

NATIONAL BUREAU OF STANDARDS REPORT

9493

LEAST SQUARES ANALYSIS OF ANNUAL EARTH TEMPERATURE CYCLES FOR SELECTED STATIONS IN THE CONTIGUOUS UNITED STATES

Report for Office of Civil Defense
Department of the Army-OSA

Under
Control No. OCD-OS-62-44
Unit 1211A



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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T. Kusuda
National Bureau of Standards

Prepared For
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Summary of Research Report

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A least squares technique, developed for the analysis of periodic earth temperature at several depths, is presented. The technique is considered an improvement over existing methods for determining the thermal diffusivity of earth with specific reference to the heat conduction theory for a semi-infinite system.

In essence, existing methods independently analyze the amplitude decay and phase shift with respect to depth of earth temperature data. These two independent analyses usually result in two different thermal diffusivities, with no rigorous basis that either one of the average of the two represent a good value for thermal diffusivity. Values computed by the methods are subject to further inconsistencies depending upon: choice of two depths, choice of harmonics for the cyclic data, and choice of specific period (annual or daily, as well as from one day to the next, and from one year to the next).

The technique developed in this report eliminates all of these vagaries because it can accommodate the entirety of the earth temperature data including the depth, duration, period, harmonics, or amplitude and phase.

In addition, the author feels that this technique is more consistent with the basic assumptions of the heat conduction theory for a

homogeneous semi-infinite medium than are the existing techniques.

All or both of the current methods for determining the thermal diffusivity of earth are based upon the following formula:

$$t = t_{\infty} + \sum_{i=1}^{\infty} a_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} \cos\left(\frac{2\pi i \theta}{T} - \sqrt{\frac{i\pi}{\alpha T}} x\right) + \sum_{i=1}^{\infty} b_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} \sin\left(\frac{2\pi i \theta}{T} - \sqrt{\frac{i\pi}{\alpha T}} x\right) \dots (1)$$

This formula was derived based on the following assumptions:

- 1) Earth surface experiences a steady periodic temperature cycle
- 2) Earth is homogeneous with respect to its thermal properties
- 3) There is no geothermal effect

There are no places on the earth where the above conditions are rigidly satisfied. The surface temperature cycle changes its characteristics day by day or year after year depending on the climatic variation. Thermal properties of the earth surface layer differ considerably from those in the depth due to weathering. Although it is not too formidable a task to develop a mathematical formula which does not require assumptions [1 and 2], the use of such a formula for determining the earth thermal diffusivity from the observed temperatures data may not be practical. At least from the standpoint of earth temperature estimation, it is a common practice to accept the above assumptions and then calculate the thermal diffusivity that best describes the observed temperature cycle. The important thing is then that once these assumptions are accepted, formula (1) should not be used in such a manner as to violate the basic

assumptions. Furthermore, it is illogical to calculate the depth variation, time variation, and harmonic dependence of thermal diffusivity using the formula (1).

The procedure proposed by the author for obtaining the best fit parameters to the entirety of the earth temperature data; covering depths, periods, harmonics, amplitude and phase shift will now be described. Essentially, it involves choosing the harmonic constants of the zero-depth data and thermal diffusivity in such a manner that the mean square deviation of the calculated temperature, by equation (1), from the observed data is at a minimum. This requires the solution of a set of regular and linear, normal least-squares equations, together with a non-linear relation for the thermal diffusivity.

An iterative procedure is needed to attain the solution of these simultaneous normal equations.

In the main text of this report are first shown two samples of earth temperature data; one from Lexington, Ky., and another from Lemont, Ill. These are used to demonstrate, in detail, the basic characteristics of the least squares method. This method is next applied to most of the currently available earth temperature data taken at a depth of more than 3 feet. The data used for this new calculation are the same as those treated in the previous NBS report 8972 entitled,

"Earth Temperature and Thermal Diffusivity at Selected Stations in the United States", except a considerable number of new stations have been added and there is a longer observed data period. Thermal diffusivity and harmonic constants for zero-depth are then best fitted to these data and in turn these best fitted constants were used to calculate the best fitted earth temperature based on equation (1). The average annual cycles of monthly averages of the observed earth temperatures, the least squares constants, and thermal diffusivity for a given temperature station are all tabulated together with the result of the best fit calculation based upon (1) at the end of this report. For those earth temperature stations having insufficient depth for the diffusivity analysis, only the average annual cycle of the monthly averages are presented. In total, 119 sets of earth temperature data are treated in this manner compared with 63 sets in the previous report. Each is identified with the type of soil, earth cover, data source and the duration of observation.

Table (7) of the main text is prepared to illustrate thermal diffusivity values determined by this new technique in comparison to those determined by the conventional amplitude decay and phase angle shift methods. Except in a very few cases, the values obtained by this new technique fall between those obtained by the two older methods.

The author believes that the diffusivity values obtained by this

improved technique are better than previously published as long as the simple heat conduction theory is the basis of the earth temperature analysis.

Hopefully the earth temperature data developed herein will be useful to those concerned with underground heat exchange.

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LEAST SQUARES ANALYSIS OF ANNUAL EARTH TEMPERATURE CYCLES
FOR SELECTED STATIONS IN THE CONTIGUOUS UNITED STATES

by

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Abstract

A least squares technique has been applied to periodic earth temperature data from the selected stations throughout the United States for the purpose of determining basic heat transfer characteristics of earth temperature cycles, such as thermal diffusivity, average temperature, amplitude and phase angle of the temperature cycle. A procedure was developed for obtaining a single thermal diffusivity which represents the entirety of earth temperature data with reference to time, depth, amplitude and phase. The thermal diffusivity was obtained as a non-linear part of least squares constants which yielded best-fit harmonic curves to a given set of observed earth temperatures. The thermal diffusivity thus calculated and the calculation method developed are preferred to those described in the previous report of similar title, which yielded two thermal diffusivities, one based on amplitude decay and another on phase angle shift.

Key Words

Earth temperature, least squares technique, thermal diffusivity of earth.

PREFACE

This is a revised version of the previous NBS Report 8972 entitled, "Earth Temperature and Thermal Diffusivity at Selected Stations in the United States". At the end of that report it was indicated that the development of an improved technique for analyzing the earth temperature data was under way. Subsequently a technical paper entitled, "Least Squares Technique for the Analysis of Periodic Temperature of the Earth's Surface Region", has been prepared and approved for publication by the Editorial Committee of the National Bureau of Standards and by the Office of Civil Defense. In that paper only two sets of earth temperature data, one from Lemont, Illinois and another from Lexington Kentucky, were used to illustrate the improved least squares technique.

Although the main text of that paper is retained in this report, the modified least squares technique has now been applied to considerably more additional data than in NBS 8972. This report, therefore, should be considered an updated version of a previous NBS report on the similar subject.

NOMENCLATURE

$A_0, A_1, A_2, \dots A_N$ = Least Squares Constants or Best Unbiased Estimates
of $a_0, a_1, a_2, \dots a_N$ ($^{\circ}\text{F}$)

$a_0, a_1, a_2, \dots a_N$ = Cosine coefficients of Expected Earth Temperature
Function ($^{\circ}\text{F}$)

$B_1, B_2, B_3, \dots B_N$ = Least Squares Constants or Best Unbiased Estimates
of $b_1, b_2, b_3, \dots b_N$ ($^{\circ}\text{F}$)

$b_1, b_2, b_3, \dots b_N$ = Sine Coefficient of Expected Earth Temperature
Function ($^{\circ}\text{F}$)

$\hat{B}_i(x)$ = i th Harmonic Amplitude of Earth Temperature Cycle at Depth,
 x ft ($^{\circ}\text{F}$)

C_i or $C_{i,K}$ = Linearized Variables (dimensionless)

D = A Least Squares Estimate of Average Thermal Diffusivity, α (ft^2/hr)

$F(\theta)$ = Surface Temperature Function

G = Amplitude of ^{i th} harmonic coefficients = $\sqrt{a_i^2 + b_i^2}$ ($^{\circ}\text{F}$)

M = Total Number of Temperature Data (number of time data multiplied by
number of depth data) (dimensionless)

M_t = Total Number of Cycles to be Considered (dimensionless)

M_x = Total Number of Depths to be Considered (dimensionless)

N = Highest Order of Harmonics to be Included for Expected Earth
Temperature Function (dimensionless)

$\hat{P}_i(x)$ = Phase Angle of i th Harmonic of Earth Temperature Cycle at
Depth x (ft), (radians)

SS = Sum of Squares of All of the Differences Between Observed and
Expected Earth Temperatures

S_i or $S_{i,k}$ = Linearized variables (dimensionless)

T = Period of Cyclic Data (8766 hrs. for annual cycle)

t = Earth Temperature ($^{\circ}\text{F}$)

t_{∞} = Earth Temperature at $x \rightarrow \infty$ ($^{\circ}\text{F}$)

t_k = Observed Earth Temperature ($^{\circ}\text{F}$)

x = Depth in Earth (ft)

x_k = Observed Depth in Earth (ft)

GREEK CHARACTERS

α = Expected Thermal Diffusivity of Earth (ft^2/hr)

β_i = Temperature Decay Factor = $\sqrt{\frac{i\pi}{\alpha T}}$ (ft^{-1})

$\bar{\beta}_i$ = Estimate of β_i = $\sqrt{\frac{i\pi}{DT}}$ (ft^{-1})

$\delta = \frac{\partial SS}{\partial D}$

θ = Time Coordinate used in the Text, Measured from January 1 (hr.)

θ_k = Observed Time with Datum Point at January 1 (hr.)

ϕ_i = Phase Angle of i th Harmonic of Zero Depth Temperature, (radians)

$$\phi_i = \tan^{-1} \frac{b_i}{a_i}$$

Δ = Root Mean Square Deviation (defined in the text)

Unit Conversion

Thermal diffusivity expressed in (cm^2/sec) can be converted to that in (ft^2/hr) by multiplying the former by 3,8744.

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1. OBJECTIVES AND INTRODUCTION

The purpose of this paper is first to introduce an improved least squares technique for analyzing periodic earth temperature data at various depths. The second objective is to apply this technique to earth temperature data currently available in the United States. The existing techniques employing a simple harmonic equation [Kusuda, 1965, Penrod, 1960] or Fourier analysis [Carson, 1963] have the disadvantage of yielding different thermal diffusivities for a given set of data, depending upon the choice of data reduction method, choice of cyclic period, choice of two depths, and the choice of computational method. The technique introduced in this paper eliminates this disadvantage and it is statistically more sound than previous methods for the analysis of periodic depth temperatures of earth. Furthermore, the method derived herein may be applied for the accurate calculation of thermal diffusivity of the surface layer of other celestial bodies in the event cyclic patterns of their depth temperatures are obtained in the future.

Numerous investigators in the past have studied earth temperatures with reference to calculation of the earth's thermal diffusivity. A recent publication of Kusuda and Achenbach [1965] includes an extensive bibliography on this subject. Most of the analyses in the papers listed in this bibliography apply the well-known periodic heat conduction formula for either diurnal or annual (or both) cycles of observed earth temperatures.

These analyses have been made to establish the average, the amplitude, and the phase angle of cyclic temperature patterns at various depth levels, so that earth temperatures may be predicted by a computational method. The amplitude decays and phase angle shifts of temperature cycles with respect to depths have been used to estimate the thermal diffusivity of the station where the earth observations were made. The analysis of periodic earth temperatures, therefore, eventually ends up with four basic parameters: thermal diffusivity, average temperature, amplitude, and phase angle of the surface temperature cycle from a given datum time point.

The investigators have encountered the following problems during the course of their studies. (1) The earth surface was difficult to define and earth surface temperatures were subject to disturbances from climatic changes above the surface, such as rainfall, cloud cover, evaporation of water, and wind velocity. (2) The actual earth

temperatures observed did not follow an ideal simple-harmonic pattern. Moreover, their cyclic patterns varied from year to year and from day to day. Except in the work of Carson and in that of Kusuda and Achenbach, some degree of arbitrary human judgment was exercised to establish meaningful periodic patterns. For example, when several years of monthly average earth temperature records were available, the annual thermal diffusivity was calculated for each set of annual data. Such calculations imply an annual change of thermal diffusivity, which is a misapplication of basic heat conduction theory, as explained later.

(3) For a given station, thermal diffusivities were computed both from the difference of logarithmic amplitudes and from the difference of phase angles for two different depths. Unfortunately, the diffusivities calculated by these two methods usually did not agree, differing by a factor of two in some instances [Kusuda, 1965]. (4) When the thermal diffusivities were computed at two different pairs of two-depth levels at a given temperature station, two different estimates of the diffusivity were obtained, even when a consistent method of diffusivity computation was employed.

These four problems resulted in uncertainties of thermal diffusivities due to time, due to depth, due to method of computation, and due to the method of data reduction for a given set of earth conditions at a given locality.

Most of the investigators also attempted to predict earth temperatures based on an average of thermal diffusivities thus computed, and on other basic parameters; namely, the earth surface temperature amplitude, the phase angle of the earth surface temperature cycle measured from a certain reference datum point, and the average earth temperature during the cycle.

Mathematical description of an earth temperature cycle by a Fourier series technique, similar in nature with the least squares technique, has been tried by several authors. The most recent and comprehensive description was made by Carson [1963] for the soil of Lemont, Illinois. The Fourier series technique is basically applicable only to a single complete cycle where data points consist of a unique set of temperatures for equally incremented time coordinates. Carson applied the technique to each individual one-year set of monthly average earth temperature cycles over a period of three years, resulting in three sets of Fourier coefficients, which did not agree with each other.

Kusuda and Achenbach [1965] applied a least squares technique in fitting observed earth temperature data to simple harmonic expressions for the purpose of computing the four basic parameters of earth temperature cycles.

In their least squares technique, Kusuda and Achenbach [1965] incorporated several years' records simultaneously, thus treating the temperature data as statistical variables or variates rather than functional variables, which is the case in a Fourier analysis. The least squares technique fits a sinusoidal curve to the observed data in such a manner that the variance calculated from the residual deviations of the observed temperature from the fitted curve is a minimum. The number of data points, the time intervals for the temperature observations, and the number of data for a given time are not restricted as they are in a Fourier analysis.

Kusuda and Achenbach [1965], however, began with the premise that the earth temperature cycles follow a simple harmonic mode. This premise may be reasonably applied to annual cycles of monthly average earth temperatures, but it is not quite valid for diurnal temperature cycles. They, however, still obtained two thermal diffusivities based upon the amplitude decay and phase angle shift techniques, same as those used by other investigators.

The extension of the least squares technique to cover the higher harmonic terms is also desirable if the method is to be applicable to diurnal earth temperature cycles of the earth theoretically differing from the simple harmonic pattern because of a complex non-linear surface heat exchange with the sun and the surrounding space.

In the following section the basic heat conduction relation of the periodic temperature cycle is first reviewed. The least squares technique is then applied to annual cycles of monthly average earth temperatures as an illustrative example.

2. BASIC HEAT CONDUCTION THEORY ON A SEMI-INFINITE SOLID

The surface layer of earth may be assumed to be a semi-infinite solid having a homogeneous thermal property, as far as the heat conduction theory is concerned. This assumption, however, may be inadequate in some cases, and a more refined model, such as composite solids (an upper layer of finite thickness over an infinitely thick solid bed of different thermal properties), is desirable. As a theory, this composite model probably represents more closely the actual surface of earth than the homogeneous model. But the thickness of the top layer, and the variation of properties between the top layer and the bottom bed are usually unknown, which makes the composite layer model less meaningful than the homogeneous model. Also, the mathematical complexity involved for the composite solid model may not be justified in finding an accurate thermal diffusivity of a surface layer from the observed depth temperature cycles. Hence, the homogeneous semi-infinite solid model is used to calculate average thermal diffusivity represented by the surface region of the earth. Or, conversely, temperature cycles at various depths are approximated by the equation derived for semi-infinite heat conduction models of homogeneous thermal properties.

The heat conduction of the semi-infinite homogeneous solid can be mathematically expressed as follows:

$$\alpha \frac{\partial^2 t}{\partial x^2} = \frac{\partial t}{\partial \theta} \quad (1)$$

$$\left. \begin{array}{l} \text{at } x \rightarrow \infty \quad t \rightarrow t_{\infty} \\ \text{at } x = 0 \quad t = F(\theta) \\ \text{and } F(\theta + T) = F(\theta) \end{array} \right\} \quad (2)$$

In actuality it is difficult to define a unique $F(\theta)$ that represents daily or annual cyclic observations of earth surface temperatures, since the character of these cycles varies from one period to the next. This variation is due to the varying nature of heat exchange over the earth surface with respect to climatic conditions. It is postulated that other celestial bodies without atmosphere may experience a much more consistent and stable $F(\theta)$ than the earth experiences. In this paper it is assumed that there exists a unique $F(\theta)$, which may be a statistical average of many periodic cycles. Since $F(\theta)$ is a periodic function of period T , it is possible to expand it as follows:

$$F(\theta) = a_0 + \sum_{i=1}^{\infty} a_i \cos\left(\frac{2\pi i}{T} \theta\right) + \sum_{i=1}^{\infty} b_i \sin\left(\frac{2\pi i}{T} \theta\right) \quad (3)$$

The values of $a_0, a_1, a_2, \dots, b_1, b_2, b_3$ are dependent upon the actual nature of the assumed surface temperature cyclic pattern.

[Echert, 1959]

The cyclic earth temperature/ at depth x that satisfies (1), (2), and (3) is

$$t = t_{\infty} + \sum_{i=1}^{\infty} a_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} \cos\left(\frac{2\pi i \theta}{T} - \sqrt{\frac{i\pi}{\alpha T}} x\right) + \sum_{i=1}^{\infty} b_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} \sin\left(\frac{2\pi i \theta}{T} - \sqrt{\frac{i\pi}{\alpha T}} x\right) \quad (4)$$

(It should be noted from equations (3) and (4) that $A_0 = t_{\infty}$)

Formula (4) can also be expressed as

$$t = t_{\infty} + \sum_{i=1}^{\infty} G_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} \cos\left(\frac{2\pi i \theta}{T} - \Phi_i - \sqrt{\frac{i\pi}{\alpha T}} x\right) \quad (5)$$

where

$$G_i = \sqrt{a_i^2 + b_i^2}$$

$$\tan \Phi_i = \frac{b_i}{a_i} \quad (6)$$

By letting

$$G_i e^{-\sqrt{\frac{i\pi}{\alpha T}} x} = \hat{B}_i(x) = \text{Depth Amplitude}$$

$$\Phi_i + \sqrt{\frac{i\pi}{\alpha T}} x = \hat{P}_i(x) = \text{Depth Phase Angle}, \quad (7)$$

the thermal diffusivity α can be readily calculated by knowing $\hat{B}_i(x)$ and $\hat{P}_i(x)$ at two different depths x_1 and x_2 by the following formulas:

$$\alpha_{Bi} = \frac{i\pi}{T} \left[\frac{x_1 - x_2}{\log \frac{\hat{B}_i(x_2)}{\hat{B}_i(x_1)}} \right]^2, \quad i = 1, 2, \dots, \infty \quad (8)$$

and

$$\alpha_{Pi} = \frac{i\pi}{T} \left[\frac{x_1 - x_2}{\hat{P}_i(x_1) - \hat{P}_i(x_2)} \right]^2, \quad i = 1, 2, \dots, \infty \quad (9)$$

In formulas (8) and (9), notation α_B and α_P are used instead of α to signify that these two thermal diffusivities are computed by amplitudes and by phase angles of i th harmonic constants, respectively. Theoretically, of course

$$\alpha_{Bi} = \alpha_{Pi} = \alpha \text{ for } i = 1, 2, 3, \dots \quad (10)$$

Unfortunately, however, these relations have seldom been found in practice. Most previous researchers have made extensive studies on α_{B1} and α_{P1} only, ignoring higher harmonics. Even for the first harmonic constants, agreement between α_{B1} and α_{P1} was poor. Not only that, the values of α_{B1} and α_{P1} varied, as mentioned before, depending upon the choice of x_1 and x_2 of formulas (8) and (9). These difficulties

have been chiefly attributed to the fact that the earth surface is not homogeneous and the heat conduction characteristics and surface temperature cycle of the earth surface region vary with respect to physical condition and time. The previous difficulties are, however, mostly due to the misuse of formula (4). It is not correct to use formula (4) either for analysis of one given periodic cycle of observation, or for analysis of depth variation of thermal diffusivity. Instead, formula (4) should be used for the entire temperature data, covering the entire depth and the entire time period. For instance, if ten years of monthly average earth temperature cycles were complete with five depth readings, all of the 600 data points should be considered simultaneously for formula (4) to yield the best fit values of t_{∞} , a_i , and b_i , for $i = 1, 2, \dots$ as well as the best fit value of α .

It is important here to mention that the foregoing statements are based upon the following statistical hypothesis:

Time data (including all the cyclic periods) follow basically a given harmonic function of a period T (8766 hours for an annual earth cycle). Any deviation of actual cycles from a prescribed harmonic function are statistical rather than functional.

3 . THE LEAST SQUARES TECHNIQUE

Although the technique described in this paper applies to any kind of periodic temperature data observed at several depths of any infinite system, the specific treatment will be given for annual cycles comprising monthly average earth temperatures taken at selected depths.

Assume that the number of annual cycles of earth temperature is M_t and each annual cycle consists of ^{twelve} monthly average readings at ^{each of} M_x depths. If there are no missing data, although this is not a requirement, the total number of observations M should be

$$M = M_t \times M_x \times 12$$

Equation (4), however, should be modified to include only the finite number of harmonic terms up to some larger number N . In other words, it is assumed that a_i and b_i will be numerically insignificant for all $i > N$.

The best unbiased estimates of $a_0, a_1, \dots, a_N, b_1, b_2, \dots, b_N$, and D , that of α are given by the solutions of the following equations

$$\left. \begin{array}{l} \frac{\partial SS}{\partial A_0} = 0 \\ \frac{\partial SS}{\partial A_1} = 0 \\ \frac{\partial SS}{\partial B_1} = 0 \end{array} \right\} \text{ for } i = 1, 2, \dots, N \quad (11)$$

$$\delta = \frac{\partial SS}{\partial D} = 0 \quad (11-a)$$

where $A_0, A_1, A_2, \dots, A_N, B_1, B_2, \dots, B_N$ and D are the best estimates of $a_0, a_1, a_2, \dots, a_N, b_0, b_1, b_2, \dots, b_N$, and α .

$$\text{And } SS = \sum_{k=1}^M \left[t_k - A_0 - \sum_{i=1}^N A_i e^{-\bar{\beta}_i x_k} \cos \left(\frac{2\pi i}{T} \theta_k - \bar{\beta}_1 x_k \right) - \sum_{i=1}^N B_i e^{-\bar{\beta}_i x_k} \sin \left(\frac{2\pi i}{T} \theta_k - \bar{\beta}_1 x_k \right) \right]^2 \quad (12)$$

$$\text{where } \bar{\beta}_1 = \sqrt{\frac{1\pi}{DT}}$$

By letting

$$C_{i,k} = e^{-\bar{\beta}_1 x_k} \cos \left(\frac{2\pi i}{T} \theta_k - \bar{\beta}_1 x_k \right) \quad (13)$$

$$S_{i,k} = e^{-\bar{\beta}_1 x_k} \sin \left(\frac{2\pi i}{T} \theta_k - \bar{\beta}_1 x_k \right) \quad (14)$$

and by noting that

$$\frac{\partial SS}{\partial D} = 0 \text{ is also satisfied by } \frac{\partial SS}{\partial \bar{\beta}_1} = 0 \text{ where } D \neq 0,$$

the equations in (11) can be expressed simply by the linear matrix equation shown in Table 1. The left-hand side of the equal sign of Table 1 is actually the product of two matrices, one square matrix of $(2N + 1) \times (2N + 1)$ and one column matrix of dimension $(2N + 1)$.

Equation (11-a) is non-linear and is expressed in terms of linearized variables, $C_{i,k}$ and $S_{i,k}$ as is shown in Table 2.

Table 1

LEAST SQUARES EQUATIONS

$\begin{matrix} M \\ (1 \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M C_{j,k} \\ j=1,N \quad (1 \times N) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M S_{j,k} \\ j=1,N \quad (1 \times N) \end{matrix}$	$\begin{matrix} A_0 \\ (1 \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M t_k \\ (1 \times 1) \end{matrix}$
$\begin{matrix} \sum_{k=1}^M C_{i,k} \\ i=1,N \quad (N \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M C_{i,k} C_{j,k} \\ (N \times N) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M C_{i,k} S_{j,k} \\ (N \times N) \end{matrix}$	$\begin{matrix} A_i \\ i=1,N \quad (N \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M C_{i,k} t_k \\ (N \times 1) \end{matrix}$
$\begin{matrix} \sum_{k=1}^M S_{i,k} \\ i=1,N \quad (N \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M S_{i,k} C_{j,k} \\ (N \times N) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M S_{i,k} S_{j,k} \\ (N \times N) \end{matrix}$	$\begin{matrix} B_i \\ i=1,N \quad (N \times 1) \end{matrix}$	$\begin{matrix} \sum_{k=1}^M S_{i,k} t_k \\ (N \times 1) \end{matrix}$

$$C_{i,k} = e^{-\sqrt{\frac{i\pi}{DT}} x_k} \cos\left(\frac{2\pi i}{T} \theta_k - \sqrt{\frac{i\pi}{DT}} x_k\right)$$

$$S_{i,k} = e^{-\sqrt{\frac{i\pi}{DT}} x_k} \sin\left(\frac{2\pi i}{T} \theta_k - \sqrt{\frac{i\pi}{DT}} x_k\right)$$

$$t = A_0 + \sum_{i=1}^N A_i C_{i,k} + \sum_{i=1}^N B_i S_{i,k}$$

Table 2

$$\sum_i^N \sqrt{A_i + B_i} \sum_k^M t_k x_k C_{i,k} - \sum_i^N \sqrt{A_i - B_i} \sum_k^M t_k x_k S_{i,k}$$

$$- A_0 \sum_i^N \sqrt{A_i + B_i} \sum_k^M x_k C_{i,k} + A_0 \sum_i^N \sqrt{A_i - B_i} \sum_k^M x_k S_{i,k}$$

$$- \sum_i^N A_i \sum_j^N \sqrt{A_j + B_j} \sum_k^M C_{i,k} C_{j,k} x_k + \sum_i^N A_i \sum_j^N \sqrt{A_j - B_j} \sum_k^M C_{i,k} S_{j,k} x_k$$

$$- \sum_i^N B_i \sum_j^N \sqrt{A_j + B_j} \sum_k^M S_{i,k} C_{j,k} x_k + \sum_i^N B_i \sum_j^N \sqrt{A_j - B_j} \sum_k^M S_{i,k} S_{j,k} x_k$$

Determination of $A_0, A_1, A_2, \dots, A_N, B_1, B_2, \dots, B_N$ as a best estimate of $a_0, a_1, a_2, \dots, a_N, b_1, b_2, \dots, b_N$ is straightforward if the $C_{i,k}$'s and $S_{i,k}$'s are known. However, these variables include an unknown D which is to be solved by (11-a).

The method employed in this paper is to calculate a number of sets of $A_0, A_1, B_1; i = 1, 2, \dots, N$, for several assumed values of D . These calculated sets are then applied to the equation in Table 2. By an iterative procedure, a set of $A_0, A_1, B_1; i = 1, 2, \dots, N$, and D can be found to satisfy $\delta = 0$ (see Table 2). These coefficients and D are then substituted into formula (12) for the calculation of the mean squared deviation of the fitted least square values from the observed data by the following equation:

$$\Delta^2 = \frac{SS}{M} \quad (15)$$

The value of Δ , or the square root of the average of the sum of squares of deviations is called hereafter the root mean squared deviations (RMSD) of the observed temperatures from those calculated by equation (4). The term "standard deviation" is purposely avoided here since the properties of these deviations resulting from the iterated non-linear fitting procedure are not known.

4. SAMPLE CALCULATIONS

The normal equations of Tables 1 and 2 have been solved for annual earth temperature data of Lexington, Ky., and Lemont, Ill., which had been obtained by Penrod [1960] and Carson [1963], respectively. The Kentucky data covered five years, from 1952 through 1956, at six depths, 0, 2, 4, 6, 8, and 10 ft. Except for the data at 2 ft and 6 ft during July and August of 1953, the data are complete. Lemont data shown in Table 3 are complete for the period of three years, from 1953 through 1955, at seven depths, 0.033, 0.33, 0.656, 1.64, 3.28, 10, and 29 ft. Data are missing for the 29 ft depth for May, June and July of 1953.

Figure 1 illustrates the trend of δ (Table 2) and corresponding values of Δ calculated for several values of thermal diffusivities for the earth temperature data of Penrod and Carson. The calculations in Figure 1 were carried out for $N=4$.

It is seen in Figure 1 that the value of Δ , the RMSD of calculated temperatures from the observed data, decreases rapidly to the value of 2°F as the assumed thermal diffusivity increases to a value at $0.02\text{ ft}^2/\text{hr}$. Also it will be interesting to compare these thermal diffusivities with those calculated by conventional techniques by means of amplitude decay and phase angle shift by Penrod from his Lexington data and with the data deduced from Carson's data for Lemont, Illinois.

