## Title
Geographical extrapolation of typical hourly weather data for energy calculation in buildings



**Authors**
Arens, Edward A
Flynn, Larry E
Nall, Daniel N
et al.

**Publication Date**
1980-08-01

Peer reviewed

NBS BUILDING SCIENCE SERIES 126

# Geographical Extrapolation of Typical Hourly Weather Data for Energy Calculation in Buildings

Edward A. Arens[1]
Larry E. Flynn[1]
Daniel N. Nall[2]
Kalev Ruberg[1]

[1]Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, D.C. 20234

[2]Berkeley Solar Group
3026 Shattuck Avenue
Berkeley, CA 94705

U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, Secretary
Luther H. Hodges, Jr., Deputy Secretary
Jordan J. Baruch, Assistant Secretary for Productivity, Technology and Innovation

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Issued August 1980

Library of Congress Catalog Card Number: 80-600059

National Bureau of Standards Building Science Series 126
Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 126, 121 pages (Aug. 1980)
CODEN: BSSNBV

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1980

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
Price $4.50
(Add 25 percent for other than U.S. mailing)

## ACKNOWLEDGMENTS

The work described in this report was supported by the Department of Energy under the Building Energy Conservation Criteria Program, Task Order A008-BCS of Interagency Agreement No. EA-77-A-01-6010. The authors thank Tracey Kistler for preparing the manuscript, and Tom Pierce and William Carroll for their helpful comments.

TABLE OF CONTENTS

ABSTRACT

Two techniques are developed and tested for creating composite and synthetic hourly weather data for a wide range of sites. The first technique selects real weather data segments from a source multiyear weather record, and links them into a composite synthetic year, in which the hourly values are unchanged from the source. The second technique adjusts the real hourly data values of the source to create a more completely synthetic year. The techniques may be applied individually or in combination. The resulting synthetic year or years can be used to provide data that is representative of long-term climate for building energy prediction either at the first-order station where the source hourly weather data were recorded, or at a nearby second-order station for which only summarized climate averages are available. Additionally, the adjustment technique can generate synthetic data to represent specific time periods at second-order stations for use in energy audits and experiments. The effectiveness of extrapolating weather data from one location to another is assessed, and the uses of the two techniques are described. Two user-interactive Fortran programs, SELECT and ADJUST, are appended.



Key words: Building energy; computerized climate data.

## CONVERSION FACTORS FROM METRIC (SI) TO ENGLISH UNITS

| Physical Characteristic | To Convert from | To | Multiply by |
|---|---|---|---|
| Length | m | ft | 3.28 |
| Area | $m^2$ | $ft^2$ | 10.76 |
| Velocity | m/s | mph | 2.24 |
| Temperature | °C | °F | $t_F = 1.8t_C + 32$ |
| Temperature difference | °C | °F | 1.8 |
| Energy | J | Btu | $0.948 \times 10^{-3}$ |
| Power | W | Btu/hr | 3.41 |
| U-value | $W/m^2 °C$ | $Btu/hr \cdot ft^2 \cdot °F$ | 0.176 |
| Thermal Resistance | $m^2 °C/W$ | $hr \cdot ft^2 \cdot °F/Btu$ | 5.678 |
| Pressure | kPa | in. Hg | 0.296 |

1 Gigajoule (GJ) = $10^9$J = 0.948 Btu x $10^6$

Cover photo:

*Average weather data from a station near the buildng site may be used to extrapolate more remotely-recorded hourly weather data to the vicinity of the building site.*

Facing page:

*Dulles International Airport, Virginia. Airports are usually the site for recording hourly weather data.*

## 1. INTRODUCTION

It is becoming common practice for building designers to analyze building energy usage with computer programs that calculate the building's thermal response for each hour of a complete year. The results of these computations are used to evaluate alternative building design and mechanical equipment schemes, to establish compliance with codes, and to predict operating costs.

These programs require complete description of the building and hourly observations of weather conditions for the building's location.

Magnetic tapes with recorded weather values for various locations are available from the National Climatic Center of the National Oceanic and Atmospheric Administration (NOAA). Data recorded on these tapes include dry- and wet-bulb temperatures, cloud cover and type, wind speed and direction, solar radiation in some cases, barometric pressure, and weather type. Using each hourly set of these variables in sequence, the hour-by-hour program calculates the heat fluxes in the building. In order to calculate the energy requirements for an annual cycle, the program must perform 8,760 separate sets of calculations.

This report addresses two problems with hourly weather data for energy calculation. The first problem is that hourly data are collected in only a limited number of locations in the U.S. The number of Weather Bureau and military stations collecting hourly or three-hourly data is roughly 450. Since potential building sites could exist in any part of the country, and climate varies regionally, there are numerous large regions within which no hourly data is available to represent a building location. If hourly data were used from a station outside the region considerable inaccuracies could result. Few studies have been done that suggest energy variability within moderately sized geographical regions. Using temperature degree day values published by NOAA [1] as an indicator of energy use, one may predict a variability of 19 percent in annual heating and 34 percent in annual cooling between Washington National Airport and Dulles International Airport, about 25 miles apart in very moderate terrain. Over rougher terrain and greater distances, one may find considerably greater variability. In addition, differences in climate variables other than temperature, such as wind and sunlight, may increase the variability. Within most geographic regions, computed energy requirements will not reflect this variability because there is an insufficient number of stations recording hourly data. There is, however, a much larger number of second-order stations recording monthly summed averages of a fewer number of climate variables. If these monthly averages could be utilized to generate hour-by-hour data for these additional locations, the prediction of building energy use in their vicinities could be improved.

The second problem is to find weather data that best predict the future energy consumption of the building under design. The best estimate of future climate over a period as long as the life cycle of a building is the record of a long period in the immediate past, the thirty year summarized normals published by NOAA usually sufficing*. There are almost no hourly data available for periods of this length, and in any case designers are unlikely to run a loads program for more than one year because of the high costs. The solution is to find a typical

---

* Averages of long-term climate as used here may be represented by 'normals', averages for a special period of record. Current normals from NOAA are for the period 1941-1970. Other sources may use different periods, which may result in different values for normals in the same location. Longer periods generally show closer correspondence between their normals [2].

year or representative year that represents as closely as possible the long-term record in energy terms. There has been considerable interest in this subject, and several approaches have been developed or are under development [3, 4, 5]. Although this project was not originally intended to create representative year weather tapes, the method developed to extrapolate data geographically has potential for generating representative hourly data for a long-term period of record.

Two techniques for creating synthetic hourly weather data are proposed and tested. The first technique is a process to select intervals of real weather from a multi-year hourly weather tape or tapes to link together to create a composite synthetic year whose monthly averages represent monthly averages taken from the long-term record (hereafter referred to as "composite years"). The long-term month averages can be taken from: (1) the same station as the hourly data tape, in which case the selection technique creates a year representative of that station; or (2) a second-order station geographically removed from the hourly data station, in which case the selection technique creates a year representative of the removed station made up of segments of actual weather recorded at the hourly data station. The extrapolated year is "representative" because its monthly averages approximate the new location's averages as closely as possible.

Clearly there are climatological and geographical limits to such extrapolation. These are discussed in the report.

The second technique for creating synthetic hourly data is a process to mathematically adjust a first-order stations's hourly data values in an hour-by-hour manner. The technique basically has two purposes: (1) The first is to make the monthly averages of the adjusted tape match the long-term averages for the second-order station almost exactly. This purpose is the same as the selection procedure described above but, when applied in sequence to the selection procedure, allows additional refinement. (2) The second purpose is to adjust the data for a real period of time at the hourly station to create a synthetic hourly tape for the identical period at a second-order station or at an experimental site. This may be useful in energy audits and experiments in which observed fuel use in test buildings is being compared to fuel use computed from climate data, or to the climate data itself. The factors used to adjust the data could be taken from the ratio of long-term averages for first- and second-order stations, or from comparison of averages for the actual period of interest as recorded at a second-order station or at an experimental site.

Again, the limits to which such hour-by-hour adjustment can be used to extrapolate climate data geographically are discussed in the report.

The two techniques are embodied in two appended user-interactive FORTRAN programs, SELECT and ADJUST. The programs have been made interactive in order to allow the user to see significant parameters of the source data tape while considering the input parameters, and to summarize these for the selected and/or adjusted output tape. The programs read in and write out data from files of previously decoded data. The programs may be easily adapted to the various formats for decoded weather files used by the major building energy analysis programs.

Facing page:

*Weather data is available in two primary forms; published summaries containing averaged information and magnetic tapes containing hourly observations. Energy loads programs, such as DOE-2 and NBSLD require hourly weather data input.*


2. METHOD

2.1 SOURCES OF MONTHLY SUMMARIZED DATA

Synthetic weather data is usually created on a monthly basis, because summarized climate data has been traditionally presented in terms of monthly averages, and because a monthly profile of building loads gives a sufficiently fine definition of a building's annual energy performance.

Weather data are available from NOAA and the Armed Forces in various sources described in the Selective Guide to Climatic Data Sources [6] and the Guide to Standard Weather Summaries and Climatic Services [7]. The chief sources are NOAA's Climatography of the States, Local Climatological Data [8]; NOAA's Climatic Atlas of the U.S. [9]; and the Armed Forces' Manual 88/29, Engineering Weather Data [10]. The other major national source is the ASHRAE Handbook of Fundamentals [11]. Detailed local data may frequently be obtained from existing sources such as air pollution control districts, utilities, industry, universities, and experimental institutions. In addition, daily or limited hourly records may be gathered at experimental buildings during specific periods while energy consumption is being measured.

The U.S. has approximately 275 first-order NOAA stations and 5,000-6,000 substations publishing monthly means. There are approximately 175 U.S. military bases collecting the equivalent of first-order station data. The number of other possible sources is not known.

## 2.2 TYPES OF SYNTHETIC WEATHER DATA

A variety of techniques can be used to create synthetic weather data. These techniques differ in the extent to which the synthesized data is artificial. A totally synthetic technique is the hourly weather generator developed by Degelman [12], which uses as input only mean values from statistical summaries for a site or period of record. The hourly values are generated by a combination of deterministic modeling of daily and yearly cycles (temperature and insolation) and probabilistic selection of weather variables from empirically-based distributions of the variables. The coincidences and sequences of hourly data thus created are totally artificial, although based on patterns analysed from real weather. The technique has the advantage of not requiring any hourly data as input.

In contrast, the selection technique used in SELECT compiles a composite of actual weather data segments into a composite synthetic year representative of a site or period of record. It requires as input both mean values and a multiyear record of actual hourly weather observations on tape. Although the ordering of the data points in a composite year does not correspond to any real year, the data coincidence and sequences actually did occur. The 'Typical Meteorological Year' (TMY) [4] and 'Test Reference Year' (TRY) [3] representative weather data tapes are also composite years, created by different selection techniques. Selection techniques such as these cannot create a composite year whose monthly means exactly match those of the input summarized data. This is because the period of record of available computerized weather data is limited (less than thirty years for most stations) and the number of segments available for selection is restricted.

A third technique that is intermediate between the totally artificial approach and the selection approach is used in ADJUST. It modifies the actual weather observations from a real or representative year on an hour-by-hour basis, to make a synthetic year whose means exactly match those of the input summarized data for a site or period of record.

## 2.3 SEGMENT SELECTION TECHNIQUE

### 2.3.1 Reasons for Selecting Unmodified Data

There are several advantages to the composite approach of using selected real weather data segments to represent a location's climate. These advantages apply particularly when creating climate data representative of the long-term summarized record for the same site as the source input tape, but they may also hold when the selected year is being made for a location remote from that of the source input tape.

First, in using actual unmodified data, the user is guaranteed that the interaction between climate variables in the composite year actually could happen, because it did. Inexpert modifying or synthesizing of hourly data could result in unlikely or impossible combinations of climate variables that could affect computed energy use.

Second, the unmodified data by default incorporates certain local subtleties of weather that may be important in determining the suitability of a building's design to its location, but that would not be characterized in available published summaries, and would be very difficult to analyse and incorporate in a totally synthetic hourly-data-generating technique. On a daily basis, such subtleties include consistent morning fogs, sea breezes, valley winds, and afternoon cumulus cloud development. On a seasonal basis, the correlation of high winds with low temperatures following cold front passages increases the effect of low temperature on building energy consumption. In order to fully characterize a particular climate, the synthetic climate must be able to capture the diurnal temperature range and distribution, the distribution of cloud cover and wind over the day, and the correlations of wind, humidity, cloud cover, and temperature distinctive to the location. The use of unmodified data tends to retain such subtle characteristics. The hour-by-hour adjustment procedure that modifies actual climate data may also keep the subtleties of the original unmodified data, providing the adjustments are not excessive.

If the unmodified composite data are being used to represent the climate of the same location at which they were recorded, the selection technique's ability to retain daily and seasonal subtleties given an appropriately-sized sample is highly advantageous. The user should note that if the composite data are being used to represent a different location, the retention of such subtleties may be less important, or counterproductive. Care must be taken to assure that the climate characteristics are similar across the geographical distance. Chapter 4 discusses such concerns, and suggests that the user consult a meterologist when uncertain.

Third, the selection technique described here (as also the totally-artificial-weather generating technique) can create a typical year from a multiyear period of record, whereas an hour-by-hour adjustment procedure necessarily requires a representative base year to adjust from. Without a representative base, for example if one were to use one year selected at random, the adjustments could well be excessive and the adjusted values have incorrect distributions. A procedure will be proposed below to use the selection and adjustment techniques in sequence, with the selection procedure being used to create a representative base year requiring minimal subsequent adjustment.

### 2.3.2 Selection Algorithm

The weather data for the composite years are chosen by a segment selection algorithm that considers the effects of the major climate variables on building energy consumption. The core of the algorithm is a linear model predicting building energy consumption as a function of daily (or monthly) averages of temperature, sun, wind, and humidity. The coefficients of this model are used to weight the deviations between the segment averages and the long-term monthly input averages for these climate variables. The weighted deviations are then summed to form a score. Of all the segments being evaluated, the segment with the lowest score is selected as the best representative of the month.

The energy-climate model is intended to represent a fairly wide range of buildings in a wide range of climates. It was developed by the authors for an hourly climate data abbreviation technique [13]. It is based on statistical analysis of the heating and cooling requirements of three different building types in response to climatic variables in three climates. The buildings used in the analysis are similar in that all are moderately well-insulated small buildings sensitive to climate through their envelopes ('envelope-dominated'), in order to get fairly high responsiveness to climatic influences. The influences of climate on the less sensitive, large 'system-dominated' buildings were not addressed in the analysis leading to the model. It may be that synthetic weather data developed for sensitive buildings would be appropriate for less sensitive buildings. This was investigated only within the context of envelope-dominated buildings, where sensitive and insensitive buildings were shown to respond to climate variables similarly, allowing one weather data set to be used for both.

The three buildings used in the analysis are a lightweight conventional frame ranch house of 112 $m^2$ (1,200 $ft^2$), a more massive passive solar variant of this ranch with additional south glazing, and a very massive masonry two-story interior townhouse unit of 120 $m^2$ (1,280 $ft^2$). The buildings were designed to meet ASHRAE 90-75 insulation requirements for a site with 5,000 heating degree days (base 65°F), but because the buildings used such conventional insulation components as R-11 wall batts or R-10 foam panels, they actually met the ASHRAE standard across a wide geographic zone up to 7,800 heating degree days [14]. The buildings were simulated on NBSLD under standardized operating conditions. [15, 16] The climates used were Minneapolis, MN, Washington, DC, and Phoeniz, AZ, with TRY tapes [3] used as data for the simulations and for the regressions of climate against energy.

The coefficients for the model were determined by a regression analysis of daily climatic averages against daily energy results. The relative influence that climate variables had on heating and cooling requirements varied somewhat from building to building and climate to climate. However, the range of variation of the individual coefficients for heating and cooling modes, in three buildings in three climates, was sufficiently small that a single averaged set of coefficients could be employed in the model.

The model was tested on a one-story office building in three climates additional to the ones above: Miami, FL, Columbia, MO, and Boston, MA. The model worked successfully in selecting segments for piecing into abbreviated weather years for both this building and the three previous buildings, even though their thermal responsiveness varied greatly.

The model for the segment-selecting score follows:

$$\text{Score} = 14.3|\Delta DB| + 4.9|\Delta CC| + 0.37|\Delta WSDB| + 9.66\text{x}10^3|\Delta MR| \quad (1)$$

The segment with the lowest score of those evaluated is selected as being most representative of the input climate in energy terms. The score is an estimate of the difference in loads between the segment being evaluated and a segment with the input averages, in MJ/day, and

$\Delta DB$ = deviation of average dry bulb temperature (°C) between segment and monthly input. The 'average temperature' is computed either as a mean of all hourly values or of daily maxima and minima (as used by the Weather Bureau), depending on the nature of the input data being selected toward.

$\Delta CC$ = deviation of average total cloud cover (tenths of cover) between segment and monthly input.

$\Delta WSDB$ = deviation of average windspeed-times-(18.3 minus dry bulb temperature) between segment and monthly input. The temperature 18.3°C is the familiar degree day base 65°F, used as an approximate base for both heating and cooling.

$\Delta MR$ = deviation of moisture ratio for (kg $H_2O$ per kg dry air) between segment and month.

The relative influence of each climate variable on heating and cooling depends on the magnitudes of these coefficients and on the range that one may expect of the variable. Assuming a range across a month of 22°C (40°F) dry bulb temperature, 0-10 tenths cloud cover, 0-13 $ms^{-1}$ (0-30 miles $hr^{-1}$) wind (at -4°C or 25°F), and 0.013 kg $H_2O$ per kg dry air (maximum moisture range, -4 to 18°C or 25 to 65°F); the relative importance of (temperature:cloud cover:wind:humidity) in this equation is (2.5:1:1:1). In warmer conditions, the influence of wind diminishes and that of humidity increases.

influence that climate variables had on heating and cooling requirements varied somewhat from building to building and climate to climate. However, the range of variation of the individual coefficients for heating and cooling modes, in three buildings in three climates, was sufficiently small that a single averaged set of coefficients could be employed in the model.

The model was tested on a one-story office building in three climates additional to the ones above: Miami, FL, Columbia, MO, and Boston, MA. The model worked successfully in selecting segments for piecing into abbreviated weather years for both this building and the three previous buildings, even though their thermal responsiveness varied greatly.

The model for the segment-selecting score follows:

$$\text{Score} = 14.3|\Delta DB| + 4.9|\Delta CC| + 0.37|\Delta WSDB| + 9.66\text{x}10^3|\Delta MR| \quad (1)$$

The segment with the lowest score of those evaluated is selected as being most representative of the input climate in energy terms. The score is an estimate of the difference in loads between the segment being evaluated and a segment with the input averages, in MJ/day, and

$\Delta DB$ = deviation of average dry bulb temperature (°C) between segment and monthly input. The 'average temperature' is computed either as a mean of all hourly values or of daily maxima and minima (as used by the Weather Bureau), depending on the nature of the input data being selected toward.

$\Delta CC$ = deviation of average total cloud cover (tenths of cover) between segment and monthly input.

$\Delta WSDB$ = deviation of average windspeed-times-(18.3 minus dry bulb temperature) between segment and monthly input. The temperature 18.3°C is the familiar degree day base 65°F, used as an approximate base for both heating and cooling.

$\Delta MR$ = deviation of moisture ratio for (kg $H_2O$ per kg dry air) between segment and month.

The relative influence of each climate variable on heating and cooling depends on the magnitudes of these coefficients and on the range that one may expect of the variable. Assuming a range across a month of 22°C (40°F) dry bulb temperature, 0-10 tenths cloud cover, 0-13 $ms^{-1}$ (0-30 miles $hr^{-1}$) wind (at -4°C or 25°F), and 0.013 kg $H_2O$ per kg dry air (maximum moisture range, -4 to 18°C or 25 to 65°F); the relative importance of (temperature:cloud cover:wind:humidity) in this equation is (2.5:1:1:1). In warmer conditions, the influence of wind diminishes and that of humidity increases.

A final consideration in selecting representative segments is the observed fact that during temperate months, heating and cooling requirements are a function of excursions from the mean temperature rather than the mean temperature itself as considered by the model for scoring segments. The temperature distribution for each month should be represented in the composite month. This cannot be handled by the scoring model itself, and is therefore done in the selection algorithm by a procedure organizing the temperature distribution of the selected segments to assure a typical monthly temperature distribution and range. The way in which means and distributions are handled in the algorithm is discussed below.

### 2.3.3 Implementation of the Algorithm

A FORTRAN program SELECT was written to process several years of hourly weather records for selecting single synthetic composite years. The version listed in Appendix A processes a minimum of 3 and maximum of 10 years from up to 10 source locations. The number of source years could be increased with increased storage.

The synthetic composite months are made up of three linked segments of 9, 10, or 11 days, depending on the length of the month. The length of the segments were determined by several considerations. First, the segments had to be long enough to contain the full length of naturally occurring climatic cycles, so that the segments will contain sufficient ranges of each climatic element. Since the primary cycles within a month are daily cycles and 4 to 7 day weather cycles, segments over a week in length will tend to include these automatically. Second, the segments need to be long enough to minimize the effect of discontinuities at the junction between the segments. Segments pulled out of their normal sequence, and linked together with up to three weeks of data missing in between, may contain a larger climatic change between the last hour of the preceding segment and the first hour of the subsequent segment than would a naturally embedded sequence of hourly climate data. The energy implications of this step change depend on the natural variability of the climate and the mass of the building. Inspection of hourly loads for natural and composite climate sequences show the energy differences resulting from the step change to be insignificant for segments a few days in length. Since the segments are substantially longer than this, the authors have not felt it was necessary to smooth the junction between segments. Third, the segments need to be short enough so that the source population contains a large number of segments to select from. The number of segments of length n available from a given source month of length m equals (m - n + 1), overlapping being permitted. The larger n becomes, the smaller the number of segments available. Fourth, the segments must be short enough to provide variability in the averages of their climatic elements. The longer the segments, the more restricted the range of their averages around the averages of the source month itself. If the input averages are different from those of its source, it becomes harder to find segments with averages matching the input averages.

A series of runs were made with segments of differing length to help decide on the most effective length. In these runs, segments were chosen with averages matching the appropriate monthly averages as closely as possible. With 10-day and shorter segments, the restricted range of temperature in the composite month was the limiting factor in energy prediction, causing underprediction of energy. Longer intervals would alleviate this only slightly, and the increased difficulty of finding longer segments that matched the input temperature averages offset the advantage. It became clear that the preferred segment length would be between 7 and 10 days (3 to 4 segments per month). The ten day length was chosen in order to assure inclusion of climatic patterns. After this choice, measures were examined to increase temperature range and to increase the population of source segments.

The population of source segments was increased to include the two months adjacent to the month being selected. This was done because the nature of the climate is unlikely to change from one month to the next, and the small change in monthly averages from month to month may be helpful in making more suitable segments available for selection when the input averages differ from the averages in the source data population. There is, thus, a source data population for each month of about 83 ten-day intervals per year of hourly weather record. For the average TD 1440 ten-year record, the 830 segments were found to provide very satisfactory fit-capability in practice.

The temperature range problem was then analyzed to determine to what extent the monthly range and distribution are caused by climate through the month, as opposed to the variation induced by weather cycle fluctuations (on the order of 4 to 7 days). The annual march of temperature was very significant in transitional months but lost importance in the peak hot and cold months (generally January and July).

Since segments appreciably shorter than 30 days were not suitable for representing the range due to annual march of temperature, some other means of representing this range in the composite year had to be found.

By selecting a month's segments to a distribution of input averages around the monthly average, the range and distribution of hourly temperatures in the month can be approximated. Considerable effort was expended to find an available published measure that could be adopted to this purpose. The most common statistic, the standard deviation of month temperature means around the long-term (30 year) mean for that month, could not be used effectively. It became clear that the measure would have to be derived by processing the input weather tape.

The SELECT program calculates what we have termed the "average segment temperature march for the month." It is found by summing the absolute values of the deviation between each segment's average temperature and the monthly average from the input tape, then dividing by the sum of the absolute values of the difference in days between midmonth and the middle day of each segment. This is a measure of the average march of temperature from one segment to the next through the month.

The population of segments for computing the average temperature march extends half a segment length beyond the ends of the month; e.g. for the 10 day intervals, the first interval begins five days before the beginning of the month and the last segment ends five days after the last days of the month. This is done to equalize the weights of days in the month because when counting the overlapping population of segments, the central days are counted more often than the end days. By extending the source month, the first day of the month is counted six times, the second seven, and so on until the fifth day is counted ten times; all the central days until five from the end are counted ten times, then decreasing as at the beginning of the month. The influence of the periods extended beyond the ends of the month is relatively small, due to the low number of times each day is counted, and compensates for the reduced weight of the first and last five days of the month itself.

SELECT incorporates the march of temperature value in the selection procedure as follows. Three segments of 9, 10, or 11 days are combined to make a month of the appropriate length, with the longer segment in the middle. The middle segment is selected first, using the selection model (Eq. 1) with the monthly mean values for each climate element as input.

The second segment selected is picked on dry bulb temperature alone, and is selected to have a mean temperature displaced from the mean monthly temperature either up or down by ten times the "average segment temperature march for the month". This value is the median value for segments in the lower or higher third of the month. The choice of whether the higher or lower part of the month is picked first is somewhat arbitrary - it is based, for each month, on which segment would be more difficult to obtain, given the input average for the month and the average for that month's population of hourly data. E.g., if the input average is lower than that of the source data, the second segment selected is displaced downward from the mean. The user of the program will have some control over the extent of displacement; this is discussed later in 2.3.4 under use of the program.

The second selection will have produced a perturbation in the composite month's temperature selected so far, and the other climatic elements will have varied as well. The third selection attempts to balance out the perturbation. The climatic elements of the two selected segments are combined to determine the requirements for each climate element in the third segment to provide the combination of the three segments with climatic averages close to the input averages, as weighted by the selection model. As a result, the third-selected segment will contain a temperature deviating from the mean in the opposite direction as the second-selected segment.

Because it was found that the third selection often could not bring the combined averages to the mean using the source segments available, a fourth selection is made to re-select the second-selected segment based on all climatic elements. The requirements for selection are the climatic elements needed to bring the combined averages to the means. In this selection, possible unusual second-selected segments (selected on temperature alone) tend to be eliminated. The process is repeated one more time, reselecting the third-selected segment based on the combined average of the other two. In practice, this fifth selection frequently selects the same segment as the third selection, so the refinement is not carried further. Note that the month's central segment has not been reselected, and is the most "average" segment in the source population in the terms of the selection model.

The three selected segments for each month are then arranged in sequence in order of the temperature march through the year; rising temperature in spring and falling in autumn. The sequence during the hot and cold "peaks" is: the average temperature in the middle, the segment with the higher dry bulb average placed next to the adjacent month with the higher dry bulb average, and the segment with the lower dry bulb average next to the adjacent month with the lower dry bulb average.

In order to avoid repeating the same climate data, the program will not select segments from the source tape if their span overlaps previously selected segments by more than five days.

The program provides an optional extra one-week initialization period needed for some transfer function loads programs. It is comprised of a duplicate of the first week of the input file.

### 2.3.4 Use of the Program SELECT

The user assigns between three and ten years of source weather tapes (of data files) in NBSLD-decoded format [16]. The decoded tapes contain the climate elements in groups of 24, followed by date and city code. The source tapes may come from one location or from many; it is possible that a user may wish to extrapolate geographically from first-order sources bracketing the location for which a composite year is being generated. The source tapes are combined, regardless of origin, into a pool from which the segments are selected.

The program processes the data and prints the monthly averages of the climate variables in the pool for each month: dry bulb temperature, daily range of dry bulb temperature, standard deviation of daily average temperature around the monthly mean, heating and cooling degree days, dewpoint and wet bulb temperatures, daytime and 24-hour average cloud cover, windspeed, and barometric pressure. The dry bulb temperature is computed either as a mean of all hourly values, or in the form of NOAA published records: the average of the daily maximum and minimum. The user should choose the form consistent with the input data that are being selected toward. The degree days are calculated to base temperatures input by the user.

The user enters below these values the input averages desired for the composite year. The input averages required are: dry bulb temperature (from many possible sources), dewpoint temperature or wet bulb temperature (from the Climatic Atlas or Air Force Manual AF 88-29), daytime or 24-hour cloud cover (from local weather summaries or the Climatic Atlas), wind speed (from the same sources), and barometric pressure averages or the elevation of the station being selected for. If information for a given element is unavailable, the user may choose to default and echo average values from the input tape. A monthly adjustment factor is also called for, to expand or contract the distribution of temperature in each composite month.

In the absence of information on monthly temperature distribution, the user inputs 1.0, giving approximately the same temperature distribution as that of the source data pool. Subsequent iterations may be desired if the composite month's daily standard deviations differ from known desired values. The exact influence on daily standard deviation of the adjustment factor, which actually adjusts segment temperature march, cannot be determined in advance.

The input averages are converted by the program to variables used in the selection algorithm. Two transformations are made: first, the dewpoint or wet bulb temperature and the barometric pressure or elevation are converted to a moisture ratio using the ASHRAE-approved psychrometric subroutine [16] and the NACA standard atmosphere [17]. Second, the windspeed and the dry bulb temperature difference from 18.3°C (65°F) are multiplied to form one windspeed-drybulb product as used in the algorithm.

The segments are then selected. The program prints out a synopsis of the segment selection sequence, the source location, date, and year of the segments chosen, with a comparison of the composite and input monthly climatic averages of each climate element. The daily standard deviation of the synthetic month is printed for comparison to the source data standard deviations. The segment ranks given reflect the estimated energy performance of each segment in MJ/day. An example of an input stream and output is presented in Appendix D.

The user may choose to either use the resulting composite year as is, or subsequently adjust the hourly values to make the monthly averages of the composite year match the input averages exactly, in what then becomes a totally synthetic weather year. The adjustment technique is described in the next section. Chapter 4 discusses considerations in using the two programs in combination.

## 2.4 HOUR-BY-HOUR ADJUSTMENT TECHNIQUE

### 2.4.1 Reasons for Hour-by-Hour Adjustment

Given a single year, it is possible to adjust each hourly value in the year to cause the monthly averages of each climate element to equal given input averages while maintaining relationships between elements. An approach like this has two advantages over the composite year approach described above. First, the monthly averages are duplicated exactly, not approached to the best of the source data pool's ability.

Second, any composite data technique using multiday segments will not be able to select for climatic characteristics that occur within the span of a day. The one diurnal characteristic commonly recorded is the daily range of dry bulb temperature, and monthly averages of daily range are widely available. This statistic is very significant in predicting energy use in transitional months where the daily average temperature is near the balance points of the building and heating or cooling loads do not exist all day. A composite month with too small a daily range will underpredict heating and cooling loads during such months, and one with too great a daily range will overpredict.

The composite weather data accordingly should not be used in extrapolations where diurnal climate characteristics differ markedly between stations. By adjusting weather data this restriction can be relaxed for whatever climatic elements diurnal characteristics are known. There is a risk attached to this, in that the data are now truly synthetic (never actually occurred), and the combinations of climate elements in the synthetic year may begin to deviate from physical reality. The extent to which such deviations will affect building energy prediction must be determined empirically.

### 2.4.2 Adjustment Procedure

The adjustment of hourly data is done differently for the various climate elements. The following techniques are employed in the FORTRAN program ADJUST:

° Dry bulb temperature

Three adjustments are made; for the monthly average, the distribution of daily averages in the month, and for the distribution of hourly values in the day. As in SELECT, the user chooses the form of 'average temperature' consistent with the input data being used: the average temperature may be either the mean of all hourly values or the mean of daily maximum and minimum, as used in NOAA published records.

1. Monthly average: for each month, the difference between source and desired input average is found. This difference between monthly values is added to each hour of the month.

2. Monthly standard deviation of daily averages: the ratio of the desired standard deviation over that of the source year is determined on a monthly basis. For each day, the deviation of the daily average from the monthly average of the source year is found and multiplied by (the ratio minus 1). This value is added to each hourly value in that day. This does not modify the diurnal distribution of hours, but expands or contracts the distribution of daily averages.

3. Daily range: the ratio of the source year and desired input value of daily range is determined for each month. The hourly adjustment is carried out by multiplying by the difference bewteen each hour's temperature and the average for that day. The adjustment expands or contracts each day's distribution of hourly temperatures.

° <u>Dewpoint/wet bulb temperature</u>

The ratio of the dewpoint depressions (dry bulb temperature - dewpoint temperature, input average over source month average) is multiplied by the hourly dewpoint depression for each hour of the real month, and subtracted from the adjusted hourly dry bulb temperature, to give the adjusted hourly dewpoint temperature:

$$DPT_{AH} = DBT_{AH} - \frac{DD_{M\ desired}}{DD_{M\ source}} \times DD_{H\ source} \qquad (2)$$

where DPT is dewpoint temperature
DBT is dry bulb temperature
DD is dewpoint depression
A represents "adjusted"
M represents monthly average
and H represents a given hour

The same process is used to determine hourly adjusted wet bulb temperatures. The ratio of the source and input average monthly wet bulb depressions is multiplied by each hour's wet bulb depression and subtracted from that hour's adjusted dry bulb temperature.

The monthly average wet bulb and dew point temperatures are determined as an average of all hours in the month, since this is the basis for the published values. If wet bulb temperature and dewpoint temperature cannot both be found, the user may enter either and the other will be calculated by the ASHRAE psychrometric subroutine on an hourly basis.

It should be noted that the adjustment procedure partially shifts the distributions of dewpoint and wet bulb temperatures from their original distribution to follow the hourly adjustments made to the dry bulb temperature.

° <u>Wind</u>

Each source year hourly velocity value is multiplied by the ratio of the monthly source average to the monthly input average. Because the distribution is bounded on one end by zero velocity, this adjustment increases variability of hourly velocities in windier locations by the same ratio. Although velocity variability does tend to follow mean velocity in general, the relationship between variability of hourly values and monthly averages is complex, depending on a variety of climatological factors. Different locations experience different weather systems and terrain, causing their distributions of hourly velocities to be different even when their monthly averages are the same. In addition, different locations have different mixes of wind directions that are included in but not specified in the monthly wind velocity averages. Each direction reflects a different weather system or terrain influence. Thus differences in the distribution of wind directions will also affect the relationship between monthly velocity average and distribution of hourly velocities in the month.

Readily available climatological information will not provide information to define the wind velocity variability at the input station. In view of this, and of the great simplifications made in prediction of infiltration and natural ventilation in state-of-the-art load programs, a model more complex than the linear approximation adopted here is not felt to be justified.

- Cloud Cover

Cloud cover adjustments are made to total cloud, as used by current loads programs to compute the solar radiation incident on a building. The Kimura and Stephenson [18] algorithm that has recently been integrated into NBSLD, replacing the original ASHRAE algorithm, computes radiation as a function of total radiation and cloud type, with cloud type divided into two categories: cirrus (including cirrostratus) and non-cirrus. ADJUST determines cloud type from the weather tape variable "type of cloud in the lowest layer." The DOE-2 radiation algorithm [19] uses total cloud and type of cloud in the lowest layer as well, but with three categories of clouds: cirrus, stratus, and other. ADJUST will work for either algorithm, and spreads the adjustments described below proportionately among the three cloud types.

The adjustment of cloud cover is complicated by the fact that the cloud cover classes fall between two bounds, 0 and 10, in whole numbers. In addition, examination of the distributions of cloud cover hourly observations in various locations around the climatic regions of the U.S. shows a bimodal distribution with between one-half and two-thirds of the classes recorded are either 0 or 10, at the bounds of the distribution. Figure 1 and Table 1 show some example distributions. Similar but somewhat less extreme distributions are observed in Great Britain [20]. This means that the application of a ratio to the data would alter the distribution significantly and perhaps cause the elimination

CLOUD DISTIBUTION BY TENTH AND YEARLY AVERAGES.

| TENTH | ALBANY HOURS | JERSEY CITY HOURS | LAKEHURST HOURS | NEW YORK HOURS | PHILADELPHIA HOURS | PHOENIX HOURS |
|---|---|---|---|---|---|---|
| 0 | 1473 | 2179 | 1897 | 2092 | 1883 | 4969 |
| 1 | 237 | 333 | 267 | 320 | 349 | 279 |
| 2 | 354 | 383 | 447 | 415 | 360 | 274 |
| 3 | 340 | 404 | 428 | 344 | 438 | 255 |
| 4 | 352 | 368 | 405 | 284 | 323 | 177 |
| 5 | 335 | 161 | 306 | 292 | 274 | 146 |
| 6 | 386 | 287 | 302 | 313 | 312 | 240 |
| 7 | 467 | 393 | 478 | 318 | 374 | 269 |
| 8 | 625 | 523 | 637 | 492 | 499 | 376 |
| 9 | 429 | 434 | 521 | 491 | 535 | 392 |
| 10 | 3762 | 3295 | 3072 | 3399 | 3403 | 1446 |
| AVG. | 6.52 | 5.72 | 5.85 | 5.85 | 6.09 | 3.06 |

Table 1. Example Distributions of Cloud Cover by Tenths.

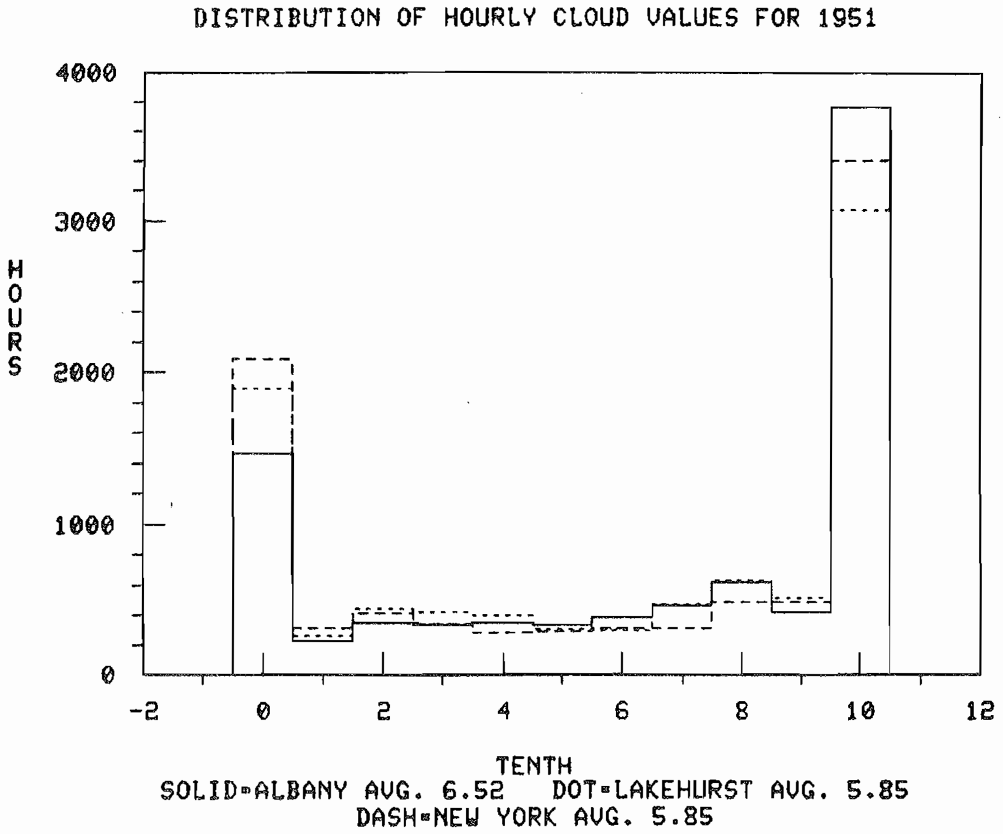



Figure 1. Example Distributions of Cloud Cover, by Tenths.

of the 10 tenths cloud cover class. Additive corrections could cause possible elimination of either the ten or the zero cloud cover classes.

To solve this, unit adjustments are made to that number of hourly cloud observations necessary to obtain the input average in the adjusted data. The hours to be adjusted are chosen in a way that disperses them throughout the month. For the 10 and 0 cloud classes, priority is given to hours that are not embedded in strings of consecutive hours with the same cloud cover class, in order to break up storms and clear spells as little as possible.

The number of unit adjustments to hourly cloud values is determined as follows: since the monthly averages are the sum of hourly values in the month divided by total hours in the month, the number of unit adjustments is the desired change in source-to-input cloud averages times the number of hours in the month. The change in source-to-input cloud averages is the difference between the 24-hour monthly cloud averages for source tape and input data. However, daytime averages are often the only data available in published form. If daytime cloud averages are being input, the change in 24-hour monthly cloud averages is approximated as follows. A subroutine calculates daytime length and the time of sunrise from latitude, longitude, and time zone of the remote station as input by the user. These are used to find the daytime monthly cloud averages for the source year. The difference between the input daytime monthly cloud average and the source-year daytime monthly cloud average is found, and multiplied by the ratio of the source 24-hour monthly cloud average over the source daytime monthly cloud average. This approximation accounts for possible differences in daytime and 24-hour cloud, and allows the number of unit adjustments to be determined.

The unit adjustments are applied to an equal number of hours from each class of cloud cover tenths. For example, in adjusting the 24-hour monthly cloud average for a 30-day (720 hour) month downward 0.1 tenths, it is necessary to adjust a total of 72 hourly cloud observations down one tenth. Since there are 10 classes available (10 through 1 tenth) for downward adjustment, one unit is subtracted from 7 hourly cloud values for each class. This alters the distribution of values by class only in the 10 and 0 classes. It was felt that the small number of values observed in the intermediate (1 through 9) classes did not justify the additional alteration of the distribution of values within them. This decision seems to be borne out by inspection of hourly distributions of adjacent stations, where changes in the means produce no consistent trends in the intermediate classes. Figure 1 shows that when moving from Lakehurst or New York, with essentially the same cloud cover mean, to Albany, with a higher mean, the number of hours in the intermediate classes for New York need to be increased while for Lakehurst they need to be decreased.

- Barometric Pressure

  The difference in source and input barometric pressure is found from the source tape monthly average and the monthly input average given by the user. This difference is subtracted from each source tape hourly pressure in the month. If monthly averages are not available, elevation differences may be input by the user. These are converted to pressure on an hour-by-hour basis using the coincident dry bulb temperature and source pressure.

### 2.4.3 Use of the Program ADJUST

The user assigns a source weather tape in NBSLD-decoded format. The composite years created by the SELECT program are in this format. The program processes one year's worth of data and prints out averages of climate elements for each month: dry bulb temperature, the cloud cover statistic being used (24-hour or daytime), wind speed, dewpoint temperature, wet bulb temperature, barometric pressure, standard deviation of daily averages around the monthly mean, and daily temperature range.

