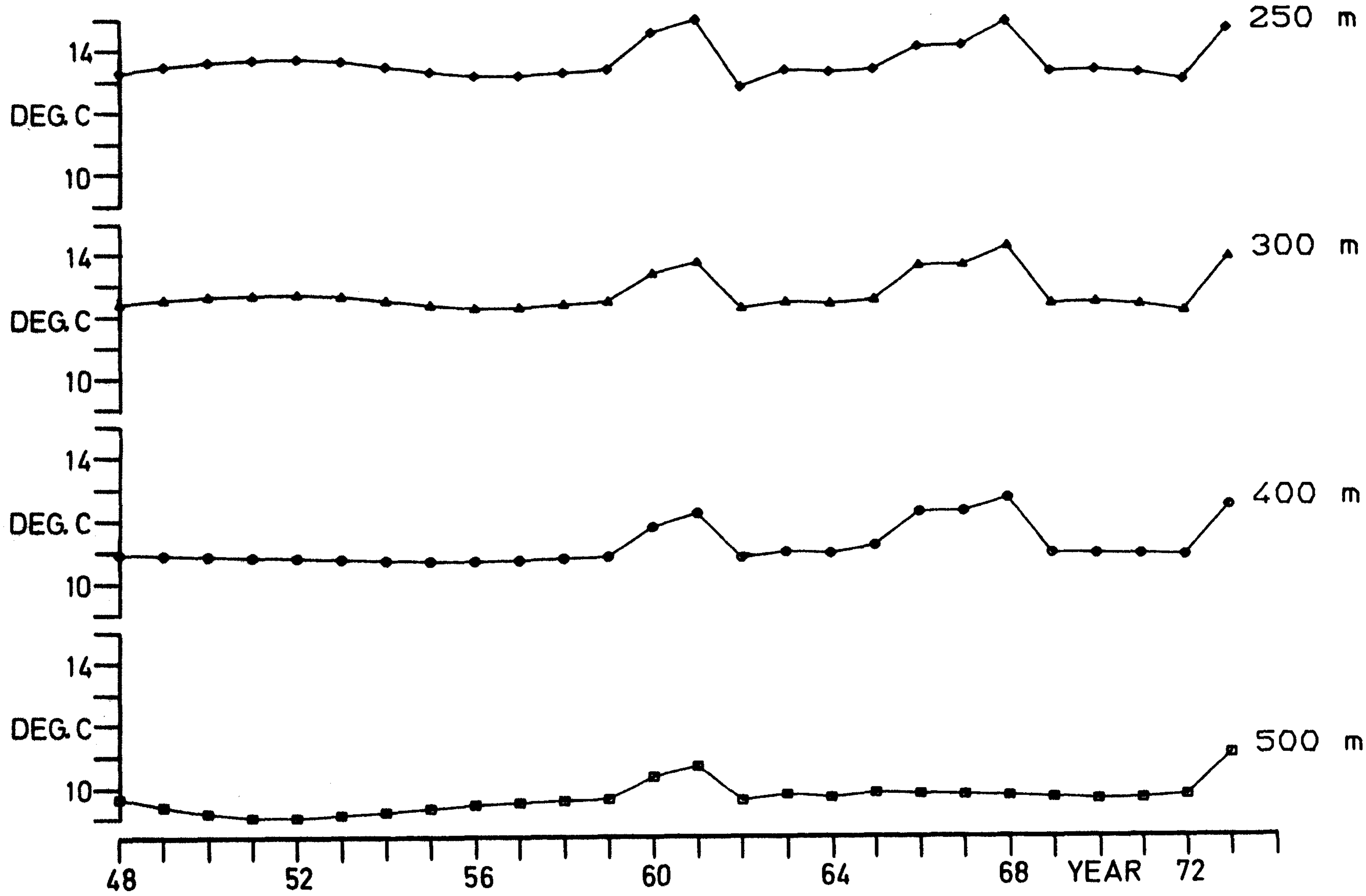


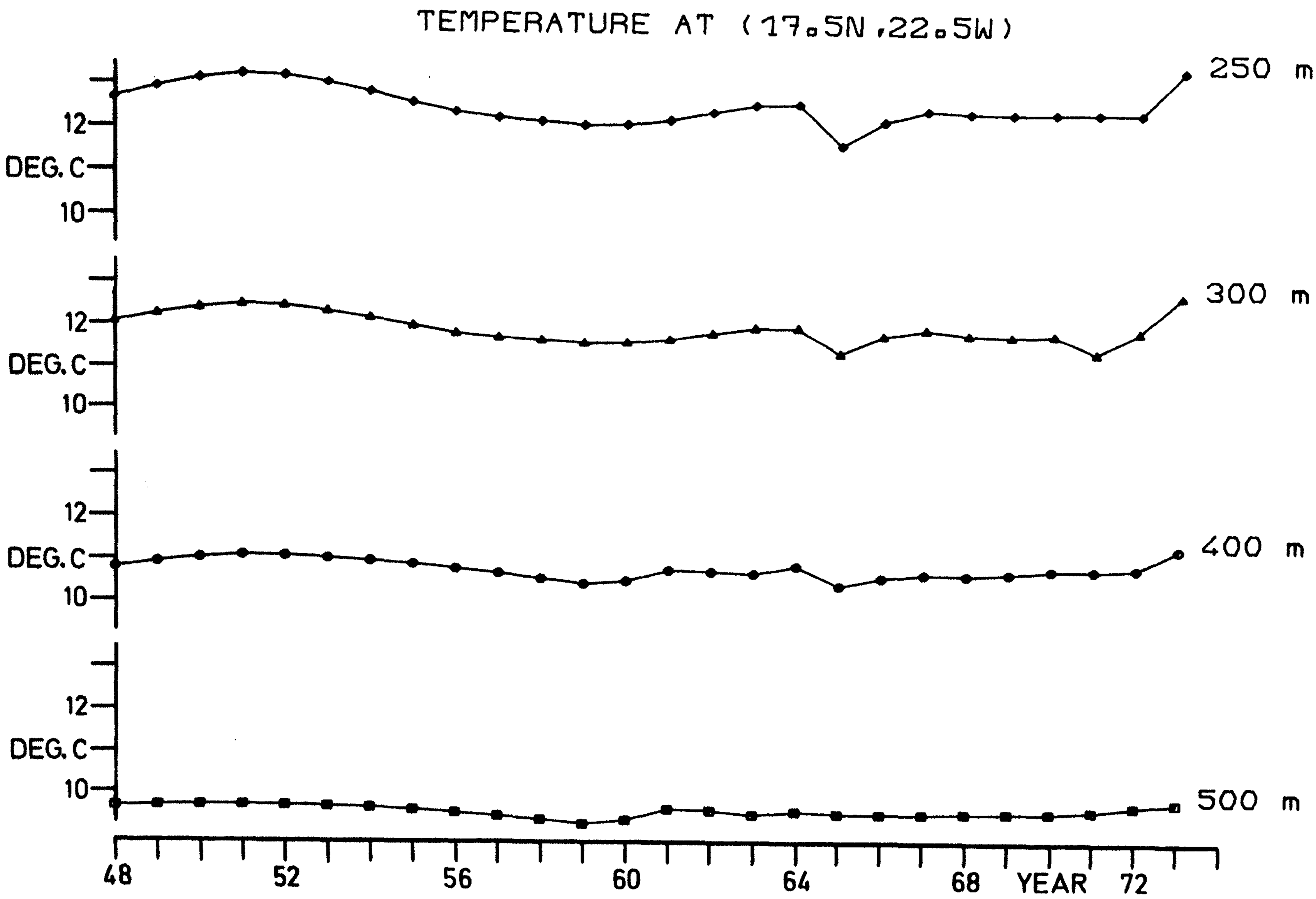
TEMPERATURE AT (17.5N,37.5W)




TEMPERATURE AT (17.5N,32.5W)
250 m
300 m
400 m
500 m
DEG. C
14
10
48
52
56
60
64
68
72
YEAR

TEMPERATURE AT (17.5N,27.5W)




TEMPERATURE AT (17.5N,22.5W)
250 m
300 m
400 m
500 m
DEG. C
12
10
48
52
56
60
64
68
YEAR
72