Table 3

Observed Earth Temperature

of Lemont, Illinois

Month	$\frac{\pi}{T} \theta$	0.33	0.66	1.64	3.28	10.0	29.0
1.	0.53364	31.6	32.4	35.2	39.2	49.5	52.3
2.	1.05007	31.5	32.0	34.2	37.4	46.9	52.3
3.	1.54928	37.9	37.4	37.2	38.3	45.1	52.5
4.	2.08292	44.8	44.2	43.3	42.8	45.0	
5.	2.59935	59.9	57.9	54.3	50.4	46.2	
6.	3.13299	72.5	70.3	65.7	59.9	49.5	
7.	3.64941	75.9	74.3	70.5	65.7	53.6	50.2
8.	4.18305	74.7	73.4	71.1	67.6	56.8	50.2
9.	4.71669	65.8	66.2	66.4	65.8	58.8	50.5
10.	5.23312	57.6	58.3	59.5	60.6	58.6	50.7
11.	5.76676	45.0	46.8	50.2	53.8	57.0	51.1
12.	6.28319	35.4	37.0	40.6	46.0	54.5	51.8
1.	0.53364	31.1	32.4	35.2	40.3	50.9	52.0
2.	1.05007	33.4	33.6	35.2	38.3	48.0	52.2
3.	1.54928	35.8	36.1	37.2	39.0	46.4	52.2
4.	2.08292	50.2	48.7	46.2	44.1	45.5	51.8
5.	2.59935	57.6	56.1	53.8	51.1	47.1	51.3
6.	3.13299	73.2	70.5	65.5	59.7	50.0	51.1
7.	3.64941	76.5	74.8	71.1	66.2	54.1	50.7
8.	4.18305	73.8	73.0	70.5	67.5	57.6	50.9
9.	4.71669	67.5	67.5	66.9	66.0	59.2	51.1
10.	5.23312	55.9	57.2	59.4	61.0	59.4	51.6
11.	5.76676	42.8	44.4	47.7	51.6	57.6	52.0
12.	6.28319	34.0	35.4	39.2	45.0	54.1	52.3
1.	0.53364	32.7	33.8	36.9	40.6	50.5	52.5
2.	1.05007	31.3	31.8	34.2	38.1	48.2	52.7
3.	1.54928	35.8	35.8	36.7	38.5	46.0	52.7
4.	2.08292	51.8	50.4	47.5	44.8	45.3	52.0
5.	2.59935	61.7	60.3	57.0	53.2	47.7	51.8
6.	3.13299	68.2	66.7	63.3	59.0	50.7	51.3
7.	3.64941	78.8	76.5	71.2	65.7	54.1	50.9
8.	4.18305	77.2	75.9	73.2	69.3	57.6	50.9
9.	4.71669	66.6	66.7	66.7	66.2	59.5	51.3
10.	5.23312	55.6	56.6	58.5	60.3	59.5	51.5
11.	5.76676	39.7	41.4	45.9	51.1	57.2	51.8
12.	6.28319	31.3	32.7	36.9	42.4	53.8	52.5

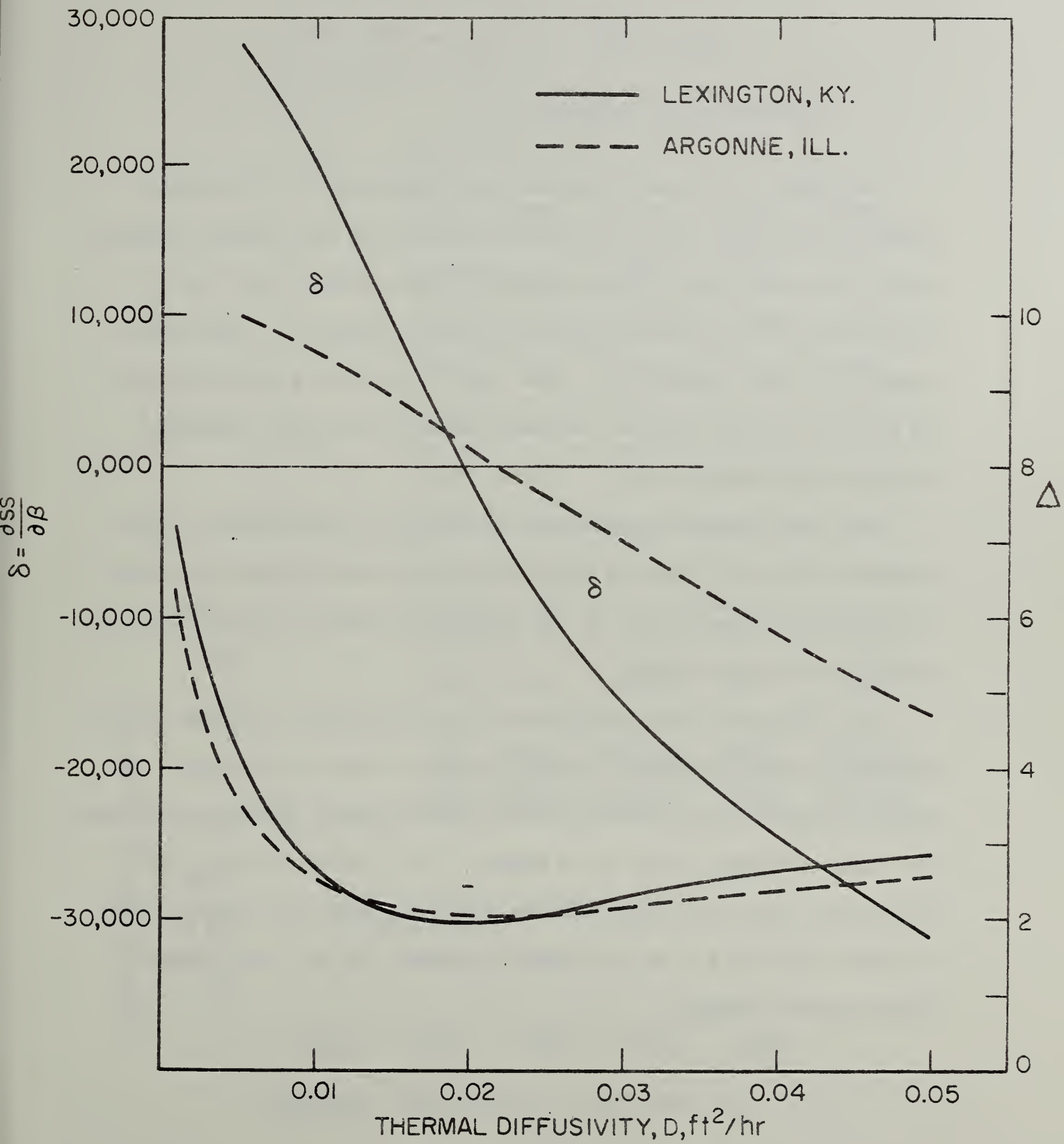


FIGURE 1

Lexington Data	$\alpha_{B1} = 0.034 \text{ ft}^2/\text{hr}$
	$\alpha_{P1} = 0.022 \text{ ft}^2/\text{hr}$

Lemont data	$\alpha_{B1} = 0.021 \text{ ft}^2/\text{hr}$
	$\alpha_{P1} = 0.018 \text{ ft}^2/\text{hr}$

Although the thermal diffusivities calculated by conventional amplitude and phase angle techniques differ from one another considerably, the values of Δ corresponding to their diffusivities are all less than 3 °F. in their ranges, as seen in Figure 1. (This small change of Δ with respect to a wide range of thermal diffusivity may be the very reason that the two methods can yield quite different thermal diffusivities.)

The mean squared deviation Δ^2 may not be as insensitive to the thermal diffusivity for the other types of periodic temperature data as it has been found to be in the analysis on annual cycles of monthly average earth temperatures.

The Lexington earth temperature data were used to examine the influence of including higher harmonic terms on the values of Δ . As shown in Figure 2, was found that the least squares analysis, including the higher harmonic terms up to degrees 2, 4, and 8, do not yield values of Δ which are significantly different from the results of the analysis ignoring all of the higher harmonics for all the thermal diffusivities assumed.

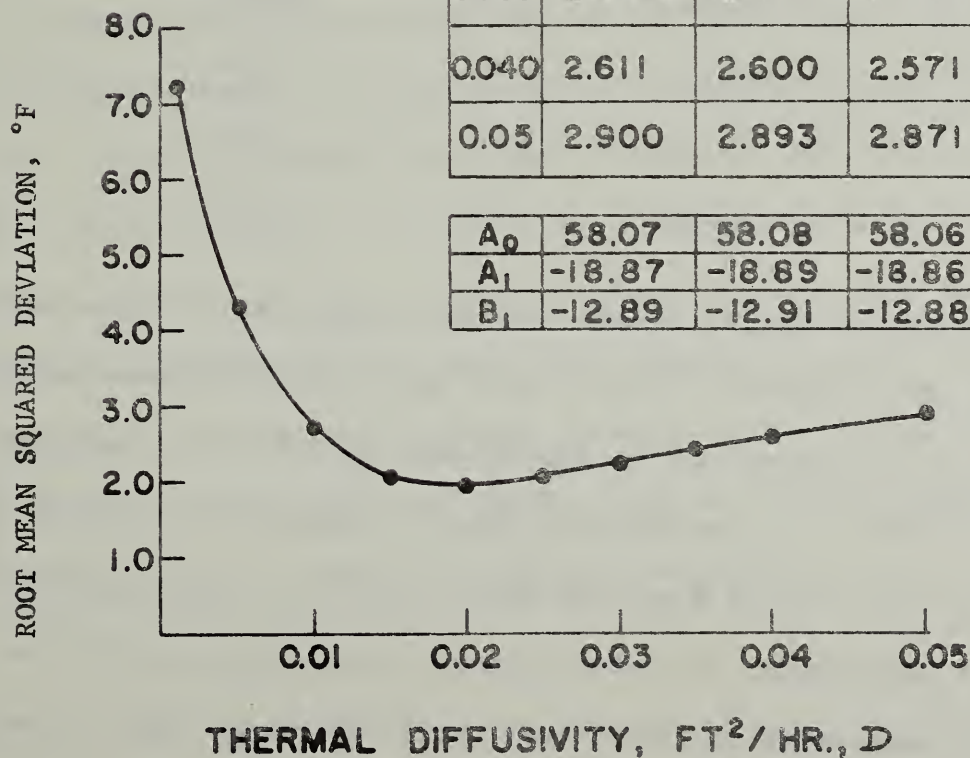
LEXINGTON, KY., EARTH TEMP DATA BY PENROD

NT = 60, KX = 6

R M S D

NUMBER OF HARMONICS				
$\frac{N}{D}$	1	2	4	8
0.001	7.233	7.246	7.276	6.904
0.005	4.367	4.362	4.364	4.411
0.010	2.731	2.709	2.686	2.713
0.015	2.116	2.088	2.048	2.066
0.020	2.003	1.976	1.931	1.948
0.025	2.102	2.080	2.037	2.056
0.030	2.268	2.250	2.213	2.233
0.035	2.444	2.430	2.397	2.420
0.040	2.611	2.600	2.571	2.596
0.05	2.900	2.893	2.871	2.900

A_0	58.07	58.08	58.06	58.06
A_1	-18.87	-18.89	-18.86	-18.86
B_1	-12.89	-12.91	-12.88	-12.89



Sample sets of least squares constants calculated for these two stations are shown in Table 4.

	Table 4.	
	<u>Lexington, Ky.</u>	<u>Lemont, Ill.</u>
M	356	213
N	4.	4.
D	0.019	0.022
Δ	1.93	2.01
A_0	58.06	52.37
A_1	-19.03	-19.20
A_2	-0.53	0.21
A_3	-0.97	-0.32
A_4	0.42	-0.53
B_1	-12.84	-14.33
B_2	0.69	1.04
B_3	0.67	0.43
B_4	0.26	0.74

It may be interesting to compare the calculated earth temperatures based upon the least squares constants with the original observed data. Table 5 shows the calculated earth temperatures when $N = 4$ is employed for formulas of Table 1 on the observed data of Lemont, Ill. (Table 3). Similar calculations such as those for Table 4 for $N = 1$ were also made to evaluate the improvement of taking higher harmonics over using the simple harmonic expression for the annual cycle of Lemont data. According

to such comparison changes in the calculated results due to the inclusion of higher harmonic terms are very small. Table 5 also may be compared with Table 6, which is the arithmetic average (or norm) of the 3-year cyclic data of Table 3. Agreement between these tables are surprisingly good.

Figure 3 compares the least squares calculation of the first harmonic constants with those derived from the observed three annual cycles of earth temperature in Lexington, Kentucky. The coordinates a_x and b_x of the figure represent first harmonic constants describing the observed earth temperature at a depth x from the ground surface. Since the Lemont data consist of seven depth observations for a period of three years, each depth point is indicated with three numerals representing the first, second and third year.

The solid curve was obtained by connecting a_x and b_x calculated by theoretical relations (depicted in the upper right corner of Figure 3) for several depths. The calculations of a_x and b_x were made with the least squares constants indicated in Table 5. The curve representing the computed values of a_x and b_x fit extremely well for all of seven groups of three points. A similar comparison was made for the second harmonic constants of the same earth temperature data. Although the scatter of these second harmonic constants derived from observed data is much more than those indicated in Figure 3, the computed curve did closely follow the centroid of the three points.

M = 213

N = 4

D = 0.022

Table 5

PREDICTED EARTH TEMPERATURES OF LEMONT, ILLINOIS

USING LEAST SQUARES CONSTANTS

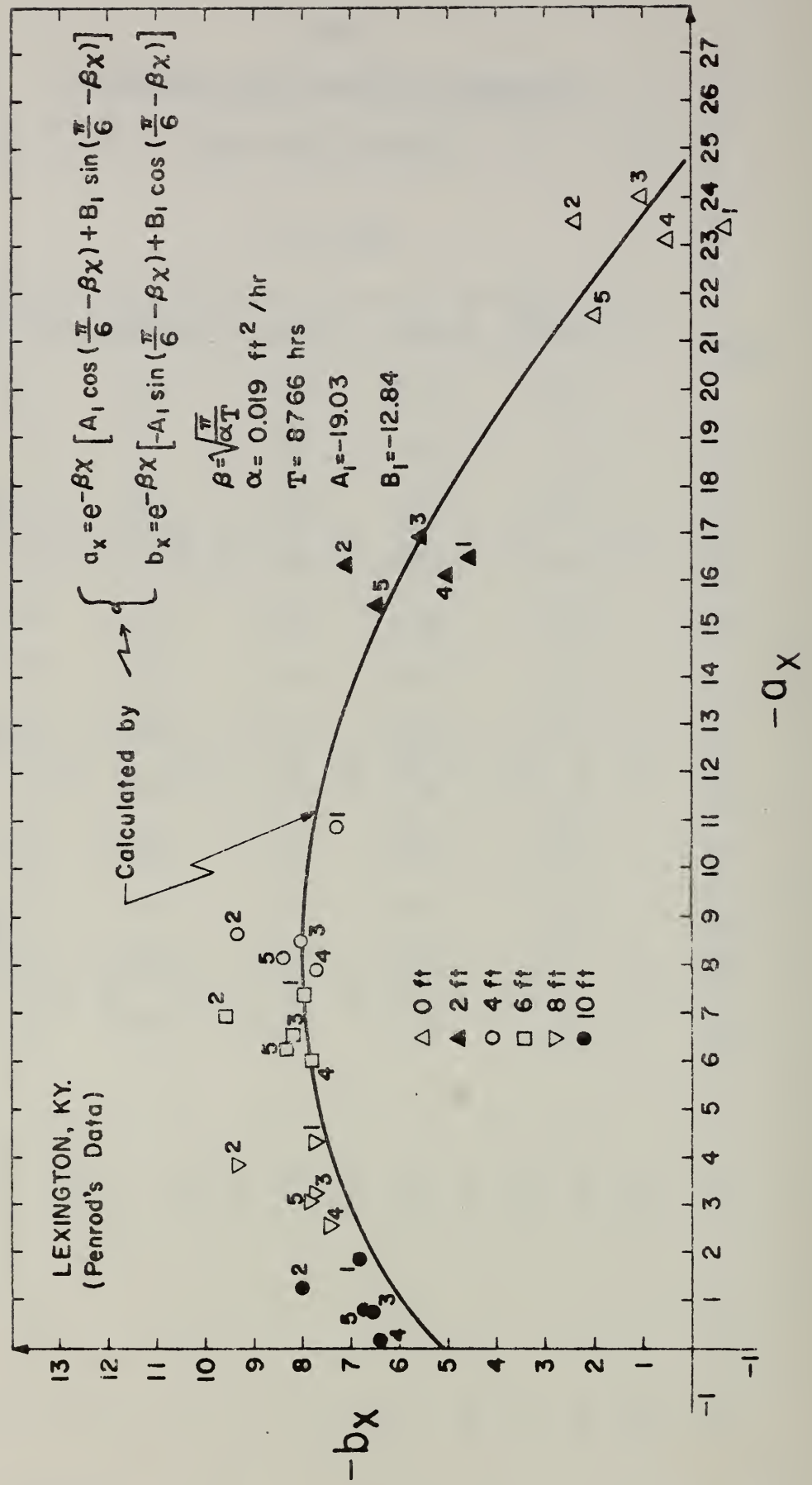
No.	Depth (ft)					
	0.325	0.658	1.64	3.281	10.0	29.0
1.	31.8	32.7	35.3	39.3	50.8	52.9
2.	31.7	32.4	34.3	37.5	48.1	53.0
3.	36.4	36.5	36.9	38.2	46.3	52.9
4.	48.0	47.3	45.5	43.8	45.7	52.7
5.	59.5	58.4	55.3	51.6	47.1	52.5
6.	70.0	68.6	64.8	59.7	49.9	52.1
7.	76.4	75.2	71.7	66.4	53.4	51.9
8.	74.1	73.6	71.9	68.7	56.9	51.8
9.	66.5	66.6	66.7	66.0	58.9	51.8
10.	56.3	57.0	58.8	60.6	59.1	52.0
11.	42.5	43.9	47.4	51.9	57.5	52.3
12.	33.8	35.1	38.6	43.7	54.4	52.6

Table 6

ARITHMETIC AVERAGE EARTH TEMPERATURE
of Lemont, Illinois

Mo.	Depth (ft)					
	0.325	0.658	1.64	3.281	10.0	29.0
1	31.8	32.9	35.8	40.0	50.3	52.3
2	32.1	32.5	34.5	37.9	47.7	52.4
3	37.6	36.5	37.0	38.6	45.8	52.5
4	48.9	47.8	45.7	43.9	45.3	51.9
5	59.7	58.1	55.0	51.6	47.0	51.5
6	71.3	69.2	64.8	59.5	50.1	51.2
7	77.1	75.2	70.9	65.9	53.9	50.6
8	75.2	74.1	71.6	68.1	57.3	50.7
9	66.6	66.8	66.7	66.0	59.2	51.0
10	56.4	57.3	59.1	60.6	59.2	51.3
11	42.5	44.2	47.9	52.2	57.3	51.6
12	33.6	35.0	38.9	44.5	54.1	52.2

FIGURE 3



5. APPLICATION OF THE NEW METHOD TO OTHER DATA

The least squares technique thus developed in this paper has been applied to the total of 119 sets of monthly average temperatures of many years at various depths reported in various sources. The results of the analysis are presented in Tables ST-1 through ST-119, in which ST-22 and 38 have been referred in the main text. Except for the stations whose depth data are inadequate for the accurate evaluation of the thermal diffusivity, the best fitted thermal diffusivity, surface harmonic constants, A_0 , A_1 , A_2 , B_1 , B_2 , B_3 and standard deviations of these constants were calculated and presented in the tables. Also presented in these tables are arithmetic averages of monthly average earth temperatures of several year's period and calculated earth monthly average temperatures based upon the least squares constants, namely the thermal diffusivity and harmonic constants. Generally the calculated and observed mean temperatures show good agreement. Only the mean annual cycle of the observed monthly average temperatures are shown for the stations whose depth data were insufficient for the diffusivity analysis. Table 7 is prepared to compare the thermal diffusivities calculated by this improved technique described in this report with those obtained by the conventional amplitude and phase shift methods. The diffusivities obtained by the new technique do not necessarily assume an intermediate value of those obtained by the amplitude and phase lag methods.

TABLE 7

COMPARISON OF THE THERMAL DIFFUSIVITIES ANALYZED BY VARIOUS METHODS

Location	Soil	Earth Cover	Thermal Diffusivity Ft ² /hr		
			* Amplitude	Phase Shift *	Modified Least Squares
Decatur, Alabama	Salt Loam	Grass	0.032	0.015	0.023
Tempe, Arizona	Sand	Citrus Grove	0.027	0.026	0.026
Brawley, California	Salt Clay	Bare	0.019	0.019	0.016
Ft. Collins, Colorado	Loam	Spare Vegetation	0.020	0.029	0.025
Lemont, Illinois	Sand Clay	Grass	0.026	0.027	0.022
Burlington, Iowa	Salt Loam	Cultivated	0.023	0.014	0.014
Manhattan, Kansas	Salt Clay	Blue Grass	0.019	0.026	0.022
Lexington, Kentucky	Salt Clay	Grass Sod	0.029	0.025	0.019
Upper Marlboro, Maryland	Sandy Loam	Bare	0.039	0.036	0.042
St. Paul, Minnesota	Salt Loam	Sod	0.033	0.028	0.023
Sikeston, Missouri	Sandy Loam	Grass	0.042	0.027	0.030
Huntley, Montana	Clay	Sod	0.028	0.012	0.017
Ithaca, New York	Loam	Sod	0.026	0.021	0.023
Corvallis, Oregon	Clay Loam	Unknown	0.013	0.011	0.013
Madison, South Dakota	Salt Clay	Grass Sod	0.011	0.009	0.020
Jackson, Tennessee	Salt Loam	Grass	0.024	0.020	0.019
Temple, Texas	Clay	Horticultural	0.018	0.019	0.017
Salt Lake City, Utah	Sandy Loam	Bare	0.035	0.035	0.030

6. CONCLUSIONS AND DISCUSSION

With the use of annual cyclic earth temperature data of Lexington, Ky., and of Lemont, Ill., a new technique is illustrated to yield single thermal diffusivity that will satisfy the least squares relation from the entirety of observed data. The technique requires an iterative solution of a non-linear part of normal equations. The calculated earth temperatures based upon the theoretical heat conduction relation agrees very well with the average annual cyclic data of the monthly average earth temperatures when the least squares constants are properly evaluated.

It has also been found in this analysis that the deviation of the observed earth temperatures from the calculated temperatures is fairly insensitive to the thermal diffusivity as long as the thermal diffusivity is in the neighborhood of $0.02 \text{ ft}^2/\text{hr}$, at least for the annual cycles of monthly average earth temperatures for two station studied in this paper. This insensitivity may be the very reason that the current and existing techniques resulted in two quite different thermal diffusivities depending upon the method of calculation used, the amplitude method or the phase angle method.

Finally the method developed in the paper was applied to the majority of currently available earth temperature data to yield the best fit values on thermal diffusivities and harmonic constants for calculating the annual cycles of monthly average earth temperatures. The calculated values for most of the stations show good agreement to the observed earth temperatures.

REFERENCES

1. Kusuda, T., and Achenbach, P. R., Earth Temperature and Thermal Diffusivity at Selected Stations in the United States, Transactions of American Society of Heating, Refrigerating and Air Conditioning Engineers, Vol 71, Part 1, 61-75, 1965.
2. Penrod, E. B., Variations of Soil Temperature at Lexington, Ky., from 1952 to 1956, Engineering Experiment Station Bulletin, University of Kentucky, No. 47, Sept. 1960.
3. Carson, J. E., Analysis of Soil and Air Temperature by Fourier Technique, J. of Geophysical Research, 68, No. 8, 2217-2232, April 15, 1963
4. Eckert, E. R. G., and Drake, R. M., Heat and Mass Transfer, McGraw-Hill Book Co., Inc., New York, New York; Toronto, Canada; London, England, 99-107, 1959.

TABLES ST-1 through -119

Annual cycle of monthly average earth temperatures:

Observed and calculated with the least squares constants for
selected stations in the United States.

Remarks:

- 1) The period of observation indicated in the following pages
is the number of annual data employed to the least squares
analysis.
- 2) -0.0, 0.0, or .0 in the section of observed monthly average
earth temperature mean that the particular data are missing
from the record.

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

AUBURN, ALABAMA
 SANDY SOIL
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1889

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	48.5	50.5	55.2	65.5	72.2	74.0	86.5	82.2	75.5	64.8	52.2	52.0
6.0	48.2	55.5	53.8	64.8	72.0	73.5	85.8	81.5	75.0	65.2	52.8	51.2
24.0	49.5	50.5	53.8	62.5	70.5	74.2	81.5	80.0	80.8	68.2	58.8	55.0
48.0	52.5	50.5	53.5	59.8	67.2	72.2	77.0	78.0	70.8	70.8	63.5	58.5
96.0	58.0	55.5	55.2	57.2	61.2	67.2	71.0	73.2	75.0	72.5	77.0	63.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	48.8	49.2	54.8	65.6	71.8	77.5	84.4	83.5	75.4	65.8	54.8	49.1
6.0	49.2	49.5	54.7	65.1	71.4	77.0	83.7	83.2	75.5	66.3	55.5	49.7
24.0	51.4	51.1	54.3	62.8	68.9	74.0	80.2	81.5	76.1	68.5	59.2	52.9
48.0	54.2	53.3	54.7	60.7	66.3	70.7	76.1	78.8	76.0	70.4	63.0	56.8
96.0	59.2	57.4	56.9	59.2	62.9	66.4	70.1	73.6	73.9	71.6	67.3	62.6

M= 60.
 N= 4
 D= 0.0368

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
65.150	-15.843	-0.977	1.013	-0.793	-9.716	1.151	0.237	0.853

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3178	0.5630	0.5994	0.6244	0.6463	0.5620	0.5998	0.6259	0.6434
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

DECATUR, ALABAMA
 SILT LOAM
 GRASS

CLIMATOLOGICAL DATA
 1949-1951

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	39.7	45.3	47.2	55.3	67.0	72.4	75.0	71.9	67.5	61.5	41.2	35.4
12.0	43.8	45.2	46.7	54.7	67.6	76.3	77.1	75.9	70.8	64.9	51.7	44.5
24.0	42.8	43.8	46.9	51.3	60.1	68.5	70.3	73.3	68.3	62.3	53.7	45.4
48.0	49.3	46.8	49.8	52.5	59.2	67.3	71.3	76.8	72.9	68.6	59.8	51.4
72.0	51.4	50.9	51.1	52.8	58.1	62.9	67.1	72.3	69.0	69.4	65.9	59.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	41.3	44.6	47.1	56.4	68.3	76.0	78.3	75.8	71.0	62.4	47.7	36.9
12.0	42.3	45.1	47.2	55.1	66.0	73.8	76.7	75.1	71.0	63.7	50.5	41.3
24.0	43.9	46.0	47.6	53.6	63.0	70.7	74.3	73.9	70.8	65.0	54.0	44.8
48.0	47.6	48.1	48.9	52.1	58.8	65.6	69.8	71.1	69.8	66.4	59.0	50.8
72.0	51.2	50.4	50.4	52.0	56.3	61.8	66.0	68.2	68.2	66.5	61.8	55.3

M= 124.

N= 4

D= 0.0226

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
59.055	-17.847	-0.862	-1.983	-0.763	-10.362	0.701	1.466	0.304

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3311	0.6163	0.6757	0.6988	0.7396	0.6143	0.6621	0.7159	0.7367
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PALMER AAES, ALASKA
 SILT LOAM
 FALLOW PLOT
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	18.1	19.5	21.1	.0	42.0	43.3	57.7	54.1	46.5	34.9	22.2	23.3
4.0	18.9	19.4	20.9	.0	40.8	42.4	57.5	53.9	46.5	35.1	22.5	23.8
8.0	19.5	20.4	22.5	.0	38.0	41.0	56.5	54.1	48.0	36.6	25.5	25.2
20.0	25.4	23.4	26.1	.0	32.9	37.4	53.7	55.0	51.4	41.0	32.5	30.2
40.0	31.6	29.0	29.8	.0	31.3	32.2	45.1	50.4	49.8	43.6	36.5	33.8
60.0	34.1	32.8	32.5	.0	32.5	32.5	39.5	46.2	47.8	44.6	39.1	35.8
120.0	37.1	36.4	36.2	.0	34.5	34.9	36.5	40.0	42.8	42.7	40.2	38.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	21.3	19.1	23.7	33.0	38.4	47.1	58.5	58.9	47.8	35.3	25.9	23.0
4.0	21.8	19.6	23.7	32.6	37.9	46.3	57.4	58.4	48.1	36.0	26.7	23.5
8.0	22.8	20.5	23.7	31.9	37.1	44.7	55.5	57.4	48.5	37.3	28.2	24.6
20.0	25.6	23.1	24.5	30.2	35.1	41.0	49.8	54.0	49.0	40.3	32.0	27.7
40.0	29.4	27.1	26.4	29.2	32.9	36.9	45.1	48.3	47.7	42.8	36.6	32.0
60.0	32.5	30.3	28.9	29.7	32.0	34.7	38.8	43.5	45.1	43.1	39.1	35.2
120.0	37.0	35.7	34.5	33.5	33.2	33.6	34.5	36.1	38.0	39.2	39.5	38.4

M= 175.

N= 4

D= .0104

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
36.102	-15.220	-.269	2.324	-.517	-11.971	3.778	-.296	.951

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.3070	.5880	.6538	.6907	.6978	.6272	.6432	.6600	.7041
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PALMER AAES, ALASKA
 SILT LOAM
 GRASS PLOT
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
2.0	23.1	23.7	24.9	55.3	38.1	41.9	58.8	56.7	50.3	38.3	27.8	26.0
4.0	24.2	24.3	26.2	54.7	36.5	41.3	58.7	56.9	50.8	38.8	29.1	27.0
8.0	25.5	23.5	27.0	51.3	35.3	39.8	57.7	57.2	51.8	40.4	30.7	28.5
20.0	28.5	26.5	28.6	52.5	32.4	38.1	56.6	56.3	52.1	42.3	33.5	31.0
40.0	33.2	32.2	32.8	52.8	32.1	32.3	46.8	51.4	50.6	44.8	37.3	34.1
60.0	34.9	33.9	34.1	-0.0	32.5	32.8	42.3	47.2	47.8	44.9	39.3	35.9
120.0	37.8	37.1	36.8	-0.0	35.8	35.3	38.4	41.9	43.6	43.3	40.6	38.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
2.0	25.9	23.8	27.2	32.5	34.3	44.6	59.1	60.2	50.2	39.1	29.5	26.7
4.0	26.2	24.1	27.2	32.4	34.2	44.0	58.2	59.8	50.3	39.6	30.1	27.1
8.0	26.9	24.7	27.3	32.2	34.0	42.8	56.3	58.9	50.6	40.5	31.2	27.8
20.0	28.7	26.6	27.7	31.8	33.5	39.8	51.4	56.1	50.8	42.6	34.2	30.0
40.0	31.4	29.4	29.1	31.5	33.2	36.8	45.1	51.2	49.8	44.5	37.9	33.4
60.0	33.7	31.9	30.8	31.9	33.2	35.3	40.9	46.8	47.8	45.0	40.2	36.1
120.0	38.1	36.6	35.3	34.6	34.6	34.9	36.1	38.8	41.3	42.2	41.6	39.9

M= 175.