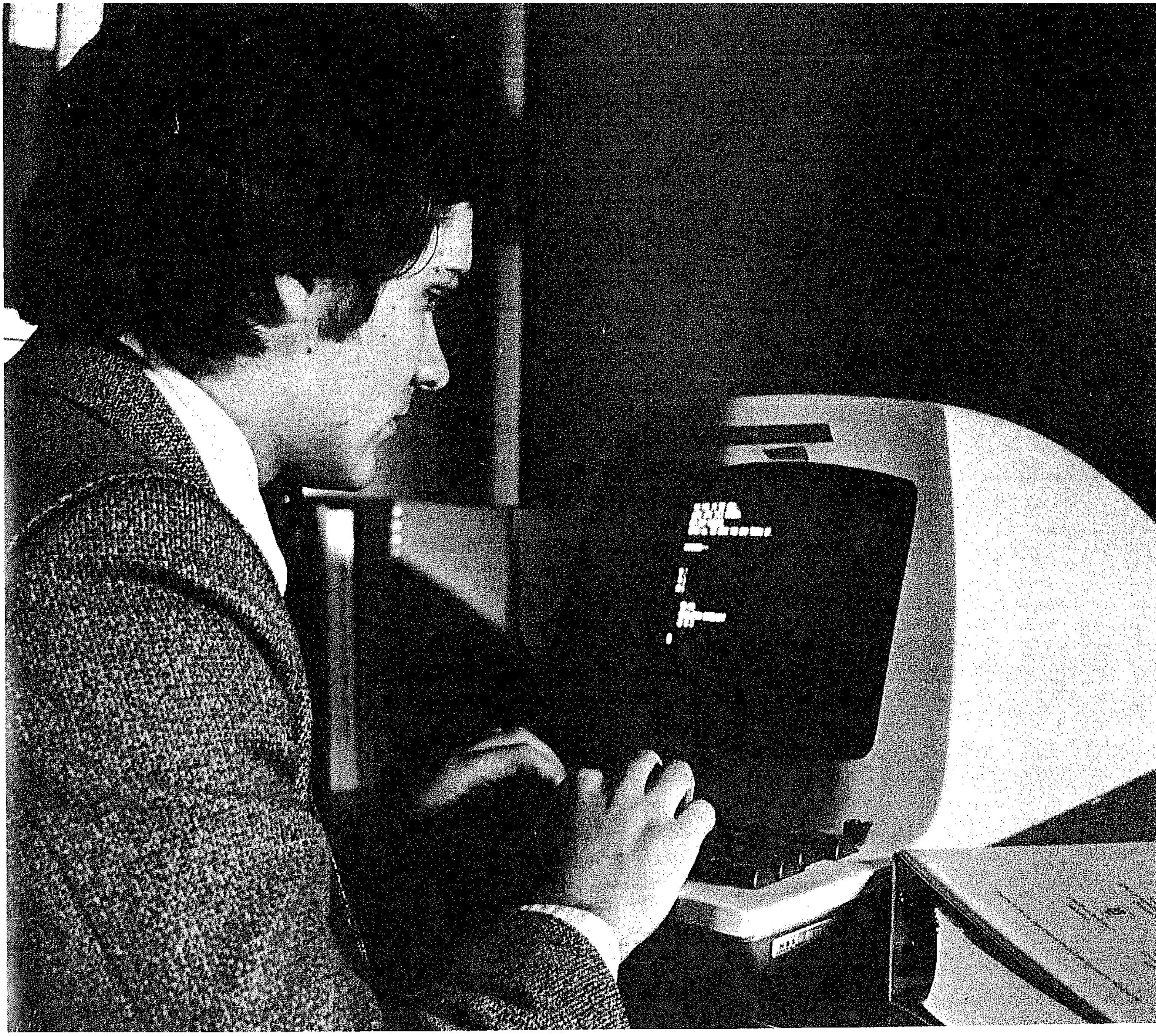
The user enters below these values the input averages desired for the adjusted year. Options are given for: 24-hour or daytime cloud cover, dewpoint or wet bulb temperature, and barometric pressure or station elevation. If input values are not available for standard deviations of daily temperatures around the monthly mean, the user should echo the values given for the source tape.

The program will skip any desired number of days on the input tape before adjusting a full consecutive year. The user should remember to skip the seven-day initialization period provided by the SELECT program, if that option had been exercised in creating the composite year. The program will begin on any desired month of the year on the input tape, providing that a full year of data follows that month.

An example input stream is given in Appendix E.

Facing page:

*The ADJUST program, used in an interactive mode, describes each required input and cues the user upon completion of the program run.*



## 3. TESTS AND RESULTS

### 3.1 TEST PROGRAM

The SELECT and ADJUST techniques were tested across a network of cities in the Northeast: New York NY (LaGuardia Airport), Jersey City NY, Lakehurst NJ, Philadelphia PA, and Albany NY. New York and Jersey City are considered central cities in this network, acting as data sources for making composite and synthetic tapes for all the cities. Two ten-year TD 1440 tapes were obtained for New York and Jersey City, each with the period 1949-59. The two nearby stations experience different daily temperature range and wind speed, and allow comparison of how differences in the source data affect the weather data synthesized for remote stations.

The year 1951 was a fairly typical year in New York City; this is the year selected by the "Test Reference Year" procedure [3] from the 27-year period 1948-75. (The TRY procedure picks a complete year from a record that contains the smallest number of months with large deviation from their long-term temperature averages. It is meant to produce fairly representative single data years for comparative testing of building energy systems). 1951 tapes were obtained for Albany, Lakehurst, and Philadelphia. In this test program, the monthly averages for 1951 were substituted for the long-term monthly averages that would normally be input to produce representative composite or synthetic years, not because they are as good as long-term averages, but because they allow much easier validation without impairing the test's precision. If long-term averages had been used to create actual representative years, the validation would have required 30-year energy loads runs to determine long-term energy performance. The costs of such an approach outweigh the advantages.

The tests were designed to test the extrapolation potential of the SELECT and ADJUST programs from New York and Jersey City to the other stations. Composite and synthetic years were created from the New York and Jersey City 10-year source data tapes for all cities in the network using the 1951 monthly averages of climate elements in those cities. The 1951 averages for each city were obtained by computer processing that city's 1951 weather tape. Each city's composite or synthetic 1951 year could then be directly compared to its real 1951 year, both climatically and in terms of its influence on the energy performance of buildings calculated by NBSLD.

The tests were carried out in several ways for different purposes:

(1) The composite years created by SELECT for 1951 New York and 1951 Jersey City from their 1949-58 hourly records and 1951 climatic averages were compared to the real 1951 years for those stations. This tests the ability of SELECT to produce representative years. The input averages normally would be long-term values rather than 1951 values.

(2) Composite 1951 years were created using SELECT for the remote stations Lakehurst, Philadelphia, and Albany. This tests the ability of the selection technique to extrapolate across geographical distances. These distances are generally greater than what the selection technique was intended for, but show the capabilities and limitations of the technique.

(3) The adjustment technique was used to create synthetic 1951 years at remote stations using the real New York and Jersey City 1951 tapes. This tests the ability of the adjustment technique to extrapolate hourly weather data for a real period of time to a location where only climatic averages are being recorded. Data created this way would be used

in analysis of data collected in experimental buildings on sites with limited climate measuring capability.

The performance of this "real period" synthetic year might be expected to be better than a synthetic year created using a composite 1951 at the source station. This is obvious in that a composite 1951 at the source station cannot have day-to-day similarity to the weather patterns of the real 1951 at the remote station. Such similarity in weather patterns occur throughout any real period of time in two reasonably proximate locations.

(4) There are two ways the selection and adjustment techniques can be used together to create representative synthetic weather data at a remote location. First, the selection technique could be used with the input averages of the remote station, to create a composite year at the remote station that would then be adjusted so that its averages matched the input averages exactly. The selection step of this is tested in (2) above.

Second, the selection technique could be used to create a representative year at the source location itself by using long-term input averages for the source location (tested in (1) above). This composite year would then be adjusted using the long-term averages for the remote station as inputs to the adjustment technique.

Synthetic 1951s were created by both methods for the remote stations to compare results. It should be noted that the adjustment technique could be used to improve the performance of representative years at their source location. However, because the error resulting from using SELECT alone for this purpose is small, it was felt that ADJUST would be better tested by creating years for remote locations.

All tests of loads prediction were done by using the Fort Meyer Building, for which the NBSLD input stream has been published [16]. The building is a zone of a one-story office building of 303.3 $m^2$ (3265 $ft^2$), with 330 mm (13 in.) uninsulated brick walls, a 1.94 $m^2$ °C $W^{-1}$ (R-11) ceiling below an attic, 14.4 $m^2$ (155 $ft^2$) of glass facing west, and 7.4 $m^2$ (80 $ft^2$) facing east. The north wall is a partition to another zone of the building. The assumed interior conditions include thermostat settings of 20.0°C (68°F) for heating and 25.5°C (78°F) for cooling, with nighttime setbacks to 15.5°C (60°F) and 29.4°C (85°F), respectively. This building is substantially different from the three buildings used to develop the selection model (Eq. 1, described in 2.3.2.). The building is more massive and more dominated by interior loads than the three houses. It remains, however, sensitive to climate through the building envelope, as reflected in plots of daily heating and cooling requirements for various seasons of the year (Figure 2).

## 3.2 COMPARISON OF WEATHER DATA BETWEEN STATIONS

Tables 2 through 5 and Figures 3 through 5 give the comparative monthly averages, processed by computer from the real 1951 hourly weather records, of the climate variables in the different stations of the network (New York, Albany, Lakehurst, Philadelphia). The corresponding values for the composite years produced by SELECT are also given on the tables. Consistent displacements are observed between stations in the variables temperature, dewpoint, windspeed, and barometric pressure.

Table 6 gives the means and ranges of climatic elements in New York over the 10-year record. The ranges also appear in Figures 3 through 5. The corresponding values for Jersey City can be found in the example SELECT run given in Appendix D. These ranges are an indication of the limits of SELECT's ability to find segments representative of remote locations.

The distribution of climate elements within the day has been compared only for dry bulb temperature, using the variable daily range. Tables 2 through 5 and the daily range graph in Figure 5 present average daily ranges, by month, for the four stations. The relatively low daily range seen in New York/LaGuardia was seen to have a significant effect on SELECT's ability to extrapolate representative energy-predicting years from New York to remote stations. This resulted in the inclusion of Jersey City in the network, and is discussed in section 3.3.

Figures 6 through 8 present simultaneous daily climate averages for the stations New York, Albany, Philadelphia, and Lakehurst during selected periods of time in the 1951 hourly record. These show strong similarity in the weather patterns experienced at each station, with occasional displacement of a day visible as weather systems cross the distance between stations. The 4 to 7 day weather cycles are quite visible. Figures 9 through 11 present heating and cooling requirements for three houses during the same periods, together with monthly values for the full year.* The heating and cooling requirements can be seen to inversely follow the variation in dry bulb temperatures quite closely (compare to Figures 6 through 8). The other influences are less visible.

The authors did not perform a systematic analysis of relationships of coincident climate elements in the climates of the various stations in the network. Future work on this may be desirable for a variety of climatic regions, because it could affect the way the two proposed extrapolation techniques are used. The question for any given pair of stations is essentially this: is the climate of the station being extrapolated to more similar to the overall climate pattern of the source station or is it more similar to occasional periods in the source's climate when specific weather systems are present at the

---

* The three houses are described in section 2.3.2. They were used in the development of the selection model, and represent widely varying responsiveness to climate.

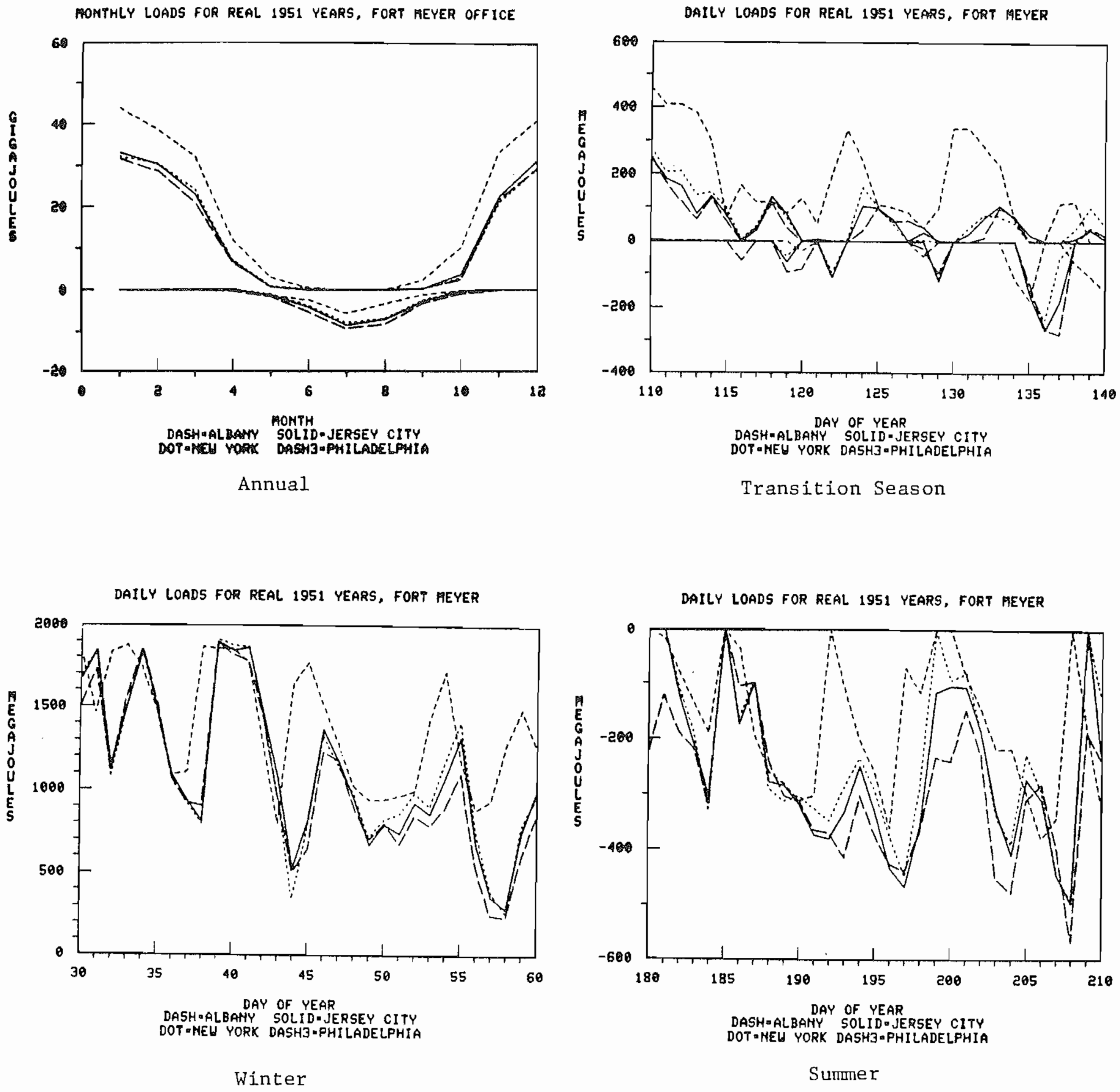



Figure 2. Heating and Cooling Requirements for the Fort Meyer Office Building, Using Real 1951 Years.

MONTHLY WEATHER AVERAGES FOR ALBANY 1951

| MONTH | DRY BULB TEMPERATURE DEGREES CELSIUS | | | S.D. OF DAILY AVERAGES DEGREES CELSIUS | | | DAILY RANGE OF DRY BULB DEGREES CELSIUS | | | DEWPOINT TEMPERATURE DEGREES CELSIUS | | | WIND SPEED METERS/SECOND | | | DAYTIME CLOUD COVER TENTHS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ |
| 1 | -2.79 | -2.80 | -3.00 | 5.6 | 4.8 | 5.2 | 10.4 | 7.7 | 8.2 | -7.0 | -8.6 | -8.0 | 4.57 | 5.82 | 4.52 | 7.66 | 6.45 | 7.08 |
| 2 | -2.74 | -2.58 | -2.78 | 6.2 | 4.7 | 4.6 | 8.5 | 6.4 | 7.5 | -7.2 | -8.4 | -8.6 | 4.55 | 5.32 | 4.37 | 6.51 | 6.27 | 6.27 |
| 3 | 2.06 | 2.02 | 2.03 | 3.7 | 4.4 | 4.5 | 8.9 | 6.2 | 6.9 | -2.8 | -3.1 | -2.9 | 4.57 | 5.45 | 4.56 | 7.48 | 7.70 | 7.57 |
| 4 | 8.86 | 8.82 | 8.88 | 3.1 | 4.9 | 4.2 | 10.7 | 7.9 | 9.4 | 2.3 | 2.4 | 2.5 | 4.18 | 5.12 | 4.62 | 6.64 | 6.58 | 6.58 |
| 5 | 15.28 | 15.28 | 15.27 | 4.4 | 3.4 | 3.4 | 13.1 | 8.7 | 10.3 | 7.1 | 7.0 | 7.2 | 3.30 | 5.31 | 4.63 | 5.94 | 5.77 | 5.77 |
| 6 | 18.73 | 18.67 | 18.71 | 3.3 | 4.0 | 3.5 | 11.2 | 8.8 | 9.3 | 12.6 | 12.6 | 12.8 | 3.21 | 3.95 | 4.39 | 7.15 | 6.85 | 6.88 |
| 7 | 22.04 | 22.07 | 21.99 | 2.1 | 2.0 | 3.9 | 11.5 | 7.5 | 8.9 | 16.1 | 16.1 | 16.1 | 3.16 | 4.38 | 3.52 | 6.38 | 6.47 | 6.36 |
| 8 | 19.42 | 19.46 | 19.41 | 2.6 | 2.5 | 2.8 | 12.3 | 7.0 | 8.6 | 15.0 | 14.3 | 14.3 | 2.33 | 4.27 | 3.70 | 6.54 | 6.58 | 6.66 |
| 9 | 15.52 | 15.55 | 15.52 | 3.9 | 3.8 | 3.5 | 12.2 | 7.9 | 9.3 | 11.1 | 10.1 | 11.0 | 3.00 | 4.69 | 4.23 | 5.82 | 5.74 | 5.69 |
| 10 | 10.30 | 10.30 | 10.32 | 4.4 | 3.9 | 4.0 | 12.1 | 6.6 | 8.8 | 6.3 | 5.2 | 5.7 | 3.51 | 5.07 | 3.57 | 6.29 | 6.61 | 6.30 |
| 11 | 1.11 | 1.11 | 1.07 | 5.2 | 4.6 | 4.0 | 9.0 | 5.4 | 6.3 | -3.4 | -4.8 | -3.3 | 3.78 | 5.22 | 4.16 | 7.00 | 5.87 | 7.01 |
| 12 | -2.47 | -2.47 | -2.23 | 8.4 | 5.3 | 5.9 | 10.6 | 7.6 | 9.0 | -6.5 | -8.3 | -6.5 | 3.71 | 5.84 | 4.37 | 6.47 | 6.26 | 6.64 |
| AVG. | 8.78 | 8.79 | 8.77 | 4.4 | 4.0 | 4.1 | 10.9 | 7.3 | 8.5 | 3.6 | 2.9 | 3.4 | 3.66 | 5.04 | 4.22 | 6.66 | 6.43 | 6.57 |

Table 2. Monthly Weather Averages for Albany 1951.

SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.

MONTHLY WEATHER AVERAGES FOR LAKEHURST 1951

| | DRY BULB TEMPERATURE DEGREES CELSIUS | | | S.D. OF DAILY AVERAGES DEGREES CELSIUS | | | DAILY RANGE OF DRY BULB DEGREES CELSIUS | | | DEWPOINT TEMPERATURE DEGREES CELSIUS | | | WIND SPEED METERS/SECOND | | | DAYTIME CLOUD COVER TENTHS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ |
| 1 | 2.41 | 2.39 | 2.42 | 5.0 | 4.3 | 3.9 | 9.3 | 6.6 | 6.6 | -2.5 | -2.9 | -3.0 | 5.25 | 5.25 | 5.20 | 6.55 | 6.53 | 6.50 |
| 2 | 1.88 | 1.86 | 1.85 | 5.5 | 5.0 | 3.5 | 10.6 | 7.0 | 7.1 | -3.1 | -3.4 | -4.0 | 5.01 | 5.07 | 4.92 | 5.66 | 6.20 | 5.67 |
| 3 | 5.42 | 5.39 | 5.43 | 3.5 | 3.4 | 3.3 | 9.5 | 7.6 | 7.2 | -.0 | .3 | -.6 | 5.42 | 5.42 | 5.29 | 6.14 | 6.50 | 6.26 |
| 4 | 10.94 | 10.89 | 10.94 | 3.6 | 4.3 | 3.4 | 12.4 | 9.1 | 10.0 | 4.4 | 4.5 | 4.2 | 5.06 | 5.55 | 4.54 | 5.78 | 5.77 | 5.79 |
| 5 | 16.51 | 16.50 | 16.52 | 3.5 | 2.9 | 3.6 | 12.2 | 8.2 | 8.6 | 9.2 | 9.3 | 9.1 | 4.55 | 5.52 | 4.85 | 6.52 | 6.49 | 6.69 |
| 6 | 19.88 | 19.94 | 19.91 | 3.6 | 3.5 | 3.5 | 10.1 | 7.9 | 8.3 | 15.6 | 15.0 | 15.5 | 3.76 | 5.24 | 3.37 | 7.48 | 7.58 | 7.65 |
| 7 | 23.59 | 23.64 | 23.60 | 1.9 | 2.2 | 2.0 | 10.7 | 7.0 | 9.5 | 18.2 | 18.2 | 18.3 | 3.68 | 4.12 | 3.32 | 6.56 | 6.50 | 6.45 |
| 8 | 22.15 | 22.16 | 22.13 | 2.6 | 2.6 | 2.7 | 11.1 | 7.3 | 7.7 | 17.8 | 17.5 | 17.6 | 2.96 | 4.00 | 3.10 | 6.32 | 6.66 | 6.28 |
| 9 | 18.84 | 18.86 | 18.87 | 3.2 | 3.2 | 4.0 | 12.2 | 8.2 | 10.4 | 13.8 | 13.2 | 13.8 | 3.70 | 5.62 | 3.68 | 5.33 | 5.51 | 5.51 |
| 10 | 13.72 | 13.68 | 13.76 | 4.0 | 3.8 | 3.6 | 10.2 | 8.2 | 8.0 | 10.1 | 9.1 | 9.1 | 3.85 | 6.13 | 4.00 | 6.64 | 6.54 | 6.72 |
| 11 | 5.78 | 5.75 | 5.74 | 5.4 | 4.8 | 3.9 | 10.6 | 7.2 | 7.8 | .9 | -.4 | .0 | 4.93 | 4.92 | 4.90 | 5.69 | 5.77 | 5.67 |
| 12 | 3.49 | 3.47 | 3.54 | 6.9 | 3.8 | 5.4 | 10.1 | 7.0 | 8.5 | .1 | -1.5 | -.4 | 4.63 | 5.60 | 4.60 | 6.76 | 6.85 | 7.07 |
| AVG. | 12.05 | 12.05 | 12.06 | 4.1 | 3.7 | 3.5 | 10.8 | 7.6 | 8.3 | 7. 0 | 6.6 | 6.6 | 4.40 | 5.20 | 4.31 | 6.29 | 6.41 | 6.36 |

Table 3. Monthly Weather Averages for Lakehurst 1951.

SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.

MONTHLY WEATHER AVERAGES FOR NEW YORK 1951

| MONTH | DRY BULB TEMPERATURE DEGREES CELSIUS | | | S.D. OF DAILY AVERAGES DEGREES CELSIUS | | | DAILY RANGE OF DRY BULB DEGREES CELSIUS | | | DEWPOINT TEMPERATURE DEGREES CELSIUS | | | WIND SPEED METERS/SECOND | | | DAYTIME CLOUD COVER TENTHS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ |
| 1 | 2.71 | 2.75 | 2.70 | 4.7 | 3.5 | 2.9 | 7.5 | 6.8 | 6.3 | -3.6 | -3.6 | -3.6 | 6.48 | 6.40 | 5.89 | 6.38 | 6.45 | 6.24 |
| 2 | 2.28 | 2.26 | 2.21 | 5.3 | 3.7 | 4.0 | 7.9 | 6.9 | 7.8 | -4.2 | -4.4 | -4.4 | 6.88 | 6.91 | 6.69 | 6.11 | 6.12 | 6.02 |
| 3 | 5.48 | 5.48 | 5.47 | 3.2 | 3.7 | 3.6 | 6.7 | 7.0 | 7.3 | -1.0 | -1.6 | -1.5 | 7.43 | 7.38 | 6.17 | 6.25 | 6.31 | 6.40 |
| 4 | 11.42 | 11.46 | 11.41 | 3.0 | 4.4 | 5.2 | 8.4 | 8.8 | 10.5 | 3.8 | 3.8 | 3.8 | 5.76 | 5.66 | 5.22 | 5.89 | 5.89 | 5.91 |
| 5 | 16.77 | 16.77 | 16.77 | 3.3 | 3.3 | 3.5 | 9.7 | 10.1 | 9.4 | 8.1 | 8.2 | 8.1 | 5.28 | 5.24 | 4.49 | 5.99 | 6.10 | 6.11 |
| 6 | 20.77 | 20.76 | 20.75 | 3.4 | 4.8 | 2.7 | 8.0 | 8.1 | 9.0 | 14.5 | 14.4 | 14.4 | 4.72 | 5.36 | 3.47 | 6.49 | 6.53 | 6.56 |
| 7 | 24.42 | 24.39 | 24.42 | 1.9 | 2.4 | 2.2 | 8.0 | 7.9 | 10.2 | 17.1 | 17.1 | 17.1 | 4.34 | 4.34 | 3.64 | 6.19 | 6.08 | 5.95 |
| 8 | 23.41 | 23.40 | 23.45 | 2.1 | 2.8 | 1.7 | 8.0 | 8.4 | 9.6 | 17.1 | 17.2 | 17.2 | 4.41 | 4.73 | 3.91 | 6.01 | 6.21 | 6.10 |
| 9 | 20.06 | 20.05 | 20.07 | 3.0 | 3.4 | 3.8 | 7.9 | 8.4 | 10.0 | 13.0 | 13.0 | 13.0 | 5.06 | 5.12 | 4.11 | 5.45 | 5.67 | 5.48 |
| 10 | 15.03 | 15.01 | 15.01 | 3.5 | 2.7 | 3.8 | 7.0 | 7.2 | 9.0 | 8.8 | 8.9 | 8.8 | 5.98 | 5.58 | 4.29 | 6.35 | 6.26 | 6.34 |
| 11 | 6.50 | 6.50 | 6.46 | 4.9 | 5.3 | 4.3 | 7.7 | 6.9 | 9.1 | -1.0 | -.5 | -.8 | 6.11 | 6.02 | 5.17 | 5.95 | 5.94 | 5.78 |
| 12 | 3.90 | 3.93 | 3.85 | 6.6 | 5.3 | 4.2 | 7.2 | 7.4 | 7.0 | -2.9 | -2.3 | -2.5 | 5.60 | 5.70 | 5.74 | 6.72 | 6.69 | 6.68 |
| AVG. | 12.73 | 12.73 | 12.71 | 3.7 | 3.8 | 3.5 | 7. 8 | 7.8 | 8.8 | 5.8 | 5.8 | 5.8 | 5.67 | 5.70 | 4.90 | 6.15 | 6.19 | 6.13 |

Table 4. Monthly Weather Averages for New York 1951.

SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.

MONTHLY WEATHER AVERAGES FOR PHILADELPHIA 1951

| | DRY BULB TEMPERATURE DEGREES CELSIUS | | | S.D. OF DAILY AVERAGES DEGREES CELSIUS | | | DAILY RANGE OF DRY BULB DEGREES CELSIUS | | | DEWPOINT TEMPERATURE DEGREES CELSIUS | | | WIND SPEED METERS/SECOND | | | DAYTIME CLOUD COVER TENTHS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | REAL | SN | SJ | RE/L | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ | REAL | SN | SJ |
| 1 | 2.23 | 2.23 | 2.21 | 4.3 | 2.6 | 4.1 | 8.6 | 5.6 | 6.6 | -3.1 | -3.2 | -3.1 | 4.53 | 4.66 | 4.55 | 6.64 | 6.89 | 6.74 |
| 2 | 2.26 | 2.18 | 2.17 | 5.4 | 5.2 | 4.3 | 8.9 | 8.0 | 7.9 | -4.2 | -4.1 | -4.1 | 4.83 | 6.10 | 4.87 | 5.80 | 5.81 | 5.75 |
| 3 | 6.11 | 6.20 | 6.10 | 3.4 | 3.1 | 3.6 | 8.5 | 6.8 | 8.5 | -.6 | -.4 | -.8 | 5.60 | 5.65 | 5.53 | 6.50 | 6.52 | 6.57 |
| 4 | 11.98 | 12.11 | 12.00 | 3.5 | 3.8 | 4.2 | 10.9 | 8.5 | 9.4 | 4.0 | 4.1 | 4.4 | 4.91 | 5.88 | 4.93 | 6.34 | 6.32 | 6.32 |
| 5 | 17.54 | 17.54 | 17.61 | 3.1 | 3.0 | 4.1 | 11.3 | 8.0 | 11.3 | 9.1 | 9.0 | 9.2 | 4.25 | 5.61 | 4.10 | 6.42 | 6.35 | 6.49 |
| 6 | 21.58 | 21.52 | 21.57 | 3.5 | 4.3 | 3.3 | 9.5 | 8.0 | 8.7 | 16.0 | 15.9 | 16.0 | 3.80 | 4.73 | 3.53 | 7.20 | 7.21 | 7.32 |
| 7 | 24.69 | 24.77 | 24.65 | 1.8 | 1.8 | 2.0 | 9.8 | 7.2 | 8.4 | 18.5 | 18.6 | 18.5 | 3.60 | 4.02 | 4.30 | 6.62 | 6.63 | 6.60 |
| 8 | 23.68 | 23.66 | 23.70 | 2.5 | 2.2 | 2.9 | 10.3 | 7.4 | 8.9 | 17.6 | 17.6 | 17.6 | 3.14 | 4.21 | 3.58 | 6.31 | 6.24 | 6.37 |
| 9 | 20.10 | 20.12 | 20.08 | 3.1 | 2.8 | 3.0 | 11.2 | 8.3 | 10.2 | 13.5 | 13.5 | 13.6 | 3.52 | 5.32 | 3.61 | 5.53 | 5.53 | 5.58 |
| 10 | 15.43 | 15.38 | 15.43 | 3.9 | 3.0 | 3.9 | 9.2 | 7.7 | 9.2 | 9.7 | 9.6 | 9.7 | 4.16 | 3.94 | 4.21 | 6.26 | 6.27 | 6.17 |
| 11 | 5.77 | 5.76 | 5.75 | 5.0 | 5.1 | 4.8 | 9.3 | 6.8 | 8.5 | -.3 | .2 | -.3 | 4.76 | 4.75 | 4.64 | 6.09 | 6.12 | 6.00 |
| 12 | 3.58 | 3.47 | 3.57 | 6.6 | 4.3 | 4.2 | 8.5 | 6.4 | 6.0 | -1.9 | -2.0 | -1.7 | 4.55 | 4.98 | 4.37 | 6.46 | 6.57 | 6.31 |
| AVG. | 12.91 | 12.91 | 12.90 | 3.8 | 3.4 | 3.7 | 9.7 | 7.4 | 8.6 | 6.5 | 6.6 | 6.6 | 4.30 | 4.99 | 4.35 | 6.35 | 6.37 | 6.35 |

Table 5. Monthly Weather Averages for Philadelphia 1951.

SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.

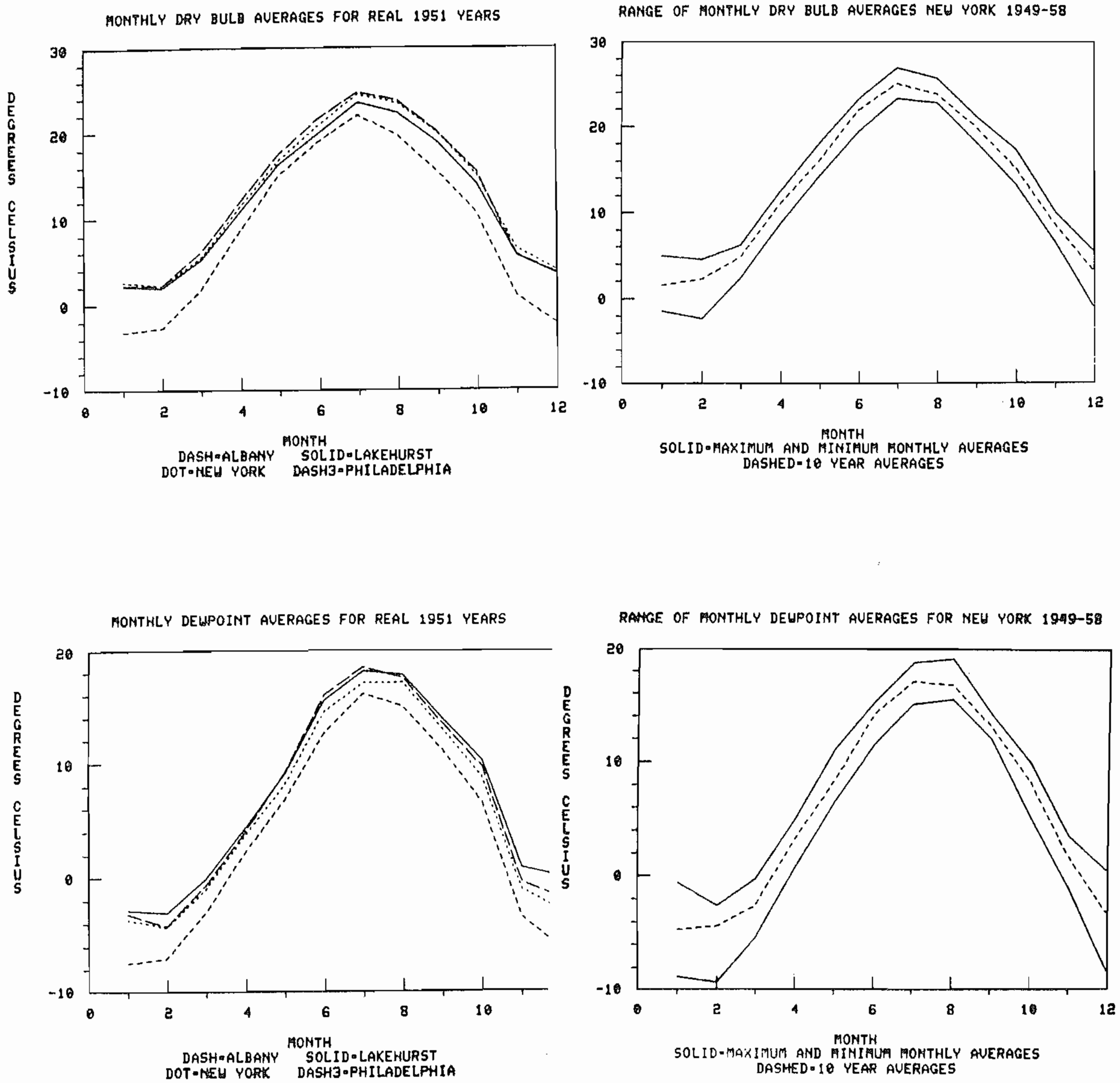



Figure 3. Means and Ranges of Monthly Weather Averages 1949-1958.

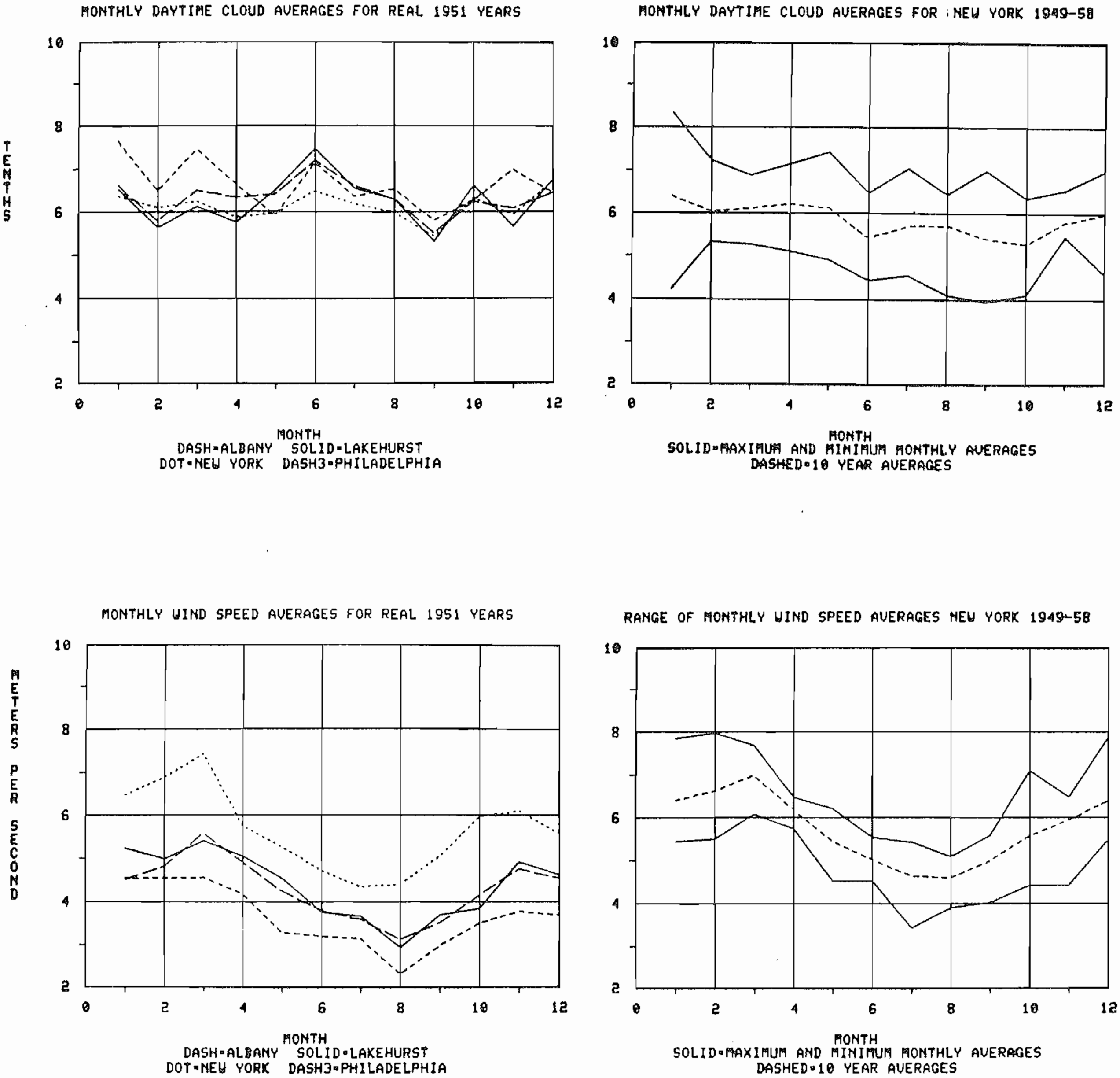



Figure 4. Means and Ranges of Monthly Weather Averages 1949-1958.

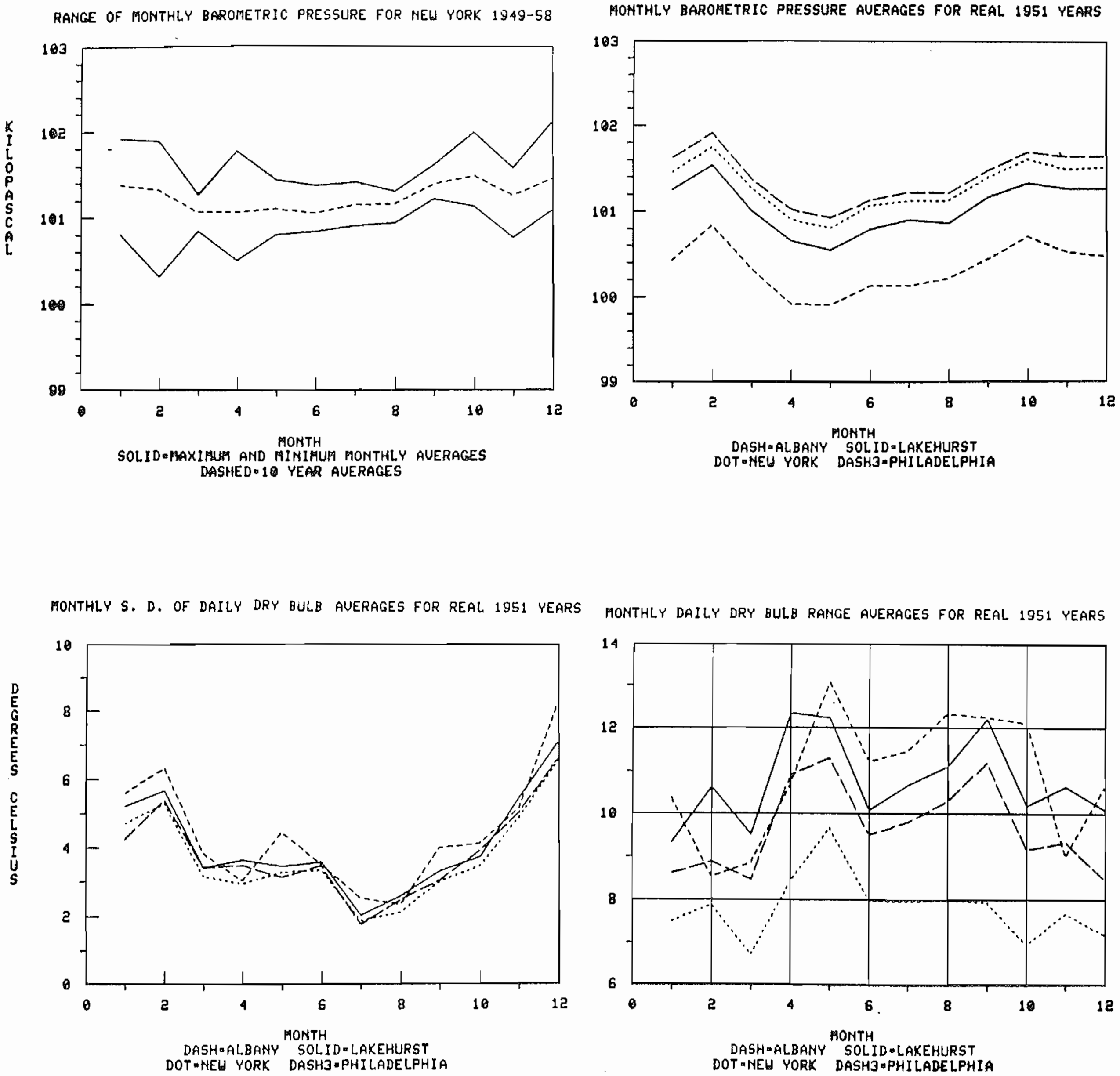



Figure 5. Means and Ranges of Monthly Weather Averages 1949-1958.