N= 4

D= 0.0162

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
37.842	-11.646	-1.415	1.986	-0.477	-12.384	5.082	-1.096	1.398

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2634	0.4775	0.5323	0.5571	0.5616	0.5089	0.5202	0.5367	0.5664
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

TEMPE, ARIZONA
 SANDY LOAM
 CITRUS GROVE

CLIMATOLOGICAL DATA
 1957-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
8.0	47.9	51.6	57.4	66.0	71.1	78.2	83.9	85.9	79.7	69.9	57.1	51.1
20.0	52.1	54.4	59.5	65.8	71.4	78.0	83.6	85.1	81.6	73.5	62.2	55.8
39.0	55.6	55.5	57.9	63.0	68.0	74.3	79.9	82.3	80.6	75.0	66.3	59.7
89.0	62.7	60.5	60.2	61.6	65.8	68.6	72.6	76.3	77.1	75.3	71.6	67.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
8.0	49.8	52.4	58.9	66.5	72.6	79.8	85.6	86.5	81.2	70.8	59.0	51.9
20.0	51.9	53.2	58.4	65.1	70.7	77.2	83.0	84.8	81.1	72.7	62.1	54.9
39.0	55.2	55.0	58.2	63.5	68.4	73.9	79.2	82.0	80.4	74.5	65.9	59.0
89.0	62.3	60.2	60.2	62.2	65.0	68.4	72.1	75.4	76.7	75.3	71.2	66.4

M= 240.

N= 4

D= 0.0264

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
67.997	-16.360	-2.319	0.393	0.141	-10.719	1.076	-0.111	0.325

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1877	0.3598	0.3947	0.4200	0.4431	0.3593	0.3947	0.4213	0.4407
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

TEMPE, ARIZONA
 SANDY LOAM
 CITRUS GROVE

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	45.9	54.3	56.7	69.1	75.4	81.1	87.1	90.3	86.3	76.7	60.5	54.3
4.0	45.2	50.3	56.5	67.6	73.1	79.0	85.1	86.3	83.1	73.8	58.4	52.0
8.0	47.9	51.6	54.3	63.4	67.1	72.8	80.1	84.4	81.1	71.4	59.5	52.4
20.0	50.6	52.9	55.6	61.5	67.1	72.8	79.4	82.1	80.1	73.8	62.3	55.5
39.0	54.3	54.6	54.9	59.9	64.5	69.6	76.0	80.4	79.1	75.0	66.3	59.2
89.0	62.4	60.2	59.6	60.6	62.1	65.3	68.6	74.4	75.4	74.8	71.6	66.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	47.4	50.1	56.5	65.3	71.8	77.6	84.2	87.2	82.6	72.3	59.0	49.8
4.0	47.8	50.3	56.4	65.0	71.4	77.2	83.7	86.8	82.6	72.6	59.7	50.4
8.0	48.7	50.7	56.2	64.4	70.7	76.3	82.7	86.0	82.5	73.2	60.9	51.6
20.0	51.2	51.9	56.0	62.9	68.8	74.0	79.8	83.7	81.8	74.7	64.0	55.1
39.0	55.0	54.2	56.4	61.4	66.5	71.0	76.0	80.1	80.2	75.8	67.8	59.8
89.0	62.9	60.3	59.6	60.9	63.4	66.3	69.4	72.8	75.0	74.8	71.9	67.4

M= 165.

N= 4

D= 0.0221

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
67.036	-14.971	-3.101	0.430	-0.338	-12.606	0.121	0.262	0.158

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2582	0.4603	0.4764	0.4930	0.5109	0.4421	0.4795	0.4986	0.5043
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

TUCSON, ARIZONA
 UNKNOWN
 BARE
 JEN-HU-CHANG
 REFERENCE(5)
 1937-1938

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
3.0	53.6	53.9	61.2	75.6	83.2	85.3	80.3	81.1	79.8	77.0	65.5	53.5
12.0	57.6	56.8	61.4	70.5	77.2	83.4	88.6	90.6	88.8	81.6	71.2	61.1
24.0	62.8	61.8	65.3	70.2	76.2	81.4	86.0	88.1	87.4	81.8	74.3	65.8
72.0	64.7	62.5	63.4	65.5	70.9	75.6	79.1	82.2	83.0	81.0	75.4	68.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
3.0	55.4	56.6	62.1	73.1	81.2	84.7	86.9	87.3	85.6	79.6	67.5	57.9
12.0	56.9	57.4	61.9	71.6	79.5	83.4	85.7	86.5	85.2	80.2	69.5	60.1
24.0	58.8	58.6	61.9	70.1	77.6	81.7	84.2	85.3	84.6	80.7	71.7	62.7
72.0	65.8	63.7	63.8	67.1	72.2	76.3	79.0	80.9	81.6	80.7	76.6	70.5

M= 48.

N= 4

D= 0.0326

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
73.239	-13.673	-1.479	-0.359	-0.550	-10.607	-2.292	0.925	0.363

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.4134	0.7120	0.7555	0.7364	0.8145	0.7107	0.7560	0.7884	0.8106
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BRAWLEY, CALIFORNIA
 SILTY CLAY
 BARE

CLIMATOLOGICAL DATA
 1960-1962

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	49.5	55.7	62.8	74.4	78.9	88.2	93.6	94.2	88.3	76.1	63.0	52.8
8.0	55.8	60.5	65.9	76.0	80.6	89.2	95.6	96.4	91.1	81.8	69.2	60.0
12.0	59.2	62.9	67.7	77.0	81.3	89.8	96.0	97.3	93.0	83.6	72.6	63.6
20.0	61.5	64.1	67.9	76.1	80.6	87.7	93.6	95.6	92.6	85.0	75.4	66.7
39.0	65.5	65.9	67.6	73.2	77.5	82.5	88.3	91.2	90.5	85.8	79.1	71.5
79.0	72.8	70.9	70.9	72.8	75.7	78.7	82.7	86.0	87.2	86.1	82.6	77.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	55.7	59.9	68.1	76.7	83.2	90.9	97.6	97.8	91.4	81.0	68.0	58.4
8.0	56.7	60.2	67.7	76.0	82.2	89.6	96.2	97.1	91.5	81.9	69.5	60.0
12.0	57.8	60.5	67.4	75.3	81.3	88.4	95.0	96.3	91.5	82.7	70.9	61.5
20.0	60.0	61.4	67.0	74.0	79.8	86.3	92.6	94.8	91.3	83.9	73.5	64.4
39.0	64.8	64.0	66.9	72.1	76.9	82.1	87.6	91.0	90.0	85.5	77.9	70.1
79.0	72.8	70.0	69.6	71.3	73.9	77.0	80.6	84.1	85.7	85.0	81.9	77.3

M= 216.

N= 4

D= 0.0159

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
77.482	-18.000	-2.819	0.154	-0.099	-11.868	0.436	-0.709	0.334

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1757	0.3217	0.3468	0.3647	0.3811	0.3212	0.3469	0.3657	0.3791
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

DAVIS, CALIFORNIA
 RECENT ALLUVIUM
 UNCROPPED
 E.M. FITTON
 REFERENCE(4)
 1925-1927

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
0.5	48.0	51.1	58.4	63.2	74.8	82.0	90.6	86.0	77.4	0.0	0.0	0.0
3.0	48.2	49.9	55.2	61.9	72.9	78.9	86.6	83.2	76.4	0.0	0.0	0.0
6.0	48.8	50.2	54.5	60.9	72.0	78.0	87.2	84.5	79.4	0.0	0.0	0.0
12.0	48.5	50.2	53.7	60.2	70.8	76.4	84.4	83.0	77.2	0.0	0.0	0.0
24.0	53.2	51.9	54.6	59.7	68.4	72.9	82.8	82.8	78.2	0.0	0.0	0.0
36.0	51.2	51.4	54.3	60.1	68.8	72.9	80.8	82.5	78.6	0.0	0.0	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
0.5	47.3	50.3	54.3	63.4	72.3	80.7	87.7	85.3	77.3	71.1	59.6	48.4
3.0	47.7	50.5	54.3	63.1	71.8	80.1	87.1	85.1	77.4	71.3	60.2	49.1
6.0	48.2	50.7	54.3	62.7	71.3	79.4	86.4	84.9	77.5	71.6	60.9	49.9
12.0	49.1	51.2	54.3	62.0	70.2	78.0	85.0	84.3	77.7	72.1	62.2	51.5
24.0	50.9	52.2	54.6	60.9	68.4	75.6	82.4	83.1	77.8	72.8	64.5	54.5
36.0	52.8	53.3	55.0	60.1	66.8	73.5	80.0	81.8	77.8	73.4	66.3	57.1

M= 54.

N= 4

D= 0.0332

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
66.559	-15.507	-0.684	-0.833	-1.279	-12.209	0.529	-0.821	0.282

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.9996	1.6699	0.7716	0.6833	0.6596	1.2722	1.6325	1.1508	0.5633
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FT. COLLINS, COLO.
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE (4)
 1889-1927

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	27.7	29.6	36.5	46.0	56.5	66.7	71.4	69.3	61.1	48.3	36.7	29.7
6.0	29.3	30.6	37.1	47.4	56.6	67.0	71.9	70.4	62.8	50.8	39.0	30.2
12.0	32.8	31.1	36.6	45.5	55.6	65.5	70.9	70.1	63.7	52.3	40.7	33.2
24.0	32.9	32.7	36.8	45.3	53.3	62.5	68.5	68.8	64.0	54.4	43.7	36.5
36.0	35.4	32.6	37.1	43.6	51.1	59.1	65.2	66.6	63.4	55.5	46.0	38.9
72.0	42.5	40.5	40.8	44.2	48.6	54.2	59.2	61.8	62.0	58.0	52.1	46.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	26.9	30.5	37.3	47.7	57.9	67.9	75.0	70.8	62.7	50.2	37.6	31.1
6.0	29.5	30.8	37.2	47.2	57.2	67.0	72.3	70.5	62.9	50.9	38.5	31.8
12.0	30.7	31.5	37.0	46.2	55.7	65.2	70.6	69.8	63.1	52.2	40.3	33.4
24.0	33.0	32.9	36.9	44.7	53.2	62.0	67.9	68.3	63.3	54.2	43.4	36.3
36.0	35.2	34.3	37.1	43.6	51.1	59.2	65.1	66.6	63.1	55.7	46.0	39.0
72.0	41.1	38.9	39.1	42.2	47.0	52.8	58.3	61.4	61.2	57.6	51.4	45.4

M= 72.

N= 4

D= .0272

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.748	-19.571	-.291	.169	.181	-12.087	1.393	.262	.410

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.1147	.1984	.2112	.2203	.2287	.1960	.2113	.2209	.2276
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FT. COLLINS, COLO.
 UNKNOWN
 GRASS
 JEN-HU-CHANG
 REFERENCE(5)
 1906-1946

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	28.1	30.2	37.1	47.1	56.8	67.2	72.6	70.3	61.7	49.0	37.2	30.2
6.0	29.4	31.0	37.4	47.8	57.0	67.3	72.3	71.1	63.3	51.2	39.1	31.7
12.0	30.7	31.6	37.2	47.3	56.4	66.1	72.1	71.2	64.4	53.1	41.2	33.8
24.0	33.3	33.2	37.3	45.8	54.2	63.2	69.6	69.8	64.7	55.1	44.4	37.0
36.0	36.1	35.4	37.8	44.5	52.1	60.1	66.6	68.0	64.6	56.6	47.2	40.0
72.0	43.1	41.2	41.5	44.9	49.9	55.8	61.1	63.9	63.5	59.3	53.3	47.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	29.3	31.1	38.1	48.5	58.6	68.6	74.1	72.0	63.5	51.1	38.6	31.7
6.0	29.9	31.4	38.0	48.0	57.9	67.7	73.4	71.7	63.7	51.7	39.4	32.5
12.0	31.1	32.0	37.8	47.1	56.5	66.0	71.9	71.0	63.9	52.9	41.1	34.0
24.0	33.4	33.4	37.7	45.6	54.0	62.8	69.0	69.5	64.2	54.9	44.1	36.9
36.0	35.6	34.8	37.8	44.5	52.0	60.1	66.3	67.8	64.1	56.4	46.7	39.6
72.0	41.5	39.3	39.6	43.0	47.9	53.8	59.4	62.7	62.2	58.4	52.0	45.9

M= 72.
 N= 4
 D= 0.0289

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.547	-19.686	-0.372	0.285	0.123	-12.248	1.392	0.067	0.380

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1233	0.2123	0.2257	0.2353	0.2442	0.2119	0.2258	0.2360	0.2430
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FT. COLLINS, COLO.
 LOAM
 SPARSE VEGETATION
 CLIMATOLOGICAL DATA
 1960-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	U	N	D
3.0	27.6	31.3	37.6	50.8	62.6	70.8	77.8	75.2	65.7	53.4	38.8	31.5
6.0	28.3	31.7	37.6	52.2	62.8	70.9	78.1	76.0	66.6	54.8	41.0	32.7
12.0	29.3	31.6	36.3	49.5	60.0	67.5	75.3	74.1	65.8	54.8	41.7	33.8
24.0	32.8	33.2	36.7	47.8	57.4	64.3	71.8	72.0	66.2	57.1	45.6	37.4
36.0	35.3	34.6	36.9	46.1	55.0	61.4	68.9	70.2	66.2	58.6	48.5	40.4
72.0	42.8	40.5	40.3	44.2	49.6	55.2	60.9	64.5	64.3	60.3	54.3	47.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
3.0	28.3	30.1	37.8	51.8	62.7	71.2	77.7	75.7	65.4	53.1	39.5	30.6
6.0	29.0	30.4	37.7	51.0	61.8	70.2	76.8	75.3	65.7	53.8	40.6	31.6
12.0	30.4	31.2	37.4	49.7	60.1	68.4	75.0	74.5	66.1	55.1	42.6	33.5
24.0	33.1	32.9	37.3	47.5	57.2	65.0	71.6	72.7	66.5	57.2	46.0	37.1
36.0	35.8	34.7	37.6	45.8	54.6	62.1	68.5	70.7	66.4	58.7	48.9	40.3
72.0	42.7	40.1	40.1	43.7	49.6	55.4	60.8	64.7	64.4	60.6	54.5	47.9

M= 350.

N= 4

D= 0.0250

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.116	-22.060	-0.488	0.681	-0.686	-13.188	0.615	0.136	0.497

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1154	0.1991	0.2120	0.2212	0.2296	0.1991	0.2122	0.2218	0.2286
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

STORRS, CONN.
 LOAM
 GRASS SOD
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	51.8	51.9	34.4	46.0	56.4	67.7	73.8	70.4	62.7	54.9	45.5	34.1
4.0	34.3	34.7	36.9	49.4	60.2	71.0	76.2	73.5	66.4	59.0	50.4	39.4
8.0	35.2	34.7	35.5	44.9	54.3	65.0	69.7	68.1	64.6	53.6	46.4	36.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	52.6	52.6	35.7	47.0	59.2	68.5	74.5	71.6	62.9	56.0	45.7	35.6
4.0	33.6	33.3	35.9	46.2	57.9	67.1	73.3	71.2	63.2	56.5	46.9	37.0
8.0	34.8	34.3	36.2	45.3	56.4	65.4	71.6	70.6	63.5	57.1	48.3	38.7

M= 72.
 N= 4
 D= .0107

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	n1	n2	n3	n4
51.956	-16.550	1.352	-.476	-1.148	-13.667	.380	-.209	.170

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.2767	.4200	.4321	.4178	.4502	.4197	.4241	.4546	.4295
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

GAINESVILLE, FLA.
 SAND AND CLAY
 GRASS
 J.W. DICKERT
 REFERENCE(19)
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	57.5	57.7	65.6	73.1	76.0	84.9	82.9	82.2	80.6	74.2	66.2	57.6
4.0	59.0	58.2	66.6	73.8	77.1	85.4	83.7	82.0	80.5	73.3	67.7	58.8
7.9	59.1	57.5	66.6	72.6	76.4	84.5	83.9	81.9	80.4	73.0	67.9	59.4
19.7	59.2	58.6	66.3	71.2	75.2	82.8	84.2	84.1	82.6	74.7	69.1	61.2
39.4	60.5	60.6	65.4	70.2	73.5	80.6	82.7	83.2	82.5	75.6	71.3	63.1
59.0	62.2	61.9	65.5	68.3	71.8	77.4	80.9	81.7	81.7	77.7	73.2	66.7
118.1	67.7	66.6	65.8	67.1	69.0	72.7	76.2	77.8	78.7	77.8	74.8	71.5
234.0	71.8	71.9	71.3	70.6	70.1	71.5	72.2	72.4	72.7	72.6	73.0	72.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
0.4	56.0	59.0	66.5	72.6	78.1	84.6	85.6	83.2	80.9	74.3	64.9	58.8
4.0	56.4	59.1	66.2	72.3	77.7	84.1	85.3	83.0	80.9	74.7	65.5	59.4
7.9	56.9	59.3	66.0	71.9	77.2	83.5	84.9	82.9	80.9	75.0	66.1	60.0
19.7	58.4	59.7	65.4	71.0	75.9	81.8	83.9	82.4	80.7	75.8	67.8	61.8
39.4	60.7	60.7	64.8	69.8	74.0	79.3	82.0	81.4	80.3	76.8	70.1	64.4
59.0	62.9	62.0	64.7	68.9	72.6	77.2	80.3	80.4	79.7	77.3	71.9	66.7
118.1	68.1	66.0	66.0	67.8	70.1	73.0	75.8	77.3	77.6	77.1	74.7	71.3
234.0	72.6	71.2	70.1	69.6	69.8	70.5	71.6	72.9	73.9	74.5	74.6	73.9

M= 104.

N= 4

D= 0.0447

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
72.103	-12.451	-1.069	-0.564	0.703	-7.402	-0.970	-0.348	0.428

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1754	0.3161	0.3346	0.3461	0.3564	0.3300	0.3497	0.3628	0.3713
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

GAINESVILLE, FLA.
 SAND AND CLAY
 BARE
 J.W. DICKERT
 REFERENCE (19)
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

J F M A M J J A S O N D

4.0	52.7	60.3	70.4	86.8	87.2	91.6	86.8	90.8	87.3	80.4	72.9	54.7
7.9	49.9	55.7	64.1	78.4	80.3	85.0	82.2	84.8	81.5	75.6	68.5	51.5
19.7	55.1	56.8	65.5	75.2	78.4	81.3	80.8	83.0	80.7	76.1	70.6	55.6
39.4	57.7	57.6	65.0	72.3	75.9	78.6	80.0	82.2	80.8	77.6	73.9	60.5
59.0	59.4	58.3	64.1	70.4	74.3	76.3	79.5	81.2	80.1	77.9	73.5	64.5
118.1	62.4	61.7	64.0	69.0	72.5	72.6	78.6	79.4	78.8	77.5	76.4	70.9
240.0	72.6	71.6	70.8	70.0	71.0	71.2	71.6	73.1	72.9	74.5	74.5	73.4
288.0	73.2	72.9	72.6	71.9	71.8	71.9	71.6	72.6	72.4	72.5	74.0	73.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

J F M A M J J A S O N D

4.0	49.6	57.3	67.8	78.7	83.5	83.4	84.9	85.3	82.0	77.7	66.9	53.0
7.9	50.3	57.2	67.3	77.9	82.9	83.0	84.5	85.0	82.0	77.9	67.7	54.2
19.7	52.3	57.4	66.0	75.9	81.3	82.0	83.4	84.3	81.9	76.4	69.8	57.4
39.4	55.8	58.1	64.7	73.1	78.7	80.3	81.7	82.9	81.5	76.8	72.4	62.0
59.0	59.1	59.4	64.1	71.0	76.5	78.7	80.1	81.5	80.9	79.0	74.3	65.7
118.1	67.1	64.4	65.0	68.0	71.8	74.7	76.3	77.8	78.5	78.1	76.4	72.4
240.0	73.5	71.7	70.3	69.7	70.1	71.1	72.2	73.2	74.2	74.8	75.1	74.8
288.0	73.9	72.8	71.7	70.9	70.7	71.1	71.7	72.5	73.2	73.8	74.3	74.4

M= 96.

N= 4

D= 0.0403

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0 A1 A2 A3 A4 B1 B2 B3 B4

72.570 -15.697 -3.807 -0.245 -0.975 -7.523 -4.382 -0.913 -0.246

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2368 0.4941 0.5322 .5561 0.5809 0.4334 0.5320 .5596 0.5781

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

GAINESVILLE, FLA.
 SAND
 SPARSE GRASS
 J.W.DICKERT
 REFERENCE(19)
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

4.0	.0	.0	.0	.0	85.3	88.7	86.8	87.3	78.4	71.0	63.5	48.6
7.9	.0	.0	.0	.0	81.5	83.3	83.0	83.3	77.2	72.2	64.1	50.5
19.7	.0	.0	.0	.0	79.8	80.7	81.2	81.9	78.0	75.4	68.2	58.0
39.4	.0	.0	.0	.0	80.0	80.8	81.1	81.6	79.8	81.0	76.4	68.3
59.0	.0	.0	.0	.0	79.8	80.3	80.5	80.8	80.7	83.8	81.2	74.7
118.1	.0	.0	.0	.0	77.8	77.2	78.4	78.6	80.6	84.3	83.5	76.8
180.0	.0	.0	.0	.0	74.3	73.3	74.5	74.5	77.6	78.1	79.4	76.3

EARTH TEMPERATURE STATION

GAINESVILLE, FLA.

TYPE OF SOIL

SAND

TYPE OF EARTH SURFACE

SOD

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	57.3	60.2	69.9	80.0	86.0	87.9	88.6	88.5	85.9	77.4	70.9	61.1
4.0	57.3	59.4	67.9	73.6	81.2	85.3	85.9	85.9	82.9	75.6	69.8	59.9
8.0	57.8	59.0	65.9	75.4	80.3	84.7	85.6	85.5	82.4	75.3	69.8	60.0

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ATHENS, GA.
 SANDY LOAM
 THIN GRASS
 CLIMATOLOGICAL DATA
 1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	44.8	46.8	54.7	64.7	77.4	83.0	84.1	84.8	79.2	69.3	58.4	45.8
4.0	44.0	46.1	53.6	64.0	76.1	81.7	82.9	82.1	78.1	68.4	57.7	45.9
8.0	46.6	48.3	55.7	65.1	76.8	82.6	83.9	85.3	80.8	71.3	60.7	49.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
2.0	43.8	47.8	54.1	65.3	77.4	82.9	84.2	84.3	79.2	69.7	57.0	47.0
4.0	44.1	47.9	54.0	65.0	76.9	82.5	83.9	84.1	79.2	70.0	58.2	47.6
8.0	44.9	48.2	53.9	64.3	75.8	81.7	83.2	83.7	79.3	70.5	59.1	48.7

M= 147.

N= 4

D= 0.0334

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
66.203	-17.936	-1.012	-0.564	-0.321	-11.601	-1.577	0.751	-0.642

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2515	0.3727	0.3772	0.3774	0.3884	0.3678	0.3755	0.3847	0.3817
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EARTH TEMPERATURE STATION

TYPE OF SOIL

TYPE OF EARTH SURFACE

DATA PROCESSED BY

DATA SOURCE

PERIOD OF OBSERVATION

TIETON, GA

LOAMY SAND

GRASS

JEN-HU-CHANG

REFERENCE (5)

1954-1955

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	47.5	51.5	65.0	74.8	85.5	90.2	89.5	89.8	83.0	69.8	56.2	49.5
6.0	54.9	57.2	64.8	74.6	78.5	83.5	85.2	86.0	80.0	74.2	62.2	54.5

EARTH TEMPERATURE STATION

TIFTON, GA

TYPE OF SOIL

LOAMY SAND

TYPE OF EARTH SURFACE

GRASS SOD

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	47.0	51.5	53.5	62.7	71.0	79.1	79.9	79.9	74.9	65.1	58.2	53.0
6.0	55.4	57.2	58.0	66.4	71.0	78.0	80.1	79.7	76.9	70.1	64.9	58.3

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

MOSCOW, IDAHO
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1898-1901

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
3.0	30.8	28.8	34.4	41.2	51.2	58.0	64.1	67.5	54.6	47.8	40.8	33.8
6.0	31.8	30.2	34.6	42.9	48.6	56.0	63.6	65.4	56.8	50.5	41.6	34.6
9.0	32.8	31.0	35.0	45.9	48.9	54.8	62.9	64.9	57.5	51.8	42.8	36.4
12.0	38.2	32.8	35.4	44.7	48.4	54.8	62.2	64.3	58.1	52.2	43.6	37.4
24.0	35.8	34.5	36.2	44.5	47.5	52.9	59.2	62.5	58.2	53.2	45.8	39.2
36.0	37.8	36.2	37.0	40.5	46.2	50.1	55.9	60.0	57.8	53.8	48.0	41.6
48.0	39.8	38.0	38.0	40.5	45.4	48.8	53.7	58.1	57.1	53.8	48.8	43.4
60.0	40.8	39.5	38.8	40.6	44.6	47.5	51.8	56.3	56.5	54.0	49.6	44.6
72.0	42.8	40.8	39.6	41.5	44.6	47.1	50.6	54.7	55.5	54.0	51.6	46.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
3.0	32.0	30.8	35.1	44.8	50.5	56.6	65.4	65.7	57.5	49.9	41.2	34.6
6.0	32.6	31.3	35.0	44.3	50.0	55.8	64.4	65.2	57.7	50.4	42.0	35.4
9.0	33.2	31.8	35.0	43.8	49.5	55.1	63.5	64.8	57.8	50.8	42.7	36.1
12.0	33.8	32.3	35.1	43.4	49.1	54.5	62.6	64.3	57.9	51.1	43.3	36.8
24.0	36.0	34.2	35.5	42.0	47.4	52.1	59.2	62.3	58.0	52.3	45.7	39.5
36.0	38.1	36.0	36.3	41.2	46.1	50.3	56.4	60.2	57.7	53.1	47.4	41.7
48.0	40.0	37.7	37.3	40.7	45.0	48.8	54.0	58.1	57.1	53.5	48.8	43.7
60.0	41.6	39.3	38.4	40.6	44.3	47.6	52.0	56.2	56.2	53.6	49.8	45.3
72.0	43.1	40.7	39.5	40.8	43.7	46.6	50.4	54.4	55.3	53.5	50.4	46.6

M= 108.

N= 4

D= 0.0188

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
47.108	-13.190	-0.383	1.348	-1.051	-11.392	1.123	-0.448	0.715

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0956	0.1787	0.1941	0.2049	0.2145	0.1785	0.1942	0.2055	0.2135
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LEMONT, ILL.
 SANDY CLAY
 PASTURE GRASS
 J.E. CARSON
 REFERENCE (10)
 1953-1955

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
3.9	31.8	32.1	36.5	48.9	59.7	71.3	77.1	75.2	66.6	56.4	42.5	33.6
7.9	32.9	32.5	36.4	47.8	58.1	69.2	75.2	74.1	66.8	57.3	44.2	35.0
19.7	35.8	34.5	37.0	45.7	55.0	64.8	70.9	71.6	66.7	59.1	47.9	38.9
39.4	40.0	37.7	38.6	43.9	51.6	59.5	65.9	68.1	66.0	60.6	52.2	44.5
120.0	50.3	47.7	45.8	45.3	47.0	50.1	53.9	57.3	59.2	59.2	57.3	54.1
348.0	52.3	52.4	52.5	51.9	51.6	51.2	50.6	50.7	51.0	51.3	51.6	52.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
3.9	31.8	31.7	36.4	48.0	59.5	70.0	76.4	74.1	66.5	56.3	42.5	33.8
7.9	32.7	32.4	36.5	47.3	58.4	68.6	75.2	73.6	66.6	57.0	43.9	35.1
19.7	35.3	34.3	36.9	45.5	55.3	64.8	71.7	71.9	66.7	58.8	47.4	38.6
39.4	39.3	37.5	38.2	43.8	51.6	59.7	66.4	68.7	66.0	60.6	51.9	43.7
120.0	50.8	45.1	46.3	45.7	47.1	49.9	53.4	56.9	58.9	59.1	57.5	54.4
348.0	52.9	53.0	52.9	52.7	52.5	52.1	51.9	51.8	51.8	52.0	52.3	52.6

M= 213.

N= 4

D= 0.0224

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.367	-19.200	0.210	-0.318	-0.525	-14.327	1.038	0.432	0.743

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0833	0.1672	0.1786	0.1866	0.1933	0.1669	0.1787	0.1871	0.1929
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LEMONT, ILLINOIS
 UNKNOWN
 GRASS
 JEN-HU-CHANG
 REFERENCE(5)
 1952-1954

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	31.2	32.8	37.8	48.9	59.9	73.4	76.2	75.1	66.5	57.4	42.4	33.8
3.9	31.3	32.4	36.8	47.5	58.7	72.9	75.8	74.7	65.9	57.5	43.3	34.0
7.9	32.4	32.8	36.8	46.4	57.1	70.4	74.2	73.4	66.1	58.2	45.0	35.6
19.7	35.2	34.8	37.2	44.8	54.0	65.6	70.6	71.0	66.3	59.6	48.6	39.4
39.4	39.8	37.8	38.7	43.4	50.6	59.8	65.7	67.6	65.8	60.6	52.0	44.4
120.0	50.2	47.4	45.8	45.2	46.6	49.7	53.5	56.8	58.7	58.6	56.0	53.6
348.0	52.2	52.2	52.1	51.8	51.3	51.0	50.1	50.2	50.5	50.8	51.4	51.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	30.4	31.8	36.9	47.2	60.0	72.1	76.7	73.3	66.4	56.1	42.2	33.0
3.9	31.3	32.2	36.9	46.6	58.8	70.7	75.8	72.9	66.5	56.8	43.4	34.1
7.9	32.2	32.8	37.0	46.0	57.6	69.3	74.6	72.5	66.6	57.5	44.7	35.4
19.7	34.9	34.5	37.4	44.6	54.6	65.3	71.4	70.9	66.5	59.1	48.1	39.0
39.4	39.1	37.5	38.6	43.3	50.9	59.9	66.4	68.0	65.6	60.6	52.3	44.1
120.0	50.8	48.0	46.2	45.7	46.9	49.8	53.5	56.9	58.7	58.9	57.4	54.4
348.0	52.8	52.9	52.9	52.6	52.4	52.0	51.8	51.7	51.7	51.9	52.2	52.5

M= 84.
 N= 4
 D= 0.0229

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.283	-18.707	0.383	-1.051	-0.052	-14.437	0.854	0.175	0.416

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0868	0.1637	0.1718	0.1773	0.1823	0.1634	0.1720	0.1777	0.1815
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

URBANA, ILLINOIS
 SILT LOAM
 BLUEGRASS SOD
 CLIMATOLOGICAL DATA
 1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	33.2	32.7	38.9	51.9	63.7	73.5	77.4	76.2	70.7	61.5	48.0	35.4
8.0	34.4	33.6	38.7	50.9	62.4	72.1	76.5	74.2	71.0	60.3	49.4	37.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	32.8	33.1	38.8	51.6	64.0	73.2	77.5	75.7	70.4	61.3	47.0	36.3
8.0	33.9	33.8	38.8	50.7	62.7	71.8	76.4	75.2	70.3	62.0	48.4	37.8

M= 120.
 N= 4
 D= 0.0203

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
55.265	-19.373	-0.039	-0.618	-0.436	-14.825	-0.863	0.717	0.559

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2136	0.3303	0.3377	0.3450	0.3541	0.3298	0.3402	0.3471	0.3504
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

URBANA, ILLINOIS
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE (4)
 1913-1915

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.2	29.5	39.8	51.0	63.0	72.6	78.2	76.2	69.0	55.5	42.2	32.1
3.0	31.0	30.6	39.5	50.6	62.2	72.2	77.8	75.8	69.0	56.8	43.0	33.4
6.0	32.6	31.5	39.3	49.2	60.5	70.5	75.8	74.8	68.8	57.0	44.0	35.0
9.0	33.2	33.0	39.2	48.7	59.8	69.4	74.7	74.0	68.6	57.4	45.2	36.0
12.0	34.0	33.2	38.6	48.4	58.8	68.0	73.8	73.2	68.2	58.0	46.2	37.4
24.0	37.6	37.1	38.6	47.1	55.4	62.6	68.5	69.7	66.7	59.5	50.6	42.7
36.0	41.0	38.3	40.1	46.0	53.6	60.3	66.0	67.8	66.1	60.7	53.0	45.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.8	31.2	39.2	51.5	62.8	72.9	77.7	75.6	68.0	55.5	41.3	33.1
3.0	30.5	31.5	39.0	50.9	62.0	71.9	77.0	75.3	68.1	56.1	42.3	34.0
6.0	31.5	32.1	38.8	50.1	60.8	70.6	75.8	74.7	68.3	57.1	43.7	35.3
9.0	32.5	32.7	39.7	49.3	59.6	69.2	74.7	74.1	68.3	57.9	45.0	36.6
12.0	33.6	33.3	38.7	48.6	58.6	67.9	73.6	73.5	68.3	58.6	46.3	37.9
24.0	37.4	35.2	39.0	46.5	55.0	63.4	69.4	70.9	67.9	60.7	52.5	42.3
36.0	41.0	38.6	39.9	45.3	52.3	59.7	65.6	68.2	66.9	61.9	53.7	46.1

$$N = 84,$$

$$K = 4$$

$$D = 0.0124$$

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
53.338	-20.609	-0.407	0.158	0.138	-13.768	0.351	0.374	0.495

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0707	0.1173	0.1237	0.1283	0.1326	0.1171	0.1238	0.1287	0.1320
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ST- 26

EARTH TEMPERATURE STATION

WEST LAFAYETTE, IND

TYPE OF SOIL

SILT LOAM

TYPE OF EARTH SURFACE

FESQUE GRASS

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1962

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J

F

M

A

M

J

J

A

S

O

N

D

2.0	.0	.0	.0	48.0	66.7	74.5	74.3	75.6	66.2	57.0	42.1	30.8
4.0	29.3	29.5	33.7	46.5	64.4	72.5	.0	75.7	66.5	57.7	43.0	32.1
8.0	.0	.0	.0	47.4	63.5	71.4	72.5	73.7	66.7	58.8	45.6	35.9

ST- 27

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

WEST LAFAYETTE, IND
 SILT LOAM
 BARE SOIL
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	33.4	32.7	35.4	53.4	.0	.0	.0	.0	.0	55.2	47.8	33.1
2.0	30.3	30.3	36.9	51.4	63.0	75.0	78.0	74.2	69.6	58.4	46.7	33.3
4.0	30.7	30.9	37.6	51.4	63.8	75.0	78.2	74.9	70.3	59.2	47.6	34.0
8.0	33.7	32.3	37.5	50.2	61.2	71.0	75.0	72.7	68.8	58.8	48.7	36.5
20.0	40.2	35.8	37.6	48.1	.0	.0	.0	.0	.0	59.1	53.4	40.4
40.0	43.8	40.6	40.2	44.8	.0	.0	.0	.0	.0	60.8	56.0	47.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.3	30.7	37.5	51.8	65.3	74.7	78.5	75.0	68.0	58.7	44.8	34.1
2.0	30.6	31.0	37.4	51.5	64.8	74.2	78.1	74.9	68.1	58.9	45.2	34.6
4.0	31.4	31.4	37.4	50.8	63.8	73.3	77.4	74.6	68.1	59.4	46.2	35.5
8.0	32.8	32.4	37.4	49.6	62.1	71.5	76.0	74.0	68.2	60.2	47.9	37.4
20.0	36.9	35.3	37.9	46.9	57.6	66.6	71.9	71.9	68.0	61.9	52.1	42.4
40.0	43.0	40.1	40.2	44.9	52.5	60.2	65.7	68.0	66.6	63.1	56.6	48.9

M= 105.

N= 4

D= .0127

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.229	-20.362	.731	-.494	-.497	-14.550	-1.041	.469	.492

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.2377 .3791 .3819 .3840 .3969 .3579 .3789 .3938 .3857
 THE INTERPRETATION OF MEANINGLESS INPUT WAS ATTEMPTED.

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

AMES, IOWA
 SILTY CLAY LOAM
 CULTIVATED
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	23.8	26.0	34.8	55.1	67.3	76.4	83.0	76.5	69.7	59.8	43.3	28.1
2.3	24.2	25.9	33.9	50.7	66.6	78.3	83.1	77.0	69.5	59.3	44.5	29.3
4.0	25.1	26.4	33.0	48.8	65.5	77.1	83.0	77.3	68.8	58.9	45.4	30.1
8.0	26.6	27.3	32.1	46.5	63.2	74.5	80.6	75.3	66.9	58.5	46.4	32.0
20.0	30.6	29.8	32.5	43.4	58.0	67.7	74.4	71.5	65.0	58.6	49.0	35.5
40.0	37.3	34.4	35.2	37.0	52.6	60.7	67.2	67.1	63.9	59.3	53.2	43.2
72.0	42.1	39.0	39.1	43.0	49.5	55.9	60.3	63.8	62.3	59.3	55.0	47.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	23.9	25.4	32.9	50.3	66.4	77.1	81.7	75.8	66.3	58.0	42.5	27.9
2.3	24.3	25.7	32.8	49.9	65.8	76.6	81.3	75.7	66.4	58.2	43.0	28.5
4.0	24.9	26.1	32.8	49.3	65.0	75.8	80.6	75.6	66.5	58.5	43.8	29.4
8.0	26.2	26.9	32.8	48.0	63.3	74.0	79.3	75.2	66.8	59.2	45.4	31.3
20.0	30.2	29.5	33.2	45.0	58.6	69.1	75.2	73.7	67.1	60.7	49.5	36.6
40.0	36.4	34.0	35.0	42.3	52.8	62.4	68.9	70.4	66.6	62.0	54.2	43.7
72.0	44.5	40.6	39.3	41.7	47.7	54.8	60.9	64.5	64.2	61.9	57.8	51.2

M= 193.

N= 4

D= 0.0190

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.491	-24.119	1.315	-1.072	-1.269	-16.520	-1.716	-0.097	0.538

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2335	0.4007	0.4140	0.4252	0.4387	0.3860	0.4121	0.4268	0.4281
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

HURLINGTON, IOWA
 SILTY LOAM
 CULTIVATED
 CLIMATOLOGICAL DATA
 1960-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.0	30.4	38.2	56.5	72.1	82.6	85.9	84.2	74.1	61.8	44.8	30.4
2.2	29.0	30.3	38.6	57.6	73.1	84.0	87.5	86.0	75.9	64.1	46.2	30.9
4.0	29.6	30.4	38.3	56.7	72.0	82.8	86.4	84.8	75.3	63.3	46.1	31.4
8.0	30.7	30.9	36.9	52.6	67.7	77.6	82.4	82.4	74.4	63.0	47.6	33.6
20.0	34.4	32.8	35.6	46.5	59.4	68.9	74.3	74.9	71.1	62.0	50.4	39.1
40.0	40.9	38.2	38.4	44.4	54.8	63.1	68.8	72.0	70.4	64.3	55.8	45.8
72.0	47.3	43.4	42.3	43.5	49.0	55.2	61.5	65.8	66.8	64.3	60.1	53.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	27.1	29.1	36.8	55.3	71.7	80.9	85.0	82.8	73.3	60.7	42.8	29.5
2.2	27.0	29.4	36.7	54.8	71.0	80.3	85.1	82.6	73.3	61.1	43.5	30.2
4.0	28.3	29.8	36.7	54.0	70.1	79.4	84.4	82.3	73.5	61.7	44.0	31.2
8.0	29.8	30.7	36.6	52.4	68.0	77.5	82.7	81.5	73.0	62.7	46.7	33.5
20.0	34.2	33.7	37.1	48.8	62.5	72.1	76.0	78.8	73.6	65.2	52.1	39.7
40.0	41.2	38.8	39.4	45.9	56.0	64.8	71.0	74.0	72.1	67.0	58.2	47.9
72.0	49.9	46.2	44.5	45.9	50.9	57.2	62.0	66.6	67.9	66.5	62.4	56.1

M= 412.

N= 4

D= .0140

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
56.452	-25.868	-.075	-.450	-1.174	-16.761	-1.032	1.124	.355

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.1569	.2690	.2827	.2919	.3000	.2667	.2830	.2925	.2987
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

CASTANA, IOWA
 SILT LOAM
 BARE SOIL
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	24.0	26.0	31.8	50.2	73.4	79.2	86.1	77.0	69.3	60.1	42.3	21.9
2.3	23.0	24.9	30.0	47.8	68.6	75.6	83.8	75.1	67.6	58.3	41.3	21.8
4.0	23.6	25.0	29.8	46.3	67.7	74.6	82.7	74.3	66.8	57.4	42.2	22.8
8.0	24.5	25.6	29.5	42.9	63.1	70.8	78.5	72.1	65.6	56.9	43.2	25.1
20.0	27.8	27.5	29.9	39.5	58.9	66.3	74.2	70.8	65.4	58.2	47.8	31.7
40.0	34.1	32.6	32.5	37.3	53.5	60.8	67.9	68.9	65.4	59.9	53.4	41.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	22.0	24.9	28.9	48.3	67.5	77.3	82.1	75.7	65.3	58.3	39.5	21.6
2.3	22.4	25.2	28.9	47.8	66.7	76.7	81.6	75.6	65.4	58.5	40.2	22.4
4.0	22.9	25.6	29.0	47.1	65.8	75.8	80.9	75.5	65.5	58.8	41.2	23.5
8.0	24.1	26.4	29.3	45.5	63.6	73.9	79.3	75.1	65.8	59.4	43.3	25.9
20.0	27.9	29.0	30.4	42.1	58.0	68.5	74.7	73.4	66.1	60.6	48.4	32.5
40.0	34.3	33.4	33.2	39.4	51.1	61.0	67.6	69.5	65.6	61.5	53.8	41.4

M= 138.

N= 4

D= 0.0162

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.092	-26.021	1.069	-2.461	-2.722	-17.228	-1.524	0.710	0.491

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2513	0.4089	0.4127	0.4218	0.4433	0.4009	0.4314	0.4466	0.4450
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

COUNCIL BLFS., IOWA
 SILT LOAM
 CULTIVATED
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.4	32.0	38.9	58.5	70.8	79.3	87.8	80.9	74.5	66.9	48.8	32.4
2.3	30.5	31.2	35.8	53.3	65.8	74.4	83.1	76.9	70.8	61.4	46.6	32.5
4.0	30.7	30.9	35.7	51.5	63.9	72.6	80.3	74.8	69.6	60.0	46.9	33.3
8.0	30.3	30.3	33.8	48.3	62.1	70.8	77.3	72.2	66.7	56.8	45.7	32.8
20.0	34.7	34.1	36.9	47.5	59.1	67.8	71.0	71.9	67.1	62.7	50.2	34.7
40.0	40.9	38.7	38.9	45.5	54.4	61.9	68.1	69.3	66.7	63.4	56.6	45.9
72.0	46.8	43.9	42.0	43.4	49.3	54.6	59.6	62.8	62.7	60.7	57.1	51.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.5	29.8	36.1	53.4	66.4	75.1	81.2	76.4	68.3	61.1	44.4	30.9
2.3	29.8	30.1	36.1	52.9	65.9	74.6	80.7	76.2	68.4	61.3	45.0	31.5
4.0	30.3	30.5	36.1	52.3	65.1	73.9	80.1	76.1	68.4	61.6	45.8	32.4
8.0	31.5	31.4	36.1	51.0	63.6	72.2	78.6	75.6	68.5	62.2	47.6	34.3
20.0	35.1	34.1	36.6	47.9	59.5	67.8	74.4	73.9	68.5	63.4	52.0	39.6
40.0	40.7	38.5	38.7	45.2	54.3	61.8	68.1	70.4	67.6	64.2	56.9	46.1
72.0	48.1	44.8	43.2	44.9	49.9	55.5	60.6	64.4	64.7	63.4	60.1	54.0

M= 182.

N= 4

D= 0.0164

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.514	-21.771	0.267	-0.888	-1.714	-15.441	-1.390	0.346	1.230

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2157	0.3724	0.3850	0.3951	0.4060	0.3604	0.3827	0.3949	0.3970
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SARATOGA, IOWA
 CRESCO LOAM
 CULTIVATED
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	23.7	24.8	28.3	47.0	64.6	78.7	84.6	77.4	69.7	59.8	43.9	26.1
2.3	23.7	24.7	27.5	45.5	62.6	75.9	81.0	73.8	66.1	58.1	43.5	25.9
4.0	24.0	24.5	26.8	42.9	58.8	69.9	75.8	69.5	62.8	54.7	42.9	26.2
8.0	23.5	23.3	17.9	35.1	0.0	0.0	0.0	67.1	61.7	48.3	44.3	29.5
20.0	28.6	23.5	24.2	31.9	0.0	0.0	0.0	65.0	62.1	52.0	45.6	34.7
40.0	35.2	34.6	34.0	36.7	49.3	57.6	63.6	65.0	61.5	55.7	49.7	39.6
72.0	41.4	39.8	38.5	37.6	46.0	51.8	56.9	59.7	59.8	56.1	51.6	46.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	23.0	23.5	26.7	43.9	63.2	74.9	79.1	72.6	62.7	55.7	40.6	25.5
2.3	23.4	23.8	26.8	43.4	62.5	74.2	78.6	72.5	62.8	55.9	41.1	26.2
4.0	24.0	24.2	26.9	42.8	61.6	73.4	78.0	72.4	62.9	56.1	41.9	27.1
8.0	25.2	25.2	27.3	41.6	59.6	71.4	76.5	72.0	63.2	56.7	43.6	29.1
20.0	29.0	28.1	28.7	39.0	54.3	66.0	72.1	70.5	63.6	58.0	47.6	34.6
40.0	34.9	32.7	31.9	37.1	48.1	58.6	65.4	67.0	63.1	59.0	52.1	41.8
72.0	42.7	39.2	37.2	37.9	43.3	50.7	56.9	60.7	60.6	58.6	55.2	49.1

M= 160.

N= 4

D= 0.0171

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.406	-23.278	2.710	-1.990	-1.861	-17.339	-0.999	0.473	0.266

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3166	0.5600	0.5709	0.5778	0.5964	0.5240	0.5651	0.5889	0.5847
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SPENCER, IOWA
 SILT LOAM
 CULTIVATED

CLIMATOLOGICAL DATA
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	21.7	25.4	28.3	44.9	56.8	70.4	75.4	71.5	64.8	54.1	41.6	26.4
2.3	21.8	25.3	27.5	45.0	58.7	70.1	74.7	72.8	64.4	54.1	41.2	27.6
4.0	22.1	25.3	26.8	44.4	58.3	68.8	73.4	70.4	64.0	53.8	41.2	27.5
8.0	23.3	26.3	17.9	44.8	59.4	69.1	74.4	70.6	64.9	53.8	43.1	28.3
20.0	28.8	28.7	24.2	43.1	58.0	66.6	72.4	71.8	64.9	55.3	46.7	34.2
40.0	37.5	34.9	34.0	40.9	50.8	58.3	64.1	66.7	63.8	58.5	52.3	43.5
72.0	44.8	42.4	38.5	41.4	46.3	51.6	56.8	59.4	60.0	58.8	55.0	50.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	22.2	25.5	33.0	46.3	60.9	71.6	76.0	72.7	63.7	53.9	40.8	27.4
2.3	22.7	25.7	33.0	46.0	60.4	71.0	75.6	72.6	63.8	54.2	41.3	28.1
4.0	23.3	26.0	32.9	45.5	59.6	70.3	74.9	72.3	63.9	54.5	42.0	28.9
8.0	24.7	26.7	32.8	44.5	58.0	68.6	73.6	71.8	64.1	55.3	43.5	30.8
20.0	28.8	28.9	33.1	42.1	53.7	63.9	69.6	69.7	64.3	57.0	47.2	35.9
40.0	35.2	32.9	34.6	40.1	48.7	57.5	63.6	65.9	63.5	58.6	51.5	42.6
72.0	43.1	39.3	38.3	40.1	44.6	50.7	56.1	59.8	60.4	58.5	54.7	49.2

M= 133.

N= 4

D= 0.0170

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.640	-21.870	0.469	-0.738	-0.560	-15.611	-0.969	-0.504	-0.252

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2125	0.3688	0.4007	0.3653	0.4272	0.3554	0.3640	0.4254	0.3858
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

GARDEN CITY, KANSAS
 SILT LOAM
 BUFFALO GRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	28.5	34.9	43.7	59.0	69.0	77.3	85.9	84.6	75.1	64.2	46.9	31.0
96.0	52.1	48.9	47.6	49.0	52.8	56.7	60.8	64.1	65.3	64.1	61.3	56.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	28.1	33.9	43.5	58.3	68.5	76.3	84.7	83.4	73.5	63.0	45.8	30.1
96.0	52.8	49.1	48.0	49.2	52.7	56.7	60.8	65.0	67.0	66.4	63.7	58.8

M= 50.

N= 4

D= 0.0185

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
57.554	-24.778	-3.004	-0.283	-1.633	-15.128	-0.779	-0.801	0.535

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3395	0.6807	0.7120	0.7168	0.7517	0.6666	0.7067	0.7398	0.7311
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

MANHATTAN, KANSAS
 SILTY CLAY LOAM
 BLUE GRASS

CLIMATOLOGICAL DATA
 1960-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	30.3	32.8	40.5	53.3	66.2	76.6	81.4	80.6	72.3	62.2	46.0	35.1
48.0	43.3	41.0	42.6	48.4	55.8	64.5	69.1	71.6	70.5	66.0	58.2	49.9
72.0	47.8	44.7	44.5	47.5	52.8	59.9	64.0	67.2	67.7	65.2	60.3	53.9
96.0	51.3	47.3	45.7	47.1	50.8	56.6	60.1	63.6	64.9	63.7	60.4	55.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	30.6	33.0	40.7	53.6	66.5	76.3	80.7	79.1	72.0	60.9	46.4	34.9
48.0	42.6	40.3	41.9	47.5	55.4	63.5	69.2	71.8	70.5	65.8	57.8	49.0
72.0	47.7	44.4	44.1	47.1	52.5	59.0	64.3	67.7	68.2	65.8	60.6	53.8
96.0	51.7	48.1	46.7	47.8	51.2	56.0	60.6	64.2	65.7	65.0	61.8	57.0

M= 188.

N= 4

D= 0.0221

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
56.353	-21.905	-0.545	-0.407	-0.207	-15.033	-0.714	0.252	0.108

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1369	0.3036	0.3378	0.3605	0.3807	0.3038	0.3431	0.3668	0.3798
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

MOUND VALLEY, KANS.
 SILTY CLAY
 BERMUDA GRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

J F M A M J J A S O N D

4.0	36.6	37.1	45.3	61.8	71.8	79.3	83.5	81.7	75.9	66.5	54.4	36.4
72.0	52.0	48.2	46.9	49.8	55.8	61.4	66.8	70.5	70.9	67.8	65.3	58.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

J F M A M J J A S O N D

4.0	34.9	36.8	44.2	60.6	71.8	77.7	83.5	81.3	74.2	67.3	52.0	37.6
72.0	52.1	48.9	48.2	51.3	57.3	62.7	67.2	70.7	70.9	69.2	65.4	58.5

M= 56.
 N= 4
 D= 0.0204

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
60.277	-21.325	-1.100	-0.376	-1.748	-14.375	-2.382	0.126	0.851

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3011	0.5803	0.6092	0.6282	0.6476	0.5606	0.6069	0.6307	0.6330
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LEXINGTON, KY.
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1922-1927

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	32.7	35.5	42.1	56.0	62.8	74.6	77.1	76.7	73.1	58.3	45.6	39.7
4.0	20.4	17.3	35.4	49.8	55.6	69.4	75.4	74.6	63.3	55.8	37.6	24.4
18.0	36.3	35.9	41.5	52.0	57.5	67.8	70.6	73.4	70.2	59.8	49.1	41.1
36.0	41.8	40.5	44.0	50.3	56.2	65.8	70.5	73.4	68.8	62.0	53.9	47.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	28.6	29.7	41.4	53.9	62.1	72.5	78.2	75.9	69.5	57.1	42.5	34.2
4.0	28.9	29.9	41.2	53.6	61.8	72.1	77.9	75.7	69.5	57.4	42.9	34.6
18.0	33.9	32.5	39.9	50.4	57.9	66.7	73.2	73.3	69.4	60.5	48.2	39.8
36.0	39.4	36.4	39.9	47.6	54.1	61.3	67.8	69.9	68.2	62.6	53.2	45.3

M= 48.

N= 4

D= 0.0163

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
53.916	-21.311	-1.260	0.822	0.821	-13.917	-0.502	-0.464	1.079

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.6405	1.0674	1.1259	1.1683	1.2075	1.0654	1.1267	1.1713	1.2018
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LEXINGTON, KY.
 SILTY CLAY
 SOD
 E.B. PENROD
 REFERENCE (8,9)
 1952-1956

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	37.2	40.1	46.7	56.2	68.7	79.1	82.6	78.8	73.1	60.4	45.6	38.5
24.0	42.1	42.0	46.0	51.6	60.8	69.4	74.5	74.6	72.2	64.7	53.9	45.5
48.0	48.8	46.4	47.0	49.6	54.9	61.5	67.0	69.5	69.4	66.5	60.6	54.0
72.0	50.8	48.0	47.5	49.4	53.6	59.4	64.5	67.6	68.3	66.4	61.8	56.0
96.0	54.0	50.8	48.9	49.8	52.4	56.7	61.2	64.4	66.3	65.7	63.0	58.8
120.0	56.4	53.5	51.0	50.7	52.0	55.1	58.8	61.9	64.1	64.5	63.2	60.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
0.0	36.2	38.9	45.2	54.9	67.1	77.9	80.7	78.2	72.5	60.4	45.9	37.9
24.0	41.8	41.8	45.1	51.5	60.2	69.6	74.5	74.8	72.1	64.9	53.9	45.6
48.0	47.0	45.3	46.4	50.1	56.1	63.6	69.0	71.0	70.4	66.5	58.9	51.6
72.0	51.3	48.8	48.4	50.2	54.0	59.5	64.5	67.4	68.1	66.4	61.7	55.9
96.0	54.6	51.9	50.7	51.1	53.2	57.0	61.1	64.2	65.7	65.4	62.8	58.7
120.0	57.0	54.4	52.8	52.4	53.3	55.7	58.8	61.6	63.4	64.0	62.9	60.2

M= 356.

N= 4

D= 0.0193

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A ₀	A ₁	A ₂	A ₃	A ₄	B ₁	B ₂	B ₃	B ₄
58.054	-19.049	-0.533	-0.976	0.423	-12.840	0.687	0.667	0.257

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1023	0.2366	0.2616	0.2799	0.2905	0.2353	0.2653	0.2807	0.2934
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

UPPER MARLBORO, MD.
 SANDY LOAM
 BARE

CLIMATOLOGICAL DATA
 1960-1962

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.3	33.0	37.0	.0	.0	67.0	74.5	77.0	78.0	73.5	58.0	43.3	34.0
3.9	33.0	36.5	.0	.0	66.5	74.5	77.0	78.0	74.5	58.7	44.3	34.7
7.8	34.0	37.0	.0	.0	67.5	73.0	76.5	77.5	74.5	59.7	46.0	36.0
19.7	35.5	36.5	.0	.0	66.5	72.5	75.5	76.5	74.5	60.7	48.0	38.3
39.4	38.5	36.5	.0	.0	60.5	67.0	70.0	72.0	71.0	62.7	52.7	43.5
59.0	42.5	39.0	.0	.0	58.0	64.0	67.0	69.5	69.5	64.3	56.0	48.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.3	32.7	35.3	40.5	53.4	68.3	74.7	76.3	78.6	72.9	58.7	43.8	34.6
3.9	32.8	35.4	40.5	53.3	68.1	74.6	76.2	78.5	72.9	58.8	43.9	34.7
7.8	33.4	35.7	40.4	52.6	67.0	73.7	75.6	77.9	72.9	59.6	45.1	35.8
19.7	35.5	36.8	40.6	50.7	64.0	71.4	73.7	76.2	72.8	61.5	48.1	38.8
39.4	38.8	38.8	41.2	48.6	59.9	67.6	70.6	73.4	72.0	63.7	52.2	43.2
59.0	42.0	40.9	42.2	47.4	56.6	64.3	67.9	70.7	70.7	64.9	55.4	47.0

M= 149.

N= 4

D= .0415

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
55.926	-20.636	-1.172	-.192	-.190	-13.749	-.275	2.295	-.767

STANDARD DEVIATION OF FOURIER COEFFICIENTS

.1639 .2505 .2915 .2855 .2946 .2867 .2727 .2949 .2924

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

CHATHAM, MICHIGAN
SANDY LOAM
SOD
CLIMATOLOGICAL DATA
1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

4.0	39.3	38.3	38.4	46.2	61.7	.0	78.4	73.2	66.0	57.2	48.5	40.9
8.0	39.0	39.3	39.3	41.8	55.9	.0	72.9	67.9	61.5	53.6	48.9	44.8

ST-41

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 SAND
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1911-1915

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE(IN)

	J	F	M	A	M	J	J	A	S	O	N	D
2.0	30.6	32.2	34.3	56.2	58.7	70.0	76.2	70.8	68.2	54.1	41.1	30.2
4.0	31.3	32.7	34.5	54.4	58.1	68.6	75.0	70.0	67.4	54.0	41.5	31.8
6.0	30.5	30.5	33.6	47.7	58.5	69.9	74.5	71.4	65.3	53.0	40.5	33.8
12.0	32.2	31.4	33.4	42.9	56.3	67.8	72.8	70.7	64.5	53.6	41.9	36.0
18.0	34.3	33.0	33.9	42.5	54.4	65.5	71.1	69.9	64.8	55.0	43.8	38.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE(IN)

	J	F	M	A	M	J	J	A	S	O	N	D
2.0	30.8	29.4	35.3	49.2	60.4	70.2	75.6	72.1	64.7	53.7	38.8	31.9
4.0	31.3	29.8	35.3	48.6	59.7	69.4	75.0	71.8	64.8	54.2	39.6	32.6
6.0	31.8	30.2	35.2	48.1	59.1	68.7	74.3	71.6	64.9	54.7	40.4	33.2
12.0	33.2	31.4	35.2	46.8	57.2	66.5	72.5	70.8	65.0	55.9	42.7	35.1
18.0	34.5	32.6	35.4	45.6	55.6	64.5	70.6	70.0	65.0	56.9	44.7	36.9

M= 60.