RANGE OF MONTHLY WEATHER AVERAGES FOR NEW YORK 1949-1958

| MONTH | DRY BULB TEMPERATURE DEGREES CELSIUS | | | S.D. OF DAILY AVERAGES DEGREES CELSIUS | | | DAILY RANGE OF DRY BULB DEGREES CELSIUS | | | DEWPOINT TEMPERATURE DEGREES CELSIUS | | | WIND SPEED METERS PER SECOND | | | DAYTIME CLOUD COVER TENTHS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AVG. | LOW | HIGH | AVG. | LOW | HIGH | AVG. | LOW | HIGH | AVG. | LOW | HIGH | AVG. | LOW | HIGH | AVG. | LOW | HIGH |
| 1 | 1.58 | -1.38 | 4.99 | 4.15 | 3.03 | 5.02 | 6.59 | 5.38 | 7.69 | -4.61 | -8.85 | -.53 | 6.42 | 5.46 | 7.86 | 6.42 | 4.24 | 8.37 |
| 2 | 2.22 | -2.25 | 4.55 | 4.39 | 2.99 | 5.32 | 7.04 | 5.44 | 8.21 | -4.38 | -9.33 | -2.57 | 6.63 | 5.52 | 7.99 | 6.05 | 5.35 | 7.24 |
| 3 | 4.82 | 2.44 | 6.25 | 3.86 | 1.75 | 6.07 | 7.26 | 6.20 | 8.84 | -2.53 | -5.33 | -.19 | 7.00 | 6.10 | 7.70 | 6.12 | 5.29 | 6.90 |
| 4 | 10.96 | 8.71 | 12.43 | 3.98 | 2.95 | 5.32 | 8.48 | 7.63 | 10.07 | 3.31 | .81 | 5.09 | 6.19 | 5.76 | 6.49 | 6.23 | 5.13 | 7.15 |
| 5 | 16.01 | 14.28 | 18.07 | 3.57 | 2.76 | 4.59 | 8.96 | 7.45 | 10.39 | 8.33 | 6.50 | 11.09 | 5.47 | 4.54 | 6.22 | 6.14 | 4.93 | 7.44 |
| 6 | 21.81 | 19.26 | 23.09 | 3.69 | 2.92 | 4.12 | 9.02 | 7.98 | 9.89 | 14.11 | 11.54 | 15.21 | 5.04 | 4.54 | 5.56 | 5.44 | 4.45 | 6.49 |
| 7 | 24.93 | 23.18 | 26.74 | 2.53 | 1.88 | 2.93 | 8.50 | 7.38 | 9.10 | 17.08 | 15.06 | 18.80 | 4.65 | 3.45 | 5.44 | 5.72 | 4.57 | 7.05 |
| 8 | 23.73 | 22.67 | 25.57 | 2.49 | 1.78 | 3.29 | 8.00 | 7.44 | 8.76 | 16.74 | 15.50 | 19.12 | 4.61 | 3.92 | 5.09 | 5.73 | 4.11 | 6.44 |
| 9 | 19.85 | 18.13 | 21.05 | 3.40 | 2.65 | 4.08 | 7.82 | 6.98 | 8.50 | 13.09 | 11.99 | 14.12 | 5.01 | 4.03 | 5.58 | 5.42 | 3.95 | 7.00 |
| 10 | 15.05 | 13.20 | 16.88 | 3.72 | 2.49 | 5.58 | 7.69 | 6.95 | 8.71 | 8.31 | 5.23 | 9.91 | 5.58 | 4.44 | 7.10 | 5.29 | 4.11 | 6.35 |
| 11 | 8.61 | 6.50 | 9.84 | 4.51 | 2.50 | 5.76 | 6.77 | 5.98 | 7.09 | 1.72 | -1.01 | 3.48 | 5.96 | 4.44 | 6.49 | 5.81 | 5.47 | 6.55 |
| 12 | 3.11 | -1.06 | 5.41 | 4.62 | 3.78 | 6.56 | 6.30 | 5.47 | 7.19 | -3.32 | -8.45 | .38 | 6.40 | 5.48 | 7.86 | 5.99 | 4.60 | 6.98 |
| AVG. | 12.72 | 10.31 | 14.57 | 3.74 | 2.62 | 4.89 | 7.70 | 6.69 | 8.75 | 5.66 | 2.81 | 7.83 | 5.86 | 4.80 | 6.62 | 5.75 | 4.68 | 7.00 |

Table 6. Ranges and Averages of Monthly Weather Averages for New York 1949-1958.

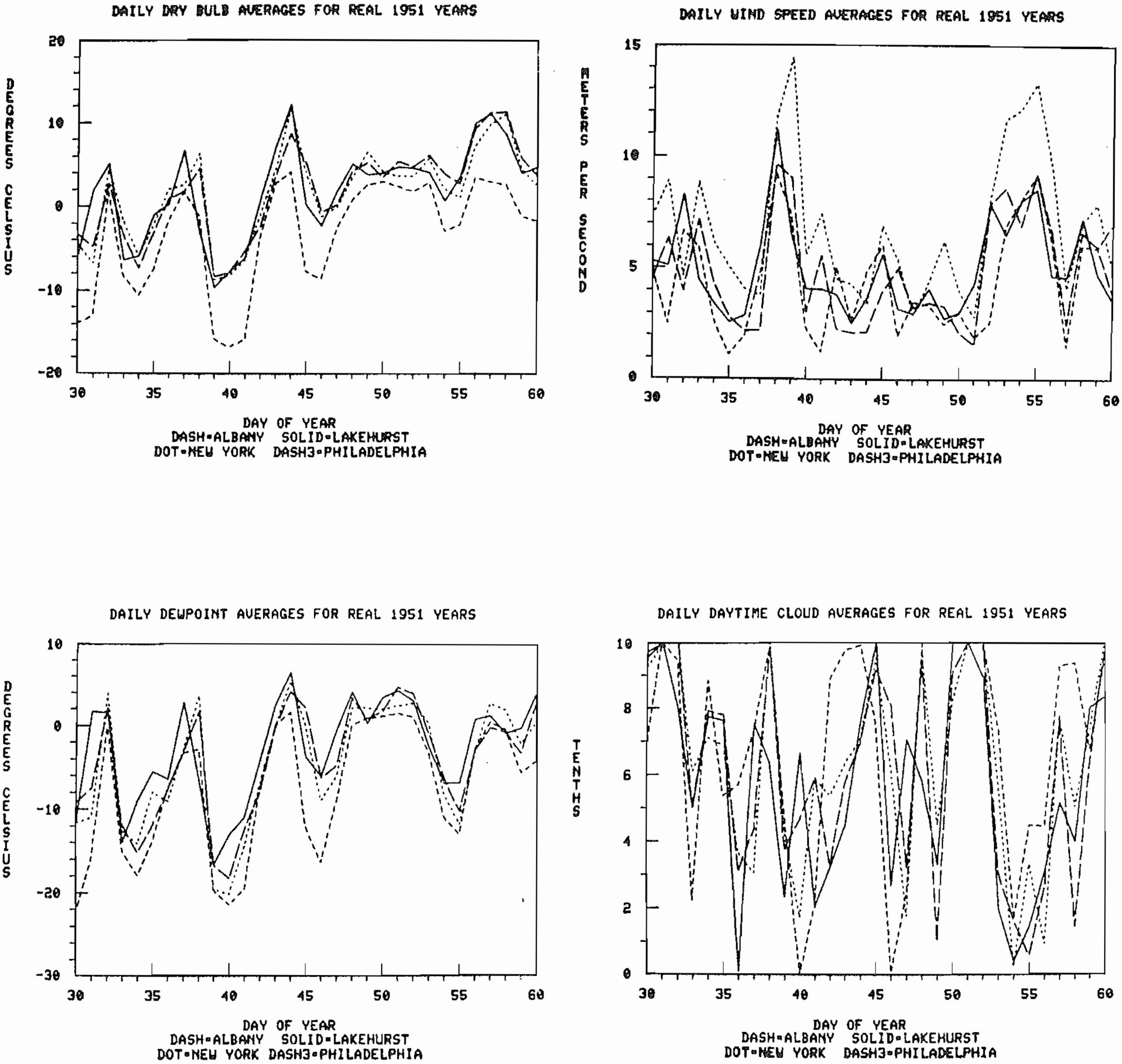



Figure 6. Comparison of Daily Averages for Climate Elements in Winter.

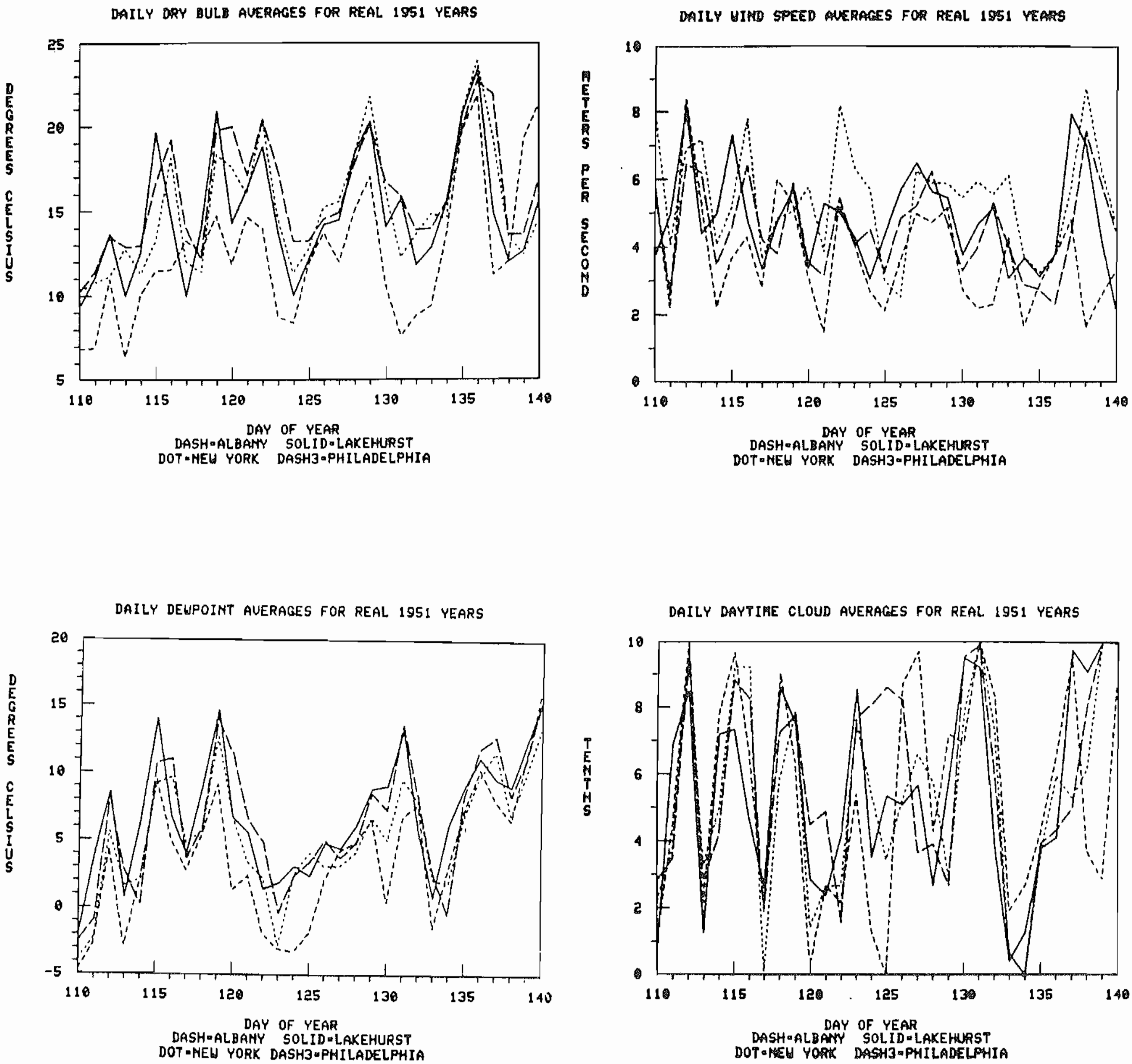



Figure 7. Comparison of Daily Averages for Climate Elements in Spring.

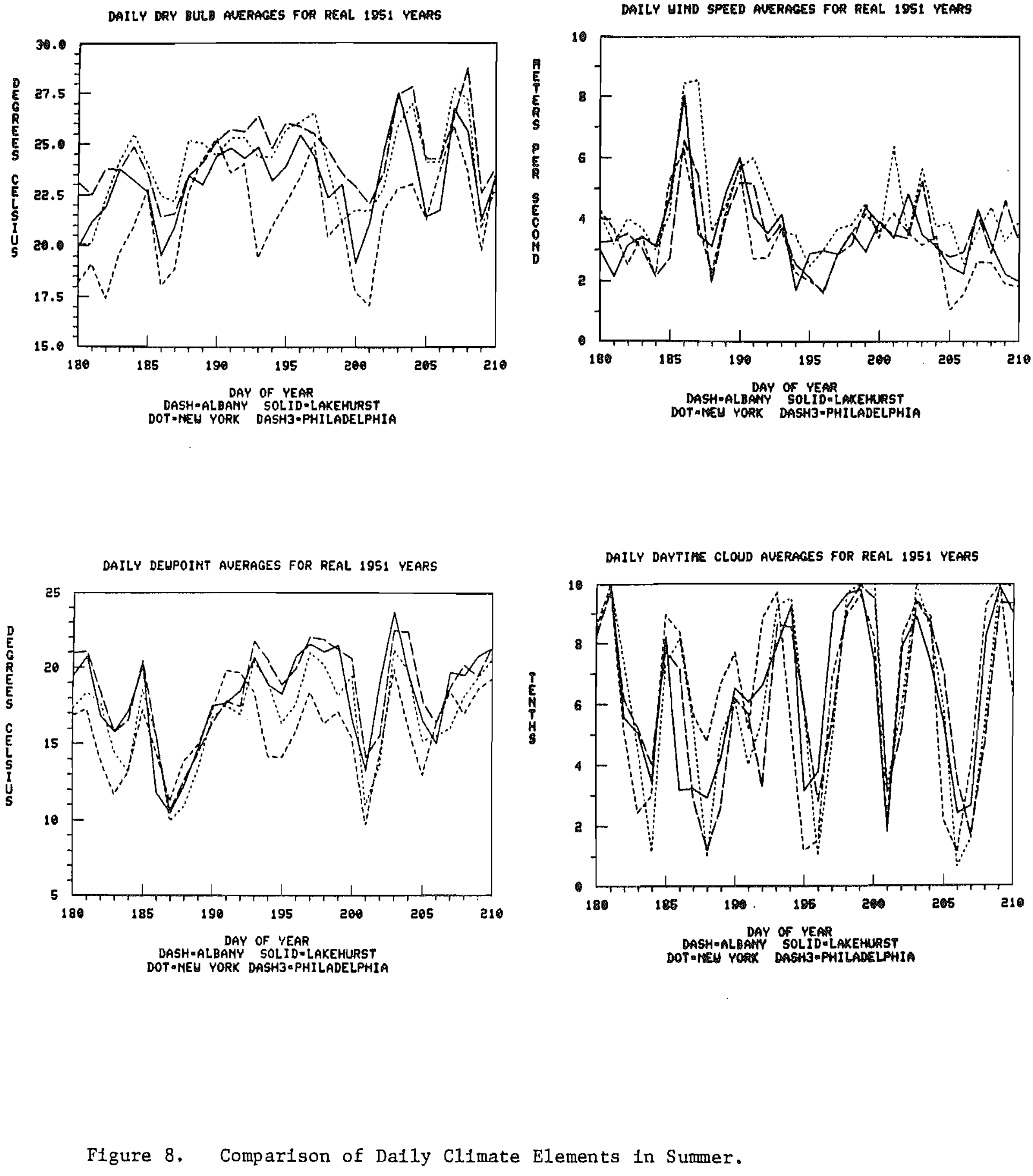



Figure 8. Comparison of Daily Climate Elements in Summer.

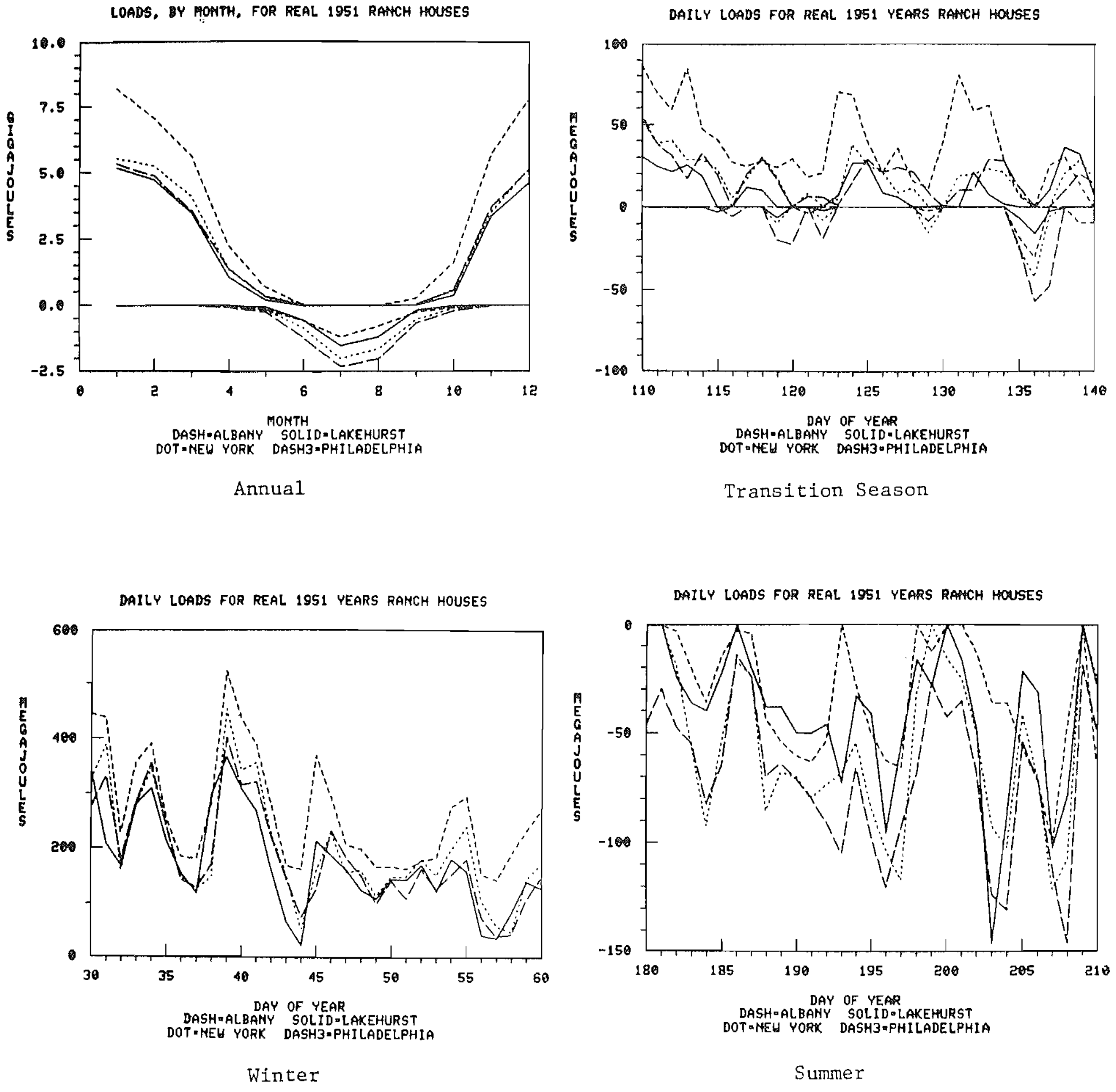
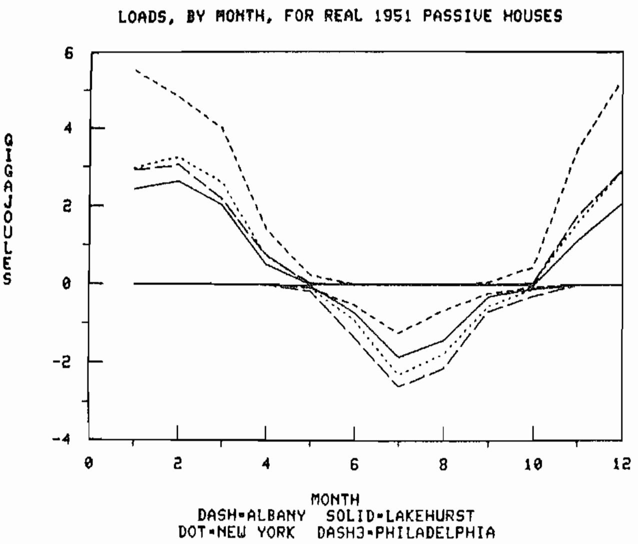
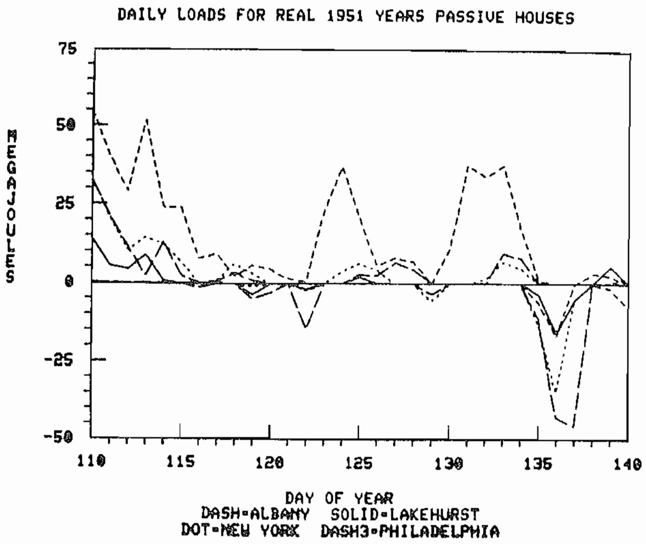


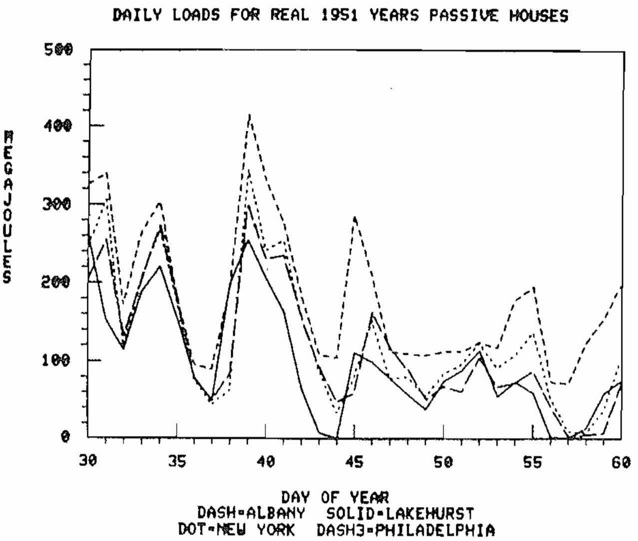

Figure 9. Heating and Cooling Requirements for Real Year Ranch Houses.



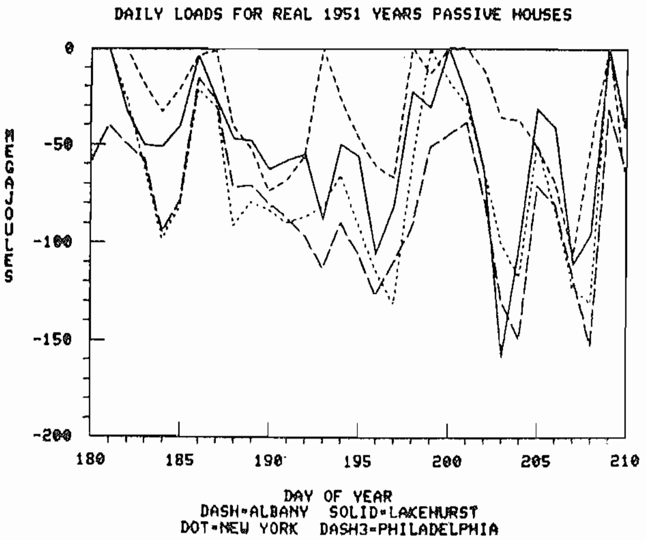

Annual




Transition Season




Winter




Summer

Figure 10. Heating and Cooling Requirements for Real Year Passive Houses.

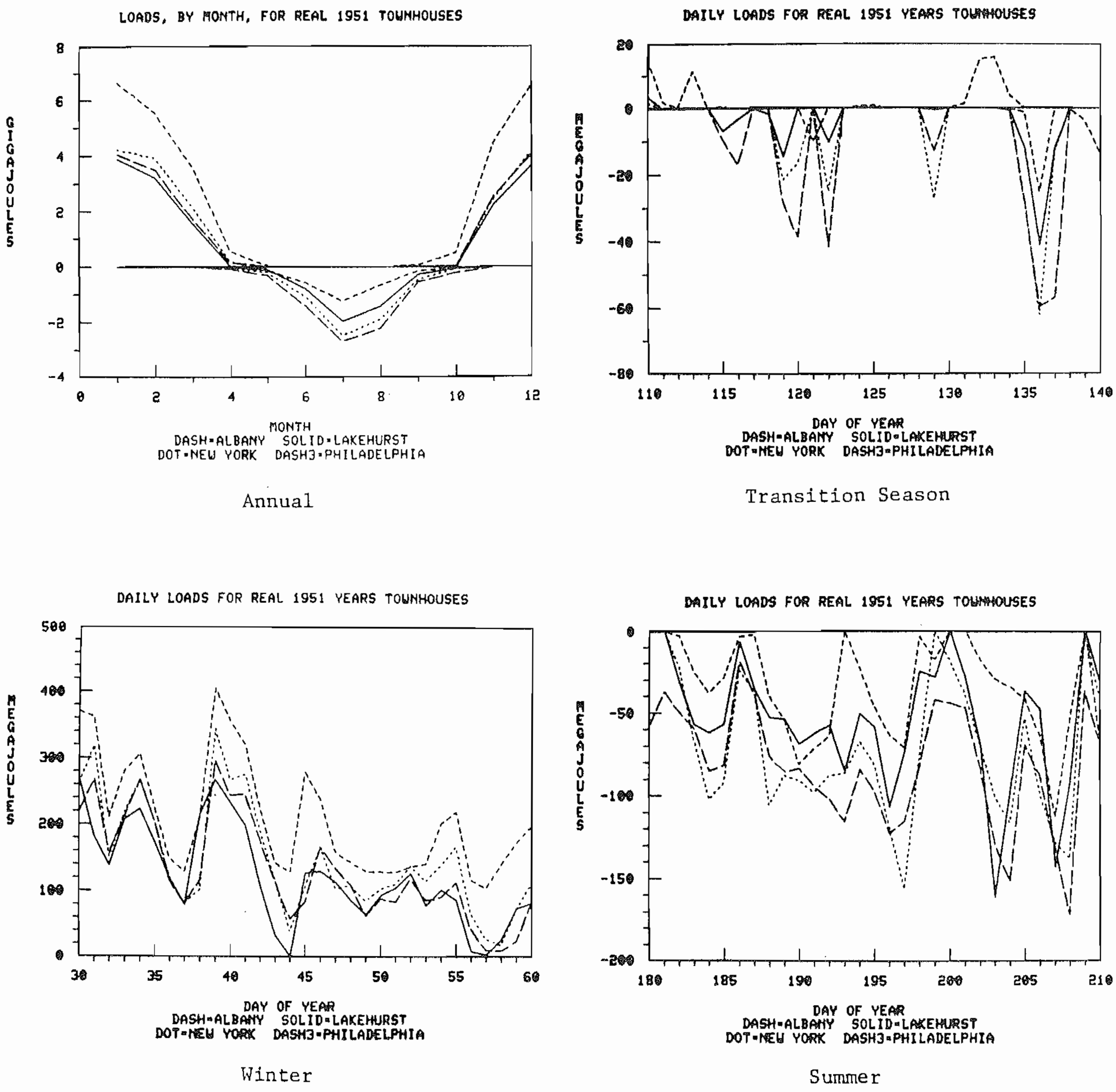



Figure 11. Heating and Cooling Requirements for Real Year Townhouses.

station? For example, if SELECT can find segments from the Jersey City source tape that have the same winter means as Albany (e.g. colder), is a collection of these segments more like Albany's overall winter climate than "typical" Jersey City winter weather with its mean adjusted to where it represents Albany's means? Inspection of Albany's means shows more clouds and less wind then Jersey City's means, which are in turn cloudier and less windy than Jersey City's coldest segments, which tend to be clear and windy, as following cold front passage. In this case Jersey City's typical weather adjusted is somewhat more similar to Albany's weather than Jersey City's cold weather. In other cases the reverse may be true. A test comparing the two uses of SELECT and ADJUST was done for two sets of stations, from Jersey City to Philadelphia and from Jersey City to Albany. The results are discussed below in Section 3.3.

## 3.3 RESULTS

### 3.3.1 Representative Years Created by SELECT

Table 7 and Figure 12 present computed heating and cooling results testing the ability of SELECT to create a representative composite year for a source location. Composite years were created by SELECT for both New York and Jersey City using their respective ten year tapes as sources and their monthly averages for 1951 as input. The 1951 averages are used as a substitute for long-term averages. The NBSLD loads program was run for the Fort Meyer Office Building in these two cities, using the real 1951 years and the two synthetic years.

The residual standard deviations of the monthly cooling requirements from the desired (real year) values are 0.43 GJ for Jersey City and 0.41 GJ for New York. These values correspond to average monthly cooling requirements during the cooling season of 3.53 GJ for Jersey City and 3.22 GJ for New York.[1] On an annual basis, the real cooling requirement for Jersey City is 24.70 GJ compared to a predicted value of 23.02 GJ. The annual values for New York are 22.53 GJ and 22.40 GJ, respectively.

For heating, the residual standard deviations of monthly requirements from the desired real year values are 0.64 GJ for Jersey City and 0.61 for New York. These values correspond to average monthly heating requirements during the heating season of 15.19 GJ for Jersey City and 15.04 GJ for New York. On an annual basis, the real heating requirement for Jersey City is 151.91 GJ compared to a predicted 153.50 GJ. The annual values for New York are 148.31 GJ and 150.35 GJ, respectively.

The selected year is a fairly good predictor of cooling and heating on an annual basis, if prediction within about 5% on an annual basis is considered good performance. On a monthly basis, the cooling predic-

---

[1] The ratio of residual standard deviation to population mean (the coefficient of variation) is a measure of goodness of fit between the synthetic and real years.

tions suffer from the generally low levels of cooling because minor variations in temperature near the balance point are significant in terms of cooling energy required. In the peak months, the selected year predicts within 5% of the real year. The heating requirements are predicted very well by the selected year both on an annual and monthly basis. The greatest errors in the heating requirements may also be seen to occur in the transition months of April and October.

It should be noted that the representative composite years selected from the 1949-58 source periods with 1951 averages did not select an excessive number of segments from the 1951 year in the source data pool. The number of segments for New York is 7 out of 36, and for Jersey City is 5 out of 36, compared to the average value of 3.6 for all the years. This supports the use of 1951 to test the ability of SELECT to create representative years, which normally would use long-term averages not corresponding directly to those of any one year.

### 3.3.2 Geographical Extrapolation Using SELECT

SELECT was tested for its ability to produce representative composite years for geographically removed locations by using the ten-year tapes from New York City and Jersey City as sources for creating two composite years for Albany. In addition, a composite Philadelphia was also tested. As before, the Albany 1951 averages were used to represent Albany long-term averages. The two Albany composite years were tested against the real 1951 Albany by comparing the results of NBSLD runs on each. The results are given in Table 8 and Figures 13a, 13b, 14a, and 14b.

As can be seen, the requirements predicted by the composite year selected from the New York source data were not accurate. Investigation of the causes found that New York had differences in climatic characteristics from Albany, preventing SELECT from finding any suitable segments. These differences were primarily due to an unusually high wind velocity due to LaGuardia's unprotected location on Flushing Bay, and its small daily temperature range. These have been presented in Tables 2 and 6. Because of this, Jersey City, showing more moderate wind speeds and daily range, was added to the network. Its climatic averages are given in the example SELECT run, Appendix D.

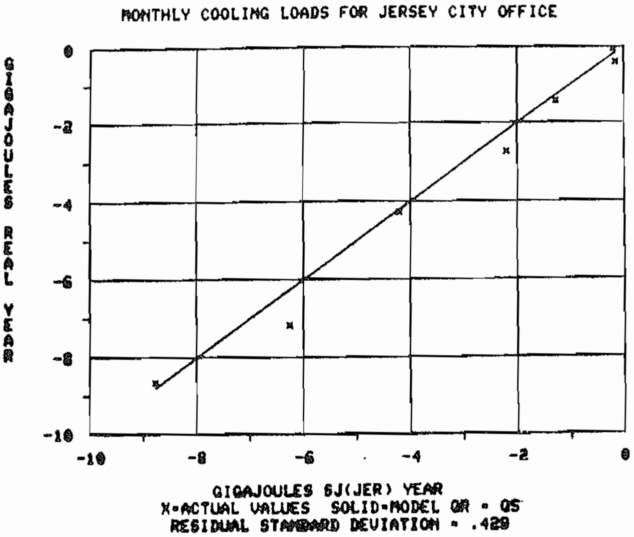
The energy requirements predicted by the composite year selected from Jersey City source data proved to be more accurate. The performance improvement is well represented by the heating and cooling requirements: 216.53 GJ and 13.96 GJ respectively for real Albany, 221.86 GJ and 11.52 GJ for composite Albany selected from Jersey City, and 228.04 GJ and 8.59 GJ for composite Albany selected from New York. Analysis of the loads program output showed that in the winter, most of the excess heating requirements in the composite years were directly attributable to infiltration losses, rather than conducted losses. In the transition seasons and summer, most of the shortfall is due to the compressed distribution of hourly temperatures around the daily averages in the

HEATING AND COOLING LOADS FOR NEW YORK AND JERSEY CITY OFFICES.

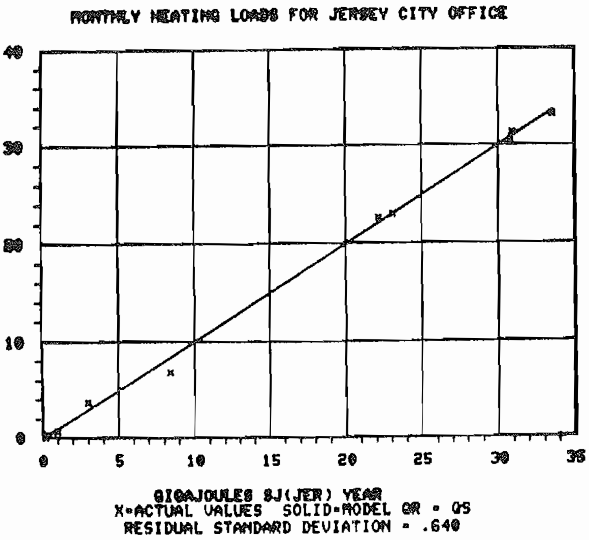
| | R(JER) | | SJ(JER) | | R(NY) | | SN(NY) | |
|---|---|---|---|---|---|---|---|---|
| MONTH | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING |
| 1 | 33.151 | .000 | 33.569 | .000 | 32.339 | .000 | 32.276 | .000 |
| 2 | 30.185 | .000 | 30.829 | .000 | 30.353 | .000 | 31.098 | .000 |
| 3 | 22.996 | .000 | 23.098 | .000 | 24.135 | .000 | 24.446 | .000 |
| 4 | 6.858 | -.063 | 8.418 | -.195 | 7.106 | -.046 | 8.630 | -.236 |
| 5 | .659 | -1.426 | .989 | -1.268 | .826 | -1.072 | 1.227 | -.812 |
| 6 | .060 | -4.268 | .188 | -4.190 | .080 | -3.831 | .051 | -4.658 |
| 7 | .000 | -8.624 | .000 | -8.773 | .000 | -7.878 | .000 | -7.936 |
| 8 | .000 | -7.171 | .000 | -6.248 | .000 | -6.842 | .000 | -6.729 |
| 9 | .344 | -2.742 | .337 | -2.197 | .295 | -2.530 | .265 | -2.007 |
| 10 | 3.767 | -.406 | 3.008 | -.149 | 2.746 | -.331 | 2.044 | -.020 |
| 11 | 22.674 | .000 | 22.154 | .000 | 21.065 | .000 | 20.894 | .000 |
| 12 | 31.217 | .000 | 30.907 | .000 | 29.363 | .000 | 29.412 | .000 |
| SUBTOTAL | 151.91 | -24.70 | 153.50 | -23.02 | 148.31 | -22.53 | 150.35 | -22.40 |
| TOTAL | 176.61 | | 176.52 | | 170.84 | | 172.75 | |

Table 7. Comparison of Real and Composite Heating and Cooling Requirements for the Fort Meyer Office Building in New York and Jersey City.

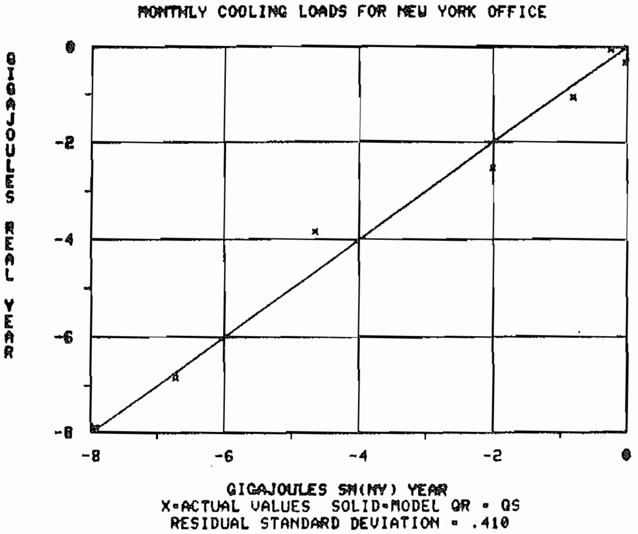
R = Real 1951
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the Source.
SN = Selected Composite 1951 using New York 1949-1958 as the Source.
JER = Jersey City 1951 Averages used as Input.
NY = New York 1951 Averages used as Input.



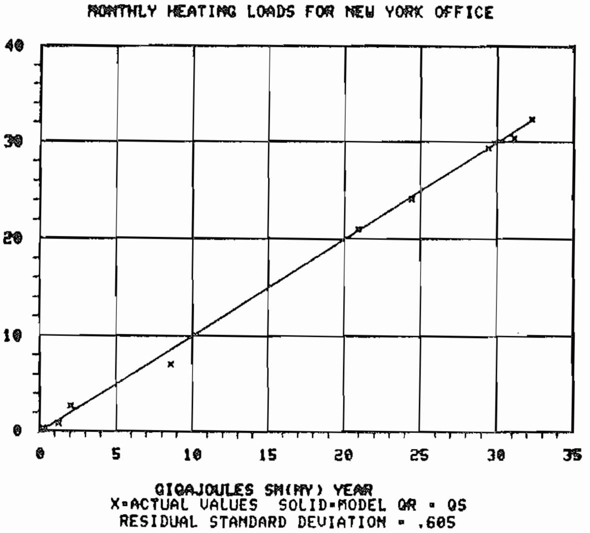

12A




12B




12C




12D

Figure 12. Monthly Heating and Cooling Requirements for Jersey City and New York Real Years Versus Synthetic Years, Using the Fort Meyer Office Building.

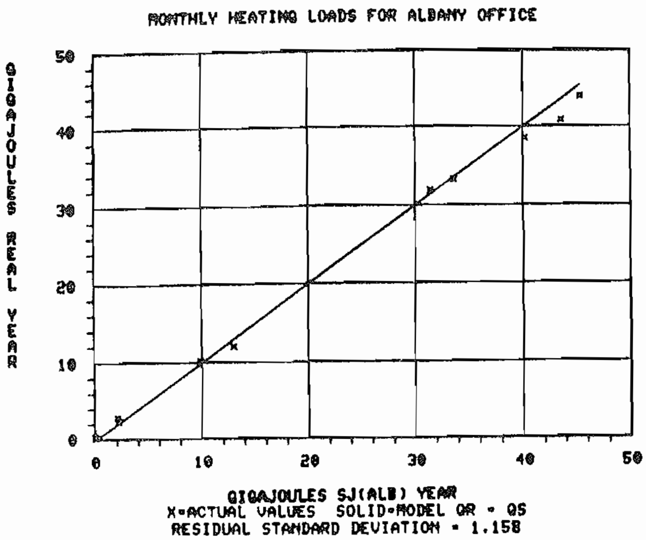
R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.

HEATING AND COOLING LOADS FOR ALBANY OFFICE.

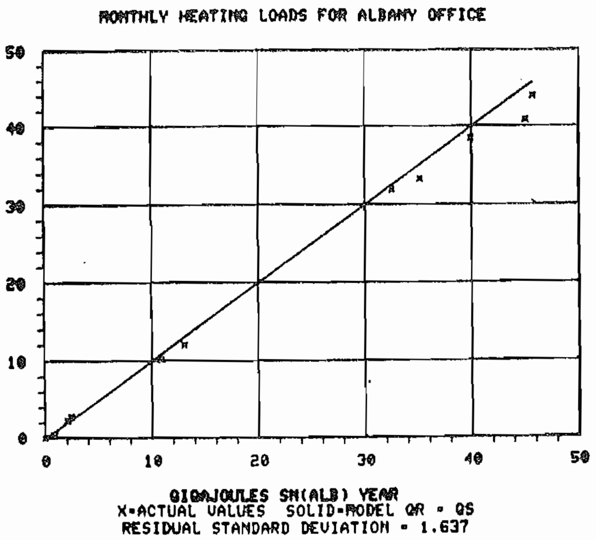
| | R(ALB) | | SJ(ALB) | | SN(ALB) | | SJ(JER)A(ALB) | | SJ(ALB)A(ALB) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING |
| 1 | 43.996 | .000 | 45.469 | .000 | 45.746 | .000 | 44.439 | .000 | 44.692 | .000 |
| 2 | 38.514 | .000 | 40.210 | .000 | 39.963 | .000 | 39.667 | .000 | 38.919 | .000 |
| 3 | 31.981 | .000 | 31.523 | .000 | 32.557 | .000 | 31.748 | .000 | 31.716 | .000 |
| 4 | 12.060 | -.029 | 13.005 | -.041 | 13.103 | .000 | 12.125 | .000 | 12.297 | -.015 |
| 5 | 2.849 | -1.264 | 2.082 | -.638 | 2.402 | -.256 | 2.834 | -1.154 | 2.734 | -1.249 |
| 6 | .393 | -2.417 | .052 | -2.173 | .880 | -2.284 | .422 | -2.487 | .042 | -2.365 |
| 7 | .000 | -5.689 | .000 | -5.942 | .000 | -3.980 | .000 | -5.685 | .000 | -5.652 |
| 8 | .012 | -3.275 | .079 | -2.127 | .001 | -1.553 | .126 | -3.064 | .094 | -3.019 |
| 9 | 2.351 | -1.125 | 2.261 | -.589 | 2.118 | -.521 | 2.595 | -.810 | 2.518 | -1.022 |
| 10 | 10.226 | -.161 | 9.867 | -.008 | 10.971 | .000 | 10.367 | -.120 | 10.289 | -.120 |
| 11 | 33.302 | .000 | 33.716 | .000 | 35.174 | .000 | 33.420 | .000 | 32.844 | .000 |
| 12 | 40.847 | .000 | 43.601 | .000 | 45.128 | .000 | 41.260 | .000 | 41.818 | .000 |
| SUBTOTAL | 216.53 | -13.96 | 221.86 | -11.52 | 228.04 | -8.59 | 219.00 | -13.32 | 217.96 | -13.44 |
| TOTAL | 230.49 | | 233.38 | | 236.63 | | 232.32 | | 231.40 | |

Table 8. Comparison of Real and Synthetic Heating and Cooling Requirements for the Albany Fort Meyer Office Building.

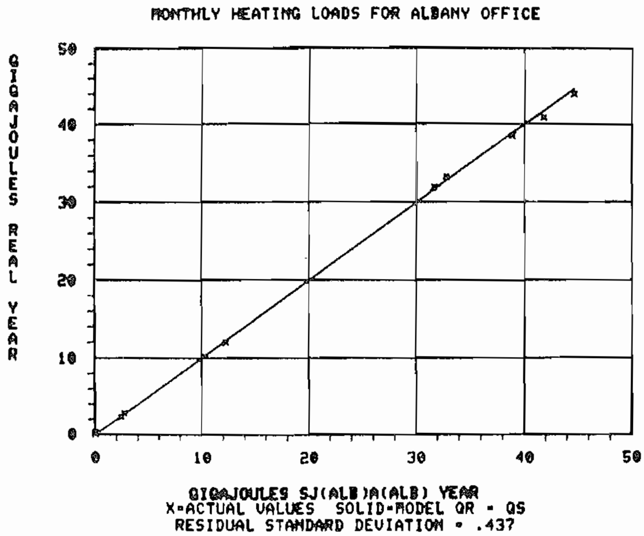
R = Real 1951
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.