N= 4

D= 0.0186

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.130	-19.971	0.474	0.041	-0.371	-13.354	0.731	1.044	1.288

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2607	0.4051	0.4193	0.4304	0.4415	0.4043	0.4197	0.4314	0.4393
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 CLAY
 UNKNOWN
 E. M. FITTON
 REFERENCE(4)
 1911-1915

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.9	32.1	33.9	54.4	57.4	67.8	74.4	69.4	66.7	52.9	41.1	32.3
4.0	32.0	32.3	33.7	52.0	55.3	65.5	71.6	68.2	65.5	52.3	41.2	33.0
6.0	31.3	30.9	33.2	45.7	57.2	68.8	73.8	70.5	64.8	52.8	41.2	34.4
12.0	32.7	31.7	32.9	42.3	55.5	67.0	72.2	70.2	64.6	53.5	42.2	36.6
18.0	34.2	32.8	33.3	41.5	54.2	65.3	70.9	69.8	64.9	55.1	43.9	38.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.9	29.8	34.6	47.2	58.4	68.3	73.7	71.0	64.1	53.3	39.6	33.5
4.0	32.2	30.1	34.6	46.9	57.9	67.7	73.2	70.8	64.1	53.7	40.2	33.9
6.0	32.6	30.4	34.6	46.5	57.4	67.1	72.8	70.6	64.2	54.0	40.8	34.3
12.0	33.6	31.3	34.7	45.6	56.1	65.5	71.4	70.0	64.3	54.9	42.4	35.6
18.0	34.6	32.3	34.9	44.8	54.8	64.0	70.0	69.4	64.3	55.8	43.8	36.9

M= 60.

N= 4

D= 0.0328

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.560	-18.089	0.725	0.112	-0.276	-13.454	1.027	1.083	1.070

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2450	0.3739	0.3838	0.3917	0.3999	0.3731	0.3842	0.3926	0.3980
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 GRAVEL
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1911-1915

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.8	32.2	34.3	56.2	58.5	69.8	75.7	70.5	67.7	53.7	41.4	32.3
4.0	32.3	32.7	34.4	54.8	57.8	67.9	74.2	69.4	66.7	53.6	41.7	33.0
6.0	31.2	31.0	33.6	47.6	58.4	70.4	75.0	71.5	65.4	53.2	40.9	34.2
12.0	32.1	31.4	33.5	44.0	56.6	68.7	73.6	71.0	64.7	53.6	41.6	35.8
18.0	33.7	32.8	33.7	42.8	55.0	66.8	72.2	70.4	64.9	54.6	43.1	37.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.8	29.7	35.4	48.9	59.9	69.9	75.3	71.8	64.6	53.8	39.4	33.2
4.0	32.1	30.0	35.3	48.5	59.5	69.3	74.9	71.6	64.7	54.2	40.0	33.6
6.0	32.5	30.3	35.3	48.2	59.0	68.8	74.4	71.5	64.7	54.5	40.6	34.0
12.0	33.5	31.2	35.3	47.2	57.7	67.2	73.1	71.0	64.9	55.4	42.2	35.3
18.0	34.4	32.1	35.4	46.3	56.4	65.7	71.8	70.4	64.9	56.2	43.7	36.6

M= 60.

N= 4

D= 0.0362

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.266	-19.064	0.709	0.131	-0.295	-13.333	0.840	1.037	1.313

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2589	0.3920	0.4019	0.4099	0.4181	0.3912	0.4024	0.4108	0.4162
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 PEAT
 UNKNOWN
 E. M. FITTON
 REFERENCE (4)
 1911-1915

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	32.0	31.9	31.9	49.9	56.7	67.5	74.2	69.4	66.9	52.9	40.5	33.3
4.0	31.9	31.7	31.6	46.6	55.0	64.6	71.5	67.5	64.7	51.5	40.7	34.0
6.0	30.8	30.4	31.4	41.1	56.8	68.5	73.9	71.0	65.1	52.9	40.9	34.7
12.0	32.6	31.6	31.9	38.6	54.7	66.9	72.1	71.3	65.6	54.8	42.8	36.6
18.0	35.2	33.7	33.4	37.8	53.2	64.5	70.8	70.3	65.6	56.4	45.2	39.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	32.0	29.9	32.3	43.4	57.3	68.6	73.4	71.5	64.6	53.2	40.1	33.7
4.0	32.3	30.2	32.4	43.1	56.7	68.0	72.9	71.2	64.7	53.6	40.7	34.2
6.0	32.7	30.6	32.5	42.8	56.2	67.4	72.4	71.0	64.7	54.0	41.2	34.7
12.0	33.8	31.6	32.9	42.1	54.6	65.5	70.9	70.2	64.8	55.0	42.9	36.1
18.0	34.8	32.6	33.4	41.4	53.1	63.8	69.5	69.4	64.7	55.8	44.4	37.4

M= 60.

N= 4

D= 0.0284

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.121	-17.635	1.394	-0.453	-0.161	-14.644	1.727	1.440	0.446

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2335	0.3566	0.3668	0.3748	0.3831	0.3559	0.3672	0.3757	0.3813
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 LOAM
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1914-1916

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.3	31.5	33.3	55.2	57.0	67.9	73.4	68.5	67.2	53.4	41.0	32.5
4.0	32.0	32.1	33.9	53.0	56.4	66.4	72.8	68.1	65.9	52.8	41.4	33.6
6.0	30.8	30.4	32.6	45.4	57.0	68.9	74.0	70.6	64.8	52.6	40.7	34.2
12.0	32.7	31.7	32.5	42.0	55.5	67.6	73.0	70.9	65.1	54.1	42.4	36.7
18.0	34.5	33.1	33.1	40.8	53.1	64.3	70.2	69.3	64.5	55.1	44.0	38.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.6	29.2	34.4	47.5	58.7	68.7	74.0	70.9	64.3	53.5	39.4	33.4
4.0	32.1	29.6	34.3	47.0	58.1	68.0	73.5	70.7	64.3	53.9	40.1	33.9
6.0	32.5	29.9	34.3	46.6	57.5	67.4	72.9	70.5	64.4	54.3	40.7	34.4
12.0	33.7	31.1	34.5	45.5	55.9	65.5	71.3	69.8	64.4	55.3	42.6	35.9
18.0	34.9	32.2	34.7	44.6	54.5	63.7	69.7	69.1	64.4	56.3	44.3	37.3

M= 60.
 N= 4
 D= 0.0238

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.568	-18.494	0.823	0.137	-0.187	-13.561	0.880	1.148	1.249

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2679	0.4119	0.4247	0.4348	0.4450	0.4111	0.4252	0.4358	0.4429
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

EAST LANSING, MICH.
 FINE SANDY LOAM
 FESCUE GRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	32.6	31.1	35.0	49.3	64.2	67.9	78.4	73.6	68.1	59.7	48.4	35.6
6.0	33.1	31.4	34.0	45.8	60.3	66.4	73.9	70.7	66.1	58.2	48.3	36.4
12.0	33.8	32.0	33.4	43.0	56.9	68.9	70.3	68.4	64.3	57.0	48.8	38.0
24.0	36.2	33.7	34.0	41.8	54.2	67.6	69.0	67.3	64.2	58.4	51.4	41.3
36.0	38.1	35.2	34.7	41.0	52.6	64.3	65.5	66.6	64.1	59.1	52.8	43.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	31.5	30.2	33.1	46.5	61.3	70.5	74.2	71.4	64.9	57.9	46.0	35.2
6.0	32.2	30.8	33.3	45.9	60.2	69.5	73.4	71.1	65.0	58.3	46.9	36.2
12.0	33.7	32.0	33.7	44.7	58.3	67.6	71.9	70.4	65.0	58.9	48.5	38.1
24.0	36.5	34.3	34.8	43.1	54.9	64.0	69.0	69.0	64.9	59.8	51.2	41.6
36.0	39.1	36.5	36.1	42.1	52.2	60.9	66.2	67.3	64.4	60.3	53.2	44.6

M= 125.

N= 4

D= 0.0229

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.011	-17.816	1.890	-0.879	-1.025	-14.972	-0.900	0.807	0.230

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2259	0.4019	0.4053	0.4046	0.4332	0.3393	0.3796	0.3972	0.3895
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FAIRMONT, MINN.
 CLAR.-NICL.-WBSTR.
 GRASS

CLIMATOLOGICAL DATA
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE(IN)

	J	F	M	A	M	J	J	A	S	O	N	D
3.0	27.2	30.4	31.7	49.9	64.2	72.1	78.4	74.6	67.5	54.9	41.3	28.4
6.0	27.4	30.2	31.3	48.8	62.2	69.4	76.6	72.4	66.6	54.4	40.9	29.4
12.0	29.0	29.0	30.9	44.4	56.6	62.6	71.4	68.8	62.5	54.9	44.3	32.2
24.0	33.4	32.0	32.0	42.4	53.2	58.4	67.4	67.5	62.7	56.1	47.6	37.4
36.0	36.9	35.3	34.4	41.2	50.5	55.4	64.0	65.6	62.5	57.1	50.2	41.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE(IN)

	J	F	M	A	M	J	J	A	S	O	N	D
3.0	26.9	27.2	31.7	49.0	62.5	69.8	76.6	72.9	62.2	53.9	39.2	27.2
6.0	27.9	28.0	31.8	47.7	60.9	68.3	75.2	72.5	62.6	54.6	40.9	28.9
12.0	29.8	29.6	32.0	45.4	58.1	65.6	72.4	71.5	63.1	55.8	43.8	32.1
24.0	33.6	32.6	33.3	42.3	53.4	60.8	67.3	68.9	63.4	57.5	48.4	37.8
36.0	37.2	35.6	35.1	40.7	49.8	56.9	62.9	66.0	62.9	58.4	51.5	42.5

M= 101.

N= 4

D= 0.0107

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.053	-22.768	0.663	-0.226	-2.277	-14.083	-0.328	0.070	0.960

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2986	0.5261	0.5825	0.5844	0.6349	0.5286	0.5544	0.6059	0.5941
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FARIBAULT, MINN.
 SILT LOAM
 GRASS

CLIMATOLOGICAL DATA
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	25.5	22.1	26.7	43.4	59.2	67.5	74.1	66.9	59.5	49.0	0.0	0.0
6.0	27.5	26.2	29.0	41.3	56.2	64.3	69.9	69.1	57.5	50.3	38.7	27.2
12.0	27.8	26.8	29.7	39.2	55.8	63.6	68.5	67.8	58.6	51.4	41.6	29.6
24.0	31.0	29.2	30.3	37.3	52.0	63.2	67.3	66.7	60.0	54.6	44.7	33.9
36.0	33.3	31.5	31.1	35.9	47.9	57.4	63.3	64.4	60.3	53.7	49.1	38.4
48.0	34.3	32.7	32.6	35.8	46.9	55.8	61.3	63.0	59.8	55.8	50.2	41.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	25.8	25.8	27.7	42.1	58.4	67.4	72.1	68.7	58.5	50.6	39.2	27.9
6.0	26.4	26.3	27.9	41.3	57.3	66.4	71.2	68.5	58.8	51.0	40.1	28.9
12.0	27.7	27.3	28.3	40.1	55.2	64.4	69.6	67.8	59.2	51.8	41.7	30.8
24.0	30.2	29.3	29.5	38.3	51.6	60.9	66.4	66.4	59.7	53.1	44.5	34.4
36.0	32.6	31.3	30.8	37.1	48.6	57.7	63.4	64.7	59.8	54.0	46.7	37.6
48.0	35.0	33.2	32.2	36.6	46.3	54.9	60.6	62.9	59.5	54.6	48.4	40.3

M= 115.

N= 4

D= 0.0251

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
47.121	-20.013	2.278	-0.810	-1.747	-14.541	0.072	0.701	-0.169

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1584	0.2833	0.2973	0.3156	0.3212	0.2689	0.2960	0.3042	0.3156
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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

LAMBERTON, MINN.
SILTY CLAY LOAM
BARE SOIL
CLIMATOLOGICAL DATA
1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

	MONTH OF YEAR											
DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
2.0	21.7	23.5	30.8	46.4	63.3	71.4	82.4	76.0	66.6	57.1	39.3	23.4
12.0	25.3	25.8	29.0	39.8	54.4	65.6	72.1	69.4	61.5	53.7	43.6	30.1

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST. PAUL, MINN.
 SILT LOAM
 SOD

CLIMATOLOGICAL DATA
 1961-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	25.2	25.7	30.6	43.5	62.8	74.9	80.8	77.3	65.6	54.9	39.6	30.8
1.9	25.2	25.4	30.0	42.0	61.9	74.3	79.6	76.4	65.6	55.0	40.1	30.9
3.9	25.7	25.2	29.6	40.4	59.8	72.0	77.4	74.8	65.0	54.9	40.6	31.5
7.9	26.6	25.5	29.2	36.1	56.1	67.5	73.6	71.7	63.8	54.2	41.2	33.1
15.7	29.5	26.6	29.0	34.5	52.6	63.2	69.2	69.3	63.4	54.7	43.5	36.4
31.5	33.5	29.8	30.4	33.3	48.1	58.4	65.3	67.3	63.4	56.3	46.4	39.2
47.2	37.0	33.7	32.4	33.6	45.2	54.7	61.8	64.3	62.7	57.2	50.0	42.1
62.9	39.4	36.1	34.2	34.1	43.4	52.4	59.4	62.6	61.9	57.6	51.9	44.3
125.9	45.8	42.9	40.3	39.2	41.0	45.8	51.0	55.2	57.2	56.0	53.8	49.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	24.7	24.4	27.7	40.6	59.3	72.6	76.8	74.0	64.4	52.1	39.6	29.4
1.9	25.1	24.7	27.8	40.2	58.6	72.0	76.3	73.8	64.5	52.4	40.1	30.0
3.9	25.7	25.1	27.9	39.8	57.8	71.1	75.7	73.5	64.6	52.9	40.7	30.7
7.9	26.8	25.9	28.3	39.1	56.2	69.5	74.4	72.9	64.8	53.7	41.9	32.0
15.7	28.9	27.5	29.0	38.0	53.3	66.4	72.1	71.7	65.0	55.0	44.1	34.6
31.5	33.0	30.6	30.8	36.8	48.8	60.9	67.4	68.8	64.8	57.0	47.8	39.1
47.2	36.6	33.6	32.9	36.5	45.6	56.4	63.2	65.9	63.9	58.1	50.5	42.8
62.9	39.8	36.4	35.0	36.9	43.6	52.7	59.5	63.0	62.5	58.5	52.4	45.7
125.9	48.1	44.9	42.6	41.3	42.2	45.6	49.8	53.6	55.9	56.2	54.6	51.7

M= 440.

N= 4

D= 0.0234

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
48.925	-21.009	2.461	-0.817	-0.276	-17.475	1.048	0.767	-0.512

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1230	0.2180	0.2283	0.2358	0.2436	0.2128	0.2265	0.2347	0.2382
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST. PAUL, MINN.
 SILT LOAM
 SOD

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
189.0	49.4	47.3	44.9	42.1	42.8	44.4	46.7	49.4	51.8	53.1	52.9	50.6
252.0	50.3	49.4	48.4	47.1	46.1	45.7	46.1	47.0	48.5	49.8	50.6	50.7
315.0	49.8	49.4	49.2	48.2	47.8	47.5	46.9	47.0	48.3	50.8	49.7	49.3
378.0	48.6	49.1	48.7	48.4	48.2	48.0	47.3	47.4	47.6	47.8	48.3	48.3
441.0	48.3	48.4	48.6	48.3	48.2	48.2	47.8	47.5	47.6	47.5	47.9	48.0
504.0	47.9	48.2	48.4	48.3	48.3	48.2	47.9	47.8	47.9	47.8	47.7	47.7

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE(IN)	J	F	M	A	M	J	J	A	S	O	N	D
189.0	49.4	47.8	45.0	42.7	43.0	44.6	46.8	49.6	52.0	53.2	52.8	51.0
252.0	50.0	49.2	48.1	46.5	45.5	45.5	46.0	47.2	48.7	50.0	50.7	50.7
315.0	49.5	49.3	48.9	48.2	47.4	46.9	46.7	47.0	47.6	48.3	49.0	49.5
378.0	48.8	48.9	48.9	48.6	48.3	47.8	47.5	47.4	47.5	47.8	48.2	48.6
441.0	48.3	48.5	48.6	48.6	48.5	48.3	48.0	47.9	47.8	47.8	47.9	48.1
504.0	48.1	48.2	48.3	48.4	48.4	48.3	48.2	48.1	48.0	48.0	48.0	48.0

M= 159.

N= 4

D= 0.0251

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
48.183	-29.363	5.640	9.631	5.348	-15.043	-1.565	-0.662	5.273

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0529	1.0653	2.5035	4.7083	7.9688	1.0614	2.5091	4.7183	7.9263
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST. PAUL, MINN.
 SILT LOAM
 BARE SOIL

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	18.3	23.5	32.1	51.8	71.0	86.7	94.8	85.6	71.0	58.8	39.4	25.8
1.9	19.2	23.5	31.3	50.1	68.9	85.3	93.4	84.5	71.3	59.8	42.0	27.6
3.9	19.7	23.0	29.7	46.9	65.3	80.9	89.3	80.4	69.4	57.3	41.7	28.4
7.9	19.9	21.7	28.2	41.2	59.6	73.9	83.3	76.5	66.3	55.9	41.7	29.7
15.7	22.7	21.9	27.9	36.6	55.0	68.6	77.9	73.8	65.1	55.5	43.6	32.8
31.5	28.2	24.9	28.3	32.8	49.2	62.4	72.5	71.8	65.4	57.1	47.3	37.3
47.2	34.6	31.4	31.3	32.6	47.8	58.9	68.5	69.9	64.7	55.1	49.6	40.7

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	17.3	20.0	29.0	46.3	66.1	82.9	88.9	80.6	66.6	54.6	38.8	23.4
1.9	17.9	20.3	28.9	45.8	65.2	81.8	88.2	80.5	66.8	55.0	39.0	24.3
3.9	18.9	20.8	28.9	45.0	64.0	80.5	87.2	80.2	67.1	55.6	40.6	25.6
7.9	20.7	21.8	28.9	43.7	61.7	77.9	85.2	79.7	67.7	56.7	42.5	27.9
15.7	24.1	23.8	29.2	41.7	57.8	73.2	81.5	78.5	68.3	58.4	45.8	32.1
31.5	30.7	28.2	30.7	39.1	51.6	65.1	74.3	75.1	68.6	60.9	51.0	39.4
47.2	36.5	32.6	33.0	38.2	47.6	58.9	67.9	71.1	67.8	62.0	54.4	44.9

M= 183.

N= 4

D= 0.0158

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.351	-28.918	2.585	-1.163	-0.688	-19.651	-0.090	-1.106	0.185

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3444	0.5704	0.5857	0.6003	0.6190	0.5476	0.5827	0.6023	0.6034
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST. PAUL, MINN.
 SILT LOAM
 MULCH

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	20.3	23.2	31.3	49.4	67.8	82.9	83.0	74.9	66.8	56.3	40.3	25.8
1.9	20.7	22.6	31.1	48.7	66.6	79.5	80.1	73.3	66.4	56.9	40.9	26.0
3.9	21.9	23.3	29.6	46.0	64.6	77.3	79.0	72.7	65.8	56.7	42.0	27.3
7.9	22.5	22.6	28.7	41.3	59.5	72.4	76.3	70.7	64.3	55.4	42.3	28.9
15.7	24.9	23.2	28.1	36.4	54.8	66.8	72.9	68.7	63.1	55.0	44.4	31.9
31.5	31.0	26.8	29.0	33.8	50.3	61.6	68.3	66.8	63.0	56.6	48.4	37.3
47.2	35.9	31.3	31.8	33.6	49.0	58.5	65.0	65.6	62.5	55.1	50.3	40.7

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.4	19.3	21.2	28.8	45.8	65.6	78.8	79.6	72.4	64.2	54.5	38.7	24.6
1.9	19.9	21.6	28.8	45.2	64.7	77.9	79.1	72.3	64.3	54.9	39.5	25.4
3.9	20.7	22.0	28.8	44.5	63.5	76.8	78.5	72.1	64.4	55.3	40.4	26.5
7.9	22.4	23.0	28.8	43.2	61.2	74.6	77.1	71.7	64.5	56.1	42.2	28.6
15.7	25.5	24.9	29.2	41.1	57.3	70.5	74.5	70.8	64.7	57.4	45.3	32.5
31.5	31.3	28.9	30.7	38.5	51.1	63.3	69.1	68.4	64.3	59.0	49.9	39.1
47.2	36.5	32.9	32.9	37.7	46.9	57.5	64.1	65.5	63.3	59.6	52.9	44.1

M= 182.

N= 4

D= 0.0156

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.592	-25.456	2.483	-1.924	-0.350	-17.074	-2.000	0.360	0.106

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2489	0.4121	0.4227	0.4333	0.4470	0.3952	0.4207	0.4348	0.4355
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

WASECA, MINN.
 CLAY LOAM
 BARE SOIL
 CLIMATOLOGICAL DATA
 1964-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.9	16.1	19.9	-0.0	-0.0	-0.0	0.0	0.0	70.8	60.7	47.7	0.0	34.9
3.9	17.4	18.8	-0.0	-0.0	-0.0	0.0	0.0	68.4	59.2	47.0	0.0	36.2
7.9	18.0	19.6	-0.0	-0.0	-0.0	0.0	0.0	67.5	57.2	47.4	0.0	37.6
19.7	28.5	26.5	-0.0	-0.0	-0.0	60.9	69.8	68.0	62.5	52.8	0.0	46.3
39.4	0.0	0.0	-0.0	-0.0	-0.0	55.0	62.6	64.4	61.5	54.8	0.0	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.9	14.9	19.7	45.8	55.1	57.2	72.1	77.3	69.6	58.5	46.9	43.8	35.8
3.9	16.7	19.9	44.6	54.5	56.6	70.8	76.5	69.5	59.0	47.6	44.2	36.8
7.9	20.1	20.6	42.6	53.3	55.4	68.2	74.7	69.2	59.8	49.0	45.1	38.7
19.7	28.8	24.0	38.3	49.8	52.5	62.0	69.6	67.7	61.1	52.4	47.4	43.0
39.4	39.0	31.5	36.2	45.5	49.1	54.8	61.9	63.8	61.1	55.7	50.7	47.6

M= 31.
 N= 4
 D= 0.0076

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.845	-22.937	0.572	3.450	3.771	-11.694	-3.318	-6.586	0.358

STANDARD DEVIATION OF FOURIER COEFFICIENTS

1.1025	0.7825	2.7815	2.1615	0.9815	3.0076	1.5943	1.5026	1.7067
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

STATE UNIV. MISS.
 CLAY
 BARE
 CLIMATOLOGICAL DATA
 1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	45.5	47.9	54.8	68.0	79.8	85.9	85.9	86.8	82.0	70.8	59.0	46.5
4.0	45.1	49.0	56.2	67.1	77.8	82.2	85.3	86.8	82.5	72.2	59.0	47.2
8.0	47.3	49.3	55.0	65.0	75.2	79.6	82.3	83.7	80.1	70.0	57.9	48.0
16.0	47.7	49.0	54.0	64.5	74.2	79.5	82.4	83.6	81.1	71.9	63.3	50.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	44.7	48.6	55.2	67.4	78.4	82.9	85.1	86.2	81.2	70.7	57.0	46.6
4.0	45.2	48.7	55.1	66.9	77.8	82.4	84.7	85.9	81.2	71.1	57.7	47.4
8.0	46.1	49.1	54.9	65.9	76.5	81.4	83.8	85.2	81.2	71.8	59.2	48.9
16.0	48.1	50.0	54.7	64.2	74.2	79.5	82.1	83.8	81.0	73.1	61.7	51.8

M= 187.

N= 4

D= 0.0192

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
67.092	-18.586	-1.926	-0.229	-0.536	-11.545	-1.373	1.161	-0.340

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2123	0.3346	0.3344	0.3373	0.3510	0.3151	0.3363	0.3477	0.3469
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

FAUCETT, MO.
 UNKNOWN
 SOD
 JEN-HU-CHANG
 REFERENCE(5)
 1951-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	33.0	33.8	38.7	47.8	64.1	73.8	83.4	81.1	71.4	56.4	43.8	34.4
3.0	33.2	33.6	38.0	46.3	63.0	71.1	79.9	78.3	70.2	55.8	43.6	35.1
6.0	33.8	33.8	37.5	45.2	62.1	69.1	76.7	76.4	69.4	56.5	44.1	36.4
12.0	35.3	35.2	37.5	43.8	61.1	68.0	73.6	74.6	70.2	56.8	46.2	38.6
24.0	37.2	36.0	38.5	44.3	58.0	65.3	71.1	73.6	68.0	59.5	49.2	42.4
48.0	43.2	41.6	41.7	44.8	53.5	60.7	65.4	67.7	66.6	62.6	55.6	48.6
72.0	45.5	44.4	44.2	46.0	48.9	55.6	61.3	64.0	64.7	62.5	57.0	51.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	32.4	33.9	37.0	48.2	63.3	73.3	78.5	78.8	69.1	55.3	42.9	34.6
3.0	32.9	34.2	37.1	47.7	62.5	72.6	77.9	78.4	69.2	55.8	43.6	35.3
6.0	33.6	34.6	37.2	47.2	61.4	71.5	76.9	77.9	69.4	56.6	44.7	36.3
12.0	35.0	35.5	37.6	46.2	59.4	69.4	75.0	76.7	69.7	58.0	46.6	38.2
24.0	37.8	37.4	38.6	44.9	56.0	65.6	71.5	74.1	69.7	60.2	50.0	41.9
48.0	42.9	41.1	41.0	44.0	51.3	59.5	65.3	69.1	68.2	62.5	54.8	47.8
72.0	47.2	44.7	43.7	44.6	49.0	55.3	60.6	64.6	65.7	62.9	57.6	52.0

M= 84.
 N= 4
 D= 0.0203

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.053	-19.688	0.428	-0.090	-0.486	-14.840	1.923	1.095	-0.692

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1373	2.2374	0.2508	0.2600	0.2681	0.2370	0.2510	0.2606	0.2668
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

KANSAS CITY, MO.
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE(5)
 1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	34.8	41.1	41.8	54.5	70.3	77.7	75.4	75.5	71.2	61.1	48.5	34.5
7.9	35.6	37.8	41.3	52.9	63.4	75.2	73.3	76.6	67.4	58.8	47.6	36.6
11.8	36.9	38.0	40.3	49.8	60.6	70.7	72.2	78.3	66.0	58.9	48.3	38.7
19.7	38.1	38.9	40.2	47.7	58.0	67.0	69.8	69.1	64.9	59.4	49.7	40.8
39.4	39.5	39.7	40.9	47.1	55.4	63.7	67.7	71.2	65.1	60.1	50.6	43.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	34.3	38.0	40.7	51.4	66.1	73.1	75.3	74.6	67.4	57.8	45.9	35.2
7.9	35.0	38.3	40.8	50.7	64.7	72.1	74.4	74.1	67.5	58.5	47.1	36.6
11.8	35.7	38.7	40.9	50.0	63.5	71.0	73.6	73.6	67.7	59.1	48.2	37.8
19.7	37.1	39.4	41.3	48.9	61.3	69.1	72.0	72.6	67.8	60.1	50.1	40.2
39.4	40.8	41.3	42.4	47.2	56.7	64.6	68.3	69.9	67.5	61.8	54.1	45.4

M= 60.
 N= 4
 D= 0.0257

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
55.075	-18.913	0.017	-1.235	-1.026	-12.051	0.002	1.137	-0.855

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2827	0.4644	0.4897	0.5089	0.5273	0.4636	0.4901	0.5103	0.5247
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SIKESTON, MO.
 SANDY LOAM
 GRASS

CLIMATOLOGICAL DATA
 1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	37.3	41.1	48.2	60.0	71.5	80.5	85.5	83.4	75.9	65.2	51.2	38.1
3.0	37.6	37.8	47.9	59.8	71.7	80.7	85.6	83.9	76.7	66.1	52.2	38.5
6.0	37.7	38.0	47.5	59.2	71.2	80.2	85.2	83.3	76.2	66.1	52.4	39.4
24.0	38.6	38.9	44.6	53.1	63.7	71.4	75.9	77.2	73.1	65.0	54.1	43.7
72.0	47.3	39.7	44.7	48.4	55.5	62.0	67.1	70.3	70.5	67.1	61.5	53.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	35.2	39.2	46.3	58.8	70.8	79.5	84.4	82.3	74.7	64.3	49.2	37.1
3.0	35.7	39.4	46.2	58.4	70.3	79.0	83.9	82.1	74.7	64.7	49.8	37.8
6.0	36.3	39.7	46.1	57.8	69.4	78.1	83.1	81.8	74.8	65.1	50.8	38.8
24.0	40.1	41.5	45.9	54.9	65.1	73.4	78.9	79.5	74.9	67.4	55.8	44.6
72.0	49.6	47.5	48.2	51.8	57.9	64.3	69.6	72.8	72.4	69.4	63.4	55.7

M= 300.

N= 4

D= 0.0302

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
60.266	-20.823	-1.184	-0.780	-0.739	-13.855	-0.400	0.125	0.144

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1891	0.3090	0.3203	0.3291	0.3381	0.3092	0.3228	0.3309	0.3350
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SPICKARD, MO.
 SILT LOAM
 GRASS

CLIMATOLOGICAL DATA
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.6	31.4	39.5	53.4	64.3	73.5	76.9	75.0	69.9	65.4	49.5	33.6
3.0	32.7	30.6	38.5	52.3	60.0	70.3	74.4	73.3	69.0	63.9	50.7	37.3
6.0	35.0	33.9	37.9	50.5	61.8	68.0	73.0	72.2	68.7	63.7	50.7	40.0
12.0	43.0	36.5	38.8	48.6	60.1	64.4	70.0	0.0	0.0	0.0	59.9	53.1
24.0	40.5	43.0	42.4	47.8	56.2	59.3	63.8	66.7	66.5	63.8	0.0	0.0
48.0	0.0	45.7	44.9	46.7	53.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
1.0	35.3	34.1	38.9	51.6	62.1	68.7	73.2	72.6	69.2	64.1	52.2	40.4
3.0	35.6	34.4	38.9	51.3	61.8	68.4	72.9	72.5	69.1	64.2	52.6	40.8
6.0	36.1	34.8	38.9	50.9	61.3	67.9	72.4	72.2	69.0	64.3	53.1	41.0
12.0	37.2	35.6	39.1	50.1	60.3	66.9	71.5	71.7	68.8	64.5	54.1	42.8
24.0	39.2	37.1	39.5	48.9	58.4	65.0	69.7	70.6	68.4	64.8	55.8	45.2
48.0	43.0	40.1	40.7	47.3	55.4	61.7	66.4	68.4	67.3	64.8	58.3	49.3

M= 75.

N= 4

D= 0.0500

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
55.306	-14.061	0.160	-0.376	-0.905	-14.636	-2.252	0.336	0.451

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.4312	0.6544	0.6755	0.6919	0.6889	0.6457	0.6528	0.6580	0.6492
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BOZEMAN, MONTANA
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE(5)
 1916-1920

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	29.7	29.1	30.2	35.0	44.2	55.4	64.4	62.9	55.4	44.6	35.4	31.5
24.0	31.8	30.7	31.4	34.8	42.8	52.3	60.0	61.4	56.2	47.0	38.6	34.1
36.0	33.5	32.2	32.0	34.1	40.0	48.7	56.1	58.1	55.1	47.6	39.9	35.6
48.0	36.0	34.4	33.6	34.6	38.8	46.1	53.8	57.3	55.2	49.2	42.8	38.3
60.0	37.7	35.7	34.7	35.3	38.8	44.8	51.0	54.2	53.7	49.8	44.4	40.2
90.0	41.2	39.3	37.9	37.4	38.7	42.0	46.6	50.8	51.9	50.0	46.4	43.4
120.0	41.8	39.8	38.5	37.9	38.7	41.7	46.1	50.0	51.4	50.1	46.9	43.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	30.6	29.6	30.5	35.2	44.1	55.7	63.4	63.0	55.3	44.7	36.0	32.1
24.0	32.3	31.1	31.4	34.8	42.0	52.2	60.0	61.2	55.7	46.8	38.5	34.3
36.0	34.0	32.5	32.3	34.8	40.5	49.3	56.9	59.3	55.6	48.3	40.7	36.2
48.0	35.5	33.9	33.3	34.9	39.5	47.0	54.1	57.3	55.2	49.4	42.6	38.0
60.0	36.9	35.2	34.4	35.3	38.8	45.1	51.6	55.4	54.5	50.0	44.1	39.6
90.0	40.0	38.1	36.9	36.7	38.2	42.0	46.9	50.9	52.1	50.2	46.4	42.7
120.0	42.2	40.4	39.0	38.3	38.7	40.7	44.0	47.4	49.4	49.3	47.2	44.6

M= 84.
 N= 4
 D= 0.0230

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
43.446	-15.156	1.392	0.067	0.126	-12.159	4.324	0.045	0.180

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0796	0.1797	0.2078	0.2289	0.2483	0.1796	0.2076	0.2297	0.2470
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BOZEMAN, MONTANA
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1916-1920

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	29.7	29.1	30.2	35.0	44.2	55.4	64.4	62.9	55.4	44.6	35.4	31.5
24.0	31.9	30.7	31.4	34.8	42.8	52.3	60.0	61.4	56.2	47.0	38.6	34.1
36.0	33.5	32.2	32.0	34.1	40.0	48.7	56.1	58.1	55.1	47.6	39.9	35.6
48.0	36.0	34.4	33.6	34.6	38.8	46.1	53.8	57.3	55.2	49.2	42.8	38.3
60.0	37.7	35.7	34.7	35.3	38.8	44.8	51.0	54.2	53.7	49.8	44.4	40.2
90.0	41.2	39.3	37.9	37.4	38.7	42.0	46.6	50.8	51.9	50.0	46.4	43.4
120.0	41.8	39.8	38.5	37.9	38.7	41.7	46.1	50.0	51.4	50.1	46.9	43.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	30.6	29.6	30.5	35.2	44.1	55.7	63.4	63.0	55.3	44.7	35.9	32.1
24.0	32.4	31.1	31.4	34.8	42.0	52.2	60.0	61.2	55.7	46.8	38.5	34.3
36.0	34.0	32.5	32.3	34.8	40.5	49.3	56.9	59.3	55.6	48.3	40.7	36.2
48.0	35.5	33.9	33.3	34.9	39.5	47.0	54.1	57.3	55.2	49.4	42.6	38.0
60.0	36.9	35.2	34.4	35.3	38.8	45.1	51.6	55.4	54.5	50.0	44.0	39.6
90.0	40.0	38.1	36.9	36.7	38.2	42.0	46.9	50.9	52.1	50.2	46.4	42.7
120.0	42.2	40.4	39.0	38.3	38.7	40.7	44.0	47.4	49.4	49.3	47.2	44.6

M= 84.
 N= 4
 D= 0.0230

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
43.447	-15.149	1.395	0.070	0.126	-12.158	4.327	0.051	0.187

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0795	0.1795	0.2075	0.2286	0.2480	0.1793	0.2073	0.2294	0.2467
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BOZEMAN, MONTANA
 SILT LOAM
 BLUEGRASS

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	32.2	32.1	32.3	38.1	51.4	60.7	67.5	65.1	55.4	48.0	38.3	32.8
8.0	32.5	31.8	31.9	36.2	48.9	58.0	65.7	63.9	56.2	49.3	38.8	33.5
20.0	31.4	31.0	31.1	36.3	45.9	56.8	60.7	60.0	55.1	50.8	40.8	32.2
40.0	37.8	36.0	34.9	37.6	45.2	53.3	57.7	60.0	55.2	53.5	47.7	39.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	31.6	31.7	31.1	38.1	50.2	60.8	66.3	64.0	56.6	48.6	38.4	31.4
8.0	32.1	32.2	31.5	37.7	49.1	59.5	65.2	63.6	56.8	49.2	39.4	32.4
20.0	33.7	33.6	32.7	37.0	46.5	56.1	62.2	62.3	57.1	50.6	42.1	35.1
40.0	36.3	35.8	34.7	36.7	43.4	51.5	57.6	59.6	56.8	52.1	45.5	39.1

M= 95.
 N= 4
 D= 0.0235

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
45.817	-14.601	1.328	-1.295	-0.831	-12.185	2.610	0.572	0.061

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1872	0.3030	0.3322	0.3363	0.3603	0.3136	0.3194	0.3429	0.3327
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

HUNTLEY, MONTANA
 SILTY CLAY
 BARE GROUND
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	29.5	30.7	35.3	46.6	59.4	67.9	75.9	71.7	62.7	51.9	36.9	30.9
4.0	30.0	30.6	35.0	46.0	59.6	68.3	77.1	73.3	63.9	53.8	38.2	32.1
8.0	31.2	31.3	34.4	43.8	57.8	64.4	73.4	70.5	62.9	53.7	40.1	33.6
20.0	34.1	33.3	35.1	42.7	54.5	61.9	71.0	69.7	63.1	56.1	44.3	37.3
40.0	39.4	37.7	37.5	42.0	50.2	56.8	65.1	66.0	62.3	57.8	50.4	43.7
60.0	43.2	40.5	40.0	42.2	47.6	53.6	60.6	62.7	61.7	58.3	52.9	47.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	30.4	30.4	34.7	47.0	59.1	69.7	76.1	72.5	62.9	52.1	38.6	30.9
4.0	30.8	30.8	34.7	46.5	58.3	68.8	75.3	72.2	63.1	52.6	39.4	31.6
8.0	31.7	31.5	34.8	45.6	57.0	67.2	73.9	71.7	63.4	53.5	41.0	32.9
20.0	34.4	33.6	35.4	43.5	53.4	62.8	69.8	69.9	63.8	55.8	45.1	36.9
40.0	38.6	37.1	37.2	41.8	49.2	57.0	63.7	66.2	63.3	57.9	50.0	42.5
50.0	42.4	40.3	39.4	41.6	46.7	52.9	58.7	62.4	61.9	58.6	53.0	46.8

M= 168.
 N= 4
 D= 0.0170

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.459	-19.989	0.730	-0.279	-0.771	-13.332	1.734	0.509	0.757

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1513	0.2698	0.2827	0.2936	0.3054	0.2604	0.2823	0.2948	0.2977
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

HUNTLEY, MONTANA
 CLAY
 SOD

CLIMATOLOGICAL DATA
 1961-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	29.6	31.7	36.3	47.6	59.7	69.9	74.9	71.6	60.3	50.2	37.6	31.1
4.0	28.8	30.2	34.8	46.4	58.3	68.4	73.9	70.8	60.1	50.1	37.7	31.0
8.0	30.1	30.5	33.7	43.3	55.1	65.0	71.2	69.2	59.5	50.0	38.6	33.5
20.0	33.5	33.8	37.3	44.7	53.8	63.7	71.6	70.6	61.8	52.5	43.0	36.4
40.0	38.2	36.9	38.0	42.2	48.9	57.3	65.9	63.6	60.7	56.0	48.3	42.3
60.0	40.9	39.0	38.9	41.1	47.3	53.6	60.4	64.6	63.7	59.8	55.8	48.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	29.5	30.5	35.4	46.7	58.8	69.4	75.1	71.0	60.4	49.4	38.0	30.8
4.0	29.9	30.8	35.4	46.3	58.1	68.6	74.4	70.9	60.7	49.9	38.7	31.5
8.0	30.8	31.4	35.4	45.4	56.8	67.1	73.1	70.4	61.1	50.9	40.1	32.7
20.0	33.4	33.1	35.7	43.5	53.4	62.9	69.3	68.9	61.9	53.2	43.6	36.3
40.0	37.5	36.2	37.0	41.8	49.2	57.2	63.7	65.7	62.0	55.8	48.2	41.4
60.0	41.1	39.1	38.8	41.4	46.6	53.1	58.9	62.2	61.0	56.9	51.2	45.4

M= 218.

N= 4

D= 0.0189

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.698	-20.003	1.136	-0.119	-0.549	-12.175	1.811	0.042	0.331

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1824	0.3023	0.3093	0.3197	0.3275	0.2935	0.3125	0.3202	0.3265
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ST- 65

EARTH TEMPERATURE STATION

BOX BUTTE, NEBRASKA

TYPE OF SOIL

UNKNOWN

TYPE OF EARTH SURFACE

BARE SOIL

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

2.0 28.9 30.1 32.8 50.5 64.0 72.5 84.7 79.5 69.2 58.3 40.8 28.9

8.0 28.6 29.3 30.4 45.5 58.3 66.9 79.0 75.3 66.0 56.8 41.3 29.7

ST- 66

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

CONCORD, NEBRASKA
SILTY CLAY LOAM
BROME GRASS
CLIMATOLOGICAL DATA
1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	26.7	28.5	33.4	46.8	65.5	70.9	76.0	73.4	67.9	60.5	42.2	31.6
4.0	27.0	27.9	32.3	46.1	60.0	68.5	74.5	72.4	66.2	60.2	42.4	31.8
8.0	29.2	29.3	32.1	44.3	57.4	66.1	72.6	71.4	66.5	60.2	45.4	33.9

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LINCOLN, NEBRASKA
 UNKNOWN
 BARE
 E.M. FITTON
 REFERENCE (4)
 1900-1904

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.0	28.2	42.4	58.6	74.5	82.3	90.8	85.6	72.0	60.0	43.5	31.0
3.0	30.0	28.7	41.1	59.3	72.1	81.2	88.6	85.3	72.9	61.4	44.3	31.6
6.0	29.6	28.0	37.9	54.5	68.7	77.5	83.6	82.0	71.0	60.2	44.1	31.9
9.0	30.0	28.4	35.7	50.8	64.4	73.0	79.4	77.9	70.5	59.0	44.3	33.4
12.0	31.4	29.3	35.0	48.2	60.8	69.5	75.8	75.0	66.6	58.4	45.1	34.8
24.0	35.1	32.9	34.7	44.8	56.5	64.2	70.8	71.6	66.9	57.7	49.5	39.5
36.0	38.1	35.3	35.7	43.0	53.2	61.1	67.5	69.4	66.7	60.7	52.1	43.2

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	26.2	25.9	37.1	56.8	69.9	79.0	85.6	80.7	69.0	56.5	39.7	28.7
3.0	27.1	27.5	36.8	55.7	68.7	77.7	84.5	80.4	69.4	57.3	41.1	30.0
6.0	28.5	28.4	36.4	54.0	66.9	75.9	82.8	79.9	69.8	58.5	43.0	31.9
9.0	29.9	29.3	36.2	52.6	65.3	74.2	81.2	79.2	70.1	59.5	44.9	33.7
12.0	31.2	30.3	36.2	51.3	63.7	72.6	79.6	78.6	70.3	60.4	46.6	35.5
24.0	36.3	34.2	36.8	47.4	58.4	66.7	73.8	75.4	70.4	63.0	52.2	41.8
36.0	41.0	38.0	38.5	45.4	54.4	62.1	68.7	71.9	69.5	64.2	56.0	47.0

M= 84.
 N= 4
 D= 0.0093

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

AO	A1	A2	A3	A4	B1	B2	B3	B4
54.813	-26.581	0.209	0.708	-1.123	-15.111	-0.658	0.367	1.235

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3116	0.5282	0.5598	0.5826	0.6038	0.5272	0.5601	0.5842	0.6008
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LINCOLN, NEBRASKA
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE(4)
 1894-1904

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	28.2	28.0	40.1	58.7	70.9	79.2	86.9	85.1	73.7	58.1	40.6	31.2
3.0	38.5	27.8	38.8	57.6	69.7	78.1	85.1	84.0	73.5	59.4	42.7	31.4
6.0	29.0	28.1	37.4	53.6	66.7	76.1	82.1	80.9	72.0	58.3	42.6	31.7
9.0	29.8	28.0	36.0	50.8	64.2	73.7	79.7	78.9	71.0	58.5	38.9	28.8
12.0	30.2	29.0	35.6	49.1	61.2	69.7	75.8	75.6	69.2	57.9	44.5	34.6
24.0	35.1	33.1	35.3	45.4	56.9	64.6	70.5	72.0	68.2	60.0	49.2	39.5
36.0	38.1	35.1	36.0	43.6	53.8	61.5	67.7	69.8	67.9	61.3	51.0	43.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	27.8	27.1	36.6	56.1	68.6	77.2	83.8	80.9	70.0	55.8	37.5	29.0
3.0	28.5	27.7	36.4	55.1	67.5	76.1	82.8	80.5	70.8	56.6	38.8	30.0
6.0	29.7	28.5	36.1	53.6	66.0	74.5	81.3	79.8	71.1	57.8	40.8	31.6
9.0	30.8	29.4	35.9	52.3	64.6	73.0	79.9	79.2	71.2	58.9	42.6	33.1
12.0	31.9	30.3	35.0	51.1	63.2	71.6	78.5	78.4	71.3	59.9	44.3	34.6
24.0	36.2	33.0	36.4	47.5	58.4	66.4	73.2	75.3	71.0	62.7	50.0	40.2
36.0	40.1	37.4	37.9	45.4	54.7	62.1	68.6	71.9	70.0	64.1	54.2	45.0

M= 84.

N= 4

D= 0.0112

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.380	-25.803	-0.449	1.092	-0.785	-15.124	0.127	1.414	1.419

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2649	0.4431	0.4680	0.4861	0.5030	0.4423	0.4683	0.4874	0.5005
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LINCOLN, NEBRASKA
 SILTY CLAY LOAM
 BARE SOIL
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	26.0	31.3	39.4	-0.0	76.4	85.2	93.3	86.3	74.8	66.1	47.2	26.4
2.0	25.5	29.7	36.8	-0.0	68.7	76.1	84.9	78.6	69.3	60.6	45.2	27.8
4.0	27.2	29.6	35.3	-0.0	64.4	73.6	81.9	76.8	68.4	60.2	46.4	29.4
8.0	29.8	31.1	35.6	-0.0	63.3	72.5	80.8	77.6	69.9	61.6	49.3	32.7
16.0	35.0	33.9	39.1	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0	32.9	31.8	33.5	-0.0	57.8	66.2	74.4	74.8	69.3	61.9	52.4	37.8
32.0	38.4	34.8	36.4	-0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0	39.8	37.3	37.5	-0.0	53.1	61.2	68.6	71.8	68.8	63.6	56.7	45.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	25.2	29.6	35.5	52.3	58.7	79.2	85.7	80.4	69.2	61.0	43.9	26.5
2.0	26.0	30.0	35.5	51.5	67.6	78.0	84.7	80.2	69.4	61.4	45.1	27.9
4.0	26.7	30.4	35.5	50.6	66.4	76.9	83.7	79.9	69.6	61.8	46.3	29.1
8.0	28.3	31.2	35.6	49.2	64.3	74.7	81.7	79.2	69.9	62.0	48.4	32.1
16.0	31.4	33.0	36.1	46.9	60.5	70.7	77.9	77.6	70.2	63.7	52.1	37.0
20.0	33.0	33.9	36.5	46.0	58.9	68.9	76.1	76.7	70.2	64.2	53.6	39.3
32.0	37.7	36.8	38.0	44.4	54.8	64.1	71.2	73.7	69.8	64.9	57.1	45.2
40.0	40.6	38.8	39.2	43.9	52.7	61.3	68.2	71.6	69.1	65.1	58.7	48.4

M= 162.

N= 4

D= 0.0118

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

AC	A1	A2	A3	A4	B1	B2	B3	B4
54.898	-24.722	0.153	-1.716	-2.136	-17.008	-0.909	-0.388	0.194

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2695	0.4440	0.4589	0.4778	0.4819	0.4355	0.4598	0.4668	0.4792
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LINCOLN, NEBRASKA
 SILTY CLAY LOAM
 BROME GRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	25.6	30.1	36.9	51.3	76.4	85.2	93.3	79.7	70.0	61.3	43.4	26.9
2.0	27.3	29.1	33.8	47.6	68.7	76.1	84.9	75.1	67.3	58.1	44.3	28.5
4.0	27.8	29.0	32.9	44.1	64.4	73.6	81.9	72.4	66.1	56.6	44.1	28.6
8.0	30.6	30.7	34.4	45.5	63.3	72.5	80.8	73.5	67.6	58.8	47.7	32.9
16.0	32.6	30.2	34.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20.0	34.2	33.0	34.5	43.4	57.8	66.2	74.4	72.3	67.9	60.8	51.9	38.8
32.0	38.0	34.6	36.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40.0	38.4	36.4	36.5	40.9	53.1	61.2	68.6	70.1	67.3	61.7	55.0	44.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	26.5	29.2	33.7	49.0	64.6	73.7	79.3	76.4	67.2	58.5	43.0	28.1
2.0	27.1	29.6	33.7	48.3	63.7	72.8	78.5	76.1	67.3	58.9	43.9	29.2
4.0	27.7	30.0	33.8	47.7	62.7	71.9	77.7	75.8	67.4	59.3	44.8	30.3
8.0	28.9	30.7	34.0	46.5	61.0	70.3	76.2	75.2	67.5	59.9	46.6	32.3
16.0	31.4	32.3	34.6	44.7	57.9	67.2	73.3	73.7	67.6	60.9	49.5	36.2
20.0	32.6	33.1	34.9	44.0	56.5	65.7	71.9	72.9	67.6	61.3	50.8	38.0
32.0	36.3	35.5	36.3	42.6	53.0	61.8	68.0	70.4	67.1	62.1	53.8	42.7
40.0	38.6	37.1	37.3	42.1	51.2	59.5	65.6	68.6	66.5	62.3	55.4	45.4

M= 144.
 N= 4
 D= 0.0157

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.551	-21.563	0.147	-1.278	-1.740	-16.233	-0.687	0.334	-0.029

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2796	0.4820	0.4695	0.4658	0.4692	0.4153	0.4675	0.4871	0.4807
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

NORFOLK, NEBRASKA
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE (5)
 1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	29.9	33.6	36.2	.0	63.0	71.6	78.0	71.9	65.0	55.6	37.7	34.0
7.9	31.0	36.4	35.8	.0	63.2	72.6	79.0	73.0	67.7	56.8	40.6	33.7
11.8	29.7	35.4	33.2	.0	62.2	71.5	76.7	73.8	68.1	57.6	41.7	33.8
19.7	30.1	34.9	32.0	.0	60.8	70.0	75.0	72.9	68.0	56.8	43.4	34.4
39.4	33.7	34.3	33.7	.0	57.8	66.8	72.5	71.6	67.7	59.0	47.6	38.2

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

NEW BRUNSWICK, N.J.
 UNKNOWN
 BLUE GRASS SOD
 JEN-HU-CHANG
 REFERENCE(5)
 1953-1955

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	32.9	34.9	39.3	50.4	62.0	69.6	78.7	75.2	67.6	59.7	45.9	35.9
3.0	33.6	35.0	39.7	49.9	57.6	67.9	73.9	72.0	66.7	60.2	46.7	38.2
10.0	35.2	35.3	39.9	48.9	56.5	65.6	71.7	71.3	66.8	60.4	48.2	39.8
24.0	37.8	36.4	40.1	47.0	54.4	62.6	68.3	69.8	66.4	61.4	50.8	42.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	33.2	34.0	39.8	50.3	59.4	69.0	75.5	73.2	67.1	59.1	46.0	36.1
3.0	33.7	34.3	39.7	49.9	58.9	68.4	74.9	73.0	67.1	59.4	46.6	36.8
10.0	35.3	35.3	39.7	48.8	57.3	66.2	72.9	72.1	67.1	60.3	48.7	39.0
24.0	38.5	37.5	40.1	47.1	54.5	62.4	69.1	70.1	66.7	61.5	52.2	43.1

M= 48.
 N= 4
 D= 0.0213

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
53.659	-16.465	-0.519	-0.414	-0.496	-13.762	0.090	-0.292	0.793

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1465	0.2278	0.2353	0.2410	0.2466	0.2273	0.2355	0.2415	0.2454
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST-73
 NEW BRUNSWICK, N.J.
 LOAM
 BLUEGRASS
 CLIMATOLOGICAL DATA
 1963

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
1.0	32.2	31.1	36.2	48.8	60.2	70.0	78.6	75.2	67.6	0.0	0.0	0.0
2.0	32.2	31.1	35.9	48.4	59.6	71.5	77.6	72.0	67.0	0.0	0.0	0.0
4.0	32.8	32.0	35.4	47.8	59.0	69.8	76.4	71.3	66.4	0.0	0.0	0.0
8.0	33.8	33.0	35.4	47.2	57.8	65.0	75.1	69.8	66.6	0.0	0.0	0.0
16.0	35.8	34.4	35.5	46.1	55.6	65.4	72.4	71.6	66.6	0.0	0.0	0.0
32.0	38.2	36.3	36.0	44.9	52.8	61.9	68.6	72.3	66.1	0.0	0.0	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
1.0	32.3	31.3	35.4	48.8	59.8	70.3	77.6	73.8	66.8	58.4	42.1	32.3
2.0	32.5	31.4	35.5	48.6	59.5	69.9	77.3	73.7	66.8	58.6	42.5	32.6
4.0	32.9	31.8	35.5	48.2	58.9	69.2	76.7	73.5	66.9	58.9	43.2	33.3
8.0	33.7	32.5	35.6	47.4	57.9	67.8	75.5	73.1	66.9	59.5	44.7	34.6
16.0	35.2	33.9	35.9	46.1	56.0	65.3	73.0	72.1	66.8	60.4	47.3	37.0
32.0	38.3	36.7	37.1	44.3	52.8	61.0	68.5	69.8	66.3	61.5	51.4	41.6

M= 48.
 N= 4
 D= 0.0237

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.525	-18.580	0.009	-0.835	-1.150	-14.902	0.747	0.590	1.512

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.5333	0.9653	0.3831	0.7551	0.3849	0.6981	1.1196	0.6008	0.4222
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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

ST- 74
NEW BRUNSWICK, N.J.
LOAM
BARE SOIL
CLIMATOLOGICAL DATA
1963

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.6	30.2	41.0	55.3	65.8	79.3	85.0	.0	67.8	.0	.0	.0
2.0	30.8	30.2	40.6	54.6	65.2	78.7	84.1	.0	67.4	.0	.0	.0
4.0	31.2	30.8	39.6	53.8	63.9	77.3	82.8	.0	66.8	.0	.0	.0
8.0	31.1	31.6	37.4	51.9	62.2	74.3	80.1	.0	66.3	.0	.0	.0

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

RUTGERS, N. J.
 LOAM
 BLUEGRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	33.7	33.2	37.9	46.3	60.4	68.2	74.3	74.6	67.8	57.3	48.3	35.2
2.0	33.7	31.9	37.6	46.1	59.8	67.6	73.8	74.0	67.4	57.0	48.3	36.6
4.0	34.1	32.5	37.6	45.3	59.2	67.0	73.2	73.3	66.8	57.3	48.5	37.4
8.0	35.1	33.0	37.6	44.9	58.0	65.8	72.0	72.4	66.3	57.5	49.5	38.6
16.0	36.9	34.4	37.7	43.8	55.4	63.0	69.7	71.1	66.6	58.5	51.0	41.0
32.0	39.3	36.3	38.0	42.5	52.4	60.0	66.4	69.2	66.1	59.4	52.8	44.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	32.5	33.1	36.5	46.4	59.0	68.1	73.4	74.1	67.0	57.3	47.2	37.3
2.0	32.7	33.2	36.6	46.2	58.8	67.8	73.2	74.0	67.0	57.5	47.4	37.6
4.0	33.2	33.5	36.6	46.0	58.2	67.3	72.7	73.7	67.1	57.8	47.8	38.2
8.0	34.0	34.0	36.8	45.5	57.3	66.2	71.7	73.1	67.1	58.3	48.7	39.3
16.0	35.8	35.2	37.3	44.6	55.4	64.2	69.8	71.8	67.1	59.2	50.3	41.4
32.0	39.1	37.4	38.4	43.6	52.5	60.7	66.3	69.2	66.6	60.4	52.9	45.0

M= 120.

N= 4

D= 0.0285

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.774	-15.628	0.423	-0.067	-0.443	-14.905	0.363	0.245	-0.568

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1251	0.2009	0.2056	0.1915	0.2093	0.1850	0.1943	0.2183	0.2028
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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

RUTGERS, N.J.
LOAM
BARE SOIL
CLIMATOLOGICAL DATA
1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.5	30.9	39.9	48.7	65.2	74.6	78.0	78.8	.0	56.3	45.8	32.3
2.0	30.7	31.1	39.6	48.4	64.3	73.5	77.2	78.0	.0	56.3	45.8	32.7
4.0	31.4	31.5	39.0	47.6	63.2	72.3	76.3	76.9	.0	56.1	46.0	33.4
8.0	32.5	32.3	38.3	46.2	60.8	69.8	74.6	75.3	.0	56.3	47.0	35.2

ST- 77

EARTH TEMPERATURE STATION

CANTON, NEW YORK

TYPE OF SOIL

CLAY

TYPE OF EARTH SURFACE

BLUEGRASS

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

4.0 28.9 27.2 30.6 35.4 55.2 62.8 69.7 64.1 59.5 50.8 42.1 .0

8.0 31.8 29.6 31.4 33.7 54.1 62.2 69.0 64.6 60.7 52.5 44.8 .0

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

GENEVA, NEW YORK
SILT LOAM
BLUEGRASS
CLIMATOLOGICAL DATA
1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
4.0	34.6	32.6	34.4	45.4	58.7	68.1	74.4	70.4	64.5	55.6	47.4	.0
8.0	30.5	28.7	30.4	41.1	54.7	64.3	71.0	67.1	61.8	52.6	44.4	.0

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ITHACA, NEW YORK
 UNKNOWN
 GRASS SOD
 JEN-HU-CHANG
 REFERENCE(5)
 1941-1946

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	32.4	31.4	35.7	43.8	54.6	62.9	67.6	66.3	63.0	51.3	41.1	33.8
6.0	32.8	31.8	35.5	43.3	53.6	62.2	67.1	66.2	63.3	52.0	42.0	34.4
12.0	33.9	32.7	35.2	42.5	52.1	60.6	65.8	65.6	63.1	53.4	43.5	36.1
24.0	36.5	34.6	35.7	41.6	49.8	56.4	63.7	64.5	62.8	55.3	46.6	39.1
48.0	40.0	37.7	37.3	40.6	45.9	52.8	58.3	61.0	61.1	56.9	50.6	43.9
96.0	45.7	43.0	41.1	41.6	53.8	47.5	51.4	54.5	56.7	56.1	53.2	49.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.0	32.2	31.6	35.4	44.3	54.2	63.0	67.6	67.5	62.7	52.6	40.8	34.5
6.0	32.7	32.1	35.4	43.9	53.5	62.2	66.9	67.1	62.7	53.1	41.6	35.2
12.0	33.8	32.9	35.6	43.2	52.2	60.6	65.5	66.2	62.6	54.0	43.2	36.6
24.0	36.0	34.6	36.1	42.1	49.9	57.7	62.9	64.5	62.2	55.4	45.9	39.2
48.0	39.9	37.8	37.8	41.2	46.8	53.2	58.3	60.9	60.6	56.8	49.8	43.7
96.0	45.8	43.3	41.9	42.2	44.4	48.0	51.8	54.9	56.4	56.0	53.2	49.3

M= 72.