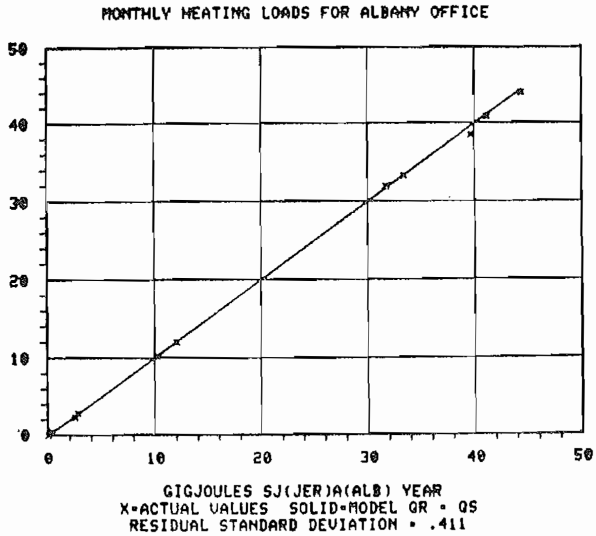

13A




13B



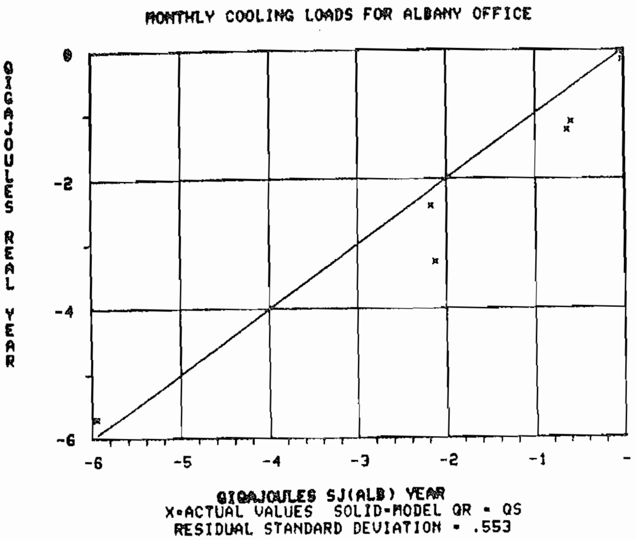

13C



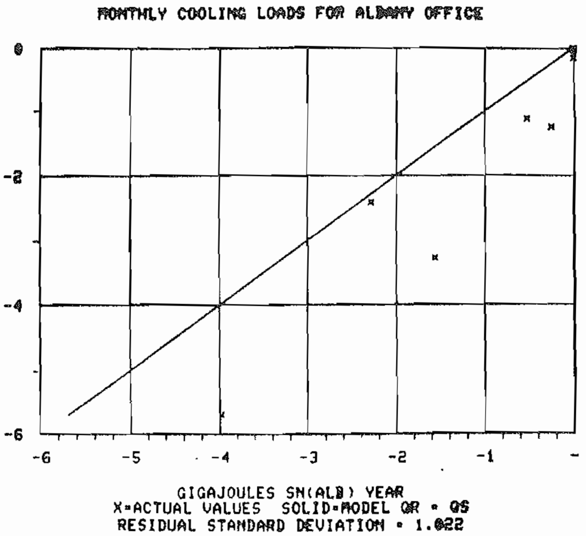

13D

Figure 13. Monthly Heating Requirements for Albany Real Year Versus Synthetic Years, Using the Fort Meyer Office Building.

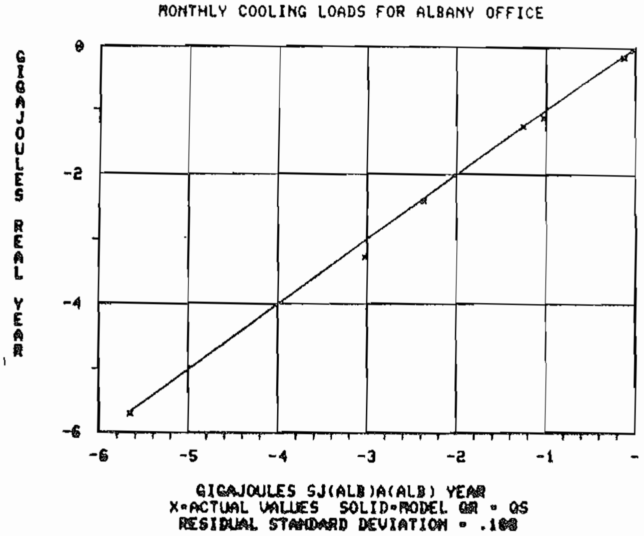
R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.



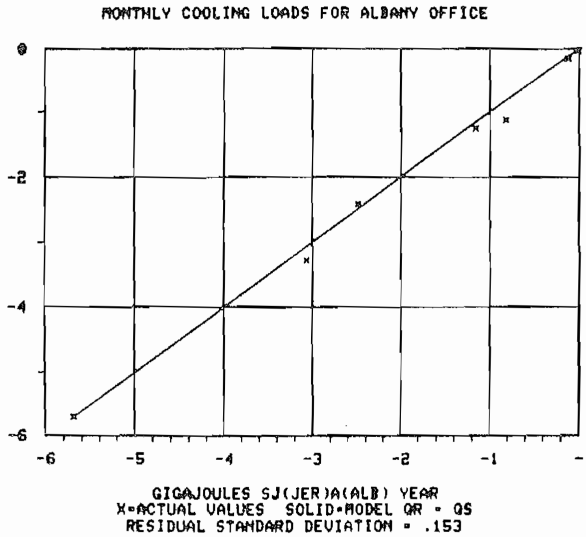

14A




14B




14C




14D

Figure 14. Monthly Cooling Requirements for Albany Real Year versus Synthetic Years, Using the Fort Meyer Office Building.

R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.

composite years. The daily range for real Albany is 10.9°C, 8.5°C for composite Albany selected from Jersey City, and 7.3°C for composite Albany selected from New York. The averages for the three years are basically the same, and the differences in the other climatic averages between the years are also small. Because very few Albany days have the majority of their hours in the cooling region (the averages for July is 7.6 hours per day) most of the cooling occurs in the hottest hours of the day. With a restricted range, the duration and severity of this daily cooling period is diminished. The number of annual cooling hours for real Albany is 752, for composite Albany selected from Jersey City 608, and for composite Albany selected from New York 512.

The composite year selected for Philadelphia from Jersey City source data showed a similar relationship between daily range and cooling hours. The number of annual cooling hours for real Philadelphia is 1185 and for the composite Philadelphia selected from Jersey City is 1121, corresponding to annual daily range averages of 9.7°C and 8.6°C, and total cooling requirements of 28.73 GJ and 26.11 GJ. The daily range was the only major discrepancy found in Philadelphia composite year climate averages. The total heating requirements are less sensitive to daily range because most heating in Philadelphia takes place at average temperatures far below the balance point, and are better predicted: 142.52 GJ for real Philadelphia and 144.77 GJ for the composite Philadelphia selected from Jersey City.

SELECT alone did not perform satisfactorily, particularly in cooling predictions, in the geographical extrapolation from New York and Jersey City to Albany. This is not surprising in view of the large distances and climatic differences between the source and remote stations. The tests pointed up the importance of climatic similarity between source and remote station, as shown by the comparison of New York- and Jersey City-based composite years for Albany. The greater climatic similarity between Jersey City and Philadelphia allowed a more effective extrapolation.

### 3.3.3 Geographical Extrapolation Using ADJUST

Table 9 and Figures 15a, 15b, 16a, and 16b give the monthly heating and cooling requirements for the synthetic years created for 1951 Philadelphia from 1951 Jersey City and 1951 New York. These results show the ability of the adjustment technique to extrapolate hourly weather data for a real period of time. The performance is excellent, because the similarity of weather patterns in real time between nearby stations means that hour-by-hour adjustment of the source weather will produce a synthetic year with not only the identical means as the real year, but the same sequences of weather events as well.

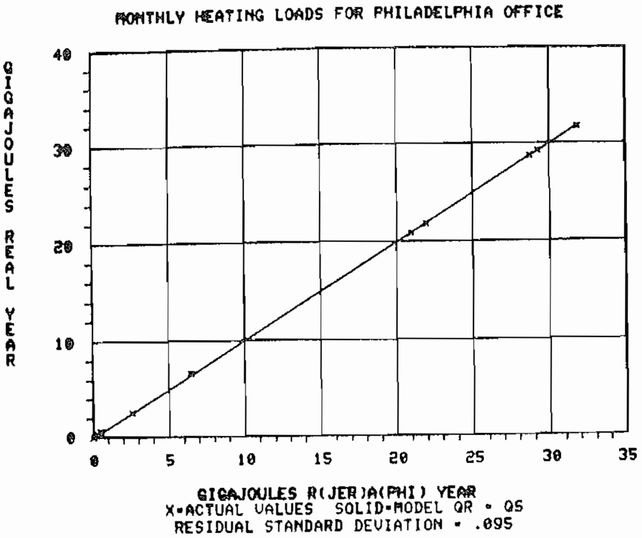
The residual standard deviation of predicted monthly heating and cooling requirements about the real requirements are 0.095 GJ and 0.134 GJ for the adjusted Jersey City year and 0.141 GJ and 0.134 for the adjusted New York year. The 0.134 GJ residual standard deviations are about

HEATING AND COOLING LOADS FOR PHILADELPHIAOFFICE.

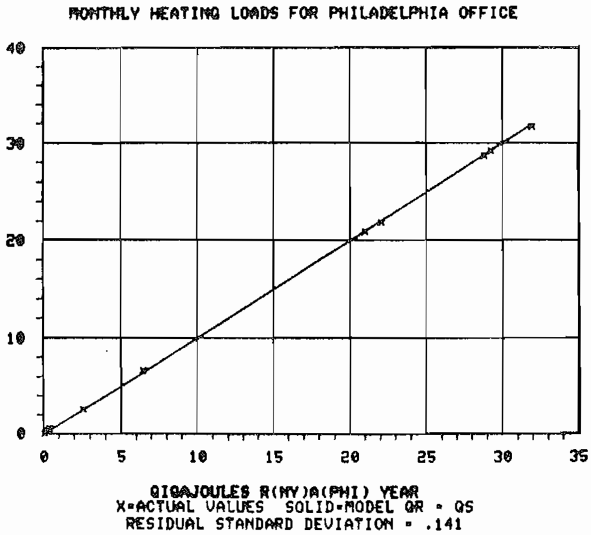
| | R(PHI) | | R(JER)A(PHI) | | R(NY)A(PHI) | | SJ(JER)A(PHI) | | SJ(PHI)A(PHI) | |
|---|---|---|---|---|---|---|---|---|---|---|
| MONTH | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING | HEATING | COOLING |
| 1 | 31.674 | .000 | 31.840 | .000 | 31.947 | .000 | 32.096 | .000 | 32.412 | .000 |
| 2 | 28.710 | .000 | 28.743 | .000 | 28.809 | .000 | 29.095 | .000 | 29.070 | .000 |
| 3 | 20.941 | .000 | 20.992 | .000 | 20.997 | .000 | 20.761 | .000 | 21.063 | .000 |
| 4 | 6.653 | -.236 | 6.466 | -.210 | 6.452 | -.263 | 6.793 | -.138 | 6.672 | -.116 |
| 5 | .590 | -1.565 | .504 | -1.647 | .413 | -1.633 | .665 | -1.229 | 1.119 | -1.416 |
| 6 | .047 | -5.316 | .029 | -5.257 | .048 | -5.345 | .068 | -4.998 | .002 | -4.906 |
| 7 | .000 | -9.355 | .000 | -9.313 | .000 | -9.234 | .000 | -9.334 | .000 | -9.300 |
| 8 | .000 | -8.260 | .000 | -8.192 | .000 | -8.174 | .000 | -8.047 | .000 | -8.214 |
| 9 | .309 | -3.139 | .270 | -3.375 | .304 | -3.357 | .160 | -3.114 | .086 | -2.847 |
| 10 | 2.548 | -.864 | 2.580 | -.636 | 2.576 | -.640 | 2.330 | -.567 | 2.707 | -.465 |
| 11 | 21.854 | .000 | 21.968 | .000 | 22.046 | .000 | 21.948 | .000 | 21.825 | .000 |
| 12 | 29.194 | .000 | 29.228 | .000 | 29.238 | .000 | 28.891 | .000 | 29.446 | .000 |
| SUBTOTAL | 142.52 | -28.73 | 142.62 | -28.63 | 142.83 | -28.65 | 142.81 | -27.43 | 144.40 | -27.26 |
| TOTAL | 171.25 | | 171.25 | | 171.48 | | 170.24 | | 171.66 | |

Table 9. Comparison of Real and Synthetic Heating and Cooling Requirements for the Philadelphia Fort Meyer Office Building.

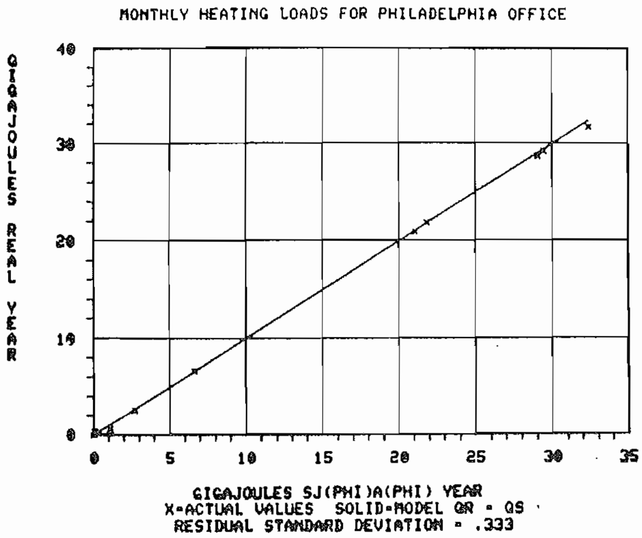
R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Year made using prefix year.



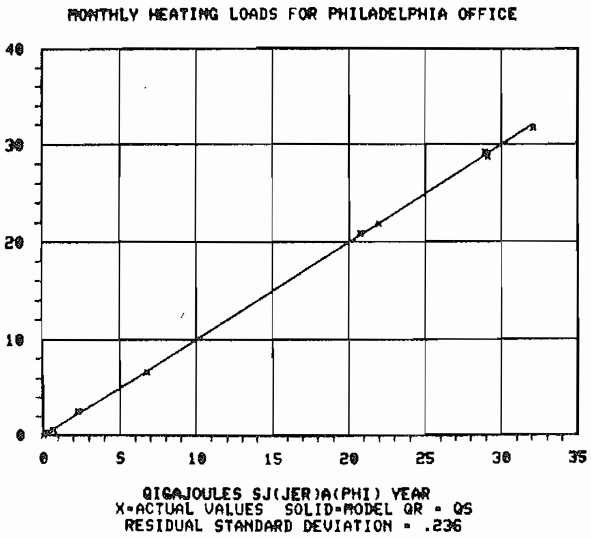

15A




15B




15C




15D

Figure 15. Monthly Heating Requirements for Philadelphia Real Year versus Synthetic Years, Using the Fort Meyer Office Building.

R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.

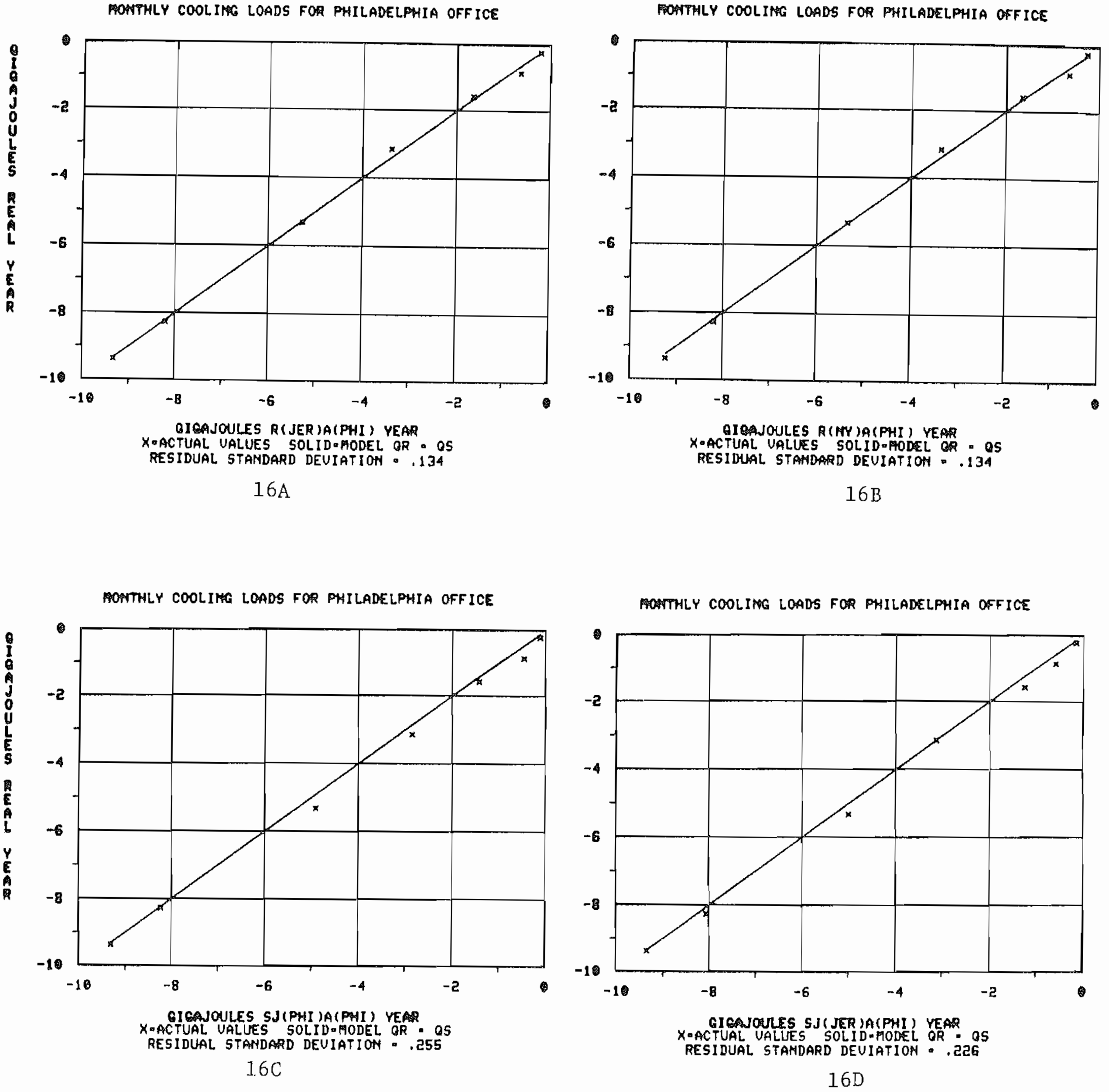



Figure 16. Monthly Cooling Requirements for Philadelphia Real Year versus Synthetic Years, Using the Fort Meyer Office Building.

R = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
SN = Selected Composite 1951 using New York 1949-1958 as the source.
JER = Jersey City 1951 averages used as input.
NY = New York 1951 averages used as input.
ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A = Adjusted Synthetic 1951 made using prefix year.

Philadelphia's average monthly cooling load of 4.10 GJ. The 0.095 and 0.141 GJ residual standard deviations are about Philadelphia's average monthly heating load of 14.25 GJ. On an annual basis the real heating requirement for Philadelphia is 142.52 GJ with the adjusted Jersey City predictions 142.62 GJ and adjusted New York 142.83 GJ. The corresponding values for cooling requirements are 28.73 GJ, 28.63 GJ and 28.65 GJ.

### 3.3.4 Geographical Extrapolation Using Both SELECT and ADJUST

The first tests are on using SELECT for geographic extrapolation by creating a representative composite year at the remote location, and then using ADJUST so that the monthly averages are the same as the input averages. The composite 1951 Philadelphia and Albany years selected from Jersey City source data were adjusted to the real 1951 Philadelphia and Albany monthly averages. The predicted heating and cooling requirements are presented in Tables 8 and 9, and in Figures 13c, 14c, 15c, and 16c.

For Philadelphia, the ADJUST program improved the total heating and cooling requirement prediction from 144.77 GJ and 26.11 GJ for the composite year selected from Jersey City (discussed above), to 144.40 GJ and 27.26 GJ, with the real requirements being 142.52 GJ and 28.73 GJ.

For Albany, the improvements in heating and cooling requirement prediction are from 221.86 GJ and 11.52 GJ for the Albany composite selected from Jersey City, also discussed above, to 217.96 GJ and 13.44 GJ, with the real requirements being 216.53 GJ and 13.96 GJ. The residual standard deviations of the predicted monthly requirements about the real monthly requirements showed the following improvements from the composite to the adjusted composite: from 1.158 GJ to 0.437 GJ for heating and from 0.553 GJ to 0.108 GJ for cooling. The average monthly heating is 19.68 GJ and average monthly cooling is 1.99 GJ.

It might be noted that ADJUST made the following improvements to the Albany composite year selected from New York, which as discussed above does not predict well: from 228.04 GJ and 8.59 GJ for the composite year, to 217.60 GJ and 12.96 GJ. The rest of the New York results have not been shown in tables because it is felt that although the results as good as those from Jersey City, Jersey City is a climatologically a better source for Albany climate data.

The second set of tests of SELECT and ADJUST combined use SELECT to create a representative composite year at the source location, and use ADJUST to make a year with monthly averages the same as those of the remote location. ADJUST thus performs the extrapolation. The representative composite year for Jersey City was adjusted to both Philadelphia and Albany using their 1951 monthly averages. The predicted heating and cooling requirements are presented in Tables 8 and 9 and Figures 13d, 14d, 15d, and 16d.

For Philadelphia, heating and cooling requirements using this second method are 142.81 GJ and 27.43 GJ. For Albany, they are 219.00 GJ and

13.32 GJ. The residual standard deviations for Philadelphia are 0.236 GJ heating and 0.226 GJ for cooling, corresponding to monthly averages of 14.25 GJ and 4.10 GJ. The residual standard deviations for Albany are 0.411 GJ heating and 0.153 GJ cooling, corresponding to monthly averages of 19.68 GJ and 1.99 GJ.

The Philadelphia predictions using the second method (ADJUST performing the extrapolation) are slightly better than those of the first method (SELECT performing the extrapolation). This can be seen in both the predicted heating and cooling requirements, and in the residual standard deviations, which for the first method are 0.333 GJ for heating, and 0.255 GJ for cooling. The Albany predictions using the second method are slightly worse than those of the first method. This can been seen in the predicted heating and cooling requirements, and in the residual standard deviations for cooling. For heating, the residual standard deviations go slightly the other way.

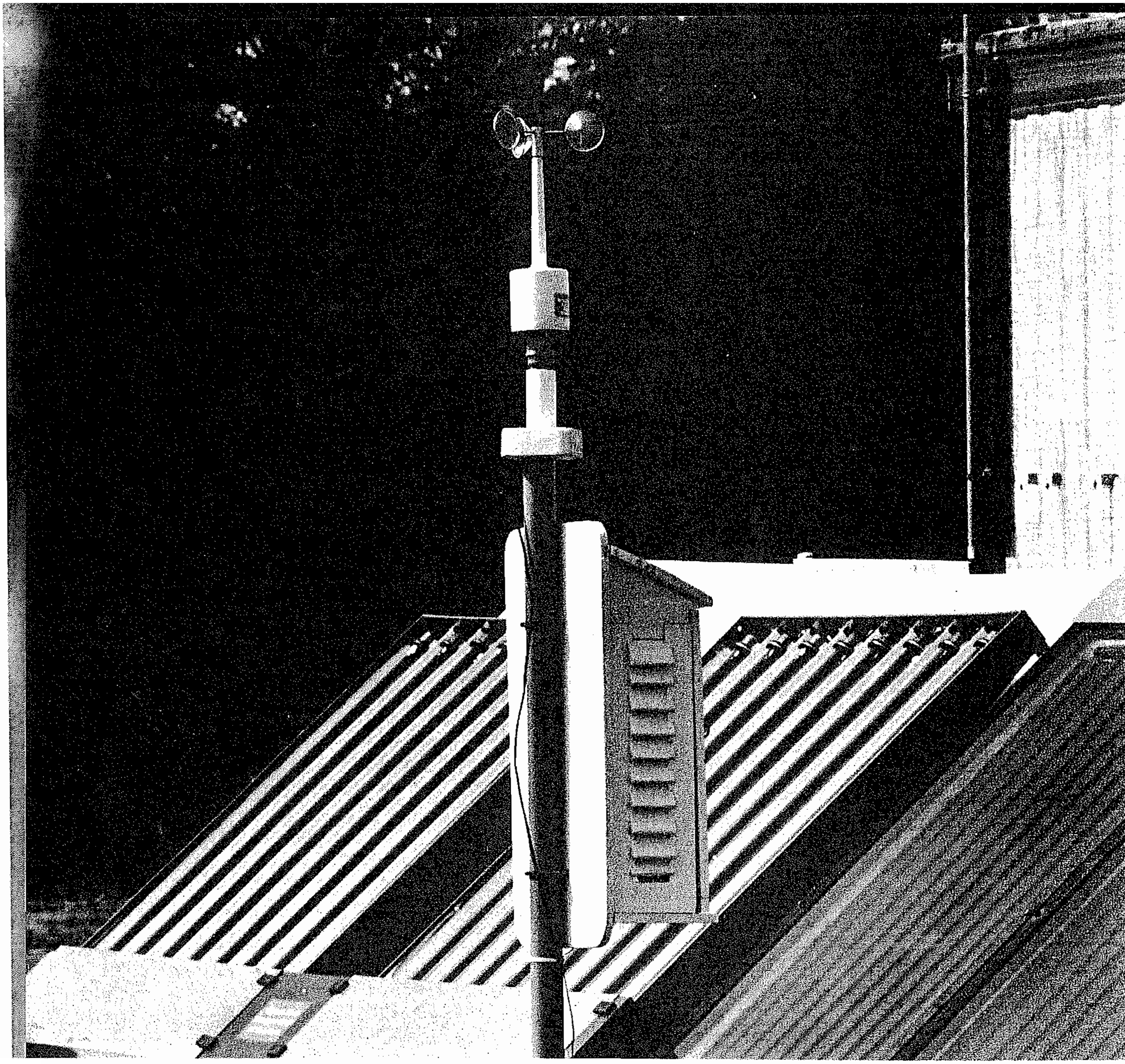
Although Philadelphia had better results extrapolating a composite source year with ADJUST, the small magnitudes of the differences do not permit conclusions about the climatological causes for the differences. In Albany, extrapolating with SELECT produced slightly better results over the whole year. The initial analysis of Jersey City and Albany climate characteristics during cold weather (section 3.2) did suggest that extrapolating with ADJUST would be better. This is borne out in the fit of energy values for the coldest months, but the differences again are not sufficient to warrant a conclusion.

It may be concluded that the use of ADJUST together with SELECT substantially improves the predictive ability of representative years that have been extrapolated to remote locations. It is not possible to conclude from these tests which combinations of SELECT and ADJUST yield better extrapolated weather years.

Two untested uses of SELECT and ADJUST are: the improvement of composite years representative of the source location by ADJUST using as input the averages of the source location, and the use of SELECT and ADJUST to create specific years for which hourly data are missing using as a source other years available from the same location and as input monthly averages available from those years. It is probable that these uses of the two techniques will yield successful results since SELECT alone has been shown to produce accurate representative years at the source location and the additional improvement required of ADJUST is likely to be small.

Facing page:

*Anemometer and Stevenson thermometer measure wind speed and temperature respectively near solar collector array.*



4. SYNTHESIZING CLIMATE DATA: CAVEATS

Climate data should be synthesized with caution. Although this report has presented some successful examples of composite and synthetic years representing the energy usage both of long-term climate and of geographically separate locations, it is also possible to create unsuccessful ones. Success or failure would depend on: (1) the effectiveness of the synthesis technique itself, (2) the appropriateness and quality of the input data, and (3) in the case of geographical extrapolation, the climatological homogeneity between source and remote station. Taking the proposed synthesis techniques as given, the following precautions should be adopted in their use.

- Input data

  Care must be taken to assure that the monthly input averages for all climate variables come from the same period of record, or that if there are different periods, the effect is insignificant. The period 1941-70 is the current standard for normals published by NOAA, but many stations have shorter periods of record, and some published sources such as the Climatic Atlas use earlier periods for their monthly summarized values. Since climate is variable over time, including periods as long-term as 30 years, the use of different periods for different climate elements could lead to distorted joint distributions of climate elements. If the use of different data periods cannot be avoided, the periods should be compared using elements for which there are averages available from each period.

  The user should also check whether the weather recording station has moved during the period of record. NOAA will make adjustments for the changes in the data caused by such moves, but not all records have such corrections.

- Climatological homogeneity

  The synthesis techniques described in this paper do not require a statistically-based understanding of the climate patterns in a region in order to synthesize hourly climate data. The use of fairly long segments of actual hourly data in the selection technique, and of systematic adjustment of real weather data in the adjustment technique, retains the naturally-occurring climate pattern, providing the differences between the remote station's input averages and the source's averages are not excessive. The user must, however, avoid extrapolations with excessive adjustment, and must determine whether the remote station does in fact have climatic patterns similar to the source station.

The authors do not now know the limits to successful use of the adjustment technique, given similar climatic patterns for the source and remote stations. The Jersey City-to-Albany extrapolation produced a synthetic year giving very successful annual energy prediction, although the distance and climatic differences between stations were considerably greater than the technique had been intended for. The limits to such adjustment should be tested in the future.

The critical issue for the user of these techniques is determining whether the climatic patterns in the two locations are similar. The New York/La Guardia-to-Albany extrapolation showed that differences in climatic patterns could have a noticeable effect on the success of the extrapolation. New York's climate, with decreased daily range and higher wind, could not be made into Albany (using SELECT only), as successfully as Jersey City's climate, with more inland values of daily range and wind.

Some of the differences between New York/La Guardia and Jersey City may be detected from the data printout by examining the relative magnitudes of monthly means. However, the user should at least qualitatively understand the daily characteristics of the climates on the two sites. Within-day subtleties such as early morning fog, afternoon cumulus activity, sea and lake breezes, and valley winds must be considered in the selection of source sites. In addition, the user should know whether the locations experience periodically recurring events that could influence energy consumption. Various regional examples might be Chinook or Santa Ana winds, unusual frontal passages, and lake or ocean fogs. The user can obtain such qualitative information from a variety of sources, such as flight weather services at airports, agricultural extension services, and local residents. Stations situated near mountainous terrain or discontinuities such as coasts should be examined with particular care.

If there are remaining questions about the nature or extent of differences between stations, the user is strongly recommended to retain a consulting meteorologist to analyze the climatic differences. Although the energy implications of the climatic differences will probably not be readily apparent, the analysis may suggest ways to use the techniques that will yield the most realistic synthetic climate data. For example, analysis could suggest the most effective combination of SELECT and ADJUST discussed in Section 3.2 and 3.3. It could also form the basis for deciding whether to use a combination of sources bracketing the remote station to mix the types of data selected.

Once a synthetic year is created, the user can inspect and analyze the hourly values to see whether daily and sub-monthly climatic patterns are similar; but if they are not, there is nothing he can do about it with unmodified versions of the programs other than change the location of the source data and create another synthetic year.

Facing page:

*Local wind direction indicator: weathervane, Governor's Palace, Williamsburg, Virginia.*


## 5. CONCLUSIONS

Two techniques have been developed and tested for creating representative weather data for the hour-by-hour computation of building energy requirements. The data, in the format of NBSLD-decoded hourly weather tapes, may be synthesized at a source location for which there is a long record of hourly observations on tape or at a remote location for which there are only monthly averaged data available. The techniques may be used for simulations of probable future building energy use (composite and/or synthetic years representative of long-term climate), or to represent specific periods of time, as used for simulations to match experimental measurements being made on buildings in locations where only climatic averages are being recorded.

The two techniques are described and their listings appended. The selection technique embodied in SELECT chooses unchanged segments of actual hourly weather data from the source and links them into composite years. The procedure is based on an empirical function weighting the importance of various climate variables on the energy consumption of a range of envelope-dominated buildings, and upon determination of several issues, particularly the effects of segment length and monthly temperature distribution on energy prediction performance.

The adjustment technique embodied in ADJUST adjusts the hourly values of each climate element in a source tape to make the monthly means of the synthetic tape match the input means. It, unlike SELECT, is capable of incorporating a measure of the hourly temperature range around the daily mean (the daily range). This statistic is shown to be an important influence on energy use, and it has a strong effect on the extent of climatological similarity between stations.

The effectiveness of the two techniques was tested for several of their applications in a series of tests using NBSLD simulations of a one-story office building that is sensitive to climatic variation through energy exchange through the building envelope. The techniques were used to create composite and synthetic weather tapes for Albany, Philadelphia, Lakehurst, Jersey City, and New York/LaGuardia, with the latter two serving as source stations with data from the period 1949-58.

The first tests provide an indication of SELECT's effectiveness at creating representative years. Composite years were created for both New York and Jersey City from their own source data and monthly input averages from 1951. The composite years for both stations predicted annual cooling within 7 percent of the 1951 year, and heating within 1.5 percent. On a monthly basis, the residual standard deviation of monthly cooling predictions were within 13% of the real monthly mean cooling values, and the heating values within 4%. These results suggest that SELECT may be an effective way to create a year conforming to a set of input averages. Since the input averages from a single year are not dissimilar to those of a long-term record, it is concluded that SELECT can be used to produce composite years representative of a long period of record. However, the results' observed inaccuracies also suggest that, unless there is a strong reason to retain unmodified hourly data in the composite year, the ADJUST program should be applied to the composite year to make its monthly climatic means match long-term means exactly. The performance of ADJUST in the extrapolation tests showed that it is capable of strongly improving representative composite years created by SELECT. This was not tested in the case of the source cities Jersey City and New York, however.

In the second tests, SELECT was used to create, or "extrapolate", composite years for three remote stations using source data from New York and Jersey City. Climatological differences between New York and Albany caused poor prediction in the New York-to-Albany extrapolation: 39 percent low in cooling and 5 percent high in heating. Although Jersey City and New York are equally far from Albany, the lesser climatological differences cause significantly lower prediction errors: 17 percent low for cooling and 2 percent high for heating. The results for the Jersey City-to-Philadelphia extrapolations, 9 percent low for cooling and 1.5 percent high for heating, reflect Philadelphia's closer location and more similar climate.

The performance of each extrapolation was improved by using ADJUST on the extrapolated values. In the fourth set of tests, the adjusted SELECT extrapolations for Albany-from-New York predicted 8 percent low for cooling and 0.5 percent high for heating. Adjustment of the better extrapolation Albany-from-Jersey City resulted in a prediction 4 percent low in cooling and 1.0 percent high in heating. The improvement on the SELECT extrapolations to Philadelphia were from 9 percent to 5 percent low for cooling, and from 1.5 percent to 1.0 percent high for heating. These results are considered very satisfactory considering the very large distance and climatological differences between the stations.

The third and fourth sets of tests examined the effectiveness of ADJUST at extrapolating both real and composite weather data. The 'real period' extrapolations used 1951 averages from Philadelphia as input to adjust Jersey City and New York 1951 years. The results are considered extremely good, all within 1 percent on an annual basis; and on a monthly basis, both sets of residual standard deviations of predicted monthly heating and cooling values around the real monthly values are within 3 percent of the mean monthly cooling value, and within 1 percent of the mean monthly heating value. The good results are due to the day-to-day similarity between the source year and the real year providing the input data. This is exactly the situation in experimental energy evaluations where climatic averages are being collected on site and the building being measured is experiencing a climate different from the source station but with basically the same day-to-day sequence of weather events. The subsequent hour-by-hour simulation of such a building with an adjusted real period of weather data from the nearest source is likely to be quite realistic.

As expected, the adjustment of non-extrapolated SELECT representative composite years from the New York and Jersey City sources yielded somewhat less excellent results: for both Albany and Philadelphia from the Jersey City representative year, they are within 5 percent for annual cooling and 1 percent for annual heating. These values are very close to those produced by adjusting the SELECT-extrapolated Albany and Philadelphia composite years; no conclusions can be drawn about which is the better combination for producing representative years for remote locations. Both methods are considered to yield very satisfactory extrapolated weather tapes based on the results of these tests.

The report includes caveats to the users of these techniques, recommending that climatic characteristics of source and remote stations be assessed before data is extrapolated. The differences in diurnal climatic patterns are important and should be examined. The sources and recording periods of climatological data should also be checked to assure uniformity.

The techniques should also be examined for their effectiveness in different climatic regions of the country before great reliance is placed on them outside the Northeast.

## REFERENCES


1. Environmental Data Service, National Oceanographic and Atmospheric Administration (NOAA), Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1941-70, Climatography of the U.S. No. 81 (By State), National Climatic Center, Asheville, N.C., 1973.

2. R. M. Whiting, Standard Deviation of Monthly Average Temperature in the United States, NOAA Technical Report EDS 3, Environmental Data Service, Washington, D.C., 1978.

3. National Climatic Center, Tape Reference Manual "Test Reference Year," National Climatic Center, Asheville, N.C., 1976. Also published in the ASHRAE Journal, February 1977, p. 47.

4. I. J. Hall, R. R. Prairie, H. F. Anderson, and E. C. Boes, Generation of Typical Meteorological Years for 26 SOLMET Stations, Sandia Laboratory Report, N. M. 87185, 1979.

5. L. W. Crow, Summary Description of Typical Year Weather Data, Chicago Midway Airport, ASHRAE Project Report RP-100, Report 80, February 1970.

6. National Climatic Center, Selective Guide to Climatic Data Sources, Key to Meteorological Records Documentation No. 4.11, National Climatic Center, Asheville, N.C., 1969.

7. U. S. Navy, Guide to Standard Weather Summaries and Climatic Services, NAVAIR 50-1C-534, National Climatic Center, Asheville, N.C., 1978.

8. National Climatic Center. Climates of the States, Climatography of the U. S. No. 60, (by state), National Climatic Center, Asheville, N.C., (a continuing series).

9. Environmental Data Service, Climatic Atlas of the United States, Environmental Data Service, NOAA, Washington, D.C., 1968.

10. Engineering Weather Data, AFM 88-29, TM5-785, NAVFAC P-89, Departments of the Air Force, the Army, and the Navy, Washington, D.C. 20330, 1978.

11. American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE Handbook - 1977 Fundamentals, ASHRAE, 1977.

12. L. Degelman, A Weather Simulation Model for Building Energy Analysis, Computer-Aided Design and Simulation Laboratory, Pennsylvania, State University, University Park, Pennsylvania, 1974.

13. D. Nall and E. Arens, Climate Data Abbreviation for the Computerized Calculation of Heating and Cooling Requirements in Buildings, NBSIR 78-1525, National Bureau of Standards, 1978.

14. American Society of Heating, Refrigerating and Air Conditioning Engineers, ASHRAE Standard 90-75, Energy Conservation in New Building Design, ASHRAE, 1975.

15. S. R. Hastings, Three Proposed Typical House Designs for Energy Conservation Research, NBSIR 77-1309, National Bureau of Standards, 1977.

16. T. Kusuda, NBSLD, The Computer Program for Heating and Cooling Loads in Buildings, Building Science Series 69, National Bureau of Standards, 1976.

17. R. J. List, Smithsonian Meteorological Tables, Sixth Revised Edition, Smithsonian Institution Press, 1971.

18. K. Kimura, and D.G. Stephenson, Solar Radiation on Cloudy Days, ASHRAE TRANSACTIONS 1, 1969.

19. S. C. Diamond, et al., DOE-2 Program Manual, U.S. Department of Energy, Report LA-7688-M, February 1979.

20. E.C. Barrett, and C.K. Grant, Relations Between Frequency Distributions of Cloud Over the United Kingdom Based on Conventional Observations and Imagery from Landsat 2. Weather, Vol. 34, No. 11, November 1979, pp. 416-424.

APPENDIX A: Listing of the Main Program of the FORTRAN Program SELECT. This Program Requires the Following Subroutines and Functions;

Subroutine DAYW
Subroutine DEWPNT
Subroutine ORDER
Subroutine SLYEAR
Subroutine SUNNY
Function DPF
Function PVSF

Listed in APPENDIX C.

Synopsis of FORTRAN Program SELECT

Read in 3 to 10 years of decoded weather files, compute daily averages, and store in a FORTRAN DEFINE FILE.

Compute monthly averages for weather variables, and print out to user.

Read input monthly averages.

Computer averages appropriate for the selection model, and determine the order of segment selection.

By month:

> Select first segment by selection model to match input averages.
>
> Select second-selected segment by monthly temperature deviation.
>
> Select third-selected segment, so that the averages of the three segments match the input averages as closely as possible on this attempt.
>
> Reselect the second-selected segment so that the averages of the three segments approach the input averages more closely.
>
> Reselect the third-selected segment so that the averages of the three segments approach the input averages more closely.

Print out summary of selected composite year.