N= 4

D= 0.0239

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
48.954	-15.005	-0.177	-0.093	0.074	-12.597	0.970	0.940	0.344

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1550	0.2781	0.2966	0.3094	0.3209	0.2776	0.2967	0.3102	0.3193
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ITHACA, NEW YORK
 LOAM
 GRASS-SOD
 CLIMATOLOGICAL DATA
 1943-1947

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	31.6	31.2	36.0	43.6	54.2	65.0	69.0	66.4	57.8	49.8	39.2	33.4
3.0	32.2	31.8	35.0	42.8	52.8	63.8	68.6	66.0	58.4	50.6	40.4	34.4
6.0	32.8	32.2	35.2	41.4	52.4	63.4	67.4	66.0	58.8	51.2	41.2	35.2
12.0	33.8	33.2	35.2	41.6	51.2	61.4	66.3	64.0	59.0	51.0	44.0	37.2
24.0	36.6	35.2	35.6	41.2	48.8	59.0	64.2	64.2	60.2	54.4	47.6	40.6
48.0	40.2	38.4	37.4	40.6	45.2	52.0	59.2	61.0	59.8	55.8	51.0	45.4
96.0	46.0	43.2	41.4	41.6	43.8	48.2	52.6	55.4	56.8	55.8	52.8	49.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.0	31.6	31.7	35.0	43.2	54.2	65.2	69.8	66.3	59.0	50.3	40.6	34.2
3.0	32.2	32.1	35.1	42.8	53.4	64.2	69.0	66.1	59.2	50.8	41.4	35.0
6.0	32.8	32.4	35.2	42.4	52.6	63.3	68.3	65.8	59.3	51.3	42.1	35.7
12.0	33.9	33.2	35.4	41.9	51.2	61.4	66.8	65.2	59.5	52.2	43.5	37.1
24.0	36.1	34.8	36.1	41.0	48.9	58.1	63.9	63.9	59.6	53.5	45.9	39.6
48.0	40.0	38.0	37.9	40.5	45.8	52.9	58.8	60.8	58.9	55.0	49.3	43.9
96.0	45.7	43.3	42.0	41.9	43.7	47.3	51.5	54.7	55.7	54.8	52.3	49.0

M= 414.
 N= 4
 D= 0.0227

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
48.528	-15.003	1.312	-0.581	-0.037	-11.967	1.479	-0.067	0.268

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1200	0.2081	0.2191	0.2264	0.2325	0.2086	0.2194	0.2269	0.2320
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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

ITHACA, NEW YORK
LOAM
GRASS SOD
CLIMATOLOGICAL DATA
1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	32.3	31.0	33.3	42.8	55.2	64.6	69.0	66.8	62.0	53.6	45.5	33.4
8.0	33.0	31.7	33.5	42.4	54.6	63.5	68.6	66.9	62.7	54.3	46.9	34.4

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

RALEIGH, N.C.
SANDY LOAM
BARE

CLIMATOLOGICAL DATA
1960-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

	MONTH OF YEAR											
DEPTH BELOW SURFACE (IN)	J	F	M	A	M	J	J	A	S	O	N	D
4.0	41.0	42.9	49.6	61.4	71.1	64.6	80.4	79.6	73.6	64.5	54.2	43.2
8.0	41.4	43.0	49.2	60.3	70.1	63.5	78.6	78.4	73.2	64.8	54.9	44.3

ST- 83

EARTH TEMPERATURE STATION

RALEIGH, N.C.

TYPE OF SOIL

SANDY LOAM

TYPE OF EARTH SURFACE

NATIVE SOD

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	41.2	41.7	50.1	60.2	68.9	75.8	78.7	77.6	72.4	62.6	54.5	44.9
8.0	41.2	41.7	49.5	59.7	68.3	75.1	78.6	78.3	72.6	63.0	54.7	44.9

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

COLUMBUS, OHIO
 SILT LOAM
 GRASS
 CLIMATOLOGICAL DATA
 1960-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	31.9	32.3	38.7	49.2	59.2	68.3	72.0	70.5	68.2	57.9	46.7	34.8
8.0	34.0	33.7	39.4	49.2	59.4	69.6	72.9	72.1	69.5	58.1	48.4	36.1
20.0	36.8	35.4	39.1	47.1	56.6	65.1	69.3	69.1	67.1	59.6	50.5	41.0
39.0	40.8	38.9	40.6	46.5	54.3	61.4	66.3	67.3	66.4	60.8	53.9	45.5
59.0	43.5	41.5	42.3	45.5	51.3	57.0	62.2	63.9	63.7	60.8	56.5	49.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	U	N	D
4.0	32.2	33.4	39.3	49.5	60.6	69.4	72.8	71.9	67.6	58.6	45.9	36.4
8.0	33.2	33.9	39.2	48.9	59.5	68.3	71.9	71.4	67.5	59.2	47.1	37.6
20.0	35.9	35.5	39.3	47.3	56.7	65.1	69.4	69.8	67.2	60.5	50.0	41.0
39.0	40.0	38.3	40.1	45.7	53.2	60.8	65.6	67.2	66.1	61.7	53.6	45.5
59.0	43.8	41.2	41.6	45.1	50.8	57.3	62.1	64.5	64.5	61.9	56.1	49.3

M= 260.
 N= 4
 D= 0.0250

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
53.240	-17.213	-0.411	-0.588	0.084	-13.507	-0.751	0.453	0.169

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1392	0.2366	0.2516	0.2624	0.2726	0.2360	0.2514	0.2632	0.2713
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

COSHOCTON, OHIO
 SILT LOAM
 MEADOW
 JEN-HU-CHANG
 REFERENCE(5)
 1942-1955

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.5	31.6	32.0	38.4	48.1	59.2	71.2	75.5	73.9	69.9	55.5	41.6	33.0
3.0	32.6	32.5	38.0	46.6	57.9	69.2	72.8	71.4	65.7	54.8	42.4	34.3
6.0	33.0	32.9	38.5	47.6	58.2	69.4	72.9	72.0	67.1	56.9	44.8	43.0
12.0	34.6	33.9	38.0	46.4	55.6	65.8	70.5	70.2	65.9	57.3	46.7	37.7
24.0	36.6	35.0	38.8	46.2	55.0	63.4	68.8	68.6	65.5	57.6	48.3	38.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.5	31.7	32.2	38.4	48.0	59.2	70.3	74.1	72.3	66.9	55.2	42.2	35.4
3.0	32.3	32.5	38.3	47.6	58.5	69.5	73.5	72.0	66.9	55.7	43.0	36.1
6.0	32.9	32.9	38.3	47.2	57.8	68.5	72.8	71.6	66.9	56.3	43.8	36.8
12.0	34.3	33.7	38.3	46.4	56.3	66.8	71.4	70.9	66.9	57.3	45.4	38.3
24.0	36.8	35.4	38.5	45.3	53.8	63.5	68.8	69.3	66.5	58.8	48.3	41.1

M= 60.
 N= 4
 D= 0.0267

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.261	-17.355	0.035	-0.297	0.631	-13.564	0.720	0.543	0.385

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1698	0.2608	0.2685	0.2744	0.2803	0.2603	0.2688	0.2750	0.2790
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

COSHOCTON, OHIO
 SILT LOAM
 MEADOW

CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.5	33.2	32.1	37.8	49.2	56.0	67.0	71.8	67.6	62.8	55.2	42.7	25.8
3.0	33.0	32.0	37.8	48.5	57.6	68.4	73.4	70.3	66.7	59.2	47.0	35.1
6.0	32.8	31.7	36.8	47.8	56.8	66.3	71.3	68.7	65.9	57.8	47.4	35.6
12.0	35.3	33.7	38.3	47.9	57.2	66.8	69.9	66.9	64.1	57.0	46.4	35.1
24.0	37.2	35.3	39.2	45.6	55.2	62.0	67.6	67.0	65.6	56.4	0.0	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
0.5	31.8	32.4	37.6	48.9	58.5	67.8	72.9	69.0	64.3	57.8	43.2	33.0
3.0	32.3	32.7	37.6	48.5	58.0	67.2	72.3	68.9	64.3	58.0	43.9	33.7
6.0	32.8	33.0	37.5	48.1	57.4	66.4	71.7	68.6	64.2	58.3	44.7	34.6
12.0	33.8	33.8	37.6	47.2	56.1	64.8	70.4	68.2	64.1	58.8	46.3	36.2
24.0	35.9	35.3	37.8	45.8	54.0	62.0	67.9	67.1	63.8	59.5	49.0	39.2

M= 118.

N= 4

D= 0.0310

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.539	-16.457	-0.334	-1.158	-0.701	-13.011	-0.450	0.139	1.180

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2570	0.3935	0.3957	0.4007	0.4110	0.3780	0.3940	0.4020	0.4005
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

WOOSTER, OHIO
 SILT LOAM
 BLUEGRASS SOD
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	32.1	31.7	37.4	48.8	60.6	70.2	73.8	69.7	65.7	56.3	45.9	34.3
4.0	32.2	31.1	35.9	47.4	59.3	68.3	71.8	69.2	64.9	56.1	46.4	36.1
8.0	33.9	32.1	35.8	46.6	58.4	67.6	71.0	69.3	65.2	57.0	48.4	37.9
12.0	35.5	33.9	37.1	46.3	57.9	65.5	69.3	68.0	64.1	57.0	49.1	37.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.6	31.5	36.4	48.4	60.8	69.6	72.7	70.0	64.4	56.7	45.0	35.5
4.0	32.2	31.9	36.4	47.8	60.0	68.8	72.1	69.7	64.4	57.1	45.8	36.3
8.0	33.5	32.7	36.5	46.9	58.5	67.2	70.9	69.2	64.4	57.7	47.2	37.9
12.0	34.7	33.6	36.6	46.1	57.1	65.7	69.8	68.7	64.4	58.2	48.4	37.4

M= 112.

N= 4

D= 0.0137

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.987	-17.290	1.022	-0.626	-0.407	-13.311	-0.935	0.487	0.312

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1844	0.2899	0.2945	0.3005	0.3097	0.2778	0.2928	0.3015	0.3013
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BARNSDALL, OKLA.
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE(5)
 1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	41.1	43.0	44.8	54.3	66.3	76.0	80.8	81.2	73.2	65.0	47.9	41.6
7.9	42.6	44.4	46.4	55.7	67.2	77.0	81.3	82.6	74.6	66.4	50.2	43.3
11.8	46.1	47.4	49.6	58.7	67.8	75.6	79.2	81.7	75.0	68.6	54.8	46.4
19.7	50.0	50.2	52.6	59.6	68.6	76.3	80.5	81.6	76.8	70.9	58.0	50.1
39.4	52.8	52.2	53.9	58.3	66.0	73.2	75.1	81.4	78.2	74.6	63.6	55.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	44.7	46.1	48.7	58.9	70.1	78.3	83.4	82.8	76.7	66.4	51.8	43.5
7.9	45.3	46.6	48.8	58.2	69.0	77.1	82.3	82.2	76.8	67.2	53.2	44.7
11.8	45.9	47.0	49.0	57.6	68.0	76.1	81.3	81.7	76.8	67.8	54.5	45.8
19.7	47.1	47.9	49.3	56.6	66.2	74.0	79.4	80.5	76.6	68.9	56.9	48.1
39.4	50.3	50.2	50.6	55.1	62.6	69.6	75.0	77.4	75.7	70.6	61.5	53.1

M= 60.

N= 4

D= 0.0231

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
62.716	-17.730	-0.949	-0.888	-0.832	-12.457	1.444	1.409	0.441

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3349	0.5542	0.5858	0.6097	0.6326	0.5532	0.5862	0.6114	0.6293
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ST- 89

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

HOMINY, OKLA.
UNKNOWN
UNKNOWN
JEN-HU-CHANG
REFERENCE(S)
1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
3.9	46.2	46.4	50.2	57.5	68.1	77.8	84.7	84.8	79.2	69.4	55.7	49.0
7.9	44.4	44.7	48.7	55.8	67.5	77.9	85.1	85.4	79.4	68.6	54.3	46.8
11.8	45.8	46.0	49.8	56.7	67.7	76.8	83.5	83.8	78.2	68.9	55.3	48.7
19.7	48.9	46.6	50.0	56.6	67.8	76.7	83.2	83.0	78.0	68.4	59.2	48.2
39.4	48.4	45.7	49.1	55.9	66.0	73.8	80.1	82.1	77.1	68.2	61.6	47.3

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

LAKE HEFNER, OKLA.
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE(5)
 1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	39.3	41.7	49.1	58.3	72.0	81.0	81.9	83.6	75.6	70.7	51.8	41.9
7.9	41.3	41.5	49.0	57.3	69.0	80.2	86.6	86.5	78.6	71.8	53.7	44.9
11.8	44.7	43.5	49.8	59.4	69.8	78.8	81.8	84.5	78.1	74.6	58.6	47.9
39.4	49.1	46.7	50.5	56.5	65.8	73.2	77.8	81.0	77.4	74.3	64.6	53.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	40.8	42.7	48.6	60.1	71.4	80.9	85.7	84.0	79.4	70.5	54.8	43.2
7.9	41.6	43.1	48.6	59.4	70.4	79.8	84.7	83.6	79.3	71.0	56.1	44.5
11.8	42.4	43.6	48.6	58.8	69.5	78.7	83.8	83.1	79.2	71.5	57.2	45.8
39.4	48.2	47.2	49.4	55.9	64.1	72.2	77.9	79.5	77.8	73.3	63.6	53.4

M= 48.

N= 4

D= 0.0298

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
63.623	-18.998	-1.136	-1.139	-0.419	-14.714	-0.626	0.478	0.621

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2532	0.4078	0.4264	0.4404	0.4539	0.4070	0.4268	0.4416	0.4517
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PAWHUSKA, OKLA
 UNKNOWN
 UNKNOWN
 JEN-HU-CHANG
 REFERENCE(5)
 1950-1952

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	41.0	41.2	45.1	56.1	69.1	80.6	81.7	82.6	74.4	65.6	48.4	41.4
7.9	39.8	40.8	43.8	53.9	65.8	76.6	79.8	80.8	73.1	64.4	48.2	41.2
11.8	44.6	44.6	48.0	56.4	65.5	74.4	78.4	80.8	74.1	67.6	55.2	46.8
19.7	46.6	46.3	49.2	54.1	64.5	72.1	77.0	78.7	74.8	69.0	58.4	49.6
39.4	50.2	49.0	50.5	54.6	63.2	67.4	73.6	76.5	74.8	70.2	62.2	54.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
3.9	41.4	42.6	46.3	57.1	69.3	78.4	82.8	81.5	75.4	64.6	50.3	41.9
7.9	42.4	43.2	46.4	56.2	67.8	76.8	81.4	80.8	75.4	65.7	52.1	43.5
11.8	43.4	43.9	46.5	55.4	66.4	75.3	80.1	80.1	75.4	66.5	53.7	45.0
19.7	45.3	45.3	47.0	54.1	63.9	72.5	77.6	78.5	75.2	67.8	56.6	47.9
39.4	49.9	48.7	48.9	52.6	59.5	66.7	72.0	74.6	73.6	69.5	61.8	54.1

M= 60.

N= 4

D= 0.0135

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
61.065	-19.184	-0.361	-0.787	-0.469	-13.023	0.978	1.309	0.378

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2155	0.3721	0.3985	0.4183	0.4369	0.3715	0.3987	0.4196	0.4346
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

OTTAWA, ONTARIO
 UNKNOWN
 UNKNOWN
 E.B. PENROD
 REFERENCE(9)
 1950

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	32.6	30.6	30.8	35.0	49.7	58.2	66.0	63.6	56.9	48.2	40.2	34.8
24.0	34.9	33.6	33.0	34.6	45.8	57.2	64.1	63.4	58.8	51.6	43.5	38.1
48.0	40.2	38.3	36.7	36.6	41.9	50.1	56.3	58.8	57.9	54.1	48.4	42.8
96.0	46.0	44.5	43.1	41.8	41.6	43.9	47.5	50.5	52.3	52.7	51.4	48.4

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	33.0	31.3	30.6	36.3	49.3	61.4	66.7	65.3	58.0	49.2	40.8	35.0
24.0	35.5	34.1	32.6	35.7	45.6	56.5	62.6	63.2	58.4	51.3	43.9	38.2
48.0	39.8	38.0	36.3	36.6	41.6	49.5	55.6	58.5	57.3	53.3	48.0	43.2
96.0	45.6	43.7	42.1	40.8	41.1	43.7	47.3	50.6	52.3	52.2	50.6	48.2

M= 48.
 N= 4
 D= 0.0134

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
46.539	-16.826	3.236	-1.049	-0.414	-13.077	3.083	0.911	-0.346

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1311	0.2950	0.3378	0.3699	0.3995	0.2947	0.3376	0.3712	0.3973
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

CORVALLIS, OREGON
 CLAY LOAM
 UNKNOWN

CLIMATOLOGICAL DATA
 1961-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	39.0	43.8	46.4	52.9	58.9	69.0	75.5	74.5	65.9	54.9	45.0	40.4
4.0	39.4	43.3	45.4	51.6	56.3	67.4	73.5	73.5	65.6	55.7	45.4	41.2
8.0	38.8	42.9	44.2	51.1	55.1	66.1	72.0	72.3	64.8	55.0	45.5	41.0
20.0	43.7	45.7	47.2	52.0	56.4	65.1	70.3	72.8	68.2	61.2	52.3	45.2
40.0	46.4	46.2	47.1	50.0	52.8	59.1	62.7	67.3	66.4	62.7	55.7	49.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	39.6	42.7	46.7	51.9	59.1	68.6	75.3	74.4	66.0	55.1	45.1	39.7
4.0	40.0	42.8	46.6	51.6	58.6	67.8	74.6	74.0	66.2	55.7	45.8	40.3
8.0	40.7	43.1	46.5	51.2	57.6	66.4	73.2	73.4	66.5	56.7	47.2	41.5
20.0	42.9	44.1	46.6	50.3	55.4	62.7	69.3	71.1	66.8	59.2	50.8	45.0
40.0	46.6	46.2	47.3	49.6	53.0	58.3	63.9	67.2	66.0	61.4	55.1	49.7

M= 273.

N= 4

D= 0.0131

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
55.412	-15.122	-1.051	-0.100	-0.072	-9.890	3.087	-0.424	0.088

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1209	0.2055	0.2104	0.2246	0.2287	0.2006	0.2187	0.2208	0.2287
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

HOOD RIVER, OREGON
 SANDY LOAM
 GRASS SOD
 CLIMATOLOGICAL DATA
 1963

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	36.1	37.1	42.9	47.3	54.0	58.8	-0.0	61.5	59.9	53.6	46.3	37.8
24.0	42.7	41.0	46.3	49.8	55.1	59.8	-0.0	64.5	63.8	60.2	52.8	0.0
36.0	43.4	40.7	44.5	47.3	51.6	56.4	-0.0	61.2	61.1	58.7	52.9	46.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
12.0	37.2	39.1	44.1	49.9	55.2	61.2	64.7	64.3	62.1	56.8	47.4	39.9
24.0	40.0	40.4	43.7	48.5	53.0	58.2	62.0	62.7	61.4	57.8	50.5	43.6
36.0	42.6	41.9	43.9	47.6	51.4	55.9	59.6	61.0	60.6	58.2	52.7	46.6

M= 32.

N= 4

D= 0.0117

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
51.896	-13.890	-1.833	-0.756	0.180	-8.667	-0.374	-0.189	0.431

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3973	0.8719	0.9177	0.9278	0.9367	0.6916	0.8507	1.0180	1.1503
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

MEDFORD, OREGON
 CLAY ADOBE
 CLOVER-RYE / BARE
 CLIMATOLOGICAL DATA
 1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	39.7	43.4	49.1	54.4	60.0	64.2	71.3	71.7	64.7	57.6	46.6	43.8
12.0	39.9	43.8	46.9	52.2	58.4	65.0	71.4	73.1	67.0	59.2	48.5	44.8
24.0	45.4	47.6	48.5	52.8	56.3	61.8	67.9	71.4	67.3	62.4	54.3	49.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	40.8	43.4	48.4	54.1	59.4	66.3	72.8	73.4	66.6	57.2	48.3	42.5
12.0	42.4	44.0	48.1	53.2	58.0	64.2	70.4	72.1	67.0	58.8	50.6	44.7
24.0	44.7	45.1	48.0	52.1	56.3	61.5	67.2	69.9	66.9	60.6	53.4	47.8

M= 39.

N= 4

D= 0.0143

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
56.187	-13.679	-1.591	0.513	-0.115	-9.318	1.853	-0.581	0.056

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2555	0.4444	0.4427	0.4636	0.4980	0.4136	0.4701	0.4935	0.5000
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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

MORO, OREGON
UNKNOWN
UNKNOWN
CLIMATOLOGICAL DATA
1963

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
4.0	.0	.0	34.3	33.6	57.6	65.6	69.2	79.7	68.0	.0	.0	.0
12.0	.0	.0	44.6	46.9	58.0	67.8	70.4	73.0	69.0	.0	.0	.0

ST- 97

EARTH TEMPERATURE STATION

NO. WILLAMETTE, ORE.

TYPE OF SOIL

SILT LOAM

TYPE OF EARTH SURFACE

BARE SOIL

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

2.0	39.0	43.9	47.2	.0	61.5	66.3	72.3	73.5	68.5	57.3	45.2	39.1
8.0	39.5	43.2	46.1	.0	58.3	64.4	69.9	71.4	67.4	57.6	46.4	40.4

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PENDLETON, OREGON
 LIGHT SOIL
 THIN GRASS
 E.M. FITTON
 REFERENCE(4)
 1890

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	26.7	37.3	44.9	62.2	72.3	74.2	84.6	83.3	73.2	57.4	45.8	0.0
8.0	27.8	36.6	40.9	55.3	66.3	68.4	77.6	75.8	66.5	53.7	43.2	0.0
12.0	30.4	37.1	39.8	52.2	63.1	65.8	73.7	73.3	65.7	54.7	45.2	0.0
24.0	34.6	38.1	40.1	50.1	60.9	63.7	71.0	71.7	66.7	57.3	48.5	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	27.4	35.5	42.9	58.2	69.1	71.8	79.3	79.6	65.5	54.5	41.2	26.5
8.0	28.7	35.7	42.3	56.1	67.0	70.2	77.1	78.6	66.5	56.0	43.7	29.6
12.0	30.1	36.0	41.9	54.2	65.1	68.7	75.0	77.5	67.2	57.2	46.0	32.5
24.0	34.7	37.6	41.6	50.2	59.9	64.5	69.6	73.7	68.2	60.1	51.4	40.0

M= 44.

N= 4

D= 0.0082

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.399	-25.617	-2.952	0.476	-3.072	-10.601	-0.017	-0.467	-0.544

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.4660	0.8833	0.9398	0.9892	1.0315	0.7043	0.7628	0.8087	0.8447
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PENDLETON, OREGON
 LIGHT SOIL
 THIN GRASS
 E.M. FITTON
 REFERENCE(4)
 1890

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	26.7	37.3	44.9	62.2	72.3	74.2	84.6	83.3	73.2	57.4	45.8	0.0
8.0	27.8	36.6	40.9	55.3	66.3	68.4	77.6	75.8	66.5	53.7	43.2	0.0
12.0	30.4	37.1	39.8	52.2	63.1	65.8	73.7	73.3	65.7	54.7	45.2	0.0
24.0	34.6	38.1	40.1	50.1	60.9	63.7	71.0	71.7	66.7	57.3	48.5	0.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	29.2	36.0	42.2	56.0	66.8	70.0	77.1	78.4	66.3	55.9	43.5	29.5
8.0	29.7	36.1	42.1	55.3	66.1	69.4	76.3	78.0	66.6	56.4	44.4	30.6
12.0	30.2	36.3	41.9	54.6	65.4	68.9	75.5	77.6	66.9	56.9	45.2	31.6
24.0	31.8	36.7	41.7	52.8	63.3	67.2	73.3	76.3	67.5	58.1	47.6	34.7

M= 44.

N= 4

D= 0.0600

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
54.353	-21.513	-2.477	0.386	-2.375	-11.844	-0.248	-0.205	-0.850

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.5576	0.9484	0.9718	0.9982	1.0202	0.7350	0.7596	0.7780	0.7908
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

STATE COLLEGE, PA.
 SILT LOAM
 BLUEGRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	26.7	29.6	36.3	48.3	61.6	71.1	74.6	71.3	65.9	55.5	45.8	33.9
4.0	27.8	29.7	35.3	47.2	60.0	69.5	75.3	70.6	65.8	55.1	46.1	34.5
8.0	30.4	30.9	34.9	47.0	58.6	67.7	73.5	70.3	66.0	56.0	47.8	37.1
12.0	34.6	31.9	34.7	45.9	57.1	65.8	71.9	68.4	65.8	56.6	48.8	37.5
16.0	46.4	32.9	35.1	45.4	56.2	64.9	70.9	69.3	66.1	56.8	50.0	39.8
20.0	40.2	34.7	35.8	44.9	56.9	64.2	71.0	68.7	66.0	57.8	50.7	40.7

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	31.1	29.9	35.0	48.3	61.1	70.6	74.8	71.6	64.7	56.2	44.4	35.3
4.0	31.7	30.3	35.0	47.8	60.3	69.8	74.2	71.4	64.8	56.6	45.1	36.0
8.0	33.0	31.2	35.1	46.8	58.9	68.2	72.9	70.9	64.9	57.3	46.4	37.5
12.0	34.1	32.2	35.3	45.9	57.5	66.7	71.7	70.4	64.9	57.9	47.7	38.9
16.0	35.3	33.1	35.6	45.2	56.2	65.3	70.5	69.8	64.9	58.4	48.8	40.2
20.0	36.4	34.0	35.9	44.6	55.0	63.9	69.3	69.2	64.9	58.9	49.9	41.5

M= 150.
 N= 4
 D= 0.0156

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.043	-18.318	1.490	-0.201	-0.492	-14.127	-0.564	0.471	0.526

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1379	0.2316	0.2292	0.2283	0.2374	0.2085	0.2326	0.2467	0.2509
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EARTH TEMPERATURE STATION

RIO PIEDRAS, P.R.

TYPE OF SOIL

CLAY

TYPE OF EARTH SURFACE

BARE SOIL

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J F M A M J J A S O N D

2.0	83.3	84.8	87.1	87.8	90.5	90.0	90.3	.0	90.6	90.2	87.3	84.0
8.0	75.6	76.3	78.6	79.4	81.5	81.4	81.5	.0	82.3	81.9	79.4	76.4

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

KINGSTON, R.I.
 SILT LOAM
 BLUEGRASS
 CLIMATOLOGICAL DATA
 1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	31.9	29.6	33.4	42.7	53.0	63.3	69.8	67.6	62.2	90.2	45.7	35.2
8.0	31.9	30.9	33.6	41.7	52.2	62.8	69.5	68.2	63.3	81.9	46.4	36.0
12.0	33.8	33.4	34.4	40.9	51.0	60.1	67.6	67.3	64.7	56.0	47.6	38.4
24.0	35.8	35.7	35.6	41.4	49.4	59.8	65.5	66.6	63.4	56.6	49.3	40.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	31.6	31.2	34.0	42.2	53.3	63.6	69.7	69.0	62.6	54.7	45.0	36.1
8.0	32.4	31.8	34.2	41.8	52.4	62.5	68.7	68.5	62.7	55.2	45.9	37.1
12.0	33.2	32.3	34.4	41.4	51.6	61.5	67.7	68.0	62.7	55.6	46.7	38.0
24.0	35.6	34.0	35.2	40.7	49.4	58.6	65.0	66.4	62.5	56.5	48.7	40.7

M= 88.

N= 4

D= 0.0284

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.527	-14.561	0.832	-0.408	-0.381	-14.450	0.811	-0.180	-0.059

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1679	0.2635	0.2818	0.2810	0.3059	0.2748	0.2805	0.3053	0.2962
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ST- 103

EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

UNION, S.C.
SANDY LOAM
GRASS SOD
CLIMATOLOGICAL DATA
1960-1962

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	37.0	39.7	42.8	54.1	65.7	73.1	76.4	75.6	72.2	59.9	51.7	38.9
4.0	38.6	41.3	44.1	54.9	66.2	73.1	77.1	76.7	72.9	62.0	53.3	41.0
12.0	40.9	43.5	46.2	56.1	67.2	74.1	78.1	78.2	74.6	65.2	56.5	43.8

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

CALHOUN, S.C.
 UNKNOWN
 BARE
 JEN-HU-CHANG
 REFERENCE(5)
 1950-1951

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	40.0	41.0	49.4	57.3	69.2	75.1	78.1	77.2	70.8	59.0	43.7	40.4
12.0	42.6	44.1	51.4	57.7	70.6	76.8	80.2	80.7	74.7	67.1	51.9	44.0
18.0	45.8	46.6	53.5	59.1	71.6	77.5	81.3	82.0	77.3	68.1	56.6	47.4
24.0	47.3	47.0	53.5	58.1	70.6	76.5	80.6	81.2	77.6	70.4	59.0	49.6
36.0	48.7	47.8	52.7	56.4	67.5	73.1	78.2	78.8	77.0	71.1	62.1	52.8
48.0	50.4	49.2	52.6	55.6	65.0	70.4	76.2	77.3	76.6	71.6	64.2	55.9
60.0	52.9	51.2	53.4	56.3	64.1	69.4	74.7	75.9	76.6	72.8	66.7	59.3
72.0	54.7	52.4	53.7	55.9	62.5	67.9	71.9	74.3	75.3	72.8	67.7	61.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
2.0	41.6	45.3	51.6	62.2	73.7	81.2	83.4	82.7	76.8	64.8	51.0	42.7
12.0	43.5	46.0	51.2	60.3	70.9	78.5	81.4	81.4	75.9	66.8	54.2	45.7
18.0	44.7	46.6	51.1	59.4	69.4	77.0	80.2	80.6	76.9	67.8	55.9	47.4
24.0	45.8	47.1	51.1	58.6	68.0	75.6	79.0	79.8	76.8	68.6	57.4	49.0
36.0	48.1	48.4	51.3	57.4	65.7	73.0	76.8	78.2	76.3	69.9	60.1	52.0
48.0	50.3	49.7	51.7	56.6	63.7	70.6	74.7	76.5	75.6	70.7	62.3	54.7
60.0	52.3	51.1	52.3	56.1	62.2	68.5	72.7	74.9	74.8	71.1	64.1	57.0
72.0	54.3	52.5	53.1	55.9	61.0	66.8	71.0	73.4	73.8	71.2	65.4	59.0

M= 96.
 N= 4
 D= 0.0257

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
63.167	-19.290	-1.238	-0.557	0.000	-11.300	0.104	1.069	-0.145

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2315	0.4386	0.4816	0.5128	0.5408	0.4380	0.4816	0.5143	0.5382
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

MADISON, S.D.
 SILTY CLAY
 GRASS SOD
 CLIMATOLOGICAL DATA
 1961-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	25.6	28.4	31.9	43.2	59.0	70.3	74.6	71.9	62.9	54.1	41.3	31.3
8.0	28.5	30.3	33.2	42.6	57.6	67.3	73.8	71.8	64.1	55.4	43.8	34.3
20.0	28.6	27.6	29.0	35.0	48.8	57.6	64.7	64.9	59.6	53.1	44.0	34.5
40.0	31.1	27.8	27.4	29.9	40.4	47.8	54.0	56.8	54.5	51.1	44.8	37.1

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	24.8	25.9	29.3	40.4	55.6	66.6	71.3	69.1	60.8	51.7	40.4	29.2
8.0	25.9	26.6	29.5	39.6	54.1	65.0	70.0	68.6	61.0	52.3	41.7	30.7
20.0	29.2	28.7	30.4	38.0	50.2	60.7	66.4	66.7	61.2	54.0	44.9	34.9
40.0	34.3	32.3	32.5	36.7	45.5	54.8	60.9	63.2	60.6	55.5	48.7	40.5

M= 165.

N= 4

D= 0.0197

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
47.204	-19.425	1.476	-0.928	-0.722	-15.471	0.231	0.125	-0.430

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3091	0.5232	0.5503	0.5660	0.5957	0.5132	0.5491	0.5805	0.5841
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

JACKSON, TENN.
 SILT LOAM
 COARSE GRASS
 CLIMATOLOGICAL DATA
 1949-1951

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
4.0	43.3	43.8	50.6	59.8	67.6	75.6	79.0	75.8	70.1	61.3	44.7	41.1
12.0	45.2	45.1	48.0	54.7	64.5	74.3	76.6	75.2	70.1	61.5	47.3	43.1
24.0	49.1	46.8	50.7	53.8	63.8	68.8	73.1	73.4	69.8	65.1	51.6	48.3
48.0	50.5	50.1	51.3	53.7	60.2	66.0	69.8	70.4	69.6	64.6	56.8	51.8
72.0	52.1	51.4	51.4	52.2	56.8	60.9	64.1	65.8	67.3	65.0	60.1	53.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
 SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
4.0	44.4	45.0	49.2	58.2	67.2	75.8	78.2	75.0	70.5	59.4	44.9	41.7
12.0	45.3	45.8	49.0	56.9	65.1	73.3	76.5	74.3	70.6	61.3	48.0	43.5
24.0	46.8	47.0	49.1	55.3	62.5	70.0	74.0	73.1	70.4	63.5	51.9	46.3
48.0	49.9	49.5	50.0	53.6	58.7	64.7	69.2	70.3	69.3	65.6	57.7	51.4
72.0	52.9	51.9	51.6	53.3	56.7	61.1	65.3	67.4	67.6	65.9	61.0	55.6

M= 130.

N= 4

D= 0.0186

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
59.212	-17.450	-0.551	-0.787	0.337	-8.529	1.897	1.812	1.201

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2013	0.3924	0.4142	0.4425	0.4656	0.3739	0.4232	0.4450	0.4610
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BUSHLAND, TEXAS
SILTY CLAY LOAM
GRASS SUD

CLIMATOLOGICAL DATA
1965[illegible]

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

TEMPLE, TEXAS
 ABILENE CLAY
 HORTICULTURAL

CLIMATOLOGICAL DATA
 1919-1924

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	50.8	53.3	59.4	68.3	79.9	85.3	92.0	92.5	84.1	72.6	58.8	53.0
3.0	50.7	52.7	58.7	67.8	79.0	84.9	90.7	92.3	83.9	71.8	58.2	52.7
6.0	51.8	53.2	58.8	64.6	78.3	83.6	89.8	90.9	83.3	71.7	61.0	53.7
12.0	52.9	53.9	58.6	65.8	75.9	83.5	87.0	88.6	83.4	73.5	62.6	55.4
24.0	55.9	55.3	58.6	64.8	72.6	78.9	83.1	87.4	82.6	75.8	65.6	58.8
36.0	58.8	57.6	59.5	64.2	70.5	76.5	80.8	83.8	82.2	77.9	69.1	62.1
48.0	55.5	58.9	60.2	63.5	67.8	74.2	78.4	81.4	81.0	77.7	70.8	64.6

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	50.3	53.2	58.4	68.3	78.7	85.8	90.6	91.5	83.5	70.8	58.8	51.6
3.0	50.7	53.4	58.4	67.8	78.0	85.2	90.0	91.1	83.6	71.3	59.6	52.3
6.0	51.4	53.7	58.3	67.2	77.1	84.2	89.1	90.6	83.8	72.1	60.7	53.3
12.0	52.7	54.3	58.2	66.1	75.4	82.5	87.4	89.4	84.0	73.5	62.7	55.2
24.0	55.4	55.8	58.5	64.6	72.5	79.3	84.2	86.9	83.8	75.7	66.1	58.8
36.0	58.0	57.4	59.0	63.6	70.3	76.6	81.3	84.5	83.2	77.0	68.9	62.0
48.0	60.4	59.1	59.9	63.1	68.6	74.3	78.8	82.2	82.1	77.7	71.0	64.7

M= 413.

N= 4

D= 0.0167

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
70.217	-17.815	-1.220	0.323	-0.292	-11.618	1.262	0.747	-0.345

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1601	0.2743	0.2882	0.2995	0.3122	0.2728	0.2925	0.3050	0.3111
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

TEMPLE, TEXAS
 UNKNOWN
 UNKNOWN
 E.M. FITTON
 REFERENCE (4)
 1918-1924

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	53.1	52.6	59.4	69.1	78.8	88.6	93.7	93.2	83.8	72.6	59.8	52.6
3.0	53.2	52.3	58.6	67.9	78.3	86.5	92.2	93.3	83.9	73.1	60.2	52.8
6.0	53.3	52.7	58.7	67.5	77.3	85.6	91.7	92.3	83.8	73.3	60.9	53.4
12.0	54.6	53.5	58.1	65.9	74.9	83.4	87.8	88.9	83.8	74.8	62.9	55.4
24.0	56.9	55.2	58.2	64.8	72.1	78.9	84.2	86.9	83.6	76.3	67.0	59.5
36.0	59.6	57.4	59.0	64.2	70.2	76.4	81.7	84.4	83.3	78.7	71.0	62.9
48.0	61.1	58.9	59.0	63.6	68.7	74.0	79.2	82.2	82.1	79.2	73.2	65.0

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	51.5	52.5	58.1	69.0	78.6	87.1	93.1	91.9	83.9	72.1	58.9	52.2
3.0	51.9	52.8	58.0	68.5	77.9	86.3	92.4	91.6	84.1	72.7	59.7	52.9
6.0	52.6	53.2	57.9	67.8	77.0	85.2	91.3	91.1	84.2	73.5	61.0	54.0
12.0	54.1	54.2	57.9	66.6	75.2	83.1	89.3	90.0	84.4	74.9	63.3	56.0
24.0	56.8	56.2	58.3	64.8	72.3	79.4	85.4	87.6	84.2	77.0	67.1	59.8
36.0	59.5	58.2	59.1	63.8	70.1	76.4	82.1	85.1	83.5	78.2	70.1	63.1
48.0	61.9	60.1	60.2	63.4	68.5	74.0	79.2	82.7	82.4	78.7	72.3	65.9

M= 84.

N= 4

D= 0.0142

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
70.834	-18.174	-0.749	0.293	-0.357	-12.099	1.461	0.629	0.539

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.0788	0.1365	0.1451	0.1511	0.1565	0.1363	0.1452	0.1515	0.1558
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SALT LAKE CITY, UTA
 SANDY LOAM
 BARE

CLIMATOLOGICAL DATA
 1960-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	29.8	33.3	37.8	49.7	57.6	65.8	70.2	68.8	60.6	52.3	40.4	32.9
8.0	30.5	33.6	37.8	49.1	56.5	64.3	69.2	68.7	60.7	53.2	41.6	33.8
20.0	31.8	34.2	37.1	46.6	53.3	60.3	66.0	67.0	60.3	54.0	44.2	36.6
39.0	36.8	35.8	38.5	45.3	52.4	57.3	63.7	66.2	61.3	56.4	47.6	41.3

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
4.0	30.5	32.4	38.4	49.2	57.6	64.7	70.6	68.7	60.7	52.0	40.9	32.4
8.0	31.2	32.8	38.3	48.5	56.8	63.8	69.6	68.4	60.9	52.6	41.9	33.4
20.0	33.3	34.0	38.1	46.7	54.6	61.2	67.0	67.2	61.3	54.1	44.7	36.4
39.0	36.5	36.0	38.3	44.8	51.6	57.6	63.1	64.9	61.3	55.7	48.1	40.5

M= 234.

N= 4

D= 0.0297

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.946	-17.467	-0.599	0.203	-0.778	-10.979	0.325	-0.257	0.443

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1793	0.2963	0.3093	0.3181	0.3292	0.2914	0.3104	0.3254	0.3342
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

BURLINGTON, VT.
 FINE SANDY LOAM
 BLUEGRASS

CLIMATOLOGICAL DATA
 1963-1964

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.0	28.6	30.7	39.5	55.2	66.3	72.5	66.0	57.8	50.8	42.5	30.3
3.0	30.8	29.0	30.6	40.0	52.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.0	31.0	0.0	30.8	37.4	56.6	65.1	71.3	66.2	58.1	51.0	43.2	31.8
8.0	32.4	0.0	30.8	36.3	55.0	63.3	69.4	65.5	58.3	51.5	44.1	33.4
10.0	31.4	30.2	30.8	38.3	50.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.0	33.8	0.0	30.8	35.8	53.7	61.9	67.8	65.3	58.5	51.8	45.0	34.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.9	29.9	29.5	39.5	55.2	66.6	71.4	66.7	57.3	51.1	41.7	31.5
3.0	30.3	30.3	29.8	39.1	54.4	65.8	70.7	66.6	57.5	51.4	42.3	32.2
4.0	30.5	30.4	29.9	39.0	54.0	65.4	70.4	66.5	57.5	51.5	42.6	32.6
8.0	31.3	31.2	30.4	38.4	52.5	63.8	69.1	66.1	57.9	52.0	43.7	34.0
10.0	31.7	31.5	30.7	38.1	51.8	63.0	68.5	65.9	58.0	52.2	44.2	34.6
12.0	32.2	31.9	31.0	37.9	51.1	62.2	67.9	65.7	58.1	52.5	44.7	35.0

M= 63.

N= 4

D= 0.0172

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
47.621	-16.352	2.897	-1.670	-1.333	-13.807	1.316	0.024	-0.245

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1618	0.2420	0.2471	0.2659	0.2616	0.2485	0.2575	0.2525	0.2606
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EARTH TEMPERATURE STATION

BURLINGTON, VT.

TYPE OF SOIL

UNKNOWN

TYPE OF EARTH SURFACE

BARE

DATA PROCESSED BY

JEN-HU-CHANG

DATA SOURCE

REFERENCE (5)

PERIOD OF OBSERVATION

1951-1955

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

J

F

M

A

M

J

J

A

S

O

N

D

.3	29.5	29.6	32.7	45.5	58.6	69.9	78.2	72.1	62.5	49.4	38.0	32.2
1.0	29.5	30.0	34.5	45.7	58.2	69.8	77.2	71.5	61.7	48.3	37.4	32.5
3.0	29.6	29.8	32.7	45.0	57.7	69.2	76.3	71.4	61.4	48.8	37.4	32.8

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EARTH TEMPERATURE STATION
TYPE OF SOIL
TYPE OF EARTH SURFACE
DATA PROCESSED BY
DATA SOURCE
PERIOD OF OBSERVATION

PULLMAN, WASH.
SILTY LOAM
VEGETATION
JEN-HU-CHANG
REFERENCE (5)
1943-1951

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW
SURFACE (IN)

J F M A M J J A S O N D

1.0	33.7	33.4	38.3	50.1	65.1	74.6	86.1	84.5	75.2	58.5	43.0	36.4
6.0	36.8	37.5	41.5	51.6	60.1	68.7	75.5	75.7	67.5	55.8	44.1	40.2

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

PULLMAN, WASH.
 UNKNOWN
 BLUE GRASS SOD
 E. M. FITTON
 REFERENCE (4)
 1912-1913

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	31.7	0.0	0.0	46.5	60.2	62.7	66.0	75.4	60.2	42.0	40.0	33.2
2.0	31.9	0.0	0.0	45.4	57.8	63.2	65.9	73.2	58.9	42.0	39.9	33.7
6.0	32.3	0.0	0.0	44.7	54.9	62.3	64.8	70.2	57.2	42.4	40.4	34.5
12.0	32.7	0.0	0.0	44.8	52.8	62.2	64.9	67.7	56.7	45.0	42.2	36.0
24.0	35.6	0.0	0.0	44.3	50.6	59.0	62.8	66.5	58.5	48.5	45.0	39.2
36.0	37.5	0.0	0.0	44.1	48.9	56.3	60.9	64.8	58.9	50.9	47.4	41.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	31.6	43.1	44.5	45.2	57.8	63.4	67.0	72.0	57.1	41.7	40.1	33.1
2.0	31.7	42.9	44.5	45.1	57.5	63.2	66.7	71.8	57.4	42.1	40.3	33.4
6.0	32.2	42.5	44.5	44.9	56.3	62.3	65.7	70.9	58.3	43.3	41.0	34.6
12.0	33.1	41.9	44.6	44.6	54.6	61.0	64.2	69.5	59.4	45.2	42.1	36.4
24.0	35.2	41.1	44.5	44.4	51.9	58.6	61.6	66.8	60.7	48.3	44.0	39.4
36.0	37.4	41.0	44.4	44.4	49.9	56.3	59.4	64.1	61.1	50.9	45.8	41.9

M= 60.
 N= 4
 D= 0.0186

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
49.766	-15.831	-1.213	0.369	-0.335	-7.195	4.159	-0.820	-4.080

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3121	0.3321	0.5208	0.4940	0.3324	0.6199	0.4489	0.3948	0.4472
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

SEATTLE, WASH.
 SAND OVER CLAY
 BLUE GRASS
 JEN-HU-CHANG
 REFERENCE(5)
 1948-1950

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
19.7	38.9	39.6	45.4	49.7	55.7	60.4	62.8	64.3	61.9	55.3	50.1	45.0
49.2	43.9	41.9	45.7	48.4	52.0	55.4	59.9	61.2	55.7	56.9	53.2	49.1
88.6	48.3	45.1	46.5	48.5	50.9	52.6	56.0	57.7	58.2	56.7	54.1	51.8
128.0	51.2	48.7	48.1	49.3	54.7	51.5	54.1	60.6	53.3	55.8	54.1	53.1
167.3	52.9	51.3	50.2	50.6	51.0	51.4	53.5	55.0	56.1	56.0	54.9	54.1
206.7	52.3	52.4	51.7	51.2	51.2	51.3	52.8	53.9	54.5	54.7	54.1	53.9
305.1	53.2	53.1	52.6	52.6	52.1	51.6	52.5	53.1	53.5	53.4	53.3	53.5
403.5	53.1	52.1	52.7	52.8	52.6	51.9	52.8	52.7	52.6	52.4	52.2	52.7
600.4	51.1	51.1	51.1	51.4	51.7	51.7	52.1	52.2	52.0	51.4	51.0	50.8

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE(IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
19.7	39.6	40.4	46.1	51.0	54.9	60.1	63.5	63.2	59.7	55.0	50.8	45.3
49.2	43.9	42.5	45.5	49.4	52.6	56.6	60.1	61.2	59.5	56.4	52.9	48.4
88.6	48.2	45.7	46.2	48.5	50.8	53.6	56.5	58.4	56.4	56.0	54.1	51.8
128.0	51.0	48.6	47.8	48.7	50.1	51.9	54.1	56.0	56.3	56.4	55.1	53.0
167.3	52.5	50.7	49.5	49.4	50.1	51.2	52.6	54.2	55.3	55.6	55.1	54.1
206.7	53.3	52.0	50.8	50.3	50.4	51.0	51.9	53.0	54.1	54.6	54.6	54.2
305.1	53.4	53.1	52.6	52.1	51.7	51.6	51.7	52.0	52.5	52.9	53.5	53.5
403.5	52.9	52.9	52.9	52.7	52.5	52.3	52.1	52.1	52.2	52.4	52.6	52.6
600.4	52.5	52.5	52.6	52.6	52.6	52.6	52.6	52.5	52.5	52.5	52.4	52.5

M= 108.

N= 4

D= 0.0335

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
52.521	-11.016	-0.406	0.465	0.462	-7.380	-0.910	-1.589	-0.180

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.1019	0.3466	0.4118	0.4584	0.4995	0.3464	0.4116	0.4599	0.4970
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EARTH TEMPERATURE STATION

RAINBOW RES., WISC.

TYPE OF SOIL

LOAM AND GRAVEL

TYPE OF EARTH SURFACE

CLOVER AND SOD

DATA PROCESSED BY

DATA SOURCE

CLIMATOLOGICAL DATA

PERIOD OF OBSERVATION

1963-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

MONTH OF YEAR

DEPTH BELOW

SURFACE (IN)

	J	F	M	A	M	J	J	A	S	O	N	D
1.0	30.1	26.8	28.7	39.1	54.3	64.3	.0	66.3	59.2	51.7	41.0	28.5
6.0	28.2	27.4	28.5	37.6	51.4	61.2	.0	64.4	57.8	49.9	39.6	30.1

EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

AFTON, WYOMING
 GRAVELLY LOAM
 SOD

CLIMATOLOGICAL DATA
 1964-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	31.7	33.0	28.7	43.3	50.2	55.2	63.8	64.8	56.3	46.8	35.5	33.2
2.3	33.0	34.0	28.5	44.5	51.8	56.8	65.2	66.8	58.1	48.6	37.0	34.4
4.0	37.4	0.0	46.5	0.0	0.0	62.9	71.8	73.0	65.2	56.0	45.0	41.6
8.0	33.5	35.0	48.1	41.9	49.2	53.3	62.7	64.7	57.5	48.1	37.8	35.0
20.0	35.0	35.0	50.2	39.5	45.9	52.0	59.1	61.8	56.6	50.1	42.1	37.4
40.0	39.5	39.4	51.7	39.8	44.7	50.7	57.1	60.9	57.9	53.8	47.3	42.7
72.0	45.8	45.5	52.6	43.7	46.5	51.9	57.0	61.5	60.8	58.5	54.2	49.9

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	33.7	33.1	35.2	43.9	52.1	59.6	67.8	68.5	59.2	48.4	38.7	33.9
2.3	34.0	33.3	35.2	43.6	51.7	59.2	67.3	68.2	59.4	48.7	39.1	34.3
4.0	34.3	33.6	35.3	43.3	51.3	58.5	66.5	67.8	59.5	49.2	39.8	34.8
8.0	35.1	34.3	35.6	42.6	50.2	57.2	64.9	66.9	59.8	50.3	41.2	36.0
20.0	37.5	36.4	36.6	41.3	47.7	53.7	60.4	63.9	60.0	52.6	44.8	39.3
40.0	41.1	39.6	38.8	40.8	45.0	49.6	54.7	59.0	58.6	54.5	48.9	42.6
72.0	45.5	43.7	42.5	42.2	43.7	46.2	49.3	52.8	54.7	54.1	51.6	48.4

M= 96.

N= 4

D= 0.0110

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
47.927	-14.193	-0.197	0.915	-0.840	-11.371	2.907	0.522	0.256

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.3347	0.5921	0.6393	0.6547	0.6973	0.6068	0.6283	0.6616	0.6575
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ARCHER, WYOMING
 LOAM
 WHEATGRASS

CLIMATOLOGICAL DATA
 1964-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	27.2	28.7	31.5	48.0	59.4	68.1	83.9	76.2	67.9	54.0	36.6	27.6
2.3	27.4	28.8	31.1	47.5	58.8	67.0	81.4	74.7	66.2	53.2	37.4	28.0
4.0	28.0	29.3	31.3	44.3	58.0	65.6	78.6	72.8	65.1	52.6	37.6	28.9
8.0	29.7	30.5	31.3	44.3	55.7	62.9	75.2	71.0	63.6	52.2	40.0	31.6
20.0	34.5	34.1	33.8	43.8	53.3	59.3	69.1	69.0	63.6	55.7	46.2	38.1
40.0	40.8	39.9	38.6	43.8	51.1	56.7	63.8	66.3	63.5	59.0	52.4	45.2
72.0	44.8	42.9	41.7	42.9	47.5	53.0	58.6	62.4	62.0	59.6	55.3	49.5

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	29.1	28.5	32.5	47.7	59.2	69.3	79.5	75.9	63.9	53.3	37.6	27.9
2.3	29.4	28.8	32.5	47.2	58.7	68.7	78.8	75.7	64.1	53.6	38.2	28.5
4.0	29.8	29.3	32.6	46.7	58.0	67.8	77.9	75.5	64.3	54.1	39.2	29.3
8.0	30.8	30.2	32.7	45.5	56.6	66.0	75.9	74.7	64.7	55.1	41.2	31.1
20.0	33.8	33.0	33.8	42.8	52.8	61.1	70.2	72.1	65.2	57.4	46.2	36.1
40.0	38.8	37.2	36.4	40.9	48.3	55.1	62.6	67.0	64.4	59.3	51.7	43.1
72.0	45.5	43.0	41.3	41.7	45.1	49.6	54.5	59.3	60.7	59.0	55.5	50.2

M= 11.7

N= 4

D= 0.0132

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
0.483	-21.376	0.140	0.087	-1.922	-15.062	2.129	0.369	1.267

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2435	0.364	0.4487	0.4606	0.4728	0.4107	0.4459	0.4635	0.4576
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EARTH TEMPERATURE STATION
 TYPE OF SOIL
 TYPE OF EARTH SURFACE
 DATA PROCESSED BY
 DATA SOURCE
 PERIOD OF OBSERVATION

ST- 117
 GILLETTE, WYOMING
 SANDY LOAM
 RANGE
 CLIMATOLOGICAL DATA
 1964-1965

OBSERVED MONTHLY AVERAGE EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	27.6	29.0	30.0	48.4	62.0	70.8	85.7	79.2	76.8	52.8	38.4	31.0
2.3	28.5	29.5	30.5	46.9	60.7	68.3	82.5	76.8	65.0	51.8	38.5	32.0
4.0	29.1	30.0	30.8	48.0	60.6	68.1	81.8	76.9	65.8	53.2	40.4	33.3
8.0	27.2	27.5	28.1	42.6	57.2	64.4	78.3	74.8	63.4	51.2	38.9	31.6
20.0	29.8	30.2	30.2	40.1	54.2	61.5	73.7	73.1	63.3	53.5	43.3	35.4
40.0	33.2	32.4	31.7	37.4	49.8	57.4	68.2	70.5	63.2	56.1	47.4	39.1
72.0	40.3	38.0	36.8	37.8	46.2	53.7	61.5	66.6	63.6	59.1	53.2	46.7

RESULTS OF LEAST SQUARES ANALYSIS

PREDICTED EARTH TEMPERATURES

DEPTH BELOW SURFACE (IN)	MONTH OF YEAR											
	J	F	M	A	M	J	J	A	S	O	N	D
1.0	28.1	26.9	30.0	45.8	59.8	69.8	80.3	78.6	64.3	51.8	38.4	28.9
2.3	28.3	27.1	30.0	45.5	59.4	69.4	79.8	78.4	64.4	52.1	38.8	29.2
4.0	28.6	27.4	30.1	45.1	58.9	68.8	79.2	78.2	64.6	52.5	39.4	29.8
8.0	29.3	28.1	30.3	44.3	57.8	67.6	77.8	77.6	65.0	53.2	40.6	30.9
20.0	31.6	30.2	31.1	42.3	54.8	64.1	73.8	75.7	65.9	55.3	43.9	34.3
40.0	35.2	33.4	32.9	40.2	50.7	59.3	67.9	72.0	66.2	57.7	48.2	37.7
72.0	40.5	38.0	36.5	39.4	46.5	53.5	60.5	66.0	64.7	59.5	52.8	45.5

M= 112.

N= 4

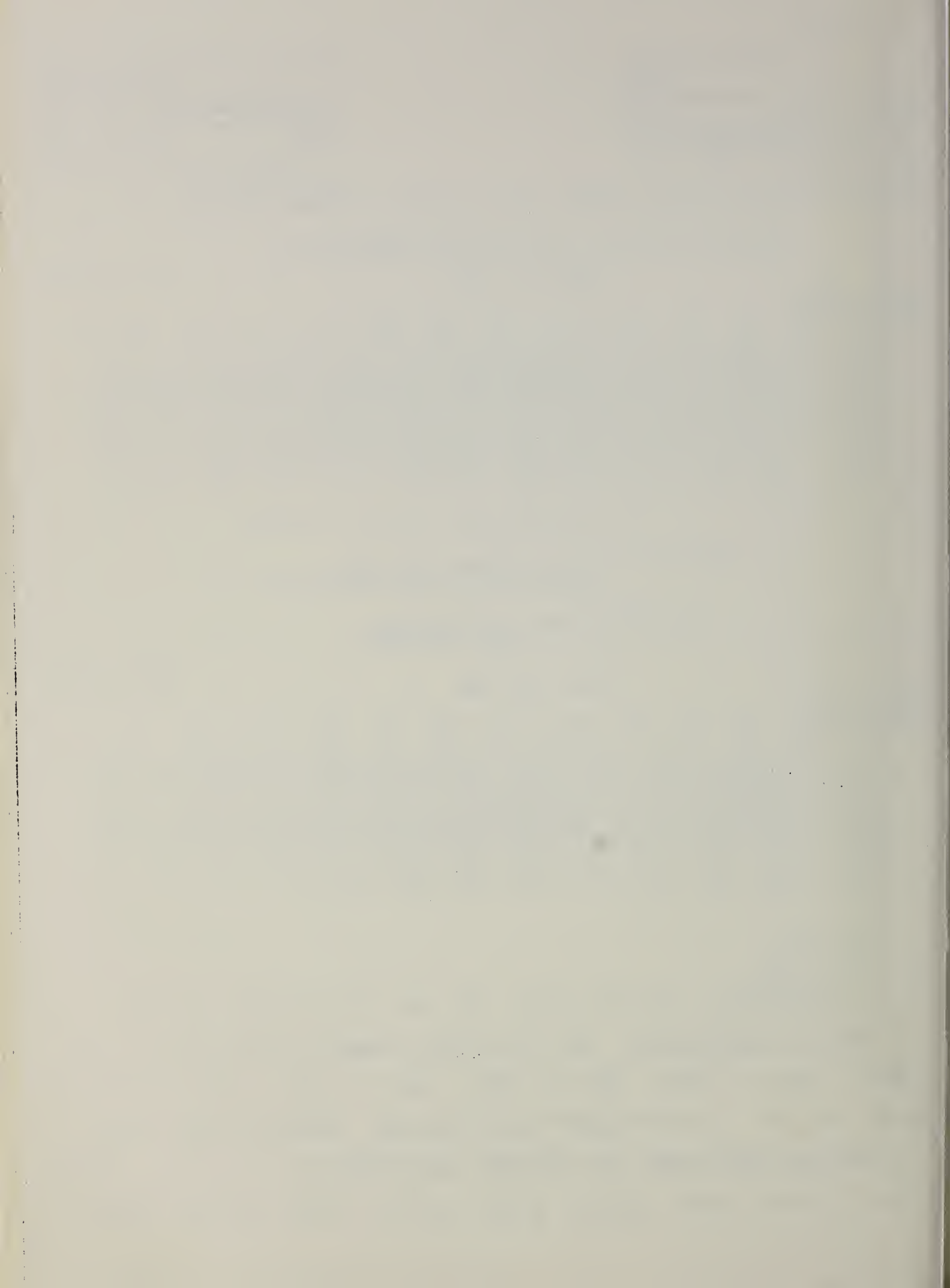
D= 0.0318

FOURIER COEFFICIENTS FOR THE LEAST SQUARES FORMULATION

A0	A1	A2	A3	A4	B1	B2	B3	B4
50.354	-21.705	1.058	0.826	-1.972	-16.453	2.491	0.520	0.387

STANDARD DEVIATION OF FOURIER COEFFICIENTS

0.2260	0.3820	0.3892	0.3972	0.4064	0.3591	0.3860	0.3996	0.3936
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13. ABSTRACT			
A least squares technique has been applied to periodic earth temperature data from selected stations throughout the contiguous United States for the purpose of determining basic heat transfer characteristics of earth temperature cycles. A procedure was developed for obtaining a single thermal diffusivity which represents the entirety of earth temperature data with reference to time, depth, amplitude and phase. The thermal diffusivity was obtained as a non-linear part of least squares constants which yielded best-fit harmonic curves to a given set of observed earth temperatures. The thermal diffusivity thus obtained and the calculation method developed herein are preferred to those described in the previous report of a similar title, which yielded two thermal diffusivities, one based upon amplitude decay and another on phase angle shift.			

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Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
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