Write out composite year weather file in decoded format for use by loads program or refinement by ADJUST.

```
C
C                          SELECTED YEAR
C
C   MAIN ROUTINE OF A PROGRAM TO CREATE FULL YEAR WEATHER TAPES
C   FOR AREAS WHERE HOURLY DATA ARE NEEDED AND ONLY MONTHLY DATA ARE
C   AVAILABLE.  WEATHER DATA MUST BE IN NBSLD-DECODED FORMAT, AND
C   MAY BE ON TAPES OR IN FILES.  THE SELECTED YEAR IS CREATED BY
C   SELECTING 9, 10, OR 11 DAY SEGMENTS FROM AN INPUT SET OF YEARS.
C   UP TO TEN TAPES MAY BE USED TO DRAW ON TO CREATE A DEFINE FILE
C   THREE TO TEN YEARS LONG.  THE SEGMENTS ARE CHOSEN FOR THEIR FIT
C   WITH INPUT MONTHLY AVERAGES.  UP TO FOUR SETS OF MONTHLY
C   AVERAGES MAY BE ENTERED WITH A FULL YEAR TAPE MADE FOR EACH.
C   USE LOGICAL UNITS 15--24 FOR THE INPUT TAPES STARTING WITH 15.
C   USE LOGICAL UNITS 11--14 FOR OUTPUT SELECTED YEARS STARTING WITH 11.
C   THE FIT OF THE SEGMENTS IS BY USE OF A REGRESSION FORMULA, BASED
C   ON THE ENERGY REQUIREMENTS OF THREE WIDELY DIFFERING BUILDINGS,
C   WHICH USES A WEIGHTED SUM OF THE AVERAGE DRY BULB TEMPERATURE,
C   DAYTIME CLOUD COVER, MOISTURE RATIO, AND WIND-SPEED-DRY-BULB
C   CROSS-PRODUCT TO RANK THE SEGMENTS.  THE RANK IS AN ESTIMATE OF
C   THE DIFFERENCE IN LOADS, IN MEGAJOULES PER DAY, BETWEEN THE
C   SEGMENT AND ONE WITH THE INPUT MONTHLY AVERAGES, AS AVERAGED OVER THE
C   THREE BUILDINGS.
C   THE SEGMENTS FOR A MONTH ARE SELECTED FROM THE SAME MONTH OR
C   THE ADJACENT MONTH ON EITHER SIDE.
C   A TEMPORARY FILE MUST BE ASSIGNED  TO HOLD A DEFINE FILE (3700,220,,).
C   ASSIGN IT TO LOGICAL UNIT 10.
C   SUBROUTINES:
C               DAYW (MN,IDAY,DBTP,DRNG,CCAD,CCT,DDHT,DDCL,DEWP,WBTP,WNSP,
C                     IYEAR,NUMDAY,INITYR,LOGUNI,DDBASH,DDBASC,BAPR)
C                     READS DAY NUMDAY FROM THE TAPE ASSIGNED TO LOGUNI,
C                     WRITES IT INTO OUR DEFINE FILE AND FINDS DAILY AVERAGES
C                     AND OTHER VALUES AS ARE NEEDED IN THE MAIN PROGRAM.
C               ORDER (RANKSP,ISEGDN,NUMBYR) ORDERS THE VALUES IN ARRAY RANKSP
C                      IN INCREASING ORDER, PLACES SUBSCRIPTS OF THEIR ORIGINAL
C                      POSITIONS IN ARRAY ISEGDN, NUMBYR IS THE NUMBER OF ENTRIES
C                      IN RANKSP.
C               SLYEAR (ICDT,LSEG,LOGUNI,IYRARR,RANKCH) WRITES OUT A SELECTED
C                       YEAR INTO LOGICAL UNIT LOGUNI USING THE STARTING DAYS
C                       IN ARRAY ICDT AND THE CORRESPONDING LENGTHS IN ARRAY
C                       LSEG TO FIND THE CHOSEN SEGMENTS.  THE YEAR AND CITY
C                       CODE FOR THE SELECTED YEAR MUST BE ENTERED BY THE USER.
C                       ALSO WRITES THE YEAR AND RANK OF THE CHOSEN SEGMENTS
C                       USING IYRARR AND RANKCH.
C               SUNNY (RLATD,RLONG,TZN)
C                      FINDS SUNRISE AND DAY LENGTH VALUES ON A MONTHLY
C                      BASIS, WHEN GIVEN LATITUDE, LONGITUDE, AND TIME ZONE.
C               DEWPNT (DBTP,WBTP,BPR,DEWP)
C                       FINDS DEWPOINT WHEN SENT DRY BULB, WET BULB, AND
C                       BAROMETRIC PRESSURE.
C   FUNCTION:
C       PVSF (DEWPIN OR DEWPSP) INPUTS A DEWPOINT TEMPERATURE AND RETURNS THE
C            PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR, KILOPASCALS.
C       DPF (VP)
C           CALCULATES DEWPOINT FOR A GIVEN VAPOR PRESSURE.
```

```
C  VARIABLES:
C     CCAD:  THE AVERAGE DAYTIME CLOUD COVER, FOUND IN DAYW, TENTHS.
C     CCT:  THE AVERAGE TOTAL CLOUD COVER, FOUND IN DAYW, TENTHS.
C     DBTP:  THE AVERAGE DRY BULB TEMPERATURE, FOUND IN DAYW, DEG. C.
C     DRNG:  THE DAILY TEMPERATURE RANGE, FOUND IN DAYW, DEG. C.
C     DEWP:  THE DEWPOINT TEMPERATURE, FOUND IN DAYW, DEG. C.
C     WBTP:  THE WET BULB TEMPERATURE, FOUND IN DAYW, DEG. C.
C     BAPR:  THE BAROMETRIC PRESSURE, FOUND IN DAYW, KILOPASCALS.
C     WNSP:  THE WIND SPEED, FOUND IN DAYW,  M PER S.
C     DDHT:  DEGREE DAYS HEATING BASED ON DDBASH.
C     DDCL:  DEGREE DAYS COOLING BASED ON DDBASC.
C     DADBTP(DAY):  THE STORED DBTP VALUE FOR EACH DAY.
C     DBTPIN(MN):  THE INPUT DBTP VALUE TO BIAS OUR CHOICE OF
C                  SEGMENTS, IN DEG. C. OR F.
C     ZMDBTP:  STORES A DBTPIN VALUE SO WE CAN WORK WITH IT MORE EASILY.
C     DBTPSL(YEAR,MN,LENGTH):  THE AVERAGE DBTP FOR OUR SELECTED SEGMENTS.
C     DBTPSP(SEGMENT):  THE AVERAGE DBTP FOR THE SEGMENTS WE ARE CHOOSING
C                       FROM FOR A MONTH.
C     DBTPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C     YDBTP(MN):  THE AVERAGE DBTP FOR A MONTH FROM OUR INPUT SET.
C     DBTPMN(N,MN):  THE MONTHLY AVERAGE DBTP FOR THE NTH INPUT YEAR.
C     SLDBTP:  THE AVERAGE DBTP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C     DADEWP(DAY):  THE STORED DEWP VALUE FOR EACH DAY.
C     DEWPIN(MN):  THE INPUT DEWP VALUE TO BIAS OUR CHOICE OF SEGMENTS.
C     ZMWAMR:  STORES A MOISTURE RATIO VALUE SO WE CAN WORK WITH IT MORE EASILY
C              COMPUTED FROM DEWPIN AND BAPRIN VALUES.
C     DEWPSL(YEAR,MN,LENGTH):  THE AVERAGE DEWP FOR OUR SELECTED SEGMENTS.
C     DEWPSP(SEGMENT):  THE AVERAGE DEWP FOR THE SEGMENTS WE ARE CHOOSING
C                       FROM FOR A MONTH.
C     DEWPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C     YDEWP(MN):  THE AVERAGE DEWP FOR A MONTH FROM OUR INPUT SET.
C     DEWPMN(N,MN):  THE MONTHLY AVERAGE DEWP FOR THE NTH INPUT YEAR.
C     SLDEWP:  THE AVERAGE DEWP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C     DAWBTP(DAY):  THE STORED WBTP VALUE FOR EACH DAY.
C     WBTPSL(YEAR,MN,LENGTH):  THE AVERAGE WBTP FOR OUR SELECTED SEGMENTS.
C     WBTPSP(SEGMENT):  THE AVERAGE WBTP FOR THE SEGMENTS WE ARE CHOOSING
C                       FROM FOR A MONTH.
C     WBTPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C     YWBTP(MN):  THE AVERAGE WBTP FOR A MONTH FROM OUR INPUT SET.
C     WBTPMN(N,MN):  THE MONTHLY AVERAGE WBTP FOR THE NTH INPUT YEAR.
C     SLWBTP:  THE AVERAGE WBTP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C     DAWNSP(DAY):  THE STORED WNSP VALUE FOR EACH DAY.
C     WNSPIN(MN):  THE INPUT WNSP VALUE TO BIAS OUR CHOICE OF SEGMENTS,
C                  IN METERS PER SEC. OR M.P.H.
C     ZMWSDB:  STORES A WIND SPEED-DRY BULB PRODUCT VALUE SO WE CAN WORK WITH
C              IT MORE EASILY COMPUTED FROM WNSPIN AND DBTPIN VALUES.
C     WNSPSL(YEAR,MN,LENGTH):  THE AVERAGE WNSP FOR OUR SELECTED SEGMENTS.
C     WNSPSP(SEGMENT):  THE AVERAGE WNSP FOR THE SEGMENTS WE ARE CHOOSING
C                       FROM FOR A MONTH.
C     WNSPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C     YWNSP(MN):  THE AVERAGE WNSP FOR A MONTH FROM OUR INPUT SET.
C     WNSPMN(N,MN):  THE MONTHLY AVERAGE WNSP FOR THE NTH INPUT YEAR.
C     SLWNSP:  THE AVERAGE WNSP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C     DACCAD(DAY):  THE STORED CCAD VALUE FOR EACH DAY.
C     CCADIN(MN):  THE INPUT CCAD VALUE TO BIAS OUR CHOICE OF SEGMENTS,
C                  IN TENTHS.
C     ZMCCT:  STORES A CCTIN OR CCADIN VALUE SO WE CAN WORK WITH IT MORE EASILY.
C     CCADSL(YEAR,MN,LENGTH):  THE AVERAGE CCAD FOR OUR SELECTED SEGMENTS.
```

```
C       CCADSP(SEGMENT):  THE AVERAGE CCAD FOR THE SEGMENTS WE ARE CHOOSING
C                           FROM FOR A MONTH.
C       CCADX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C       YCCAD(MN):  THE AVERAGE CCAD FOR A MONTH FROM OUR INPUT SET.
C       CCADMN(N,MN):  THE MONTHLY AVERAGE CCAD FOR THE NTH INPUT YEAR.
C       SLCCAD:  THE AVERAGE CCAD FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C       DACCT(DAY):  THE STORED CCT VALUE FOR EACH DAY.
C       CCTIN(MN):  THE INPUT CCT VALUE TO BIAS OUR CHOICE OF SEGMENTS,
C                 IN TENTHS.
C       CCTSL(YEAR,MN,LENGTH):  THE AVERAGE CCT FOR OUR SELECTED SEGMENTS.
C       CCTSP(SEGMENT):  THE AVERAGE CCT FOR THE SEGMENTS WE ARE CHOOSING
C                           FROM FOR A MONTH.
C       CCTX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C       YCCT(MN):  THE AVERAGE CCT FOR A MONTH FROM OUR INPUT SET.
C       CCTMN(N,MN):  THE MONTHLY AVERAGE CCT FOR THE NTH INPUT YEAR.
C       SLCCT:  THE AVERAGE CCT FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C       DADRNG(DAY):  THE STORED DRNG VALUE FOR EACH DAY.
C       DRNGSL(YEAR,MN,LENGTH):  THE AVERAGE DRNG FOR OUR SELECTED SEGMENTS.
C       DRNGSP(SEGMENT):  THE AVERAGE DRNG FOR THE SEGMENTS WE ARE CHOOSING
C                           FROM FOR A MONTH.
C       DRNGX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
C       YDRNG(MN):  THE AVERAGE DRNG FOR A MONTH FROM OUR INPUT SET.
C       DRNGMN(N,MN):  THE MONTHLY AVERAGE DRNG FOR THE NTH INPUT YEAR.
C       SLDRNG:  THE AVERAGE DRNG FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C       DADDHT(DAY):  THE STORED DDHT VALUE FOR EACH DAY.
C       DDHTSL(YEAR,MN,LENGTH):  THE TOTAL DDHT FOR OUR SELECTED SEGMENTS.
C       DDHTSP(SEGMENT):  THE TOTAL DDHT FOR THE SEGMENTS WE ARE CHOOSING
C                           FROM FOR A MONTH.
C       DDHTX:  A SUMMING VARIABLE TO HELP FIND THE TOTALS FOR THE SEGMENTS.
C       YDDHT(MN):  THE TOTAL DDHT FOR A MONTH FROM OUR INPUT SET.
C       DDHTMN(N,MN):  THE MONTHLY TOTAL DDHT FOR THE NTH INPUT YEAR.
C       SLDDHT:  THE TOTAL DDHT FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C       DADDCL(DAY):  THE STORED DDCL VALUE FOR EACH DAY.
C       DDCLSL(YEAR,MN,LENGTH):  THE TOTAL DDCL FOR OUR SELECTED SEGMENTS.
C       DDCLSP(SEGMENT):  THE TOTAL DDCL FOR THE SEGMENTS WE ARE CHOOSING
C                           FROM FOR A MONTH.
C       DDCLX:  A SUMMING VARIABLE TO HELP FIND THE TOTALS FOR THE SEGMENTS.
C       YDDCL(MN):  THE TOTAL DDCL FOR A MONTH FROM OUR INPUT SET.
C       DDCLMN(N,MN):  THE MONTHLY TOTAL DDCL FOR THE NTH INPUT YEAR.
C       SLDDCL:  THE TOTAL DDCL FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
C       DDBASH:  THE BASE TEMPERATURE FOR THE DEGREE DAYS HEATING (DDHT), DEG. C.
C       DDBASC:  THE BASE TEMPERATURE FOR THE DEGREE DAYS COOLING (DDCL), DEG. C.
C       BAPRIN(MN):  INPUT MONTHLY BAROMETRIC PRESSURE KPASCAL, OR IN OF HG.
C       DEWPIN(MN):  INPUT MONTHLY DEWPOINT TEMPERATURE DEG. C. OR F.
C       PVS:  PARTIAL VAPOR PRESSURE CALCULATED FOR SEGMENT DEWPSP(I).
C       ARRAY(216):  USED TO READ IN THE REAL VALUES FROM OUR WEATHER TAPES.
C       ICDT(MN,1-3):  THE STARTING DAYS OF OUR CHOSEN SEGMENTS AS THEY ARE IN
C                     THE DEFINE FILE.
C       ICHYR(MN,1-3):  THE YEAR OF OUR CHOSEN SEGMENTS (IN TERMS OF WHEN
C                      IT WAS READ IN).
C       ICHYR1,ICHYR2,ICHYR3:  TEMPORARY STORING PLACE FOR ICHYR VALUES.
C       LSEG(MN,1-3):  THE LENGTH OF THE SEGMENTS IN SELECTED YEAR.
C       RLSEG:  REAL NUMBER VALUE FOR LSEG(MN,3).
C       RAVG:  USED TO FIND THE PROPER WEIGHTING OF SEGMENTS IN AVERAGING.
C       RANKSP(SEGMENT):  THE VALUE OF THE REGRESSION EQUATION FOR A SEGMENT.
C       RANKCH(MONTH,TYPE):  THE RANK OF THE CHOSEN SEGMENTS.
C       DLCCT:  THE DIFFERENCE BETWEEN THE INPUT MONTHLY CCT OR CCAD
C             (CCTIN(MN) NOW IN ZMCCT) AND THE AVERAGE CCT (CCTSP(I)).
```

```
C       DLDBTP(SEGMENT):  THE DIFFERENCE BETWEEN THE INPUT MONTHLY DBTP
C             (DBTPIN(MN) NOW IN ZMDBTP) AND THE AVERAGE DBTP (DBTPSP(I)).
C       DLWAMR:   THE DIFFERENCE BETWEEN THE COMPUTED INPUT MONTHLY WAMR IN
C                 ZMWAMR AND THE AVERAGE WAMRSP.
C       DLWSDB:   THE DIFFERENCE BETWEEN THE COMPUTED INPUT MONTHLY WSDB IN
C                 ZMWSDB AND THE AVERAGE WSDBSP .
C       DBDVMN(MN):   THE AVERAGE DEVIATION OF THE DRY BULB AVERAGES OF THE SEGMENT
C                     IN THE MONTHS IN OUR INPUT TAPE, TIMES 10, DEG. C.
C       LEAPS:   THE NUMBER OF LEAP YEARS IN THE INPUT WEATHER TAPE.
C       NEXTMN,NEXTYR:   THE MONTH AND YEAR OF THE MONTH AFTER THE ONE FOR
C                        WHICH WE ARE FINDING THE SELECTED SEGMENT.
C       INIDAY:   THE FIRST DAY OF OUR SELECTION FOR A MONTH.
C       NENDAY:   THE LAST DAY OF OUR SELECTION RANGE.
C       ISLDT(YEAR,MN,LENGTH TYPE):   THE STARTING DAY OF OUR SELECTED SEGMENTS.
C       ISEG:   THE LENGTH OF THE SEGMENT WE ARE LOOKING FOR NOW.
C       NUMRUN:   THE NUMBER OF SELECTED YEAR TAPES TO BE MADE.
C       LOGUNI:   THE LOGICAL UNIT TO BE USED FOR THIS OPERATION.
C       INTAPE:   THE NUMBER OF WEATHER TAPES TO BE DRAWN ON FOR OUR
C                 SEGMENT SELECTION FILE.
C       NSPAN:   THE NUMBER OF SEGMENTS AVAILABLE FOR A MONTH.
C       L1DAY,L2DAY: USED TO KEEP TRACK OF INIDAY'S NEXT INCREASE.
C       IDV:  USED TO SEE WHICH SEGMENT OF THE MONTH WE ARE DEALING WITH.
C       IDVARR(IDV):   CONTAINS THE ORDER OF SEGMENT SELECTION.
C       NEXTDV,LASTDV:   THE POSITION OF THE SEGMENTS SURROUNDING THE ONES
C                        WE ARE PICKING./
C       SIGNX:   USES THE ADJOINING MONTHS DRYBULB INPUT AVERAGES TO DECIDE THE
C                PLACEMENT OF THE SEGMENTS.
C       IYRARR(NYR):   STORES THE A.D. YEAR OF OUR INPUT WEATHER YEARS.
C       IDAY:   DAY OF MONTH OF DATA FROM DAY.
C       NDAY(YEAR,MN):   THE NUMBER OF DAYS IN A MONTH.
C       NDAYT(MN):   THE TOTAL NUMBER OF DAYS IN A MONTH SUMMED
C                    FOR ALL THE INPUT YEARS.
C       NUMBYR:   THE TOTAL NUMBER OF YEARS OF WEATHER TAPE INPUT.
C       NUMDAY:   THE TOTAL NUMBER OF DAYS OF INPUT WEATHER TAPE.
C       NODAY:   THE NUMBER OF DAYS TO BE TAKEN FROM AN INPUT FILE.
C       NOYR:   THE NUMBER OF YEARS TO BE USED FROM AN INPUT FILE.
C       INITYR:   THE FIRST YEAR TO BE USED FROM AN INPUT FILE.
C       MN:   MONTH.
C       ISIFLG:   THE FLAG FOR SIGNALING IF AVERAGES ARE TO BE ENTERED IN
C                 NON-SI UNITS.
C       IBPFLG:   THE FLAG FOR SIGNALING IF BAROMETRIC PRESSURE AVERAGES ARE TO BE
C                 ENTERED OR IF THE INPUT TAPES AVERAGES SHOULD BE USED.
C       IDBFLG:   1 FOR MAXIMUM MINIMUM AVERAGE USE, 0 FOR 24-AVERAGE USE.
C       I1DBDV,I2DBDV,I3DBDV:   USED TO DETERMINE THE SEGMENTS USED IN THE
C                               DEVIATION CALCULATIONS.
C       IDAWN:   THE MONTHLY VALUES FOR SUNRISE.
C       LENGTH:   THE MONTHLY VALUES FOR LENGTH OF DAYLIGTH.
C
C                      DECLARE THE DIMENSIONS (ALL TYPES BY NAME.).
C
        DIMENSION ICDT(12,3),ISLDT(10,12,3),LSEG(12,3),WBTPSL(10,12,3),
       * NDAY(10,12),NDAYT(12),RANKSP(83),RANKSL(10,12,3),IDVARR(12,5),
       * ISEGDN(10),WARRAY(216),DRNGSL(10,12,3),DVAJIN(12),YDSD(12),
       * DACCT(3660),CCTSL(10,12,3),CCTSP(83),CCTIN(12,3),YWBTP(12),
       * DACCAD(3660),CCADSL(10,12,3),CCADSP(83),YCCAD(12),BAPRSP(83),
       * DADBTP(3660),DBTPSL(10,12,3),DBTPIN(12,3),DBTPSP(83),
       * CCTMN(10,12),YCCT(12),DBTPMN(10,12),YDBTP(12),YDDHT(12),
       * DRNGMN(10,12),YDRNG(12),DRNGSP(83),DBDVMN(12),BAPRIN(12),
```

```
      * RANKCH(12,3),ICY(12,3),IYRARR(10),DABAPR(3660),DADRNG(3660),
      * DADDHT(3660),DDHTSL(10,12,3),DDHTSP(83),DDHTMN(10,12),
      * DADDCL(3660),DDCLSL(10,12,3),DDCLSP(83),DDCLMN(10,12),
      * CCTRN(12),BAPRMN(10,12),YDDCL(12),DBTPRN(13),SLDBTP(12),
      * DAWNSP(3660),DAWBTP(3660),DADEWP(3660),DEWPIN(12,3),WNSPIN(12,3),
      * WNSPRN(12),DEWPRN(12),DEWPSP(83),WNSPSP(83),YBAPR(12),WBTPSP(83),
      * WNSPSL(10,12,3),DEWPSL(10,12,3),WNSPMN(10,12),DEWPMN(10,12),
      * YWNSP(12),BAPRSL(10,12,3),YDEWP(12),WBTPMN(10,12),CCADMN(10,12)
       COMMON /DT/ IDAWN(12),LENGTH(12)
C                         INITIALIZE VALUES.
       DATA LSEG /10,9,10,10,10,10,10,10,10,10,10,10,11,10,11,10,11,10,11
      * ,11,10,11,10,11,10,9,10,10,10,10,10,10,10,10,10,10/
       DEFINE FILE 10 (3660,220,V,NPLACE)
       CALL PGSIZE (3,64)
C                         ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOLLOWED
C                         BY THE NUMBER OF TAPES  USED TO INPUT WEATHER YEARS,
C                         THE NUMBER OF SELECTED YEARS TO BE MADE, THE BASE
C                         TEMPERATURES FOR DEGREE DAYS CALCULATIONS AND THE
C                         HEIGHT TO BE USED FOR THE INPUT STATION.
       PRINT 600
       READ (5,500) RLATD,RLONG,TZN,INTAPE,NUMRUN,H1,IDBFLG,DDBASH,DDBASC
       CALL SUNNY (RLATD,RLONG,TZN)
       NUMRUN=NUMRUN+10
       INTAPE=INTAPE+14
       NUMBYR=0
       NUMDAY=0
       IDAY=0
C                         FOR EACH INPUT TAPE:  READ THE PROPER YEARS INTO
C                         OUR DEFINE FILE AND INCREMENT OUR YEAR AND DAY
C                         COUNTS AS NEEDED.  THE FIRST YEAR OF THE TAPE TO
C                         BE USED AND THE NUMBER OF YEARS TO BE USED MUST
C                         BE INPUT AS REQUESTED.
       DO 50 LOGUNI=15,INTAPE
         PRINT 605 LOGUNI
         READ (5,500)  INITYR,NOYR
C                         SEE IF WE ARE AT THE START OF THE PROPER YEAR, IF NOT
C                         READ UNTIL WE GET THERE.
         READ (LOGUNI)  WARRAY, IYEAR,MN,ID,ICITY
         REWIND LOGUNI
         IF (IYEAR-INITYR) 10,20,20
   10    READ (LOGUNI)  WARRAY,IYEAR,MN,ID,ICITY
         IF (IYEAR-INITYR+MN+ID-42) 10,,
C                         FIND THE INCREMENT FOR OUR DAY AND YEAR COUNTS AND USE THEM
   20    LEAPS=(MOD(INITYR-1,4)+NOYR)/4
         NODAY=365*NOYR+LEAPS
         DO 30 I=1,NOYR
           IYRARR(NUMBYR+I)=INITYR+I-1
   30    CONTINUE
         INITYR=INITYR-NUMBYR
C                         FOR EACH DAY OF WEATHER DATA CALL DAYW TO
C                         GET THE DAILY AVERAGES AND OTHER NECESSARY
C                         INFORMATION AND STORE IT IN THE DA ARRAYS
C                         ALSO SUM THE VALUES IN OUR MONTHLY AVERAGE ARRAYS.
C                         NOTE: DAYW WRITES INTO THE DEFINE FILE.
         DO 40 K=1,NODAY
           CALL DAYW (MN,ID,DBTP,DRNG,CCT,CCAD,DDHT,DDCL,DEWP,WBTP,
      *      WNSP,IYEAR,NUMDAY,INITYR,LOGUNI,DDBASH,DDBASC,BAPR,IDBFLG)
           DACCT(NUMDAY)=CCT
```

```
                DACCAD(NUMDAY)=CCAD
                CCTMN(IYEAR,MN)=CCTMN(IYEAR,MN)+CCT
                CCADMN(IYEAR,MN)=CCADMN(IYEAR,MN)+CCAD
                DADBTP(NUMDAY)=DBTP
                DBTPMN(IYEAR,MN)=DBTPMN(IYEAR,MN)+DBTP
                DADRNG(NUMDAY)=DRNG
                DRNGMN(IYEAR,MN)=DRNGMN(IYEAR,MN)+DRNG
                DADEWP(NUMDAY)=DEWP
                DAWBTP(NUMDAY)=WBTP
                DEWPMN(IYEAR,MN)=DEWPMN(IYEAR,MN)+DEWP
                DAWNSP(NUMDAY)=WNSP
                WNSPMN(IYEAR,MN)=WNSPMN(IYEAR,MN)+WNSP
                DADDHT(NUMDAY)=DDHT
                DDHTMN(IYEAR,MN)=DDHTMN(IYEAR,MN)+DDHT
                DADDCL(NUMDAY)=DDCL
                DDCLMN(IYEAR,MN)=DDCLMN(IYEAR,MN)+DDCL
                DABAPR(NUMDAY)=BAPR
                BAPRMN(IYEAR,MN)=BAPRMN(IYEAR,MN)+BAPR
                WBTPMN(IYEAR,MN)=WBTPMN(IYEAR,MN)+WBTP
                NDAY(IYEAR,MN)=ID
   40       CONTINUE
            NUMBYR=NUMBYR+NOYR
   50 CONTINUE
        PRINT 610
C                          FOR EACH MONTH: GET THE FULL SET  MONTHLY AVERAGES
C                          AND WRITE THEM OUT.
        DO 70 MN=1,12
C                          FOR EACH YEAR: SUM THE MONTHLY TOTALS, GET THE MONTHLY
C                          AVERAGES AND WRITE THEM OUT.
          DO 60 NYR=1,NUMBYR
            N=NDAY(NYR,MN)
            YCCT(MN)=YCCT(MN)+CCTMN(NYR,MN)
            YCCAD(MN)=YCCAD(MN)+CCADMN(NYR,MN)
            CCTMN(NYR,MN)=CCTMN(NYR,MN)/N
            CCADMN(NYR,MN)=CCADMN(NYR,MN)/N
            YDBTP(MN)=YDBTP(MN)+DBTPMN(NYR,MN)
            DBTPMN(NYR,MN)=DBTPMN(NYR,MN)/N
            YDRNG(MN)=YDRNG(MN)+DRNGMN(NYR,MN)
            DRNGMN(NYR,MN)=DRNGMN(NYR,MN)/N
            YDEWP(MN)=YDEWP(MN)+DEWPMN(NYR,MN)
            YWBTP(MN)=YWBTP(MN)+WBTPMN(NYR,MN)
            DEWPMN(NYR,MN)=DEWPMN(NYR,MN)/N
            WBTPMN(NYR,MN)=WBTPMN(NYR,MN)/N
            YWNSP(MN)=YWNSP(MN)+WNSPMN(NYR,MN)
            WNSPMN(NYR,MN)=WNSPMN(NYR,MN)/N
            YBAPR(MN)=YBAPR(MN)+BAPRMN(NYR,MN)
            BAPRMN(NYR,MN)=BAPRMN(NYR,MN)/N
            YDDHT(MN)=YDDHT(MN)+DDHTMN(NYR,MN)
            YDDCL(MN)=YDDCL(MN)+DDCLMN(NYR,MN)
            NDAYT(MN)=NDAYT(MN)+N
            PRINT 615 IYRARR(NYR),MN,DBTPMN(NYR,MN),DRNGMN(NYR,MN),
     *       DEWPMN(NYR,MN),WBTPMN(NYR,MN),CCTMN(NYR,MN),CCADMN(NYR,MN),
     *       WNSPMN(NYR,MN),BAPRMN(NYR,MN),DDHTMN(NYR,MN),DDCLMN(NYR,MN)
   60     CONTINUE
          IDVARR(MN,1)=2
          N=NDAYT(MN)
          YCCT(MN)=YCCT(MN)/N
          YCCAD(MN)=YCCAD(MN)/N
```

```
              YDBTP(MN)=YDBTP(MN)/N
              YDRNG(MN)=YDRNG(MN)/N
              YDEWP(MN)=YDEWP(MN)/N
              YWBTP(MN)=YWBTP(MN)/N
              YWNSP(MN)=YWNSP(MN)/N
              YBAPR(MN)=YBAPR(MN)/N
              YDDCL(MN)=YDDCL(MN)/NUMBYR
              YDDHT(MN)=YDDHT(MN)/NUMBYR
              PRINT 620 MN,YDBTP(MN),YDRNG(MN),YDEWP(MN),YWBTP(MN),
     *         YCCT(MN),YCCAD(MN),YWNSP(MN),YBAPR(MN),YDDHT(MN),YDDCL(MN)
   70 CONTINUE
C                        FOR EACH YEAR:
      DO 90 NYR=1,NUMBYR
C                        FOR EACH MONTH:
        DO 90 MN=1,12
C                        FIND THE DAILY STANDARD DEVIATION.
          N=NDAY(NYR,MN)
          DSDM=0.0
          DO 80 ND=1,N
            IDAY=IDAY+1
            DSDM=DSDM+(DBTPMN(NYR,MN)-DADBTP(IDAY))**2
   80     CONTINUE
          DSDM=SQRT(DSDM/(N-1))
          YDSD(MN)=YDSD(MN)+DSDM/NUMBYR
   90 CONTINUE
C                        FOR EACH SELECTED YEAR TO BE CREATED:
      DO 400 LOGUNI=11,NUMRUN
C                        FIND HOW THE AVERAGES ARE TO BE ENTERED AND READ
C                        THEM IN FOR EACH MONTH.  IF CALCULATIONS ARE NEEDED,
C                        MAKE THEM.
        PRINT 625 LOGUNI
        READ (5,500) ISIFLG,IBPFLG,H2,IWBFLG,ICCFLG
        DELH=H2-H1
        PRINT 630
        IF (ISIFLG.EQ.1) PRINT 635
        IF (ISIFLG.EQ.0) PRINT 640
        DO 110 MN=1,12
          PRINT 645 MN
          READ (5,500) DBTPRN(MN),CCTRN(MN),WNSPRN(MN),
     *     DEWPRN(MN),BAPRIN(MN),DVAJIN(MN)
          IF (ISIFLG.EQ.0) GO TO 100
          DBTPRN(MN)=(DBTPRN(MN)-32.0)*5/9
          DEWPRN(MN)=(DEWPRN(MN)-32.0)*5/9
          WNSPRN(MN)=WNSPRN(MN)*1.609/3.6
          BAPRIN(MN)=BAPRIN(MN)*101.1/29.921
  100     IF (IBPFLG.EQ.1) BAPRIN(MN)=YBAPR(MN)/10.**(DELH/(((DBTPRN(MN)
     *     +YDBTP(MN))/2.0+273.)*67.4072))
          IF (IWBFLG.EQ.1) CALL DEWPNT(DBTPRN(MN),DEWPRN(MN),BAPRIN(MN),
     *     DEWPRN(MN))
  110   CONTINUE
        LASTMN=12
        DBTPRN(13)=DBTPRN(1)
C                        FOR EACH MONTH:
        DO 130 MN=1,12
C                        DECIDE THE ORDER OF SEGMENT SELECTION USING DRY BULB
C                        DIFFERENCE.
          NEXTMN=MN+1
          IDVARR(MN,2)=1
```

```
            IDVARR(MN,3)=3
            IDVARR(MN,4)=1
            IDVARR(MN,5)=3
            IF (ABS(DBTPRN(MN)-DBTPRN(LASTMN)).LT.ABS(DBTPRN(MN)
     *       -DBTPRN(NEXTMN))) GO TO 120
            IDVARR(MN,2)=3
            IDVARR(MN,3)=1
            IDVARR(MN,4)=3
            IDVARR(MN,5)=1
  120       DBTPIN(MN,2)=DBTPRN(MN)
            DEWPIN(MN,2)=DEWPRN(MN)
            CCTIN(MN,2)=CCTRN(MN)
            WNSPIN(MN,2)=WNSPRN(MN)
            LASTMN=MN
  130     CONTINUE
C                        CHOOSE SEGMENTS FIVE TIMES:
C                            FIRST BASED SOLELY ON THE INPUT AVERAGES.
C                            SECOND BASED SOLELY ON THE DRY BULB AVERAGE + OR -
C                            THE AVERAGE SEGMENT DEVIATION TIMES 10.
C                            THIRD BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 2.
C                            FOURTH BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 3.
C                            FIFTH BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 4.
         DO 240  IDV=1,5
C                        INITIALIZE THE STARTING AND ENDING DAYS FOR OUR PICKS.
            L1DAY=0
            L2DAY=0
            INIDAY=0
            NENDAY=31
C                        FOR EACH YEAR:
            DO 170 NYR=1,NUMBYR
C                        FOR EACH MONTH:
              DO 170 MN=1,12
C                        FIND THE STARTING AND ENDING DAYS OF OUR AVAILABLE DATA.
C                        FIND THE STARTING AND ENDING DAYS OF OUR SEGMENTS TO BE
C                        USED IN THE TEN DAY DEVIATION CALCULATIONS.
                I1DBDV=L2DAY-4
                I2DBDV=I1DBDV+NDAY(NYR,MN)-6
                IF (MN.EQ.1.AND.NYR.EQ.1) I1DBDV=I1DBDV+4
                NEXTYR=NYR+MN/12
                NEXTMN=MOD(MN,12)+1
                IF (NUMBYR-NEXTYR) 140,,
                NENDAY=NENDAY+NDAY(NEXTYR,NEXTMN)
                I2DBDV=I2DBDV+6
  140           INIDAY=INIDAY+L1DAY
                I3DBDV=((I2DBDV-I1DBDV+2)/2)*((I2DBDV-I1DBDV+1)/2)
                NDV=IDVARR(MN,IDV)
                ISEG=LSEG(MN,NDV)
C                        MOVE THE MONTHLY AVERAGES TO BE USED IN THIS SELECTION
C                        TO THE ZM VARIABLES.
                ZMDBTP=DBTPIN(MN,NDV)
                ZMCCT=CCTIN(MN,NDV)
                ZMWAMR=62.2*PVSF(DEWPIN(MN,NDV))/(YBAPR(MN)-
     *          PVSF(DEWPIN(MN,NDV)))
                ZMWSDB=WNSPIN(MN,NDV)*(55.0/3.0-DBTPIN(MN,NDV))
                NSPAN=NENDAY-INIDAY-ISEG+1
                ITEMP=1
                CCTX=0.0
                CCADX=0.0
```

```
                  DBTPX=0.0
                  DRNGX=0.0
                  DEWPX=0.0
                  WBTPX=0.0
                  WNSPX=0.0
                  DDHTX=0.0
                  DDCLX=0.0
                  BAPRX=0.0
C                       FOR EACH DAY OF THE FIRST SEGMENT ADD ITS VALUES
C                       TO THE SEGMENT AVERAGING VARIABLES.
                  DO 150 J=1,ISEG
                    K=J+INIDAY
                    CCTX=CCTX+DACCT(K)
                    CCADX=CCADX+DACCAD(K)
                    DBTPX=DBTPX+DADBTP(K)
                    DRNGX=DRNGX+DADRNG(K)
                    DEWPX=DEWPX+DADEWP(K)
                    WBTPX=WBTPX+DAWBTP(K)
                    WNSPX=WNSPX+DAWNSP(K)
                    DDHTX=DDHTX+DADDHT(K)
                    DDCLX=DDCLX+DADDCL(K)
                    BAPRX=BAPRX+DABAPR(K)
  150             CONTINUE
C                       FOR EACH SEGMENT AVAILABLE TO THIS MONTH:
                  DO 160 I=1,NSPAN
C                           FOR ALL THE SEGMENTS EXCEPT THE FIRST:
                    IF (I.EQ.1) GO TO 155
                    LP=K+I-1
C                           ADJUST THE SUMMING VARIABLES BY ADDING THE NEXT
C                           DAY AND SUBTRACTING THE FIRST ONE.
                    LM=LP-ISEG
                    CCADX=CCADX+DACCAD(LP)-DACCAD(LM)
                    CCTX=CCTX+DACCT(LP)-DACCT(LM)
                    DRNGX=DRNGX+DADRNG(LP)-DADRNG(LM)
                    DBTPX=DBTPX+DADBTP(LP)-DADBTP(LM)
                    DEWPX=DEWPX+DADEWP(LP)-DADEWP(LM)
                    WBTPX=WBTPX+DAWBTP(LP)-DAWBTP(LM)
                    WNSPX=WNSPX+DAWNSP(LP)-DAWNSP(LM)
                    BAPRX=BAPRX+DABAPR(LP)-DABAPR(LM)
                    DDHTX=DDHTX+DADDHT(LP)-DADDHT(LM)
                    DDCLX=DDCLX+DADDCL(LP)-DADDCL(LM)
C                           DIVIDE BY THE SEGMENT LENGTH TO GET THE AVERAGES.
  155               DBTPSP(I)=DBTPX/ISEG
                    DRNGSP(I)=DRNGX/ISEG
                    DEWPSP(I)=DEWPX/ISEG
                    WBTPSP(I)=WBTPX/ISEG
                    WNSPSP(I)=WNSPX/ISEG
                    CCTSP(I)=CCTX/ISEG
                    CCADSP(I)=CCADX/ISEG
                    BAPRSP(I)=BAPRX/ISEG
                    DDHTSP(I)=DDHTX
                    DDCLSP(I)=DDCLX
                    PVSFSP=PVSF(DEWPSP(I))
                    WAMRSP=62.2*PVSFSP/(BAPRSP(I)-PVSFSP)
                    WSDBSP=WNSPSP(I)*(55.0/3.0-DBTPSP(I))
                    DLCCT=CCTSP(I)-ZMCCT
                    IF (ICCFLG.EQ.1) DLCCT=CCADSP(I)-ZMCCT
                    DLDBTP=DBTPSP(I)-ZMDBTP
```

```
                     DLWAMR=WAMRSP-ZMWAMR
                     DLWSDB=WSDBSP-ZMWSDB
C                                FIND THE RANK AND SEE IF IT IS THE BEST FOR THIS
C                                TYPE AND MONTH.
                     RANKSP(I)=14.299*ABS(DLDBTP)+4.90*ABS(DLCCT)+
     *                .37*ABS(DLWSDB)+96.6*ABS(DLWAMR)
                     IF (IDV.EQ.2) RANKSP(I)=ABS(DLDBTP)
                     IF (IDV.EQ.1.AND.LOGUNI.EQ.11.AND.I.GE.I1DBDV.AND.
     *                 I.LE.I2DBDV) DBDVMN(MN)=ABS(DBTPSP(I)-
     *                DBTPMN(NYR,MN))*10.0/I3DBDV/NUMBYR+DBDVMN(MN)
                     IF (RANKSP(I).LT.RANKSP(ITEMP)) ITEMP=I
  160              CONTINUE
C                          STORE THE WEATHER AVERAGES OF THE BEST SEGMENT IN THIS
C                          MONTH FOR THIS TYPE (NDV) IN THE SL ARRAYS.
                   CCTSL(NYR,MN,NDV)=CCTSP(ITEMP)
                   CCADSL(NYR,MN,NDV)=CCADSP(ITEMP)
                   DBTPSL(NYR,MN,NDV)=DBTPSP(ITEMP)
                   BAPRSL(NYR,MN,NDV)=BAPRSP(ITEMP)
                   DRNGSL(NYR,MN,NDV)=DRNGSP(ITEMP)
                   DEWPSL(NYR,MN,NDV)=DEWPSP(ITEMP)
                   WBTPSL(NYR,MN,NDV)=WBTPSP(ITEMP)
                   WNSPSL(NYR,MN,NDV)=WNSPSP(ITEMP)
                   DDHTSL(NYR,MN,NDV)=DDHTSP(ITEMP)
                   DDCLSL(NYR,MN,NDV)=DDCLSP(ITEMP)
                   ISLDT(NYR,MN,NDV)=ITEMP+INIDAY
                   RANKSL(NYR,MN,NDV)=RANKSP(ITEMP)
                   L1DAY=L2DAY
                   L2DAY=NDAY(NYR,MN)
  170         CONTINUE
C                          FOR EACH MONTH.
              LASTMN=12
              DO 220 MN=1,12
                IF (IDV.NE.1) GO TO 180
C                          ADJUST THE DRY BULB TO PREPARE FOR THE SECOND
C                          SELECTION USING THE TEN DAY AVERAGE DEVIATION.
                NEXTMN=MN+1
                SIGNX=DBTPRN(LASTMN)-DBTPRN(NEXTMN)
                LASTMN=MN
                SIGNX=SIGNX/ABS(SIGNX)*1.0
                DBTPIN(MN,1)=DBTPRN(MN)+SIGNX*DBDVMN(MN)*DVAJIN(MN)
                DBTPIN(MN,3)=DBTPRN(MN)-SIGNX*DBDVMN(MN)*DVAJIN(MN)
  180           NDV=IDVARR(MN,IDV)
                DO 190 I=1,NUMBYR
                  RANKSP(I)=RANKSL(I,MN,NDV)
  190           CONTINUE
C                          INITIALIZE ISEGDN.
                DO 200 I=1,10
                  ISEGDN(I)=I
  200           CONTINUE
C                          CALL ORDER AND PLACE THE CHOSEN SEGMENT VALUES INTO THE CH
C                          ARRAYS AVOIDING EXCESSIVE OVERLAP IN THE CHOSEN DAYS.
                CALL ORDER (RANKSP,ISEGDN,NUMBYR)
                ITEMP=ISEGDN(1)
                ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
                ICY(MN,NDV)=ITEMP
                RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
                ITEMP=2
                IF (IDV.LT.4) GO TO 220
```

```
                 IF (ABS(ICDT(MN,NDV)-ICDT(MN,2)).GT.5) GO TO 210
                 ITEMP=ISEGDN(2)
                 ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
                 ICY(MN,NDV)=ITEMP
                 RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
                 ITEMP=3
      210        IF (IDV.LT.5) GO TO 220
                 LASTDV=IDVARR(MN,IDV-1)
                 IF (ABS(ICDT(MN,NDV)-ICDT(MN,LASTDV)).GT.5) GO TO 220
                 ITEMP=ISEGDN(ITEMP)
                 ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
                 ICY(MN,NDV)=ITEMP
                 RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
                 IF (ABS(ICDT(MN,NDV)-ICDT(MN,2)).GT.5) GO TO 220
                 ITEMP=ISEGDN(3)
                 ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
                 ICY(MN,NDV)=ITEMP
                 RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
      220      CONTINUE
               IF (IDV.LT.2.OR.IDV.EQ.5) GO TO 240
C                       ADJUST THE AVERAGES WE ARE USING TO SELECT THE NEXT
C                       SEGMENT, TO BALANCE THE ERRORS IN AVERAGES
C                       OF THE SEGMENTS WE HAVE ALREADY FOUND.
               DO 230 I=1,12
                 NDV=IDVARR(I,IDV)
                 NEXTDV=IDVARR(I,IDV+1)
                 ICY1=ICY(I,NDV)
                 ICY2=ICY(I,2)
                 RLSEG=LSEG(I,3)
                 RAVG=LSEG(I,2)/RLSEG+2.0
                 DBTPIN(I,NEXTDV)=RAVG*DBTPIN(I,2)-DBTPSL(ICY2,I,2)*
     *            (RAVG-2.0)-DBTPSL(ICY1,I,NDV)
                 CCTIN(I,NEXTDV)=RAVG*CCTIN(I,2)-CCADSL(ICY2,I,2)*
     *            (RAVG-2.0)-CCADSL(ICY1,I,NDV)
                 IF (ICCFLG.EQ.0) CCTIN(I,NEXTDV)=RAVG*CCTIN(I,2)
     *            -CCTSL(ICY2,I,2)*(RAVG-2.0)-CCTSL(ICY1,I,NDV)
                 WNSPIN(I,NEXTDV)=RAVG*WNSPIN(I,2)-WNSPSL(ICY2,I,2)*
     *            (RAVG-2.0)-WNSPSL(ICY1,I,NDV)
                 DEWPIN(I,NEXTDV)=RAVG*DEWPIN(I,2)-DEWPSL(ICY2,I,2)*
     *            (RAVG-2.0)-DEWPSL(ICY1,I,NDV)
      230      CONTINUE
      240    CONTINUE
             ITEMP=NDAY(1,2)
             NDAY(1,2)=28
             PRINT 650
C                       FOR EACH MONTH GET THE SELECTED YEAR AVERAGES,
             DO 250 I=1,12
               N=NDAY(1,I)
               L1=LSEG(I,1)
               L2=LSEG(I,2)
               L3=LSEG(I,3)
               ICY1=ICY(I,1)
               ICY2=ICY(I,2)
               ICY3=ICY(I,3)
               SLCCT=(CCTSL(ICY1,I,1)*L1+CCTSL(ICY2,I,2)
     *          *L2+CCTSL(ICY3,I,3)*L3)/N
               SLCCAD=(CCADSL(ICY1,I,1)*L1+CCADSL(ICY2,I,2)
     *          *L2+CCADSL(ICY3,I,3)*L3)/N
```

```
              SLBAPR=(BAPRSL(ICY1,I,1)*L1+BAPRSL(ICY2,I,2)
     *         *L2+BAPRSL(ICY3,I,3)*L3)/N
              SLDBTP(I)=(DBTPSL(ICY1,I,1)*L1+DBTPSL(ICY2,I,2)
     *         *L2+DBTPSL(ICY3,I,3)*L3)/N
              SLDRNG=(DRNGSL(ICY1,I,1)*L1+DRNGSL(ICY2,I,2)
     *         *L2+DRNGSL(ICY3,I,3)*L3)/N
              SLDEWP=(DEWPSL(ICY1,I,1)*L1+DEWPSL(ICY2,I,2)
     *         *L2+DEWPSL(ICY3,I,3)*L3)/N
              SLWBTP=(WBTPSL(ICY1,I,1)*L1+WBTPSL(ICY2,I,2)
     *         *L2+WBTPSL(ICY3,I,3)*L3)/N
              SLWNSP=(WNSPSL(ICY1,I,1)*L1+WNSPSL(ICY2,I,2)
     *         *L2+WNSPSL(ICY3,I,3)*L3)/N
              SLDDHT=DDHTSL(ICY1,I,1)+DDHTSL(ICY2,I,2)+
     *         DDHTSL(ICY3,I,3)
              SLDDCL=DDCLSL(ICY1,I,1)+DDCLSL(ICY2,I,2)+
     *         DDCLSL(ICY3,I,3)
C                          AND PRINT THEM OUT.
              PRINT 655 I,SLDBTP(I),SLDRNG,SLDEWP,SLWBTP,SLCCT,SLCCAD,SLWNSP
     *         ,SLDDHT,SLDDCL
              PRINT 660 DBTPSL(ICY1,I,1),DEWPSL(ICY1,I,1),WBTPSL(ICY1,I,1),
     *         CCTSL(ICY1,I,1),CCADSL(ICY1,I,1),WNSPSL(ICY1,I,1)
              PRINT 665 DBTPIN(I,1),DEWPIN(I,1),CCTIN(I,1),WNSPIN(I,1)
              PRINT 660 DBTPSL(ICY2,I,2),DEWPSL(ICY2,I,2),WBTPSL(ICY2,I,2),
     *         CCTSL(ICY2,I,2),CCADSL(ICY2,I,2),WNSPSL(ICY2,I,2)
              PRINT 665 DBTPIN(I,2),DEWPIN(I,2),CCTIN(I,2),WNSPIN(I,2)
              PRINT 660 DBTPSL(ICY3,I,3),DEWPSL(ICY3,I,3),WBTPSL(ICY3,I,3),
     *         CCTSL(ICY3,I,3),CCADSL(ICY3,I,3),WNSPSL(ICY3,I,3)
              PRINT 665 DBTPIN(I,3),DEWPIN(I,3),CCTIN(I,3),WNSPIN(I,3)
   250      CONTINUE
            NDAY(1,2)=ITEMP
C                          USING SLYEAR WRITE OUR SELECTED YEAR AT LOGUNI.
            CALL SLYEAR (DADBTP,SLDBTP,ICDT,LSEG,LOGUNI,IYRARR,RANKCH)
   400 CONTINUE
       PRINT 670 DBDVMN,YDSD
       PRINT 680
   500 FORMAT ( )
   600 FORMAT (' ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOR ',
     * /,' THE DAYTIME CLOUD CALCULATIONS',/,' FOLLOWED BY',
     * ' THE NUMBER OF WEATHER TAPES YOU ARE DRAWING FROM ',
     * '1-10',/,' FOLLOWED BY THE NUMBER OF SELECTED YEARS YOU ARE ',
     * 'MAKING 1-4',/,' FOLLOWED BY THE HEIGHT IN METERS OF THE',
     * ' INPUT STATION',/,' FOLLOWED BY THE FLAG FOR DRY BULB AVERAGES '
     * ,/,' 1 IF THE AVERAGE OF THE MAXIMUM AND MINIMUM IS USED',
     * /,' 0 IF THE 24HR AVERAGE IS USED',/,'FOLLOWED BY THE BASE ',
     * 'TEMPERATURES FOR DEGREE DAY CALCULATIONS',/,' HEATING THEN ',
     * 'COOLING BOTH IN DEGREES CELSIUS')
   605 FORMAT (' ENTER THE FIRST YEAR YOU ARE USING FROM THE ',
     * ' WEATHER TAPE ASSIGNED TO ',/ ,' LOGICAL UNIT',I3,' AND ',
     * 'THE NUMBER OF CONSECUTIVE YEARS OF IT YOU ARE USING')
   610 FORMAT (' YEAR OF MONTHLY AVG. MONTH   DRY BULB   DAILY',
     * '   DEWPOINT    WET BULB   TOTAL DAYTIME WIND   BAROMETRIC ',
     * '   DEGREE DAYS',/,29X,
     * 'TEMPERATURE RANGE TEMPERATURE TEMPERATURE CLOUD  CLOUD  ',
     * 'SPEED  PRESSURE  HEATING COOLING',/,31X,'DEG. C.   DEG. C.  ',
     * 'DEG. C.     DEG. C.   TENTHS TENTHS M./S.  KILOPASCAL DEG.',
     * ' C. * DAYS')
   615 FORMAT (4X,'AVG. OF ',I4,7X,I2,3X,3(F9.2),7X,F5.2,F8.2,F7.2,
     * F8.2,3X,3(F8.2))
```

```
      620 FORMAT (/,' AVG. OF ALL YEARS',I7,3X,3(F9.2),7X,F5.2,F8.2,F7.2,
     * F8.2,3X,3(F8.2),//)
      625 FORMAT (' ENTER THE AVERAGES YOU ARE USING TO SELECT THE',
     * ' SELECTED YEAR ',/,' ASSIGNED TO LOGICAL UNIT',I3,
     * /,' ENTER THE SI FLAG:',/,' 0 FOR SI UNITS (DEG. C., M/SEC.,',
     * ' KPASCAL) ',/,
     * ' 1 FOR ENGLISH UNITS (DEG. F., IN. OF HG., M.P.H.)',
     * /,' FOLLOWED BY THE BP FLAG:',/,' IF YOU ARE UNABLE TO FIND ',
     * 'BAROMETRIC PRESSURE AVERAGES',/,' ENTER 1 AND THE HEIGHT OF ',
     * 'THE SELECTED LOCATION IN METERS',/,' ELSE ENTER 0 0.0',/,
     * ' FOLLOWED BY THE WB FLAG:',/,' IF YOU ARE ENTERING WET BULB '
     * 'INSTEAD OF DEWPOINT ENTER 1',/,' ELSE ENTER 0',/,' FOLLOWED BY '
     * ,'THE CCT FLAG:',/,' 1 IF USING DAYTIME CLOUD AVERAGES INSTEAD '
     * ,'OF FULL DAY AVERAGES ',/,' ELSE ENTER 0')
      630 FORMAT ( ' THE MONTH IS PRINTED FOR CONVENIENCE ONLY AND',
     * ' SHOULD NOT BE INPUT',
     * /,8X,' DRY BULB   MEAN SKY WIND  DEW POINT?WET BULB',
     * ' BAROMETRIC DEVIATION',/,8X,'TEMPERATURE  COVER   SPEED',
     * '     TEMPERATURE       PRESSURE  ADJUSTMENT')
      635 FORMAT (' MONTH    DEG. F.     TENTHS MI./HR.     DEG. F.  ',
     * '       IN. OF HG.   ')
      640 FORMAT (' MONTH    DEG. C.     TENTHS  M./S.      DEG. C.  ',
     * '       KILOPASCAL')
      645 FORMAT (I4)
      650 FORMAT (/,'  AVERAGE OF THE SELECTED YEAR',
     * ///,3X,' MONTH  DRY BULB        DAILY        DEWPOINT '
     * ,'      WET BULB        TOTAL         DAYTIME         WIND    ',
     * '  DEGREES DAYS  DEGREES DAYS',/,9X,'TEMPERATURE          RANGE    ',
     * '  TEMPERATURE  TEMPERATURE        CLOUD          CLOUD   ',
     * '       SPEED        HEATING         COOLING')
      655 FORMAT (/,I6,9(4X,F9.3))
      660 FORMAT ('     CHOSEN',F9.3,17X,F9.3,2(4X,F9.3),4X,F9.3,4X,F9.3)
      665 FORMAT ('    DESIRED',F9.3,17X,F9.3,24X,F9.3,10X,F9.3)
      670 FORMAT (/,37X,'AVERAGE SEGMENT DEVIATION',/,' MONTH',6X,'1',7X,
     * '2',7X,'3',7X,'4',7X,'5',7X,'6',7X,'7',7X,'8',7X,'9',6X,'10',6X,
     * '11',6X,'12',/,' DEG. C.',12(F8.3),/,41X,'STANDARD DEVIATION'
     * ,/,' DEG. C.',12(F8.3))
      680 FORMAT (' FOR MORE COMPLETE DESIGN AND TEMPERATURE',
     * ' EXTREMES INFORMATION',/,' USE THE ADJUST PROGRAM IN',
     * ' AVERAGE FINDING MODE.')
          STOP
          END
```

APPENDIX B. Listings of the Main Program of the FORTRAN Program ADJUST. This Program Requires the Following Subroutines and Functions;

| | |
|---|---|
| Subroutine | CLOUD |
| Subroutine | DEWPNT |
| Subroutine | SUNNY |
| Subroutine | WETBLB |
| Function | DPF |
| Function | PVSF |
| Function | WBF |

Listing in APPENDIX C.

## Synopsis of FORTRAN Program ADJUST

Read in one year's decoded weather data or, composite year from SELECT.

Compute and store monthly averages and print out climatic summary for user.

Read input monthly climatic averages.

Calculate monthly and daily ratios for adjuting hourly weather data.

Adjust the hourly values.

Write out the adjusted synthetic weather year in decoded format.

Print out summary of the adjusted synthetic weather year.

```
C
C   MAIN PROGRAM     ADJUST
C   ADJUSTS WEATHER TAPES ON AN HOURLY BASIS TO REPRESENT LOCATIONS
C   WHICH HAVE NO WEATHER TAPES. READS IN THE YEAR FROM LOGICAL UNIT 8
C   AND WRITES IT OUT AT LOGICAL UNIT 9.  THIS PROGRAM MAY ALSO BE USED
C   TO FIND THE MONTHLY AVERAGES FOR A YEAR.  THEY ARE WRITTEN AT LOGICAL
C   UNIT 7.
C   THE PROGRAM READS TAPES IN ENGLISH UNITS.
C
C   SUBROUTINES:
C               CLOUD(DAYS IN MONTHS,DELTA CLOUD,HOURLY CLOUD)
C                    ADJUSTS CLOUD COVER ON AN MONTHLY BASIS FOR EACH HOUR
C               SUNNY(LATITUDE,LONGITUDE,TIME ZONE)
C                    GETS MONTHLY DAWN AND DAY LENGTH VALUES.
C               DEWPNT(DRY BULB,WET BULB,BAROMETRIC PRESSURE,DEWPOINT)
C                     FINDS HOURLY DEWPOINT TEMPERATURES.
C               WETBLB(DRY BULB,WET BULB,BAROMETRIC PRESSURE,DEWPOINT)
C                     FINDS HOURLY WET BULB TEMPERATURES.
C   FUNCTIONS:
C             PVSF(T)
C                 FINDS THE PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR
C                 FOR A GIVEN TEMPERATURE.
C             DPF(P)
C                FINDS THE DEWPOINT TEMPERATURE FOR A GIVEN VAPOR PRESSURE
C             WBF(H,PB)
C                APPROXIMATES WET BULB WHEN ENTHALPY IS GIVEN.
C   DBT:  THE HOURLY DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
C   DPT:  THE HOURLY DEWPOINT TEMPERATURE, DEGREES FAHRENHEIT.
C   WBT:  THE HOURLY WET BULB TEMPERATURE, DEGREES FAHRENHEIT.
C   WSP:  THE HOURLY WIND, SPEED KNOTS.
C   BPR:  THE HOURLY BAROMETRIC PRESSURE, INCHES OF MERCURY.
C   CCT:  THE HOURLY CLOUD COVER, TENTHS.
C   TOC:  THE HOURLY TYPE OF CLOUD, OF THE LOWEST LAYER OF CLOUD.
C         IN NBSLD FORMAT, NOAA'S TYPES  8 AND 9 (CIRRUS) ARE DECODED AS
C         0.0, ALL OTHER TYPES DECODED AS 1.0
C         THE DOE-2 FORMAT SAME AS ABOVE, EXCEPT THAT NOAA'S TYPE
C         2 (STRATUS) IS DECODED AS 2.0.
C   WSD:  THE HOURLY WIND DIRECTION, 16 POINTS.
C   YY:  DUMMY FOR ENTERING CURRENTLY UNUSED DATA.
C   IYEAR:  A.D. YEAR OF WEATHER TAPE.
C   MN:  MONTH OF WEATHER TAPE.
C   ID:  DAY OF MONTH OF WEATHER TAPE.
C   IC:  CITY CODE OF WEATHER TAPE.
C   DDBASH:  THE BASE FOR CALCULATION OF HEATING DEGREE DAYS, DEG. F.
C   DDBASC:  THE BASE FOR CALCULATION OF COOLING DEGREE DAYS, DEG. F.
C   DDHTRM:  MONTHLY HEATING DEGREE DAYS, (DEG. F.).
C   DDCLRM:  MONTHLY COOLING DEGREE DAYS, (DEG. F.).
C   DBTAD:  THE DAILY AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
C   DBTD:  THE DAILY SUM OF HOURLY DRY BULB TEMPERATURES.
C   DPTD:  THE DAILY SUM OF HOURLY DEWPOINT TEMPERATURES.
C   WBTD:  THE DAILY SUM OF HOURLY WET BULB TEMPERATURES.
C   WSPD:  THE DAILY SUM OF HOURLY WIND SPEEDS.
C   BPRD:  THE DAILY SUM OF HOURLY BAROMETRIC PRESSURES.
C   CCTD:  THE DAILY SUM OF HOURLY CLOUD COVERS.
C   CCDD:  THE DAILY SUM OF HOURLY DAYTIME CLOUD COVERS.
C   DBMAX:  THE MAXIMUM DRY BULB TEMPERATURE FOR A DAY, DEGREES FAHRENHEIT
C   DBMIN:  THE MINIMUM DRY BULB TEMPERATURE FOR A DAY, DEGREES FAHRENHEIT.
C   DBAD:  PSEUDONYM FOR ADBTAD
C   DBMNAD:  THE MINIMUM HOURLY TEMPERATURE IN A GIVEN DAY
C   DBMXAD:  THE MAXIMUM HOURLY TEMPERATURE IN A DAY
C   DLDRMN:  THE FACTOR FOR ADJUSTING HOURLY TEMPERATURES,
C            IF DRNGIM IS GREATER THAN DRNGRM. (THESE ARE LESS
C            THAN THE DAILY AVERAGES)
C   DLDRMX:  DLDRMN'S COUNTERPART FOR TEMPERATURES GREATER THAN
C            THE DAILY AVERAGE.
C   DBTRM:  THE MONTHLY AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
C   DBTRM0:  THE MONTHLY 24HR-AVERAGE DRY BULB TEMPERATURE,
```

```
C  DBTRM1:  THE MONTHLY MAXMIN-AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT
C  DBAMAX:  THE MONTHLY AVERAGE MAXIMUM DAILY TEMPERATURE, DEGREES FAHRENHEIT
C  DBAMIN:  THE MONTHLY AVERAGE MINIMUM DAILY TEMPERATURE, DEGREES FAHRE
C  DBMXRM:  THE MAXIMUM MONTHLY TEMPERATURE, DEGREES FAHRENHEIT.
C  DBMNRM:  THE MINIMUM MONTHLY TEMPERATURE, DEGREES FAHRENHEIT.
C  DPTRM:  THE MONTHLY AVERAGE DEWPOINT TEMPERATURE, DEGREES FAHRENHEIT.
C  WBTRM:  THE MONTHLY AVERAGE WET BULB TEMPERATURE, DEGREES FAHRENHEIT.
C  WSPRM:  THE MONTHLY AVERAGE WIND SPEED, KNOTS.
C  BPRRM:  THE MONTHLY AVERAGE BAROMETRIC PRESSURE, INCHES OF MERCURY.
C  CCTRM:  THE MONTHLY AVERAGE CLOUD COVER, TENTHS.
C  CCCTRM:  THE MONTHLY AVERAGE CIRRUS COVER, TENTHS.
C  CCSTRM:  THE MONTHLY AVERAGE STRATUS COVER, TENTHS.
C  CCOTRM:  THE MONTHLY AVERAGE OF OTHER CLOUD TYPES, TENTHS. (INCLUDES
C           STRATUS IN NBSLD FORMAT)
C  CCDRM:  THE MONTHLY AVERAGE DAYTIME CLOUD COVER, TENTHS.
C  DSDRM:  THE MONTHLY AVERAGE DAILY STANDARD DEVIATION, DEGREES FAHRENHEIT
C  DRNGRM:  THE MONTHLY AVERAGE DAILY RANGE OF DRY BULB, DEGREES FAHRENHEIT
C  DBTIM:  THE INPUT MONTHLY AVERAGE DRY BULB TEMPERATURE.
C  DPTIM:  THE INPUT MONTHLY AVERAGE DEWPOINT TEMPERATURE.
C  WBTIM:  THE INPUT MONTHLY AVERAGE WET BULB TEMPERATURE.
C  WSPIM:  THE INPUT MONTHLY AVERAGE WIND SPEED.
C  BPRIM:  THE INPUT MONTHLY AVERAGE BAROMETRIC PRESSURE.
C  CCTIM:  THE INPUT MONTHLY AVERAGE CLOUD COVER.
C  CCDIM:  THE INPUT MONTHLY AVERAGE DAYTIME CLOUD COVER.
C  DSDIM:  THE INPUT MONTHLY AVERAGE DAILY STANDARD DEVIATION.
C  DRNGIM:  THE INPUT MONTHLY AVERAGE DAILY RANGE OF DRY BULB.
C  BPRADJ:  THE DIFFERENCE BETWEEN THE INPUT BAROMETRIC PRESSURE AND THE
C           REAL (TAPE) BAROMETRIC PRESSURE, ADDED TO EACH HOUR IN A MONTH
C  DH:  THE DIFFERENCE IN HEIGHT BETWEEN THE SOURCE STATION AND THE
C       ADJUSTED LOCATION.
C  DLCCTM:  THE DIFFERENCE BETWEEN THE INPUT CLOUD AVERAGE AND THE
C           THE REAL CLOUD AVERAGE.
C  DLCCCM:  SAME AS ABOVE, FOR CIRRUS CLOUDS.
C  DLCCSM:  SAME AS ABOVE, FOR STRATUS CLOUDS.
C  DLCCOM:  SAME AS ABOVE, FOR 'OTHER CLOUDS'.
C  RATDPT:  THE RATIO OF THE INPUT DEWPOINT DEPRESSION TO THE REAL ONE.
C  RATWBT:  THE RATIO OF THE INPUT WET BULB DEPRESSION TO THE REAL ONE.
C  RATDSD:  THE RATIO OF THE INPUT DAILY STANDARD DEVIATION TO THE REAL
C           STANDARD DEVIATION.
C  RATDRN:  THE RATIO OF THE INPUT DAILY RANGE AND THE REAL ONE.
C  RATWSP:  THE RATIO OF THE INPUT WIND SPEED AND THE REAL ONE.
C  CCCARR:  HOLDS THE HOURLY CIRRUS  COVER VALUES SO CLOUD CAN ADJUST THEM
C  CCSARR:  HOLDS THE HOURLY STRATUS VALUES SO CLOUD CAN ADJUST THEM.
C  CCOARR:  HOLDS THE HOURLY ?'OTHER CLOUD' VALUES SO CLOUD CAN ADJUST THEM
C  IDBCNT:  HOURS WITH TEMPERATURE 50 DEGREES LESS THAN DELIMETER.
C  IADFLG:  THE FLAG FOR USING ADJUST TO GET AVERAGES ONLY.
C  IBPFLG:  THE FLAG FOR USING THE HEIGHT TO DETERMINE THE BAROMETRIC
C           PRESSURE ADJUSTMENT.
C  IDBFLG:  THE FLAG FOR ENTERING DRY BULB AVERAGES WHICH ARE THE AVERAGES
C          OF THE SITE.
C           MAXIMUM AND MINIMUM DAILY TEMPERATURES.
C  ICCFLG:  THE FLAG FOR DECIDING CLOUD AVERAGE ENTERING PROCEDURE.
C  IDYFLG:  THE FLAG WHICH HAS THE NUMBER OF DAYS IN THE 12 MONTH PERIOD
C  ISIFLG:  THE FLAG FOR ENTERING AVERAGES IN NON-SI UNITS.
C  IWBFLG:  THE FLAG FOR DECIDING WET BULB DEWPOINT ENTERING PROCEDURE.
C  ISKFLG:  THE FLAG WHICH HAS THE NUMBER OF DAYS SKIPPED BEFORE THE
C           START OF THE 12 MONTH PERIOD.
C  LENGTH:  THE NUMBER OF HOURS OF DAYLIGHT FOR A DAY IN A MONTH.
C  IDAWN:  THE TIME OF SUNRISE FOR A DAY IN A MONTH.
C  ISR:  TIME OF SUNRISE.
C  ISS:  TIME OF SUNSET.
C  RLONG:  THE LONGITUDE OF THE ADJUSTED LOCATION.
C  RLATD:  THE LATITUDE OF THE ADJUSTED LOCATION.
C  TZN:  THE TIME ZONE (STANDARD) OF THE ADJUSTED LOCATION.
C  NDAY:  CONTAINS THE NUMBER OF DAYS IN EACH MONTH.
C  IH:  THE HOUR OF THE DAY WE ARE ADJUSTING.
```

```
C  MH:  THE NUMBER OF HOURS ALREADY ADJUSTED THIS MONTH.
C  IHTOT:  TOTAL NUMBER OF HOURS IN THE YEAR.
C  IDBTOT:  NUMBER OF HOURS WITH A TEMPERATURE LESS THAN DELIMETER 49
C  YCCS:  THE SUM OF MONTHLY AVERAGES FOR STRATUS TYPE CLOUD.
C
      DIMENSION DBTAD(12,31),DBTIM(12),DBTRM0(12),DBT(24),DPTIM(12),
     2 DBMXAD(12,31),DBMNAD(12,31),DPTRM(12),DPT(24),WBTIM(12),WBTRM(12)
     3,CCDIM(12),CCDRM(12),CCT(24),DRNGIM(12),BPRIM(12),BPRRM(12),
     4 BPR(24),WDR(24),WSPIM(12),WSP(24),DSDIM(12),DSDRM(12),TOC(24),
     5 YY(24),NDAY(12),WBT(24),DRNGRM(12),CCTRM(12),WSPRM(12),
     6 CCCARR(12,745),DBAMAX(12),DBAMIN(12),DBMXRM(12),DBMNRM(12),
     7 IDBCNT(180),DDHTRM(12),DDCLRM(12),DDHTAM(12),DDCLAM(12),
     8 DBTRM1(12),DBMXAM(12),DBMNAM(12),DBTRM(12),CCCDRM(12),
     9 CCOARR(12,745),DLCCCM(12),CCCTRM(12),CCODRM(12),CCOTRM(12),
     * DLCCOM(12),CCSTRM(12),CCSDRM(12),CCSARR(12,745),DLCCSM(12),
     1 ALPHA(6)
      DATA ALPHA /'     AD','JUSTED','  SUMM','ARIZED','DEG.C.','DEG.F.'/
      COMMON /DT/ IDAWN(12),LENGTH(12)
      IHTOT=0
C              READ IN THE LATITUDE, LONGITUDE, AND TIME ZONE AND
C              CALL SUNNY TO GET DAWN AND DAY LENGTH DATA.
      PRINT 220
      READ (5,210) RLATD,RLONG,TZN
      CALL SUNNY (RLATD,RLONG,TZN)
      DO 10 MN=1,12
        DBMXRM(MN)=-100.0
        DBMNRM(MN)=100.0
        DBMXAM(MN)=-100.0
        DBMNAM(MN)=100.0
        DO 10 MH=1,745
        CCCARR(MN,MH)=11.0
        CCOARR(MN,MH)=11.0
        CCSARR(MN,MH)=11.0
 10     CONTINUE
      DBMXYR=-100.0
      DBMNYR=100.0
      PRINT 230
      READ (5,210) ISKFLG,IDYFLG
      PRINT 240
      READ (5,210) IADFLG
      IF (ISKFLG.EQ.0) GO TO 30
C              READ THE SKIPPED PORTION OF THE TAPE.
      DO 20 IDAY=1,ISKFLG
        READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
 20     CONTINUE
 30   CONTINUE
      IF (IADFLG.EQ.0) PRINT 250
      IF (IADFLG.EQ.0) READ (5,210) IBFLG,DH
      IF (IADFLG.EQ.0) PRINT 260
      IF (IADFLG.EQ.0) READ (5,210) ISIFLG,ICCFLG
      IALP=6
      IF (ISIFLG.EQ.0.AND.IADFLG.EQ.0) IALP=5
      PRINT 270, ALPHA(IALP)
      READ (5,210) IDBFLG,DDBASH,DDBASC
      IF (IADFLG.NE.0.OR.ISIFLG.NE.0) GO TO 40
      DDBASH=DDBASH*1.8+32.0
      DDBASC=DDBASC*1.8+32.0
C              FOR EACH DAY IN THE REAL YEAR:
 40   DO 70 IDAY=1,IDYFLG
        READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
        DBMAX=-100.0
        DBMIN=100.0
        DBTD=0.0
        BPRD=0.0
        DPTD=0.0
        CCCDD=0.0
        CCSDD=0.0
```

```
            CCODD=0.0
            CCCTD=0.0
            CCSTD=0.0
            CCOTD=0.0
            CCC=0.0
            CCS=0.0
            CCO=0.0
            WBTD=0.0
            WSPD=0.0
            NDAY(MN)=ID
            MH=ID*24-24
C                  FOR EACH HOUR:
            DO 50 IH=1,24
C                  SUM THE HOURLY VALUES.
              DBTD=DBTD+DBT(IH)
              DPTD=DPTD+DPT(IH)
              DBMAX=MAX(DBMAX,DBT(IH))
              DBMIN=MIN(DBMIN,DBT(IH))
              BPRD=BPRD+BPR(IH)
C                 IN CLOUD ARRAYS, ALL TYPES GET 0'S IN CLEAR WEATHER.
C                  EMPTY FIELDS KEEP 11'S.
              CT=CCT(IH)
              IF (TOC.EQ.0.0.OR.CT.EQ.0.0) CCCARR(MN,MH+IH)=CT
              IF (TOC.EQ.1.0.OR.CT.EQ.0.0) CCOARR(MN,MH+IH)=CT
              IF (TOC.EQ.2.0.OR.CT.EQ.0.0) CCSARR(MN,MH+IH)=CT
              IF (TOC(IH).EQ.0.0) CCCTD=CCCTD+CT
              IF (TOC(IH).EQ.1.0) CCOTD=CCOTD+CT
              IF (TOC(IH).EQ.2.0) CCSTD=CCSTD+CT
              WSPD=WSPD+WSP(IH)
              WBTD=WBTD+WBT(IH)
              IHTOT=IHTOT+1
              IDB=DBT(IH)+50.5
              IDBCNT(IDB)=IDBCNT(IDB)+1
50            CONTINUE
           DBMXAD(MN,ID)=DBMAX
           DBMNAD(MN,ID)=DBMIN
            ISR=IDAWN(MN)
            ISS=ISR+LENGTH(MN)
C                  FOR EACH DAYTIME HOUR:
            DO 60 IH=ISR,ISS
C                  SUM THE CLOUD VALUES.
              IF (TOC(IH).EQ.0.0) CCCDD=CCCDD+CCT(IH)
              IF (TOC(IH).EQ.2.0) CCSDD=CCSDD+CCT(IH)
              IF (TOC(IH).EQ.1.0) CCODD=CCODD+CCT(IH)
60            CONTINUE
C                  ADD THE DAILY AVERAGE TO THE PROPER MONTHLY AVERAGE.
            CCCDRM(MN)=CCCDRM(MN)+CCCDD/(ISS-ISR+1)
            CCSDRM(MN)=CCSDRM(MN)+CCSDD/(ISS-ISR+1)
            CCODRM(MN)=CCODRM(MN)+CCODD/(ISS-ISR+1)
            DBTAD(MN,ID)=DBTD/24.0
            IF (IDBFLG.EQ.1) DBTAD(MN,ID)=(DBMAX+DBMIN)/2.0
            IF (DBTAD(MN,ID).LT.DDBASH) DDHTRM(MN)=DDHTRM(MN)-DBTAD(MN,ID)+D
         2DBASH
            IF (DBTAD(MN,ID).GT.DDBASC) DDCLRM(MN)=DDCLRM(MN)+DBTAD(MN,ID)-D
         2DBASC
            DBTRM0(MN)=DBTRM0(MN)+DBTD/24.0
            DBTRM1(MN)=DBTRM1(MN)+(DBMAX+DBMIN)/2.0
            DBAMAX(MN)=DBAMAX(MN)+DBMAX
            DBAMIN(MN)=DBAMIN(MN)+DBMIN
            DBMXRM(MN)=MAX(DBMAX,DBMXRM(MN))
            DBMNRM(MN)=MIN(DBMIN.DBMNRM(MN))
            DPTRM(MN)=DPTRM(MN)+DPTD/24.0
            WSPRM(MN)=WSPRM(MN)+WSPD/24.0
            CCCTRM(MN)=CCCTRM(MN)+CCCTD/24.0
            CCSTRM(MN)=CCSTRM(MN)+CCSTD/24.0
            CCOTRM(MN)=CCOTRM(MN)+CCOTD/24.0
            DRNGRM(MN)=DRNGRM(MN)+DBMAX-DBMIN
```

```
          WBTRM(MN)=WBTRM(MN)+WBTD/24.0
          BPRRM(MN)=BPRRM(MN)+BPRD/24.0
   70     CONTINUE
C                FOR EACH MONTH:
        DO 80 MN=1,12
C                DIVIDE BY THE NUMBER OF DAYS IN THE MONTH TO GET THE AVER
          N=NDAY(MN)
          DBTRM0(MN)=DBTRM0(MN)/N
          DBTRM1(MN)=DBTRM1(MN)/N
          DBTRM(MN)=DBTRM0(MN)
          IF (IDBFLG.EQ.1) DBTRM(MN)=DBTRM1(MN)
          DBAMAX(MN)=DBAMAX(MN)/N
          DBAMIN(MN)=DBAMIN(MN)/N
          DBMXYR=MAX(DBMXRM(MN),DBMXYR)
          DBMNYR=MAX(DBMNRM(MN),DBMNYR)
          DPTRM(MN)=DPTRM(MN)/N
          BPRRM(MN)=BPRRM(MN)/N
          WSPRM(MN)=WSPRM(MN)/N
          WBTRM(MN)=WBTRM(MN)/N
          DRNGRM(MN)=DRNGRM(MN)/N
          CCCDRM(MN)=CCCDRM(MN)/N
          CCSDRM(MN)=CCSDRM(MN)/N
          CCODRM(MN)=CCODRM(MN)/N
          CCCTRM(MN)=CCCTRM(MN)/N
          CCSTRM(MN)=CCSTRM(MN)/N
          CCOTRM(MN)=CCOTRM(MN)/N
          CCTRM(MN)=CCCTRM(MN)+CCOTRM(MN)+CCSTRM(MN)
          CCDRM(MN)=CCCDRM(MN)+CCODRM(MN)+CCSDRM(MN)
   80     CONTINUE
        PRINT 280
C                PRINT THE EXTREME TEMPERATURE DATA FOR THE REAL YEAR.
        DO 90 MN=1,12
          PRINT 290, DBAMAX(MN),DBAMIN(MN),DBMXRM(MN),DBMNRM(MN),DDHTRM(MN
       2),DDCLRM(MN)
   90     CONTINUE
C                FIND THE SUMMER AND WINTER DESIGN STATISTICS.
        DO 100 I=1,180
          IDBTOT=IDBTOT+IDBCNT(I)
          IDBCNT(I)=0
          J=I-49
          IF (IDBTOT.LT.1) DBMNYR=J
          IF (IDBTOT.LT.10) DBDES2=J
          IF (IDBTOT.LT.50) DBDES3=J
          IF (IDBTOT.LT.200) DBDES4=J
          IF (IDBTOT.LT.500) DBDES5=J
          IF (IDBTOT.LT.(IHTOT-500)) DBDES6=J
          IF (IDBTOT.LT.(IHTOT-200)) DBDES7=J
          IF (IDBTOT.LT.(IHTOT-50)) DBDES8=J
          IF (IDBTOT.LT.(IHTOT-10)) DBDES9=J
          IF (IDBTOT.LT.IHTOT) DBMXYR=J
  100     CONTINUE
C                PRINT THEM OUT.
        PRINT 300, DBMXYR,DBDES9,DBDES8,DBDES7,DBDES6,DBMNYR,DBDES2,DBDES3
       2,DBDES4,DBDES5
        REWIND 8
        IF (ISKFLG.EQ.0) GO TO 120
C                READ THE SKIPPED PORTION OF THE TAPE.
        DO 110 IDAY=1,ISKFLG
          READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
  110     CONTINUE
  120   CONTINUE
C                FOR EACH MONTH:
        DO 140 MN=1,12
C                FIND THE MONTHLY AVERAGE DAILY STANDARD DEVIATION.
          N=NDAY(MN)
          DO 130 IDAY=1,N
            DSDRM(MN)=DSDRM(MN)+(DBTAD(MN,IDAY)-DBTRM(MN))**2
```

```
130         CONTINUE
          DSDRM(MN)=SQRT(DSDRM(MN)/(N-1))
140       CONTINUE
        IF (IADFLG.EQ.0) PRINT 310
        IF (IADFLG.EQ.0) READ (5,210) IWBFLG
        IF (IADFLG.EQ.0) PRINT 320
        IF (IDBFLG.EQ.0) PRINT 330
        IF (IDBFLG.EQ.1) PRINT 340
        IF (IADFLG.EQ.0.AND.ISIFLG.EQ.0) PRINT 350
        IF (IADFLG.EQ.1.OR.ISIFLG.EQ.1) PRINT 360
        YCCS=0.0
C                FOR EACH MONTH:
       DO 150 MN=1,12
C                CHECK TO SEE IF THERE IS A CATEGORY FOR STRATUS.
          YCCS=YCCS+CCSTRM(MN)
C                READ IN THE AVERAGES FOR THE ADJUSTED YEAR.
C                IF CALCULATIONS ARE NEEDED, MAKE THEM.
          CCPRNT=CCDRM(MN)
          IF (ICCFLG.EQ.0) CCPRNT=CCTRM(MN)
          WRITE (7,420) MN,DBTRM0(MN),DBTRM1(MN),CCPRNT,WSPRM(MN),DPTRM(MN
     2),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
          IF (IDBFLG.EQ.0) PRINT 370, MN,DBTRM0(MN),CCPRNT,WSPRM(MN),DPTRM
     2(MN),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
          IF (IDBFLG.EQ.1) PRINT 370, MN,DBTRM1(MN),CCPRNT,WSPRM(MN),DPTRM
     2(MN),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
          IF (IADFLG.NE.0) GO TO 150
          READ (5,210) DBTIM(MN),CCDIM(MN),WSPIM(MN),DPTIM(MN),BPRIM(MN),D
     2SDIM(MN),DRNGIM(MN),WBTIM(MN)
          DLCCCM(MN)=(CCDIM(MN)-CCDRM(MN))*CCCTRM(MN)/CCDRM(MN)
          DLCCSM(MN)=(CCDIM(MN)-CCDRM(MN))*CCSTRM(MN)/CCDRM(MN)
          DLCCOM(MN)=(CCDIM(MN)-CCDRM(MN))*CCOTRM(MN)/CCDRM(MN)
          IF (DSDIM(MN).EQ.0.)DSDIM(MN)=DSDRM(MN)
          IF (ICCFLG.EQ.0) DLCCCM(MN)=(CCDIM(MN)-CCTRM(MN))*CCCTRM(MN)/CCT
     2RM(MN)
          IF (ICCFLG.EQ.0) DLCCSM(MN)=(CCDIM(MN)-CCTRM(MN))*CCSTRM(MN)/CCT
     2RM(MN)
          IF (ICCFLG.EQ.0) DLCCOM(MN)=(CCDIM(MN)-CCTRM(MN))*CCOTRM(MN)/CCT
     2RM(MN)
          IF (ISIFLG.NE.0) GO TO 150
          DBTIM(MN)=DBTIM(MN)*1.8+32.0
          DPTIM(MN)=DPTIM(MN)*1.8+32.0
          DRNGIM(MN)=DRNGIM(MN)*1.8
          WBTIM(MN)=WBTIM(MN)*1.8+32.0
          DSDIM(MN)=DSDIM(MN)*1.8+32.0
          WSPIM(MN)=WSPIM(MN)*3.6/1.853
          BPRIM(MN)=BPRIM(MN)*29.92/101.1
150       CONTINUE
        IF (IADFLG.NE.0) GO TO 200
C                CALL CLOUD TO ADJUST THE CLOUD VALUES FOR THE YEAR.
        CALL CLOUD (NDAY,DLCCCM,CCCARR)
        IF (YCCS.NE.0.0) CALL CLOUD (NDAY,DLCCSM,CCSARR)
        CALL CLOUD (NDAY,DLCCOM,CCOARR)
        READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
C                FOR EACH MONTH:
        DO 170 M=1,12
C                GET THE MONTHLY RATIOS.
          RATDPT=(DBTIM(MN)-DPTIM(MN))/(DBTRM(MN)-DPTRM(MN))
          RATWBT=(DBTIM(MN)-WBTIM(MN))/(DBTRM(MN)-WBTRM(MN))
          BPRADJ=BPRIM(MN)-BPRRM(MN)
          RATWSP=WSPIM(MN)/WSPRM(MN)
          DLDBTM=DBTIM(MN)
          RATDSD=DSDIM(MN)/DSDRM(MN)
          DLDRNG=(DRNGIM(MN)-DRNGRM(MN))/2.0
          RATDRN=DRNGIM(MN)/DRNGRM(MN)
          N=NDAY(MN)
          DBAMAX(MN)=0.0
```

```
            DBAMIN(MN)=0.0
      C            FOR EACH DAY:
            DO 170 IDAY=1,N
            DBAD=DBTAD(MN,ID)
      C            GET THE DAILY DRY BULB ADJUSTMENT.
            IF (DBAD.NE.DBMXAD(MN,ID)) DLDRMX=1+DLDRNG/(DBMXAD(MN,ID)-DBAD)
            IF (DBAD.NE.DBMNAD(MN,ID)) DLDRMN=1+DLDRNG/(DBAD-DBMNAD(MN,ID))
            DLDBTD=(DBAD-DBTRM(MN))*RATDSD+DLDBTM
            IF (DLDBTD.LT.DDBASH) DDHTAM(MN)=DDHTAM(MN)-DLDBTD+DDBASH
            IF (DLDBTD.GT.DDBASC) DDCLAM(MN)=DDCLAM(MN)+DLDBTD-DDBASC
            MH=IDAY*24-24
            DBMAX=-100.0
            DBMIN=100.0
      C            FOR EACH HOUR:
            DO 160 IH=1,24
      C             FIND THE HOURLY DRY BULB, DEWPOINT, AND WET BULB ADJUSTM
              DB=DBT(IH)
              DLDBTH=DB-DBAD
              DLWBTH=(WBT(IH)-DB)*RATWBT
              DLDPTH=(DPT(IH)-DB)*RATDPT
              IF (DLDRNG.LT.0.0) DLDBTH=DLDBTH*RATDRN
      C     IF DAILY RANGE MUST BE INCREASED, AN ADDITIVE
      C     ADJUSTMENT IS MADE TO THE DAILY EXTREMES.  OTHERWISE
      C     RATDRN IS USED.
              IF (DLDRNG.GT.0.0.AND.DLDBTH.GT.0.0) DLDBTH=DLDBTH*DLDRMX
              IF (DLDRNG.GT.0.0.AND.DLDBTH.LT.0.0) DLDBTH=DLDBTH*DLDRMN
              DB=DLDBTH+DLDBTD
      C            ADJUST THE HOURLY VALUES, IF NECESSARY CALL DEWPNT OR WET
              DBMAX=MAX(DB,DBMAX)
              DBMIN=MIN(DB,DBMIN)
              IDB=DB+50.5
              IDBCNT(IDB)=IDBCNT(IDB)+1
              WBT(IH)=DB+DLWBTH
              DPT(IH)=DB+DLDPTH
              IF (IBPFLG.EQ.0) BPR(IH)=BPR(IH)+BPRADJ
              IF (IBPFLG.EQ.1) BPR(IH)=BPR(IH)/10**(DH/((459.+(DBT(IH)+DB)/2
           2.)*122.8))
              DBT(IH)=DB
              IF (IWBFLG.EQ.0) CALL DEWPNT (DBT(IH),WBT(IH),BPR(IH),DPT(IH))
              IF (IWBFLG.EQ.1) CALL WETBLB (DBT(IH),DPT(IH),BPR(IH),WBT(IH))
              CCT(IH)=MOD((CCCARR(MN,MH+IH)+CCOARR(MN,MH+IH)+CCSARR(MN,MH+IH
           2)),11.0)
              WSP(IH)=WSP(IH)*RATWSP
      160     CONTINUE
      C            WRITE OUT A DAY OF OUR ADJUSTED YEAR.
            DBAMAX(MN)=DBAMAX(MN)+DBMAX
            DBAMIN(MN)=DBAMIN(MN)+DBMIN
            DBMXAM(MN)=MAX(DBMAX,DBMXAM(MN))
            DBMNAM(MN)=MIN(DBMIN,DBMNAM(MN))
            WRITE (9) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
            READ (8,END=170) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,
           2IC
      170   CONTINUE
           IDBTOT=0
      C            FIND THE DESIGN STATISTICS FOR THE ADJUSTED YEAR.
           DO 180 I=1,180
            IDBTOT=IDBTOT+IDBCNT(I)
            J=I-49
            IF (IDBTOT.LE.0) DBMNYR=J
            IF (IDBTOT.LT.10) DBDES2=J
            IF (IDBTOT.LT.50) DBDES3=J
            IF (IDBTOT.LT.200) DBDES4=J
            IF (IDBTOT.LT.500) DBDES5=J
            IF (IDBTOT.LT.(IHTOT-500)) DBDES6=J
            IF (IDBTOT.LT.(IHTOT-200)) DBDES7=J
            IF (IDBTOT.LT.(IHTOT-50)) DBDES8=J
            IF (IDBTOT.LT.(IHTOT-10)) DBDES9=J
```

```
          IF (IDBTOT.LT.IHTOT) DBMXYR=J
180       CONTINUE
        PRINT 380, ALPHA(1),ALPHA(2)
        PRINT 390
        DO 190 MN=1,12
          N=NDAY(MN)
          DBAMAX(MN)=DBAMAX(MN)/N
          DBAMIN(MN)=DBAMIN(MN)/N
          PRINT 400, DBAMAX(MN),DBAMIN(MN),DBMXAM(MN),DBMNAM(MN),DDHTAM(MN
     2),DDCLAM(MN)
190       CONTINUE
C                  PRINT THE EXTREME TEMPERATURE DATA FOR THE ADJUSTED YEAR.
        PRINT 410, DBMXYR,DBDES9,DBDES8,DBDES7,DBDES6,DBMNYR,DBDES2,DBDES3
     2,DBDES4,DBDES5
200     CONTINUE
        IF (IADFLG.EQ.1) PRINT 380, ALPHA(3),ALPHA(4)
        STOP
C
C
C
C
210     FORMAT ()
220     FORMAT (' ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.')
230     FORMAT (' ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START'
     2,/,' OF THE 12 MONTH PERIOD BEING USED',/' FOLLOWED BY THE ',
     3 'NUMBER OF DAYS IN IT')
240     FORMAT (' ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1')
250     FORMAT (' ENTER 0 0.0 IF BAROMETRIC PRESSURE DATA IS AVAILABLE',/,
     2 ' OTHERWISE ENTER 1 AND THE HEIGHT DIFFERENCE OF THE NEW ',/,
     3 ' AND OLD LOCATION --- H(NEW)-H(OLD) IN FEET')
260     FORMAT (' ENTER 0 IF USING SI UNITS (FOR INPUT OF CLIMATE',/,
     2 ' VARIABLES ONLY), ELSE ENTER 1',/,' FOLLOWED BY THE CLOUD FLAG:'
     3,/,' 1 IF USING DAYTIME AVERAGES',/,
     4 ' 0 IF USING FULL DAY AVERAGES.')
270     FORMAT (' ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE',/,
     2 ' USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED ',/,
     3 ' (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE',/,
     4 ' DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY',/,
     5 ' BULB CALCULATIONS)',/,
     6 ' THEN ENTER THE BASE TEMPERATURES'' TO BE USED IN ',/,
     7 ' THE DEGREE DAY CALCULATIONS IN ',A6,':',/,
     8 ' FIRST HEATING, THEN COOLING.',/)
280     FORMAT (/,/,' INPUT YEAR SUMMARY',/,
     2 ' AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL')
290     FORMAT (4F9.3,2F10.3)
300     FORMAT (' SUMMER DESIGN 0 HRS:',F5.0,' 10 HRS:',F5.0,' 50 HRS:',
     2 F5.0,' 200 HRS:',F5.0,' 500 HRS:',F5.0,/,' WINTER DESIGN 0 HRS:',
     3 F5.0,' 10 HRS:',F5.0,' 50 HRS:',F5.0,' 200 HRS:',F5.0,' 500 HRS:'
     4,F5.0)
310     FORMAT (' ENTER 0 IF USING WET BULB ONLY, AS FROM AIR FORCE',
     2 ' MANUAL 88/29',/,' ENTER 1 IF USING DEWPOINT ONLY, AS FROM',
     3 ' NOAA CLIMATIC ATLAS',/,' ENTER 2 IF USING BOTH')
320     FORMAT (' ENTER THE WEATHER AVERAGES TO ADJUST THE TAPE.',/,
     2 ' EVEN IF VALUES CANNOT BE FOUND OR ARE NOT USED',/,
     3 ' SOMETHING MUST BE ENTERED FOR ALL 96 VALUES',/,
     4 ' ( ENTER ONLY ONE TYPE OF DRY BULB AVERAGE.)',/,
     5 ' IF NECESSARY ECHO THE VALUES FROM THE INPUT YEAR',/)
330     FORMAT (' MONTH   DRY BULB  CLOUD   WIND  DEW  BAROMETRIC DAILY DA
     2ILY ',' WET',/,9X,' 24-HR    COVER  SPEED POINT  PRESSURE    S.D. '
     3,'RANGE  BULB')
340     FORMAT (' MONTH   DRY BULB  CLOUD   WIND  DEW  BAROMETRIC DAILY DA
     2ILY ',' WET',/,9X,' MAXMIN   COVER  SPEED POINT  PRESSURE    S.D. '
     3,'RANGE  BULB')
350     FORMAT (9X,'  DEG.C.  TENTHS  M/S  DEG.C.   KPAS   ',
     2 'DEG.C. DEG.C. DEG.C.')
360     FORMAT (9X,'  DEG.F.  TENTHS KNOTS DEG.F.     ',
```

```
              2 'IN.HG.  DEG.F.  DEG.F.  DEG.F.')
       370     FORMAT (I4,5X,F7.2,3X,F5.2,F7.2,F6.2,F9.2,F7.2,F7.2,F7.2)
       380     FORMAT (2A6,' YEAR COMPLETE.')
       390     FORMAT (/,/,' ADJUSTED YEAR SUMMARY',/,
              2 ' AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL')
       400     FORMAT (4F9.3,2F10.3)
       410     FORMAT (' SUMMER DESIGN 0 HRS:',F5.0,' 10 HRS:',F5.0,' 50 HRS:',
              2 F5.0,' 200 HRS:',F5.0,' 500 HRS:',F5.0,/,' WINTER DESIGN 0 HRS:',
              3 F5.0,' 10 HRS:',F5.0,' 50 HRS:',F5.0,' 200 HRS:',F5.0,' 500 HRS:'
              4,F5.0)
       420     FORMAT (I4,2F7.2,3X,F5.2,F7.2,F6.2,F9.2,F7.2,F7.2,F7.2)
       C
               END
EOF AT LINE 547
```

APPENDIX C: Listings of the FORTRAN Subroutines and Functions used by the ADJUST and SELECT Programs-

| | |
|---|---|
| Subroutine | CLOUD(A)* |
| Subroutine | DAYW(S)* |
| Subroutine | DEWPNT(A) |
| Subroutine | DEWPNT(S) |
| Subroutine | ORDER(S) |
| Subroutine | SLYEAR(S) |
| Subroutine | SUNNY(A,S) |
| Subroutine | WETBLB(A) |
| Function | DPF(A,S) |
| Function | PVSF(A) |
| Function | PVSF(S) |
| Function | WBF(A) |

* A=Needed by the ADJUST Program.
S=Needed by the SELECT Program.

```
      C  SUBROU
      C  ADJUST                                                                  G
      C  UNITS
      C  A RAND
      C
      C  INPUT
      C        N
      C        D
      C        C
      C  LOCAL
      C        N[illegible]   THE NUMBER OF THAT TYPE OF TENTHS.
      C        NTP(TYPE+1,NUMBER):  THE HOURLY POSITION OF THIS TENTH.
      C        NCP(TYPE+1,NUMBER):  THE RANDOM NTP.
      C        NUMBER:  THE NUMBER OF HOURS IN A MONTH.
      C        MN:  THE MONTH.
      C        CCT:  STORES A CLOUD VALUE FOR EASIER HANDLING.
      C        IADJ:  THE NUMBER OF UNIT ADJUSTMENTS WHICH MUST BE MADE TO
      C                CHANGE THE AVERAGE BY DELCCT, DIVIDED BY TEN.
      C
      C                DIMENSION THE ARRAYS ALL TYPES BY NAME.
               DIMENSION NTC(13),NTP(13,745),NCP(13,745),CCTARR(12,745),
           *     NDAY(12),DELCCT(12)
      C                FOR EACH MONTH:
             DO 190 MN=1,12
      C                FIND THE NUMBER OF HOURS AND THE ADJUSTMENT NEEDED.
               NUMBER=NDAY(MN)*24
               DELTAC=DELCCT(MN)
      C                INITIALIZE THE CLOUD TYPE COUNTER.
               DO 10 I=1,13
                 NTC(I)=0
         10    CONTINUE
      C                FOR EACH HOUR:
               DO 70 I=1,NUMBER
      C                FIND THE TENTH OF CLOUD WE ARE DEALING WITH AND
      C                INCREMENT THE COUNT AND STORE THE HOUR.
                 CCT=CCTARR(MN,I)
                 IF (CCT.NE.10.0) GO TO 30
                 IF (CCTARR(MN,I-1).NE.10..OR.CCTARR(MN,I+1).NE.10.)GO TO 20
                 NTC(12)=NTC(12)+1
                 I12=NTC(12)
                 NTP(12,I12)=I
                 GO TO 70
         20      NTC(11)=NTC(11)+1
                 I11=NTC(11)
                 NTP(11,I11)=I
                 GO TO 70
         30      IF (CCT.NE.0.0) GO TO 50
                 IF (CCTARR(MN,I-1).NE.0..OR.CCTARR(MN,I+1).NE.0.)GO TO 40
                 NTC(13)=NTC(13)+1
                 I13=NTC(13)
                 NTP(13,I13)=I
                 GO TO 70
         40      NTC(1)=NTC(1)+1
                 I1=NTC(1)
                 NTP(1,I1)=I
                 GO TO 70
         50      DO 60 IC=2,10
                   R=IC-1
```

```
                  IF (CCT.NE.R) GO TO 60
                  NTC(IC)=NTC(IC)+1
                  IIC=NTC(IC)
                  NTP(IC,IIC)=I
                  GO TO 70
   60           CONTINUE
   70         CONTINUE
C              FOR EACH CLOUD TENTH TYPE:
              DO 100 J=1,13
C                  SEE HOW MANY OF THAT TYPE THERE ARE AND
C                  PERMUTE THEIR POSITIONS (HOURS).
                N=NTC(J)
                IC=0
                DO 75 I=1,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   75           CONTINUE
                DO 80 I=2,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   80           CONTINUE
                DO 85 I=3,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   85           CONTINUE
                DO 90 I=4,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   90           CONTINUE
                DO 95 I=5,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   95           CONTINUE
                DO 96 I=6,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
   96           CONTINUE
                DO 100 I=7,N,7
                  IC=IC+1
                  NCP(J,I)=NTP(J,IC)
  100         CONTINUE
C                  ADD ON THE STRING TENS AND ZEROES TO THE OTHERS
              N1=NTC(11)
              N2=NTC(12)
              DO 110 I=1,N2
                N1=N1+1
                NCP(11,N1)=NCP(12,I)
  110         CONTINUE
              NTC(11)=N1
              N1=NTC(1)
              N2=NTC(13)
              DO 120 I=1,N2
                N1=N1+1
                NCP(1,N1)=NCP(13,I)
  120         CONTINUE
C                  FIND HOW MANY ADJUSTMENTS MUST BE MADE.
              NTC(1)=N1
              IADJ=ABS(DELTAC*NUMBER/10.0)+.5
              IF (DELTAC) ,180,150
              IF (IADJ.GT.(NTC(11)/2)) PRINT 600 MN
              DO 140 I=11,2,-1
                N2=NTC(I-1)
                N1=NTC(I)
```

```
              NADJ=MIN(IADJ,N1)
              DO 130 J=1,NADJ
                N2=N2+1
                IP=NCP(I,J)
                CCTARR(MN,IP)=I-2
                NCP(I-1,N2)=IP
 130          CONTINUE
              NTC(I-1)=N2
 140        CONTINUE
            GO TO 180
 150        IF (IADJ.GT.(NTC(1)/2)) PRINT 600 MN
            DO 170 I=1,10
              N2=NTC(I+1)
              N1=NTC(I)
              NADJ=MIN(IADJ,N1)
              DO 160 J=1,NADJ
                N2=N2+1
                IP=NCP(I,J)
                CCTARR(MN,IP)=I
                NCP(I+1,N2)=IP
 160          CONTINUE
              NTC(I+1)=N2
 170        CONTINUE
 180        CONTINUE
 190      CONTINUE
 600  FORMAT (' !WARNING! CLOUD ADJUSTMENT FOR MONTH',I3,
     * /,' IS EXCESSIVE FOR THE ALGORITHM.')
      RETURN
      END
```

Subroutine DAYW(S)

```
      SUBROUTINE DAYW (MONTH,IDAY,DBTP,DRNG,CCT,CCAD,DDHT,DDCL,
     * DEWP,WETB,WNSP,IYEAR,K,INIYR,LOGUNI,BH,BC,BAPR,IDBFLG)
C
C  SUBROUTINE TO READ A DAY FROM A FILE CONTAINING A WEATHER TAPE
C  CALCULATE AVERAGES AND OTHER VALUES AND RETURN THEM TO MAIN.
C  WRITES THE DAY INTO OUR DEFINE FILE.
C
C  OUTPUT VARIABLES:
C        MONTH  MONTH OF THE YEAR.
C        IDAY  DAY OF THE MONTH.
C        DBTP  THE AVERAGE DRY BULB TEMPERATURE FOR THE DAY DEG. C.
C        DRNG  THE DAILY DRY BULB RANGE DEG. C.
C        CCT  THE AVERAGE CLOUD COVER IN TENTHS.
C        CCAD  THE AVERAGE DAYTIME CLOUD COVER IN TENTHS.
C        WNSP  THE AVERAGE WINDSPEED FOR THE DAY  M / S.
C        IYEAR  THE PLACE THIS YEAR WAS INPUT, FROM 1 TO 10.
C        DDCL  DEGREE DAYS COOLING BASED ON BC DEG. C. IN DEG. C. * DAYS.
C        DDHT  DEGREE DAYS COOLING BASED ON BH DEG. C. IN DEG. C. * DAYS.
C        DEWP  THE AVERAGE DEWPOINT TEMPERATURE, DEG. C.
```

```
C          WETB  THE AVERAGE WET BULB TEMPERATURE, DEG. C.
C          BAPR  THE AVERAGE BAROMETRIC PRESSURE, KILOPASCAL.
C   LOCAL VARIABLES:
C         YY  USED TO READ IN UNUSED WEATHER DATA.
C         DB  HOURLY DRY BULB TEMPERATURES DEG. F.
C         CC  HOURLY CLOUD COVER VALUES.
C         DPT  HOURLY DEWPOINT TEMPERATURES DEG. F.
C         WBT  HOURLY WET BULB TEMPERATURES DEG. F.
C         PBT  HOURLY BAROMETRIC PRESSURE VALUES INCHES OF HG.
C         WST  HOURLY WIND SPEEDS KNOTS.
C         IDAWN  APPROXIMATE HOUR OF DAWN FOR EACH MONTH.
C         LENGTH  HOURS OF SUNLIGHT FOR EACH MONTH.
C         DAYMIN  THE MINIMUM DRY BULB TEMPERATURE FOR THE DAY DEG. F.
C         DAYMAX  THE MAXIMUM DRY BULB TEMPERATURE FOR THE DAY DEG. F.
C         IDBFLG  1 IF THE MAX-MIN AVERAGE IS TO BE USED, 0 FOR 24HR
C                 AVERAGE.
C   INPUT VARIABLES:
C         BH  THE BASE FOR THE DEGREE DAYS HEATING (DDHT), DEG. C.
C         BC  THE BASE FOR THE DEGREE DAYS COOLING (DDCL), DEG. C.
C         K  POSITION OF THE DAILY DATA IN OUR DEFINE FILE.
C         INIYR  DIFFERENCE BETWEEN THE FIRST YEAR USED FROM THIS
C                TAPE AND THE NUMBER OF YEARS ALREADY USED.
C         LOGUNI  LOGICAL UNIT FROM WHICH THE TAPE IS READ.
C
C                 DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
      DIMENSION YY(72),DB(24),CC(24),PBT(24),WST(24),DPT(24),WBT(24)
      COMMON /DT/ IDAWN(12),LENGTH(12)
C                 READ IN THE RECORD FOR A FULL DAY AND WRITE IT IN
C                 IN THE DEFINE FILE.
      READ (LOGUNI,END=30) DB,DPT,WBT,WST,PBT,CC,YY,IYEAR,MONTH,
     * IDAY,ICITY
      K=K+1
      IYEAR=IYEAR-INIYR+1
      WRITE (10'K) DB,DPT,WBT,WST,PBT,CC,YY,IYEAR,MONTH,IDAY,ICITY
C                 INITIALIZE THE SUMMING VARIABLES.
      WNSP=0.0
      DEWP=0.0
      WETB=0.0
      DBTP=0.0
      CCT=0.0
      CCAD=0.0
      DDHT=0.0
      DDCL=0.0
      BAPR=0.0
C                 FOR EACH HOUR:
C                                ADD IN THE VALUES TO BE AVERAGED.
C                                CHANGE THE MINIMUM AND MAXIMUM AS NECESSARY.
      DO 10 J=1,24
        DEWP=DPT(J)+DEWP
        WETB=WBT(J)+WETB
        BAPR=PBT(J)+BAPR
        DBTP=DBTP+DB(J)
        WNSP=WNSP+WST(J)
        CCT=CCT+CC(J)
        IF (J.EQ.1) DAYMAX=DB(J)
        IF (J.EQ.1) DAYMIN=DB(J)
        DAYMAX=MAX(DAYMAX,DB(J))
        DAYMIN=MIN(DAYMIN,DB(J))
   10 CONTINUE
C                 DIVIDE THE SUMS TO GET AVERAGES, FIND THE RANGE, AND
C                 CONVERT TO SI UNITS.
      DRNG=(DAYMAX-DAYMIN)*5/9
      DBTP=(DBTP/24.0-32.0)*5/9
      IF (IDBFLG.EQ.1) DBTP=(DAYMIN+DAYMAX-64.0)*5/18
      CCT=CCT/24.0
      BAPR=(BAPR/24.0)*101.1/29.921
      DEWP=(DEWP/24.0-32.0)*5/9
      WETB=(WETB/24.0-32.0)*5/9
      WNSP=WNSP/24.0*1.853/3.6
```

```
C                    FOR EACH SUNLIT HOUR SUM THE CLOUD COVER.
      I1=IDAWN(MONTH)
      I2=I1+LENGTH(MONTH)
      DO 20 I=I1,I2
        CCAD=CCAD+CC(I)
   20 CONTINUE
      CCAD=CCAD/(LENGTH(MONTH)+1)
C                    FIND THE DEGREE DAYS.
      IF (DBTP.GT.BC) DDCL=DBTP-BC
      IF (DBTP.LT.BH) DDHT=BH-DBTP
   30 RETURN
      END
```

## Subroutine DEWPNT (A)

```
        SUBROUTINE DEWPNT (DB,WB,PB,DP)
C
C       SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 32D.
C
        PVP=PVSF(WB)
        IF (DB-WB) 10,10,
        WSTAR=0.622*PVP/(PB-PVP)
        IF (WB-32.) ,,20
        PV=PVP-5.704E-4*PB*(DB-WB)/1.8
        GO TO 30
 10     PV=PVP
        GO TO 30
 20     CDB=(DB-32.)/1.8
        CWB=(WB-32.)/1.8
        HL=597.31+0.4409*CDB-CWB
        CH=0.2202+0.4409*WSTAR
        EX=(WSTAR-CH*(CDB-CWB)/HL)/0.622
        PV=PB*EX/(1.+EX)
 30     IF (PV.LE.0) GO TO 50
        IF (DB.NE.WB) GO TO 40
        DP=DB
        GO TO 50
 40     CONTINUE
        DP=DPF(PV)
 50     RETURN
        END
```

## Subroutine DEWPNT (S)

```
        SUBROUTINE DEWPNT (DB,WB,PB,DP)
C
C       SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 32D.
C
        PVP=PVSF(WB)
        IF (DB-WB) 30,30,10
 10     WSTAR=0.622*PVP/(PB-PVP)
        IF (WB) 20,20,40
 20     PV=PVP-5.704E-4*PB*(DB-WB)
        GO TO 50
C
 30     PV=PVP
        GO TO 50
```

```
C
40     HL=597.31+0.4409*DB-WB
       CH=0.2402+0.4409*WSTAR
       EX=(WSTAR-CH*(DB-WB)/HL)/0.622
       PV=PB*EX/(1.+EX)
50     IF (PV.LE.0) GO TO 70
       IF (DB.NE.WB) GO TO 60
       DP=DB
       GO TO 70
C
60     CONTINUE
       PV=PV*29.92/101.1
       DP=(DPF(PV)-32.0)/1.8
70     RETURN
C
       END
```

## Subroutine ORDER (S)

```
C
C           SUBROUTINE ORDER
C
      SUBROUTINE ORDER(TEMP,IARRAY,N)
C
C     ORDERS TEMPS IN INCREASING VALUE-ORDERS ARRAY IARRAY ACCORDINGLY
C
C  INPUT VARIABLES:
C        TEMP  AN ARRAY CONTAINING THE VALUES TO BE SORTED.
C        IARRAY  STARTS OUT CONTAINING ITS SUBSCRIPTS IN
C                CORRESPONDING POSITIONS.  IT IS ALTERED TO CONTAIN
C                THE ORIGINAL POSITIONS OF THE ELEMENTS IN TEMP
C                IN THEIR CORRESPONDING SORTED POSITIONS.
C        N  THE NUMBER OF ELEMENTS  IN TEMP.
C
C  OUTPUT VARIABLES:
C         TEMP  THE VALUES IN INCREASING ORDER.
C         IARRAY  THE ORIGINAL POSITION OF THE VALUES IN TEMP.
C
C  LOCAL VARIABLES:
C        AA  TEMPORARY STORAGE FOR SORTED TEMP.
C        IA  TEMPORARY STORAGE FOR SORTED IAARAY.
C        K  THE SMALLEST UNSORTED VALUE'S POSITION.
C        BA  THE SMALLEST UNSORTED VALUE.
C
C                DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
      DIMENSION TEMP(N),IARRAY(N),AA(200),IA(200)
C                FOR EACH PLACE.
      DO 50 I=1,N
        BA=2999.0
C                FIND THE SMALLEST UNSORTED VALUE.
        DO 25 J=1,N
          IF(BA-TEMP(J)) 25,25,
C                STORE ITS LOCATION.
          K=J
          BA=TEMP(J)
   25   CONTINUE
C                MOVE THE UNSORTED VALUE AND ITS LOCATION
C                INTO THE NEXT POSITION IN OUR TEMPORARY
C                ARRAYS.
        TEMP(K)=3000.0
        AA(I)=BA
        IA(I)=IARRAY(K)
   50 CONTINUE
```

```
C               MOVE THE VALUES INTO OUR OUTPUT ARRAYS.
      DO 75 L=1,N
        TEMP(L)=AA(L)
        IARRAY(L)=IA(L)
   75 CONTINUE
      RETURN
      END
```

## Subroutine SLYEAR (S)

```
      SUBROUTINE SLYEAR(DADB,SLDB,ICDT,LSEG,LOGUNI,IYRARR,RANKCH)
C
C           SUBROUTINE SLYEAR
C
C       A SUBROUTINE TO CREATE A FULL YEAR TAPE FROM
C       SELECTED PIECES OF ANOTHER WEATHER TAPE.
C       REQUIRES FOUR INPUT ARRAYS AND READS THE TAPE
C       FROM LOGICAL UNIT 10 WHICH MUST BE A DEFINE
C       FILE 10(3700,220,U,N) AND WRITES IT AT LOGICAL
C       UNIT LOGUNI.  ALSO FINDS THE AVERAGE DAILY
C       STANDARD DEVIATION OF EACH MONTH IN THE SELECTED
C       YEAR.
C
C
C  INPUT VARIABLES:
C        DADB  CONTAINS THE DRY BULB AVERAGE FOR EACH YEAR
C              IN OUR DEFINE FILE.
C        SLDBT  CONTAINS THE MONTHLY DRY BULB AVERAGES OF OUR
C               SELECTED YEAR.
C        ICDT  CONTAINS 36 ENTRIES (12,3) WHICH ARE
C              THE STARTING DAYS OF OUR SELECTED SEGMENTS.
C        LSEG  CONTAINS THE LENGTH OF EACH SEGMENT.
C        LOGUNI  NUMBER OF THE LOGICAL UNIT ASSIGNED THE OUTPUT TAPE.
C        IYRARR  CONTAINS THE A.D. YEAR OF THE INPUT WEATHER TAPES.
C        RANKCH  CONTAINS THE RANKS OF THE SEGMENTS.
C
C  OUTPUT VARIABLE:
C         SLDSD  THE DAILY STANDARD DEVIATION FOR EACH
C                MONTH IN THE SELECTED YEAR.
C  LOCAL VARIABLES:
C        ARRAY,IYEAR,MONTH,IDAY,ICITY
C          READ IN FROM THE DEFINE FILE AND WITH SOME ALTERATIONS
C          WRITTEN AT LOGUNI.
C        NDAY  THE DAY OF THE MONTH IN OUR OUTPUT TAPE.
C        NDIS  THE STARTING POINT OF A SEGMENT.
C        IDIS  THE ENDPOINT OF THE SEGMENT.
C        MOWARM  THE SIGNAL MONTH FOR THE WARMUP WEEK.
C        NNNYR  THE YEAR GIVEN THE SELECTED YEAR.
C        NCITY  THE CITY CODE GIVEN THE WHOLE YEAR.
C
C                DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
      DIMENSION ARRAY(216),ICDT(12,3),LSEG(12,3),IYRARR(10),RANKCH(12,3)
     * ,DADB(3653),SLDSD(12),SLDB(12)
      PRINT 600 LOGUNI
      READ (5,500) NNNYR,NCITY
      MOWARM=2
      NCITY=LOGUNI
      NNNYR=1889+LOGUNI
C                READ IN THE FIRST WEEK AND WRITE IT OUT AS
C                OUR WARMUP WEEK.
      DO 20 NDAY=1,7
        READ(10'NDAY) ARRAY,IYEAR,MONTH,IDAY,ICITY
        WRITE (LOGUNI) ARRAY,NNNYR,MOWARM,NDAY,NCITY
   20 CONTINUE
```

```
          PRINT 605
C                   FOR EACH MONTH.
          DO 80 M=1,12
            NDAY=0
            SLDSD(M)=0.0
C                   FOR EACH SEGMENT.
            DO 60 J=1,3
              NDAY=NDAY+1
              NDIS=ICDT(M,J)
C                   READ THE FIRST DAY OF THE SEGMENT AND
C                   PRINT OUT ITS DATE, LENGTH, AND CITY.
              READ(10'NDIS) ARRAY,IYEAR,MONTH,IDAY,ICITY
              SLDSD(M)=(SLDB(M)-DADB(NDIS))*(SLDB(M)-DADB(NDIS))+SLDSD(M)
              PRINT 610 M,J,IYRARR(IYEAR),MONTH,IDAY,LSEG(M,J),ICITY,
     *         RANKCH(M,J)
              IDIS=NDIS+LSEG(M,J)-1
              WRITE (LOGUNI)ARRAY,NNNYR,M,NDAY,NCITY
              NDIS=NDIS+1
C                   FOR EACH DAY OF THE SEGMENT READ AND
C                   WRITE THE DATA.
              DO 40 K=NDIS,IDIS
                NDAY=NDAY+1
                READ (10'K) ARRAY,IYEAR,MONTH,IDAY,ICITY
                SLDSD(M)=(SLDB(M)-DADB(K))*(SLDB(M)-DADB(K))+SLDSD(M)
                WRITE (LOGUNI) ARRAY,NNNYR,M,NDAY,NCITY
   40         CONTINUE
   60       CONTINUE
          SLDSD(M)=SQRT(SLDSD(M)/(NDAY-1))
          PRINT 615 M,SLDSD(M)
   80   CONTINUE
  500   FORMAT ( )
  600   FORMAT (' ENTER THE A.D. YEAR AND FIVE DIGIT CITY CODE FOR ',
     * /,' THE YEAR WRITTEN AT LOGICAL UNIT ',I2)
  605   FORMAT (' MONTH SEGMENT YEAR  MONTH   DAY   LENGTH  CITY ',
     * '  RANK')
  610   FORMAT (2(I6),2X,3(I6),2X,I6,2X,I6,F7.2)
  615   FORMAT (' THE DAILY STANDARD DEVIATION FOR MONTH',I4,' IS',F8.3)
        RETURN
        END
```

## Subroutine SUNNY (A,S)

```
          SUBROUTINE SUNNY (LATD,LONG,TZN)
C
C         SUBROUTINE FOR FINDING DAWN AND DAY LENGTH DATA.
C         SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 53D.
C
          DIMENSION IDYOYR(12)
          DATA IDYOYR /16,44,75,105,136,166,197,228,258,289,319,350/
          REAL LATD,LONG,MERID,LOND
          COMMON /DT/ IDAWN(12),LENGTH(12)
C         LATD= LATITUDE,DEGREES(+NORTH,-SOUTH)
C         LONG= LONGITUDE,DEGREES(+WEST,-EAST)
C         TZN= TIME ZONE NUMBER
C                  STANDARD  TIME
C          ATLANTIC        4
C          EASTERN         5
C          CENTRAL         6
C          MOUNTAIN        7
C          PACIFIC         8
C         IDYOYR= DAYS(FROM START OF YEAR)
```

```
C       SRT=SUN RISE TIME  (HOURS AFTER MIDNIGHT)
C       SST=SUN SET TIME
C       SDA=SUN DECLINATION ANGLE,DEGREES
C       EOT=EQUATION OF TIME ,HOURS
        PI=3.1415927
        DO 20 I=1,12
          X=2*PI/366.*IDYOYR(I)
          C1=COS(X)
          C2=COS(2*X)
          C3=COS(3*X)
          S1=SIN(X)
          S2=SIN(2*X)
          S3=SIN(3*X)
          SDA=.302-22.93*C1-.229*C2-.243*C3+3.851*S1+.002*S2-.055*S3
          EOT=.4197*C1-3.2265*C2-.0903*C3-7.351*S1-9.391*S2-.3361*S3-.0002
          EOT=EOT/60.
          MERID=15*TZN
          LOND=LONG-MERID
          Y=SDA*PI/180.
          YY=LATD*PI/180.
          HP=-TAN(Y)*TAN(YY)
          TR=12/PI*ACOS(HP)
          SRT=(12-TR)-EOT+LOND/15.
          IDAWN(I)=(SRT+.5)
          SST=SRT+2.*TR
          LENGTH(I)=(SST+.5)-IDAWN(I)
     20 CONTINUE
        RETURN
        END
```

Subroutine WETBLB (A)

```
        SUBROUTINE WETBLB (DB,DP,PB,WB)
C
C       SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 33D.
C
C     THIS SUBROUTINE CALCULATES THE FOLLOWINGS WHEN DRY-BULB TEMPERATURE
C     (DB),DEW-POINT TEMPERATURE(DP),AND BAROMETRIC PRESSURE(PB) ARE GIVEN
C     WB   WET-BULB TEMPERATURE
        IF (DP-DB) 20,,
        DP=DB
20      PV=PVSF(DP)
        PVS=PVSF(DB)
        W=0.622*PV/(PB-PV)
        H=0.24*DB+(1061+0.444*DB)*W
        IF (H) ,,40
        WB=DP
        RETURN
C
40      WB=WBF(H,PB)
        RETURN
C
        END
```

Function DPF (A,S)

```
      FUNCTION DPF (PV)
C
C     SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 27D.
C
C     THIS SUBROUTINE CALCULATES DEW-POINT TEMPERATURE FOR
C     GIVEN VAPOR PESSURE.
      IF (PV) 10,10,20
10    GO TO 40
C
20    CONTINUE
      Y=LOG(PV)
      IF (PV.GT.0.1836) GO TO 30
      DPF=71.98+24.873*Y+0.8927*Y*Y
      GO TO 40
C
30    DPF=79.047+30.579*Y+1.8893*Y*Y
40    RETURN
C
      END
```

FUNCTION PVSF (A)

```
      FUNCTION PVSF(X)
C
C     SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 33D.
C
C      FUNCTION PSYCHROMETRIC SUBROUTINE FOR CALCULATION OF
C      PARTIAL VAPOUR PRESSURE OF WATER AT A GIVEN TEMPERATURE
C      FOR A SATURATED CONDITION.
C
C  INPUTS X, A TEMPERATURE, DEG F., AND RETURNS PVSF, THE SATURATED
C  PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR, INCHES OF MERCURY.
C
      DIMENSION A(6) /-7.90298,5.02808,-1.3816E-7,11.344,
     2 8.1328E-3,-3.49149/ ,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
     3 ,P(4)
      T=(X+459.688)/1.8
      IF(T.LT.273.16) GOTO 10
      Z=373.16/T
      P(1)=A(1)*(Z-1)
      P(2)=A(2)*LOG10(Z)
      Z1=A(4)*(1-1/Z)
      P(3)=A(3)*(10**Z1-1)
      Z1=A(6)*(Z-1)
      P(4)=A(5)*(10**Z1-1)
      GOTO 20
   10 Z=273.16/T
      P(1)=B(1)*(Z-1)
      P(2)=B(2)*LOG10(Z)
      P(3)=B(3)*(1-1/Z)
      P(4)=LOG10(B(4))
   20 SUM=0.
      DO 30 I=1,4
        SUM=SUM+P(I)
   30 CONTINUE
      PVSF=29.921*10**SUM
      RETURN
      END
```

Function PVSF (S)

```
C       FUNCTION PSYCHROMETRIC SUBROUTINE FOR CALCULATION OF
C       PARTIAL VAPOUR PRESSURE OF WATER AT A GIVEN TEMPERATURE
C       FOR A SATURATED CONDITION.  SEE NBS BUILDING SCIENCE
C       SERIES 69, NBSLD, PAGE 156A.
C
C   INPUTS X, A TEMPERATURE, AND RETURNS PVSF, THE SATURATED PARTIAL VAPOR
C   PRESSURE OF WATER IN MOIST AIR.
C   X:   IN DEG CELSIUS.
C   PVSF:  IN KILOPASCAL.
C
      FUNCTION PVSF(X)
      DIMENSION A(6) /-7.90298,5.02808,-1.3816E-7,11.344,
     2 8.1328E-3,-3.49149/ ,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
     3 ,P(4)
      T=X+273.16
      IF(T.LT.273.16) GOTO 10
      Z=373.16/T
      P(1)=A(1)*(Z-1)
      P(2)=A(2)*LOG10(Z)
      Z1=A(4)*(1-1/Z)
      P(3)=A(3)*(10**Z1-1)
      Z1=A(6)*(Z-1)
      P(4)=A(5)*(10**Z1-1)
      GOTO 20
   10 Z=273.16/T
      P(1)=B(1)*(Z-1)
      P(2)=B(2)*LOG10(Z)
      P(3)=B(3)*(1-1/Z)
      P(4)=LOG10(B(4))
   20 SUM=0.
      DO 30 I=1,4
        SUM=SUM+P(I)
   30 CONTINUE
      PVSF=101.1*10**SUM
      RETURN
      END
```

Function WBF (A)

```
      FUNCTION WBF (H,PB)
C
C     SEE NDS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 57D.
C
C     THIS PROGRAM APPROXIMATES THE WET-BULB TEMPERATURE WHEN
C     ENTHALPY IS GIVEN.
      IF (H) 30,30,10
10    Y=LOG(H)
      IF (H.GT.11.758) GO TO 20
      WBF=0.6041+3.4841*Y+1.3601*Y*Y+0.97307*Y*Y*Y
      GO TO 100
C
20    WBF=30.9185-39.68200*Y+20.5841*Y*Y-1.758*Y*Y*Y
      GO TO 100
C
30    WB1=150.
      PV1=PVSF(WB1)
      W1=0.622*PV1/(PB-PV1)
      X1=0.24*WB1+(1061+0.444*WB1)*W1
      Y1=H-X1
40    WB2=WB1-1
      PV2=PVSF(WB2)
      W2=0.622*PV2/(PB-PV2)
      X2=0.24*WB2+(1061+0.444*WB2)*W2
      Y2=H-X2
      IF (Y1*Y2) 90,60,50
50    WB1=WB2
      Y1=Y2
      GO TO 40
C
```

```
60      IF (Y1) 80,70,80
70      WBF=WB1
        GO TO 100
C
80      WBF=WB2
        GO TO 100
C
90      Z=ABS(Y1/Y2)
        WBF=(WB2*Z+WB1)/(1+Z)
100     RETURN
C
        END
```

APPENDIX D: Example Run of SELECT Creating a Synthetic 1951 Philadelphia Year from Jersey City 1949-1957 Years.

```
@ASG,A JER10.
READY
@USE 15.,JER10.
READY
@ASG,A SJPHI.
READY
@USE 11.,SJPHI.
READY
@ASG,A 10.,///500
READY
@MAP ,WHOLEYEAR.XSELECT
MAP 29R1 SL73R1 08/27/79 23:35:09
IN WHOLEYEAR.SELECT,.DAY,.DEWPNT,.ORDER,.PVSF,.SLYEAR
IN ADJUST.DPF,.SUNNY
END
START 016714, PROG SIZE(I/D)=9676/48197
SYS$*RLIB$. LEVEL
END MAP. ERRORS : NONE
@XQT WHOLEYEAR.XSELECT
 ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOR
 THE DAYTIME CLOUD CALCULATIONS
 FOLLOWED BY THE NUMBER OF WEATHER TAPES YOU ARE DRAWING FROM 1-10
 FOLLOWED BY THE NUMBER OF SELECTED YEARS YOU ARE MAKING 1-4
 FOLLOWED BY THE HEIGHT IN METERS OF THE INPUT STATION
 FOLLOWED BY THE BASE TEMPERATURES FOR DEGREE DAY CALCULATIONS
 HEATING THEN COOLING, BOTH IN DEGREES CELSIUS
39.5 75.2 5.0 1 1 20.0 11.333 18.0
 ENTER THE FIRST YEAR YOU ARE USING FROM THE  WEATHER TAPE ASSIGNED TO
 LOGICAL UNIT 15 AND THE NUMBER OF CONSECUTIVE YEARS OF IT YOU ARE USING
1949 9
 YEAR OF MONTHLY AVG. MONTH   DRY BULB    DAILY  DEWPOINT    WET BULB    TOTAL DAYTIME WIND    BAROMETRIC    DEGREE DAYS
                            TEMPERATURE RANGE TEMPERATURE TEMPERATURE CLOUD  CLOUD  SPEED   PRESSURE   HEATING COOLING
                              DEG. C.   DEG. C.  DEG. C.     DEG. C.   TENTHS TENTHS M./S.  KILOPASCAL DEG. C. * DAYS
     AVG. OF 1949      1        3.23      7.35    -1.70        1.45     6.82   7.06   4.59     101.82  251.17     .00
     AVG. OF 1950      1        4.69      8.03     -.82        2.72     7.78   8.21   4.63     102.02  215.11     .00
     AVG. OF 1951      1        1.91      8.67    -4.27        -.16     6.07   6.79   4.95     101.57  292.21     .00
     AVG. OF 1952      1        1.98      7.96    -3.43         .25     5.90   5.97   4.71     101.58  290.11     .00
     AVG. OF 1953      1        2.43      6.95    -1.88         .91     7.00   7.39   3.98     101.27  276.03     .00
     AVG. OF 1954      1       -1.35      8.21    -6.61       -2.81     6.24   6.69   4.99     101.65  393.14     .00
     AVG. OF 1955      1        -.88      6.56    -9.25       -3.16     4.51   5.08   5.56     101.17  378.74     .00
     AVG. OF 1956      1         .10      6.11    -5.75       -1.65     5.96   6.47   6.46     101.00  348.16     .00
     AVG. OF 1957      1       -1.90      7.90    -6.97       -3.26     6.21   6.44   4.24     101.87  410.31     .00

 AVG. OF ALL YEARS     1        1.13      7.53    -4.52        -.64     6.28   6.68   4.90     101.55  317.22     .00


     AVG. OF 1949      2        3.42      8.79    -2.69        1.27     5.83   5.94   4.61     101.72  224.70     .00
     AVG. OF 1950      2        -.24      7.20    -6.13       -1.93     6.18   7.28   5.54     101.71  323.98     .00
     AVG. OF 1951      2        1.93      8.39    -4.86        -.29     5.83   6.28   5.56     101.86  263.24     .00
     AVG. OF 1952      2        1.95      6.88    -4.83        -.30     5.29   5.51   5.36     101.07  272.18     .00
     AVG. OF 1953      2        3.19      8.37    -4.01         .69     5.34   6.04   4.74     101.30  231.11     .00
     AVG. OF 1954      2        4.06      8.87    -2.27        1.74     5.63   5.92   4.60     101.05  206.38     .00
     AVG. OF 1955      2        1.14      8.63    -4.90        -.75     5.28   5.71   4.87     101.98  285.39     .00
     AVG. OF 1956      2        2.32      6.99    -3.36         .37     6.11   6.77   4.91     101.32  261.35     .00
     AVG. OF 1957      2        2.50      7.64    -3.00         .58     6.22   7.09   4.12     101.75  247.22     .00

 AVG. OF ALL YEARS     2        2.25      7.97    -4.01         .15     5.74   6.28   4.93     101.53  257.28     .00
```

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AVG. OF 1949 | 3 | 5.64 | 9.77 | -2.35 | 2.69 | 5.64 | 5.77 | 5.66 | 101.21 | 203.53 | 2.14 |
| AVG. OF 1950 | 3 | 2.40 | 9.34 | -5.53 | -.09 | 5.60 | 6.17 | 6.27 | 101.16 | 279.88 | .00 |
| AVG. OF 1951 | 3 | 5.44 | 7.90 | -1.67 | 2.72 | 6.07 | 6.05 | 5.92 | 101.37 | 182.63 | .00 |
| AVG. OF 1952 | 3 | 4.10 | 7.42 | -2.07 | 1.77 | 6.34 | 7.03 | 5.18 | 101.21 | 224.23 | .00 |
| AVG. OF 1953 | 3 | 5.99 | 7.19 | .25 | 3.82 | 6.39 | 6.72 | 4.51 | 101.37 | 170.51 | .00 |
| AVG. OF 1954 | 3 | 5.09 | 8.55 | -3.65 | 1.96 | 4.98 | 5.71 | 5.75 | 100.95 | 197.84 | .00 |
| AVG. OF 1955 | 3 | 5.02 | 8.71 | -2.96 | 2.10 | 5.25 | 5.69 | 5.63 | 101.05 | 201.28 | .00 |
| AVG. OF 1956 | 3 | 2.78 | 7.80 | -3.81 | .48 | 5.95 | 6.33 | 5.35 | 101.28 | 265.04 | .00 |
| AVG. OF 1957 | 3 | 5.20 | 8.42 | -2.63 | 2.20 | 5.51 | 5.83 | 4.40 | 101.05 | 192.14 | .00 |
| AVG. OF ALL YEARS | 3 | 4.63 | 8.34 | -2.71 | 1.96 | 5.75 | 6.15 | 5.41 | 101.18 | 213.01 | .24 |
| AVG. OF 1949 | 4 | 11.49 | 10.81 | 3.07 | 7.54 | 5.48 | 5.80 | 5.40 | 101.02 | 43.29 | 2.29 |
| AVG. OF 1950 | 4 | 9.09 | 9.98 | .85 | 5.62 | 6.59 | 7.26 | 4.95 | 101.23 | 91.01 | .11 |
| AVG. OF 1951 | 4 | 11.50 | 9.74 | 3.39 | 7.68 | 5.61 | 6.04 | 5.08 | 101.00 | 30.30 | 1.04 |
| AVG. OF 1952 | 4 | 12.20 | 9.04 | 4.59 | 8.54 | 7.15 | 7.57 | 4.72 | 101.11 | 42.78 | 7.99 |
| AVG. OF 1953 | 4 | 10.80 | 8.02 | 3.00 | 7.21 | 6.70 | 6.96 | 5.01 | 100.62 | 46.22 | 1.49 |
| AVG. OF 1954 | 4 | 11.44 | 10.54 | 4.52 | 8.20 | 5.15 | 5.32 | 4.92 | 101.85 | 61.24 | 3.59 |
| AVG. OF 1955 | 4 | 11.36 | 9.83 | 4.29 | 7.98 | 6.95 | 7.10 | 5.28 | 101.06 | 43.86 | 1.57 |
| AVG. OF 1956 | 4 | 8.63 | 9.06 | 1.40 | 5.49 | 5.54 | 6.22 | 4.99 | 100.92 | 108.33 | 3.58 |
| AVG. OF 1957 | 4 | 11.34 | 10.70 | 4.06 | 7.99 | 6.09 | 6.38 | 4.46 | 101.62 | 69.11 | 10.13 |
| AVG. OF ALL YEARS | 4 | 10.87 | 9.75 | 3.24 | 7.36 | 6.14 | 6.52 | 4.98 | 101.16 | 59.57 | 3.53 |
| AVG. OF 1949 | 5 | 16.50 | 11.51 | 9.71 | 12.77 | 6.35 | 6.67 | 4.37 | 101.33 | .00 | 32.37 |
| AVG. OF 1950 | 5 | 14.58 | 9.12 | 8.28 | 11.30 | 7.25 | 7.42 | 4.29 | 101.38 | 7.28 | 3.96 |
| AVG. OF 1951 | 5 | 17.16 | 10.57 | 8.53 | 12.56 | 5.98 | 6.39 | 4.39 | 100.89 | .00 | 31.06 |
| AVG. OF 1952 | 5 | 15.45 | 9.84 | 6.49 | 10.98 | 5.70 | 6.13 | 4.58 | 100.91 | .00 | 9.31 |
| AVG. OF 1953 | 5 | 16.67 | 8.62 | 11.51 | 13.72 | 7.35 | 7.59 | 3.70 | 101.03 | 5.47 | 20.64 |
| AVG. OF 1954 | 5 | 15.08 | 8.44 | 7.27 | 11.01 | 6.75 | 7.21 | 4.56 | 101.03 | 3.59 | 16.76 |
| AVG. OF 1955 | 5 | 17.97 | 11.25 | 8.48 | 12.89 | 4.84 | 5.14 | 4.61 | 101.18 | 1.31 | 44.27 |
| AVG. OF 1956 | 5 | 14.69 | 10.68 | 6.13 | 10.44 | 5.87 | 6.02 | 4.95 | 101.52 | 10.19 | 15.79 |
| AVG. OF 1957 | 5 | 16.81 | 11.43 | 8.38 | 12.28 | 5.00 | 5.34 | 5.05 | 101.34 | 7.63 | 40.92 |
| AVG. OF ALL YEARS | 5 | 16.10 | 10.16 | 8.31 | 12.00 | 6.12 | 6.43 | 4.50 | 101.18 | 3.94 | 23.90 |
| AVG. OF 1949 | 6 | 22.97 | 10.54 | 15.23 | 18.15 | 4.34 | 4.80 | 4.64 | 101.42 | .00 | 152.91 |
| AVG. OF 1950 | 6 | 21.47 | 11.50 | 13.14 | 16.43 | 5.36 | 5.96 | 4.64 | 101.12 | .00 | 111.34 |
| AVG. OF 1951 | 6 | 20.86 | 8.93 | 14.85 | 17.10 | 6.29 | 6.82 | 3.79 | 101.16 | .00 | 97.95 |
| AVG. OF 1952 | 6 | 22.76 | 9.89 | 14.76 | 17.78 | 5.38 | 5.63 | 4.06 | 100.94 | .00 | 147.89 |
| AVG. OF 1953 | 6 | 22.57 | 11.39 | 14.04 | 17.35 | 4.58 | 4.89 | 4.19 | 101.29 | .00 | 145.31 |
| AVG. OF 1954 | 6 | 21.46 | 10.15 | 13.10 | 16.40 | 4.94 | 5.53 | 4.79 | 101.04 | .00 | 107.69 |
| AVG. OF 1955 | 6 | 20.34 | 9.57 | 13.23 | 15.98 | 6.10 | 6.29 | 4.42 | 100.98 | .00 | 88.51 |
| AVG. OF 1956 | 6 | 21.89 | 9.80 | 14.31 | 17.16 | 5.40 | 5.59 | 3.63 | 101.24 | .00 | 126.33 |
| AVG. OF 1957 | 6 | 23.23 | 9.57 | 16.27 | 18.77 | 5.44 | 5.71 | 3.71 | 101.18 | .00 | 161.27 |
| AVG. OF ALL YEARS | 6 | 21.95 | 10.15 | 14.33 | 17.24 | 5.31 | 5.69 | 4.21 | 101.15 | .00 | 126.58 |
| AVG. OF 1949 | 7 | 25.84 | 10.13 | 18.88 | 21.15 | 6.46 | 6.86 | 4.07 | 101.26 | .00 | 243.09 |
| AVG. OF 1950 | 7 | 23.95 | 10.50 | 16.18 | 18.96 | 6.56 | 7.04 | 3.99 | 101.33 | .00 | 184.48 |
| AVG. OF 1951 | 7 | 24.41 | 10.20 | 17.39 | 19.81 | 5.74 | 6.30 | 3.52 | 101.22 | .00 | 198.64 |
| AVG. OF 1952 | 7 | 25.93 | 10.43 | 18.24 | 20.82 | 4.65 | 5.02 | 2.65 | 101.51 | .00 | 245.82 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AVG. OF 1953 | 7 | 24.86 | 9.78 | 16.08 | 19.24 | 4.44 | 4.73 | 3.94 | 101.31 | .00 | 212.81 |
| AVG. OF 1954 | 7 | 24.11 | 10.68 | 14.64 | 18.18 | 4.54 | 4.91 | 4.46 | 100.99 | .00 | 189.41 |
| AVG. OF 1955 | 7 | 26.51 | 9.73 | 18.62 | 21.18 | 5.01 | 5.43 | 4.56 | 101.29 | .00 | 263.76 |
| AVG. OF 1956 | 7 | 22.57 | 8.48 | 16.22 | 18.52 | 6.65 | 7.12 | 3.96 | 101.20 | .00 | 146.52 |
| AVG. OF 1957 | 7 | 25.06 | 10.90 | 15.09 | 18.78 | 5.04 | 5.32 | 4.41 | 101.07 | .00 | 219.01 |
| AVG. OF ALL YEARS | 7 | 24.81 | 10.09 | 16.82 | 19.63 | 5.45 | 5.86 | 3.95 | 101.24 | .00 | 211.50 |
| AVG. OF 1949 | 8 | 24.21 | 10.45 | 17.28 | 19.72 | 5.39 | 6.19 | 3.76 | 101.26 | .00 | 192.39 |
| AVG. OF 1950 | 8 | 22.51 | 9.64 | 16.48 | 18.66 | 5.81 | 6.53 | 3.40 | 101.37 | .00 | 139.92 |
| AVG. OF 1951 | 8 | 23.19 | 9.34 | 17.17 | 19.32 | 5.05 | 5.86 | 3.31 | 101.23 | .00 | 160.96 |
| AVG. OF 1952 | 8 | 23.15 | 8.46 | 17.68 | 19.63 | 5.85 | 6.12 | 2.59 | 101.38 | .00 | 159.88 |
| AVG. OF 1953 | 8 | 23.69 | 10.30 | 15.75 | 18.61 | 4.22 | 4.40 | 3.41 | 101.39 | .00 | 176.24 |
| AVG. OF 1954 | 8 | 22.24 | 9.46 | 14.76 | 17.63 | 5.48 | 6.09 | 4.30 | 101.10 | .00 | 131.42 |
| AVG. OF 1955 | 8 | 24.97 | 8.53 | 18.89 | 20.93 | 5.82 | 5.99 | 4.85 | 101.23 | .00 | 215.98 |
| AVG. OF 1956 | 8 | 23.05 | 8.84 | 16.45 | 18.80 | 5.18 | 5.73 | 3.52 | 101.15 | .00 | 157.75 |
| AVG. OF 1957 | 8 | 22.76 | 9.95 | 14.31 | 17.53 | 5.38 | 5.74 | 4.07 | 101.35 | .00 | 147.60 |
| AVG. OF ALL YEARS | 8 | 23.31 | 9.44 | 16.53 | 18.98 | 5.35 | 5.85 | 3.69 | 101.27 | .00 | 164.68 |
| AVG. OF 1949 | 9 | 18.17 | 10.24 | 11.92 | 14.59 | 5.11 | 5.58 | 4.42 | 101.45 | .00 | 38.78 |
| AVG. OF 1950 | 9 | 17.77 | 8.50 | 12.66 | 14.80 | 6.97 | 7.19 | 3.65 | 101.51 | 4.03 | 43.31 |
| AVG. OF 1951 | 9 | 19.51 | 10.76 | 12.96 | 15.67 | 4.99 | 5.93 | 3.64 | 101.49 | .70 | 66.62 |
| AVG. OF 1952 | 9 | 19.94 | 10.80 | 13.91 | 16.26 | 3.89 | 4.54 | 3.09 | 101.54 | .00 | 72.40 |
| AVG. OF 1953 | 9 | 20.34 | 10.00 | 13.14 | 16.05 | 4.05 | 4.13 | 4.13 | 101.37 | .00 | 92.56 |
| AVG. OF 1954 | 9 | 18.98 | 8.61 | 13.35 | 15.63 | 5.04 | 5.45 | 4.14 | 101.30 | .00 | 57.30 |
| AVG. OF 1955 | 9 | 19.45 | 8.33 | 13.17 | 15.80 | 5.29 | 5.72 | 4.14 | 101.69 | .00 | 61.32 |
| AVG. OF 1956 | 9 | 17.49 | 8.89 | 12.21 | 14.48 | 5.93 | 6.48 | 4.04 | 101.51 | .71 | 45.81 |
| AVG. OF 1957 | 9 | 20.77 | 9.70 | 13.76 | 16.65 | 6.15 | 6.26 | 3.99 | 101.52 | .45 | 109.59 |
| AVG. OF ALL YEARS | 9 | 19.16 | 9.54 | 13.01 | 15.55 | 5.27 | 5.70 | 3.92 | 101.49 | .65 | 65.30 |
| AVG. OF 1949 | 10 | 16.11 | 10.20 | 9.47 | 12.54 | 5.63 | 6.06 | 4.25 | 101.84 | 6.27 | 24.07 |
| AVG. OF 1950 | 10 | 14.72 | 9.75 | 9.15 | 11.73 | 5.14 | 5.42 | 3.72 | 101.53 | 8.45 | 9.21 |
| AVG. OF 1951 | 10 | 14.24 | 8.67 | 9.12 | 11.50 | 5.85 | 6.25 | 4.38 | 101.71 | 11.40 | 12.73 |
| AVG. OF 1952 | 10 | 11.70 | 11.36 | 4.03 | 8.08 | 3.10 | 4.09 | 3.84 | 101.43 | 41.74 | 1.14 |
| AVG. OF 1953 | 10 | 14.59 | 10.54 | 7.95 | 11.07 | 4.04 | 4.18 | 3.71 | 101.50 | 5.79 | 4.10 |
| AVG. OF 1954 | 10 | 15.43 | 9.34 | 8.96 | 12.05 | 4.78 | 5.45 | 5.10 | 101.43 | 19.57 | 48.53 |
| AVG. OF 1955 | 10 | 14.63 | 9.35 | 9.41 | 11.87 | 4.92 | 5.49 | 4.51 | 101.22 | 11.68 | 8.47 |
| AVG. OF 1956 | 10 | 13.93 | 9.09 | 8.51 | 11.13 | 4.63 | 5.08 | 4.06 | 102.07 | 13.18 | 2.25 |
| AVG. OF 1957 | 10 | 13.12 | 9.28 | 6.21 | 9.69 | 5.23 | 5.50 | 4.50 | 101.63 | 25.27 | 2.16 |
| AVG. OF ALL YEARS | 10 | 14.28 | 9.73 | 8.09 | 11.07 | 4.81 | 5.28 | 4.23 | 101.60 | 15.93 | 12.52 |
| AVG. OF 1949 | 11 | 6.96 | 9.35 | .19 | 4.15 | 5.01 | 5.53 | 4.81 | 100.87 | 141.14 | .00 |
| AVG. OF 1950 | 11 | 8.47 | 9.30 | 2.35 | 5.80 | 6.01 | 6.44 | 4.99 | 101.18 | 123.96 | 5.04 |
| AVG. OF 1951 | 11 | 5.45 | 8.85 | -.59 | 3.15 | 5.45 | 6.16 | 4.77 | 101.60 | 189.33 | .00 |
| AVG. OF 1952 | 11 | 8.12 | 7.54 | 2.27 | 5.64 | 5.63 | 6.12 | 3.61 | 101.60 | 107.97 | .00 |
| AVG. OF 1953 | 11 | 8.32 | 9.96 | 2.74 | 5.78 | 5.11 | 5.59 | 3.57 | 101.66 | 106.83 | .00 |
| AVG. OF 1954 | 11 | 7.01 | 7.80 | 1.41 | 4.71 | 5.24 | 5.89 | 5.11 | 101.43 | 137.07 | .00 |
| AVG. OF 1955 | 11 | 6.30 | 7.63 | .10 | 3.82 | 4.90 | 5.10 | 4.90 | 101.09 | 157.70 | .00 |
| AVG. OF 1956 | 11 | 7.72 | 7.98 | 2.17 | 5.37 | 5.46 | 6.18 | 4.31 | 101.47 | 140.10 | .31 |
| AVG. OF 1957 | 11 | 9.03 | 8.11 | 2.49 | 6.25 | 6.11 | 6.04 | 4.52 | 101.41 | 97.49 | .00 |

```
AVG. OF ALL YEARS     11        7.49      8.50     1.46       4.96    5.44   5.90   4.51    101.37  133.51    .59


   AVG. OF 1949       12        3.60      8.33    -2.30       1.57    5.39   5.36   4.51    102.21  245.01    .00
   AVG. OF 1950       12        1.08      6.76    -4.44       -.70    5.78   6.30   4.74    101.34  318.29    .00
   AVG. OF 1951       12        2.80      7.67    -2.72        .99    5.70   6.77   4.62    101.63  272.27    .00
   AVG. OF 1952       12        2.82      6.47    -2.31       1.02    6.00   6.52   4.29    101.51  263.90    .00
   AVG. OF 1953       12        4.07      8.58    -1.75       1.96    5.25   5.84   4.75    101.32  225.01    .00
   AVG. OF 1954       12        1.82      6.99    -4.75       -.31    5.87   6.49   6.32    101.21  294.97    .00
   AVG. OF 1955       12       -1.39      7.31    -8.46      -3.33    4.58   5.16   5.13    101.74  394.27    .00
   AVG. OF 1956       12        4.36      7.63      .96       3.03    6.91   7.24   4.08    101.33  218.13    .00
   AVG. OF 1957       12        4.13      6.76    -1.13       2.18    6.29   6.78   4.45    101.50  226.63    .00

AVG. OF ALL YEARS     12        2.59      7.39    -2.99        .71    5.75   6.27   4.77    101.53  273.16    .00


ENTER THE AVERAGES YOU ARE USING TO SELECT THE SELECTED YEAR
ASSIGNED TO LOGICAL UNIT 11
ENTER THE SI FLAG:
0 FOR SI UNITS (DEG. C., M/SEC., KPASCAL)
1 FOR ENGLISH UNITS (DEG. F.,MPH, IN. OF HG., KNOTS)
FOLLOWED BY THE BP FLAG:
IF YOU ARE UNABLE TO FIND BAROMETRIC PRESSURE AVERAGES
ENTER 1 AND THE HEIGHT OF THE SELECTED LOCATION IN METERS
ELSE ENTER 0 0.0
FOLLOWED BY THE WB FLAG:
IF YOU ARE ENTERING WET BULB INSTEAD OF DEWPOINT ENTER 1
ELSE ENTER 0
FOLLOWED BY THE CCT FLAG:
1 IF USING DAYTIME CLOUD AVERAGES INSTEAD OF FULL DAY AVERAGES
ELSE ENTER 0
1 0 0.0 0 1
THE MONTH IS PRINTED FOR CONVENIENCE ONLY AND SHOULD NOT BE INPUT
          DRY BULB    MEAN SKY WIND   DEW POINT?WET BULB BAROMETRIC DEVIATION
         TEMPERATURE  COVER   SPEED     TEMPERATURE       PRESSURE  ADJUSTMENT
MONTH      DEG. F.    TENTHS MI./HR.      DEG. F.         IN. OF HG.
   1
             36.01      6.33     8.79       26.47              30.08       1.0
   2
             36.06      5.79     9.38       24.52              30.16       1.0
   3
             43.00      6.33    10.88       30.87              30.00       1.0
   4
             53.56      6.07     9.54       39.27              29.90       1.0
   5
             63.56      6.14     8.25       48.39              29.87       1.0
   6
             70.85      6.67     7.38       60.74              29.93       1.0
   7
             76.45      5.95     6.99       65.29              29.96       1.0
   8
             74.63      5.35     6.10       63.67              29.95       1.0
   9
             68.19      4.97     6.85       56.26              30.03       1.0
  10
             59.78      6.28     8.08       49.46              30.09       1.0
  11
             42.38      5.83     9.24       31.37              30.08       1.0
```

12

| | | | | | |
|---|---|---|---|---|---|
| 38.44 | 6.01 | 8.85 | 28.65 | 30.08 | 1.0 |

AVERAGE OF THE SELECTED YEAR

| MONTH | DRY BULB TEMPERATURE | DAILY RANGE | DEWPOINT TEMPERATURE | WET BULB TEMPERATURE | TOTAL CLOUD | DAYTIME CLOUD | WIND SPEED | DEGREES DAYS HEATING | DEGREES DAYS COOLING |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.254 | 7.312 | -3.133 | .424 | 6.336 | 6.648 | 4.543 | 281.448 | .000 |
| CHOSEN | 3.891 | | -1.002 | 1.995 | 6.562 | 6.836 | 3.946 | | |
| DESIRED | 3.809 | | -.813 | | | 5.850 | 3.890 | | |
| CHOSEN | 2.258 | | -3.466 | .364 | 6.083 | 5.810 | 4.582 | | |
| DESIRED | 2.228 | | -3.072 | | | 6.330 | 4.524 | | |
| CHOSEN | .613 | | -4.898 | -1.081 | 6.387 | 7.382 | 5.096 | | |
| DESIRED | .531 | | -4.709 | | | 6.396 | 5.039 | | |
| 2 | 2.323 | 9.464 | -4.045 | .189 | 5.378 | 5.974 | 4.826 | 255.383 | .000 |
| CHOSEN | -.229 | | -5.059 | -1.497 | 5.310 | 5.636 | 4.702 | | |
| DESIRED | -.439 | | -5.403 | | | 5.064 | 4.707 | | |
| CHOSEN | 2.257 | | -3.400 | .250 | 6.075 | 7.055 | 4.916 | | |
| DESIRED | 2.256 | | -4.156 | | | 5.790 | 4.828 | | |
| CHOSEN | 4.949 | | -3.747 | 1.808 | 4.671 | 5.111 | 4.852 | | |
| DESIRED | 4.738 | | -4.091 | | | 4.539 | 4.857 | | |
| 3 | 6.101 | 8.495 | -.774 | 3.372 | 5.984 | 6.898 | 5.534 | 165.356 | .000 |
| CHOSEN | 3.671 | | -2.451 | 1.472 | 5.742 | 7.108 | 5.325 | | |
| DESIRED | 3.701 | | -1.999 | | | 5.348 | 5.531 | | |
| CHOSEN | 6.098 | | -.690 | 3.481 | 6.333 | 7.299 | 5.609 | | |
| DESIRED | 6.111 | | -.628 | | | 6.330 | 5.600 | | |
| CHOSEN | 8.535 | | .813 | 5.153 | 5.842 | 6.247 | 5.660 | | |
| DESIRED | 8.565 | | 1.265 | | | 4.487 | 5.865 | | |
| 4 | 11.988 | 10.259 | 4.040 | 8.279 | 5.922 | 6.044 | 4.816 | 35.365 | 1.477 |
| CHOSEN | 9.565 | | 2.523 | 6.449 | 6.500 | 7.153 | 4.808 | | |
| DESIRED | 9.535 | | 2.519 | | | 7.230 | 5.093 | | |
| CHOSEN | 11.910 | | 3.979 | 8.176 | 5.883 | 5.667 | 4.731 | | |
| DESIRED | 11.978 | | 4.039 | | | 6.070 | 4.910 | | |
| CHOSEN | 14.488 | | 5.618 | 10.211 | 5.383 | 5.313 | 4.907 | | |
| DESIRED | 14.459 | | 5.614 | | | 5.390 | 5.192 | | |
| 5 | 17.625 | 10.520 | 9.105 | 12.983 | 6.062 | 6.258 | 4.678 | 1.310 | 40.495 |
| CHOSEN | 15.593 | | 4.347 | 10.127 | 4.604 | 4.973 | 5.102 | | |
| DESIRED | 15.710 | | 4.350 | | | 4.607 | 3.764 | | |
| CHOSEN | 17.355 | | 9.804 | 13.125 | 6.386 | 6.212 | 4.145 | | |
| DESIRED | 17.533 | | 9.106 | | | 6.140 | 4.246 | | |
| CHOSEN | 19.553 | | 13.093 | 15.683 | 7.162 | 7.593 | 4.841 | | |
| DESIRED | 19.270 | | 13.095 | | | 7.227 | 3.502 | | |
| 6 | 21.582 | 9.259 | 16.019 | 18.013 | 6.958 | 7.060 | 3.633 | .000 | 113.009 |
| CHOSEN | 18.968 | | 14.354 | 16.111 | 6.367 | 6.353 | 2.728 | | |
| DESIRED | 18.972 | | 14.199 | | | 5.183 | 3.225 | | |
| CHOSEN | 21.650 | | 15.984 | 18.030 | 7.371 | 7.667 | 4.141 | | |
| DESIRED | 21.583 | | 15.967 | | | 6.670 | 3.799 | | |
| CHOSEN | 24.127 | | 17.718 | 19.898 | 7.137 | 7.160 | 4.030 | | |
| DESIRED | 24.132 | | 17.562 | | | 5.990 | 4.527 | | |
| 7 | 24.695 | 9.785 | 18.449 | 20.537 | 5.733 | 6.172 | 3.203 | .000 | 207.532 |

```
    CHOSEN   24.035              20.472     21.572      7.417        7.487        1.969
   DESIRED   24.034              20.613                          6.798             3.192
    CHOSEN   24.672              18.013     20.217      5.720        6.600        3.611
   DESIRED   24.694              18.494                          5.950             3.598
    CHOSEN   25.380              16.905     19.854      4.063        4.387        3.989
   DESIRED   25.379              17.046                          3.698             5.213

      8      23.675     8.763    17.608     19.681      5.137        5.553        3.980      .000    177.176
    CHOSEN   24.986              18.829     20.866      4.971        5.253        4.851
   DESIRED   25.053              18.913                          5.266             2.920
    CHOSEN   23.615              17.582     19.602      4.943        5.648        3.238
   DESIRED   23.683              17.594                          5.350             3.140
    CHOSEN   22.428              16.417     18.583      5.517        5.747        3.925
   DESIRED   22.455              16.374                          5.118             1.320

      9      20.082     9.926    13.468     16.130      4.539        5.179        3.978      .000     75.949
    CHOSEN   22.620              14.593     17.660      5.312        6.140        4.023
   DESIRED   22.692              14.623                          5.513             2.668
    CHOSEN   20.014              13.495     16.218      4.867        5.431        4.184
   DESIRED   20.106              13.478                          4.970             3.526
    CHOSEN   17.611              12.315     14.514      3.438        3.967        3.725
   DESIRED   17.682              12.345                          3.339             2.370

     10      15.385     9.211     9.797     12.328      5.864        6.465        3.268     4.995      9.338
    CHOSEN   17.859              12.711     14.845      5.262        6.285        2.608
   DESIRED   17.732              12.598                          5.293             4.915
    CHOSEN   15.421               9.674     12.250      6.462        6.773        3.568
   DESIRED   15.433               9.700                          6.280             4.159
    CHOSEN   12.870               7.019      9.896      5.808        6.308        3.599
   DESIRED   13.022               6.718                          5.733             6.360

     11       5.776     8.278     -.380      3.412      5.276        5.852        4.733   179.962       .000
    CHOSEN    8.722               2.942      6.176      5.042        5.255        4.242
   DESIRED    8.694               3.031                          5.190             4.310
    CHOSEN    5.914                .111      3.701      5.804        6.682        4.875
   DESIRED    5.767               -.350                          5.830             4.756
    CHOSEN    2.692              -4.192       .359      4.983        5.618        5.083
   DESIRED    2.934              -4.059                          4.526             5.194

     12       3.569     6.792    -2.038      1.520      5.707        6.194        4.696   248.383       .000
    CHOSEN    6.282                .688      3.977      5.250        5.827        4.748
   DESIRED    6.309               1.235                          5.258             4.312
    CHOSEN    3.721              -1.915      1.713      6.288        6.504        4.439
   DESIRED    3.578              -1.861                          6.010             4.555
    CHOSEN     .690              -4.898     -1.148      5.525        6.218        4.926
   DESIRED     .716              -4.350                          5.649             4.490
 ENTER THE A.D. YEAR AND FIVE DIGIT CITY CODE FOR
 THE YEAR WRITTEN AT LOGICAL UNIT 11
1951 14732
 MONTH INTERVAL YEAR  MONTH   DAY   LENGTH  CITY   RANK
     1     1    1956     2     8      10   14734   5.34
     1     2    1949    12     4      11   14734   2.96
     1     3    1950     1    30      10   14734   1.99
 THE DAILY STANDARD DEVIATION FOR MONTH   1 IS  3.368
     2     1    1952     1    24       9   14734   5.22
     2     2    1951     1     2      10   14734   3.64
     2     3    1953     2    17       9   14734   4.74
 THE DAILY STANDARD DEVIATION FOR MONTH   2 IS  5.790
```

```
      3     1    1952     3    13        10    14734    4.43
      3     2    1950     3    22        11    14734     .28
      3     3    1949     4     1        10    14734    8.85
THE DAILY STANDARD DEVIATION FOR MONTH   3 IS   3.640
      4     1    1952     3    29        10    14734    5.01
      4     2    1949     4    11        10    14734    2.23
      4     3    1956     5    18        10    14734    1.25
THE DAILY STANDARD DEVIATION FOR MONTH   4 IS   3.756
      5     1    1955     5     6        10    14734    4.91
      5     2    1949     5     3        11    14734    7.21
      5     3    1951     6     2        10    14734    5.35
THE DAILY STANDARD DEVIATION FOR MONTH   5 IS   3.744
      6     1    1953     5     8        10    14734    7.09
      6     2    1956     7     3        10    14734    4.98
      6     3    1949     7     4        10    14734    7.71
THE DAILY STANDARD DEVIATION FOR MONTH   6 IS   3.414
      7     1    1952     8     3        10    14734    6.80
      7     2    1949     8     9        11    14734    5.20
      7     3    1953     6    19        10    14734    6.20
THE DAILY STANDARD DEVIATION FOR MONTH   7 IS   2.843
      8     1    1955     8    17        10    14734    7.53
      8     2    1956     8    12        11    14734    3.25
      8     3    1953     8     3        10    14734    6.42
THE DAILY STANDARD DEVIATION FOR MONTH   8 IS   3.058
      9     1    1957     8    10        10    14734    4.15
      9     2    1955     9    12        10    14734    2.18
      9     3    1955    10     3        10    14734    2.32
THE DAILY STANDARD DEVIATION FOR MONTH   9 IS   2.923
     10     1    1952     9    18        10    14734    3.36
     10     2    1953    10    18        11    14734    1.70
     10     3    1951    10    20        10    14734    8.89
THE DAILY STANDARD DEVIATION FOR MONTH  10 IS   3.075
     11     1    1955    11     8        10    14734    1.49
     11     2    1951    11    14        10    14734    3.86
     11     3    1949    11    21        10    14734    6.00
THE DAILY STANDARD DEVIATION FOR MONTH  11 IS   5.323
     12     1    1956    11    15        10    14734    3.99
     12     2    1952    11    26        11    14734    4.57
     12     3    1950    12    10        10    14734    4.89
THE DAILY STANDARD DEVIATION FOR MONTH  12 IS   4.970

                                        AVERAGE INTERVAL DEVIATION
MONTH       1        2        3        4        5        6        7        8        9       10       11       12
DEG. C.   1.809    2.602    2.434    2.524    1.850    2.562     .929    1.335    2.725    2.327    3.012    2.602
                                             STANDARD DEVIATION
DEG. C.   4.148    4.230    4.140    4.196    3.603    3.737    2.539    2.583    3.610    3.813    4.532    4.576
```

APPENDIX E. Example run of ADJUST Creating a Synthetic 1951 Philadelphia Year from the Real New York City 1951 Year.

Synopsis of execution

1. Link appropriate subroutines to main program as indicated in APPENDIX B.
2. Assign input and output files to appropriate units. Assign unit 7. to a file for summarized year output.
   (The output to unit 7. is in the same format as the summarized adjusted, or unadjusted year output without the alphanumeric headings.)
   Assign unit 8. to the hourly weather data input.
   Assign unit 9. to the hourly weather data output.
3. Execute program: Two runstreams are shown.
   Runstream A. Creation of synthetic Philadelphia weather year from the real New York City year.
   Runstream B. Summarizing hourly weather data from a synthetic Philadelphia on a monthly basis.

RUNSTREAM A. Hourly climate adjustment.

```
@ASG,A ADOUT.
>READY

@ASG,A NY51.
READY

@ASG,A NYADPHI.
READY

@USE 7.,ADOUT.
READY

@USE 8.,NY51.
READY

@USE 9.,NYADPHI.
>READY

@XQT ADJUST.ADJUST2
 ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.
>39.5 75.2 5.0
 ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START
 OF THE 12 MONTH PERIOD BEING USED
 FOLLOWED BY THE NUMBER OF DAYS IN IT
>0 365
 ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1
>0
 ENTER 0 0.0 IF BAROMETRIC PRESSURE DATA IS AVAILABLE
 OTHERWISE ENTER 1 AND THE HEIGHT DIFFERENCE OF THE NEW
 AND OLD LOCATION --- H(NEW)-H(OLD) IN FEET
>0 0.0
 ENTER 0 IF USING SI UNITS (FOR INPUT OF CLIMATE
 VARIABLES ONLY), ELSE ENTER 1
 FOLLOWED BY THE CLOUD FLAG:
 1 IF USING DAYTIME AVERAGES
 0 IF USING FULL DAY AVERAGES.
>1 0
 ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE
 USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED
 (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE
 DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY
 BULB CALCULATIONS)
 THEN ENTER THE BASE TEMPERATURES' TO BE USED IN
 THE DEGREE DAY CALCULATIONS IN DEG.F.:
 FIRST HEATING, THEN COOLING.
>1 55. 75.



  INPUT YEAR SUMMARY
 AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
    43.645    30.129    64.000    12.000    561.500      .000
    43.714    29.536    65.000    11.000    514.500      .000
    48.290    36.194    61.000    25.000    395.500      .000
    61.000    45.833    83.000    39.000     95.500      .000
    71.645    54.226    90.000    46.000      1.500      .000
    77.000    62.633    90.000    53.000       .000    15.500
    83.710    69.387    93.000    63.000       .000    77.500
    82.226    67.839    93.000    60.000       .000    57.500
    76.033    61.167    84.000    46.000      4.000     2.500
    65.677    53.161    83.000    44.000     26.000     1.000
    51.033    37.200    67.000    22.000    340.000      .000
    45.645    32.710    64.000     9.000    498.500      .000
  SUMMER DESIGN 0 HRS:  93. 10 HRS:  90. 50 HRS:  87. 200 HRS:  83. 500 HRS:  79.
  WINTER DESIGN 0 HRS:   9. 10 HRS:  12. 50 HRS:  16. 200 HRS:  22. 500 HRS:  28.
```

```
ENTER 0 IF USING WET BULB ONLY, AS FROM AIR FORCE MANUAL 88/29
ENTER 1 IF USING DEWPOINT ONLY, AS FROM NOAA CLIMATIC ATLAS
ENTER 2 IF USING BOTH
>2
ENTER THE WEATHER AVERAGES TO ADJUST THE TAPE.
EVEN IF VALUES CANNOT BE FOUND OR ARE NOT USED
SOMETHING MUST BE ENTERED FOR ALL 96 VALUES
( ENTER ONLY ONE TYPE OF DRY BULB AVERAGE.)
IF NECESSARY ECHO THE VALUES FROM THE INPUT YEAR

MONTH   DRY BULB  CLOUD   WIND  DEW   BAROMETRIC DAILY DAILY  WET
          MAXMIN  COVER  SPEED POINT   PRESSURE   S.D. RANGE  BULB
          DEG.F.  TENTHS KNOTS DEG.F.   IN.HG.  DEG.F. DEG.F. DEG.F.
  1        36.89   6.09  14.48 25.55    30.03   8.56  13.52  33.00
>          36.01  6.33  8.79  26.47  30.08  7.66  15.52  32.66
  2        36.62   6.00  15.38 24.37    30.11   9.58  14.18  32.32
>          36.06  5.79  9.38  24.52  30.16  9.75  16.04  32.19
  3        42.24   6.33  16.60 30.24    29.97   5.80  12.10  37.45
>          43.00  6.33 10.88  30.87  30.00  6.16  15.23  38.26
  4        53.42   5.72  12.87 38.77    29.86   5.89  15.17  46.09
>          53.56  6.07  9.54  39.27  29.90  6.27  19.63  46.70
  5        62.94   6.21  11.79 46.57    29.83   5.98  17.42  53.98
>          63.56  6.14  8.25  48.39  29.87  5.64  20.35  55.37
  6        69.82   6.38  10.55 58.10    29.91   5.92  14.37  62.47
>          70.85  6.67  7.38  60.74  29.93  6.28  17.13  64.42
  7        76.55   6.02   9.70 62.75    29.93   3.69  14.32  67.47
>          76.45  5.95  6.99  65.29  29.96  3.18  17.65  69.04
  8        75.03   5.17   9.86 62.82    29.93   4.29  14.39  66.93
>          74.63  5.35  6.10  63.67  29.95  4.49  18.55  67.52
  9        68.60   5.01  11.31 55.40    30.01   5.85  14.87  60.77
>          68.19  4.97  6.85  56.26  30.03  5.52  20.13  61.15
 10        59.42   5.94  13.36 47.86    30.07   6.50  12.52  53.22
>          59.78  6.28  8.08  49.46  30.09  7.09  16.52  54.11
 11        44.12   5.49  13.65 30.18    30.04   8.46  13.83  38.58
>          42.38  5.83  9.24  31.37  30.08  9.09  16.80  38.14
 12        39.18   5.80  12.50 26.81    30.04  11.60  12.94  34.97
>          38.44  6.01  8.85  28.65  30.08 11.91  15.26  35.11
   ADJUSTED YEAR COMPLETE.


ADJUSTED YEAR SUMMARY
AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
  43.770   28.250   62.489   11.838   588.690      .000
  44.080   28.040   65.648    9.155   530.320      .000
  50.615   35.385   63.774   23.588   372.486      .000
  63.375   43.745   86.280   36.339    96.736      .000
  73.735   53.385   91.427   45.643      .000      .000
  79.415   62.285   92.883   51.993      .000    26.461
  85.275   67.625   94.023   61.931      .000    69.255
  83.905   65.355   94.982   57.164      .000    53.729
  78.255   58.125   85.948   43.857     3.079     1.121
  68.040   51.520   86.857   41.375    28.718     2.855
  50.780   33.980   68.009   17.724   389.804      .000
  46.070   30.810   64.920    6.465   520.606      .000
SUMMER DESIGN 0 HRS:  95. 10 HRS:  92. 50 HRS:  88. 200 HRS:  85. 500 HRS:  80.
WINTER DESIGN 0 HRS:   6. 10 HRS:  10. 50 HRS:  15. 200 HRS:  21. 500 HRS:  27.
```

RUNSTREAM B. Summary of hourly data.

```
@ASG,A ADOUT.
>READY

@ASG,A NYADPHI.
>READY

@ASG,A NYOUT.
>READY

@USE 7.,ADOUT.
READY

@USE 8.,NYADPHI.
READY

@USE 9.,NYOUT.
READY

@XQT ADJUST.ADJUST2
 ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.
>39.5 75.2 5.0
 ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START
 OF THE 12 MONTH PERIOD BEING USED
 FOLLOWED BY THE NUMBER OF DAYS IN IT
>0 365
 ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1
>1
 ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE
 USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED
 (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE
 DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY
 BULB CALCULATIONS)
 THEN ENTER THE BASE TEMPERATURES' TO BE USED IN
 THE DEGREE DAY CALCULATIONS IN DEG.F.:
 FIRST HEATING, THEN COOLING.
>0 55. 75.

  INPUT YEAR SUMMARY
 AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
   43.770   28.250   62.489   11.838   589.253      .000
   44.080   28.040   65.648    9.155   547.455      .000
   50.615   35.385   63.774   23.588   386.218      .000
   63.375   43.745   86.280   36.339   108.879      .000
   73.735   53.385   91.427   45.643     1.786      .100
   79.415   62.285   92.883   51.993      .000    25.937
   85.275   67.625   94.023   61.931      .000    47.904
   83.905   65.355   94.982   57.164      .000    27.851
   78.255   58.125   85.948   43.857     2.669      .000
   68.040   51.520   86.857   41.375    27.923      .390
   50.780   33.980   68.009   17.724   407.641      .000
   46.070   30.810   64.920    6.465   527.217      .000
 SUMMER DESIGN 0 HRS:  95. 10 HRS:  92. 50 HRS:  88. 200 HRS:  85. 500 HRS:  80.
 WINTER DESIGN 0 HRS:   6. 10 HRS:  10. 50 HRS:  15. 200 HRS:  21. 500 HRS:  27.
 MONTH    DRY BULB  CLOUD   WIND  DEW   BAROMETRIC DAILY DAILY  WET
            24-HR   COVER  SPEED POINT   PRESSURE   S.D. RANGE  BULB
            DEG.F.  TENTHS KNOTS DEG.F.   IN.HG.  DEG.F. DEG.F. DEG.F.
   1        35.99    6.27   8.79 26.47    30.08    7.60  15.52  32.66
   2        35.45    5.85   9.38 24.40    30.16    9.72  16.04  32.05
   3        42.55    6.32  10.88 30.81    30.00    6.06  15.23  38.19
   4        52.51    5.97   9.54 39.06    29.90    5.59  19.63  46.45
   5        62.67    6.17   8.25 48.20    29.87    5.59  20.35  55.17
   6        70.35    6.67   7.38 60.61    29.93    6.43  17.13  64.29
   7        75.72    5.95   6.99 65.04    29.96    2.87  17.65  68.79
   8        73.47    5.36   6.10 63.31    29.95    3.99  18.55  67.15
   9        67.53    4.95   6.85 56.05    30.03    5.05  20.13  60.94
  10        59.34    6.25   8.08 49.34    30.09    6.80  16.52  54.00
  11        41.86    5.79   9.24 31.18    30.08    9.54  16.80  37.94
  12        38.28    6.02   8.85 28.62    30.08   12.15  15.26  35.08
  SUMMARIZED YEAR COMPLETE.
```

# FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

| 01. Summary date | 02. Summary prepared by (Name and Phone) | 03. Summary action |
|---|---|---|
| Yr. 79 Mo. Day | Edward Arens (301) 921-3595 | New [X] Replacement [ ] Deletion [ ] |
| 04. Software date: Yr. 79 Mo. Day | 05. Software title: Fortran V Programs: SELECT and ADJUST | Previous Internal Software ID |
| 06. Short title | | 07. Internal Software ID |

**08. Software type**
- [ ] Automated Data System
- [X] Computer Program
- [ ] Subroutine/Module

**09. Processing mode**
- [X] Interactive or
- [X] Batch
- [ ] Combination

**10. Application area**

General:
- [ ] Computer Systems Support/Utility
- [X] Scientific/Engineering
- [ ] Bibliographic/Textual
- [ ] Management/Business
- [ ] Process Control
- [ ] Other

Specific: Heating & Cooling

**11. Submitting organization and address**

Environmental Design Research Division
Center for Building Technology
National Engineering Laboratory
National Bureau of Standards

**12. Technical contact(s) and phone**

Edward Arens
Architectural Research Group
(301) 921-3595

**13. Narrative**

Two interactive programs, plus 12 subroutines, create composite and synthetic year-long hourly weather data tapes for building loads prediction programs, using Weather Bureau tapes as source data. The programs provide the user the capability for producing 'typical' weather years representative of a long-term record, and also 'extrapolated' weather years representative of locations for which hourly data are not available. The programs can be used individually or in sequence.

**14. Keywords**

Climate, Data, Buildings, Energy Prediction, Loads.

| 15. Computer manuf'r and model | 16. Computer operating system | 17. Programing language(s) | 18. Number of source program statements |
|---|---|---|---|
| 1108 UNIVAC | 1100 VER 33R3-RSI | FORTRAN V | 1000, 500 |
| **19. Computer memory requirements** | **20. Tape drives** | **21. Disk/Drum units** | **22. Terminals** |
| 100K | None | L & S tracks, input/output | 132 character/line |

**23. Other operational requirements**

**24. Software availability**
- [X] Available
- [ ] Limited
- [ ] In-house only

**25. Documentation availability**
- [X] Available
- [ ] Inadequate
- [ ] In-house only

**26. FOR SUBMITTING ORGANIZATION USE**

185-101

Standard Form 185
1974 July
U.S. Dept. of Commerce—NBS
(FIPS. Pub. 30)

NBS-114A (REV. 9-78)

| U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET | 1. PUBLICATION OR REPORT NO. NBS BSS 126 | 2. Gov't. Accession No. | 3. Recipient's Accession No. |
|---|---|---|---|

| | |
|---|---|
| 4. TITLE AND SUBTITLE<br>Geographical Extrapolation of Typical Hourly Weather Data for Energy Calculation in Buildings | 5. Publication Date<br>August 1980<br>6. Performing Organization Code |
| 7. AUTHOR(S) Edward A. Arens, Larry E. Flynn, Daniel N. Nall, and Kalev Ruberg | 8. Performing Organ. Report No. |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS<br>NATIONAL BUREAU OF STANDARDS<br>DEPARTMENT OF COMMERCE<br>WASHINGTON, DC 20234 | 10. Project/Task/Work Unit No.<br>11. Contract/Grant No. |
| 12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*<br>Same | 13. Type of Report & Period Covered<br>Final<br>14. Sponsoring Agency Code |

15. SUPPLEMENTARY NOTES

Library of Congress Catalog Number: 80-600059

☐ Document describes a computer program; SF-185, FIPS Software Summary, is attached.

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

Two techniques are developed and tested for creating composite and synthetic hourly weather data for a wide range of sites. The first technique selects real weather data segments from a source multiyear weather record, and links them into a composite synthetic year, in which the hourly values are unchanged from the source. The second technique adjusts the real hourly data values of the source to create a more completely synthetic year. The techniques may be applied individually or in combination. The resulting synthetic year or years can be used to provide data that is representative of long-term climate for building energy prediction either at the first-order station where the source hourly weather data were recorded, or at a nearby second-order station for which only summarized climate averages are available. Additionally, the adjustment technique can generate synthetic data to represent specific time periods at second-order stations for use in energy audits and experiments. The effectiveness of extrapolating weather data from one location to another is assessed, and the uses of the two techniques are described. The user-interactive Fortran programs, SELECT and ADJUST are appended.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Building energy; computerized climate data.

| 18. AVAILABILITY | 19. SECURITY CLASS (THIS REPORT) | 21. NO. OF PRINTED PAGES |
|---|---|---|
| [X] Unlimited<br>☐ For Official Distribution. Do Not Release to NTIS<br>[X] Order From Sup. of Doc., U.S. Government Printing Office, Washington, DC 20402<br>☐ Order From National Technical Information Service (NTIS), Springfield, VA. 22161 | UNCLASSIFIED | 121 |
| | 20. SECURITY CLASS (THIS PAGE)<br>UNCLASSIFIED | 22. Price<br>$4.50 |

USCOMM-DC

☆U.S. GOVERNMENT PRINTING OFFICE: 1980-311-046/192

# NBS TECHNICAL PUBLICATIONS

## PERIODICALS

**JOURNAL OF RESEARCH**—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent Bureau publications in both NBS and non-NBS media. Issued six times a year. Annual subscription: domestic $13; foreign $16.25. Single copy, $3 domestic; $3.75 foreign.

NOTE: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

**DIMENSIONS/NBS**—This monthly magazine is published to inform scientists, engineers, business and industry leaders, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing. Annual subscription: domestic $11; foreign $13.75.

## NONPERIODICALS

**Monographs**—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

**Handbooks**—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

**Special Publications**—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

**Applied Mathematics Series**—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

**National Standard Reference Data Series**—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NBS under the authority of the National Standard Data Act (Public Law 90-396).

NOTE: The principal publication outlet for the foregoing data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

**Building Science Series**—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

**Technical Notes**—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

**Voluntary Product Standards**—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

**Consumer Information Series**—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

*Order the* **above** *NBS publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.*

*Order the* **following** *NBS publications—FIPS and NBSIR's—from the National Technical Information Services, Springfield, VA 22161.*

**Federal Information Processing Standards Publications (FIPS PUB)**—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

**NBS Interagency Reports (NBSIR)**—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services, Springfield, VA 22161, in paper copy or microfiche form.

# BIBLIOGRAPHIC SUBSCRIPTION SERVICES

**The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:**

**Cryogenic Data Center Current Awareness Service.** A literature survey issued biweekly. Annual subscription: domestic $35; foreign $45.

**Liquefied Natural Gas.** A literature survey issued quarterly. Annual subscription: $30.

**Superconducting Devices and Materials.** A literature survey issued quarterly. Annual subscription: $45. Please send subscription orders and remittances for the preceding bibliographic services to the National Bureau of Standards, Cryogenic Data Center (736) Boulder, CO 80303.

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, $300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215

U.S. MAIL

SPECIAL FOURTH-CLASS RATE
BOOK