NBS BUILDING SCIENCE SERIES 126

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

U.S. DEPARTMENT OF COMMERCE • NATIONAL BUREAU OF STANDARDS

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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

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ABSTRACT

Two techniques are developed and tested for creating composite and syn-
thetic hourly weather data for a wide range of sites. The first tech-
nique 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 speci-
fic 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	0.948×10^{-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) = 10^9J = 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

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* 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 <u>select</u> intervals of real weather from a multi-year hourly weather tape or tapes to link together to create a <u>composite</u> 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 <u>adjust</u> 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

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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.

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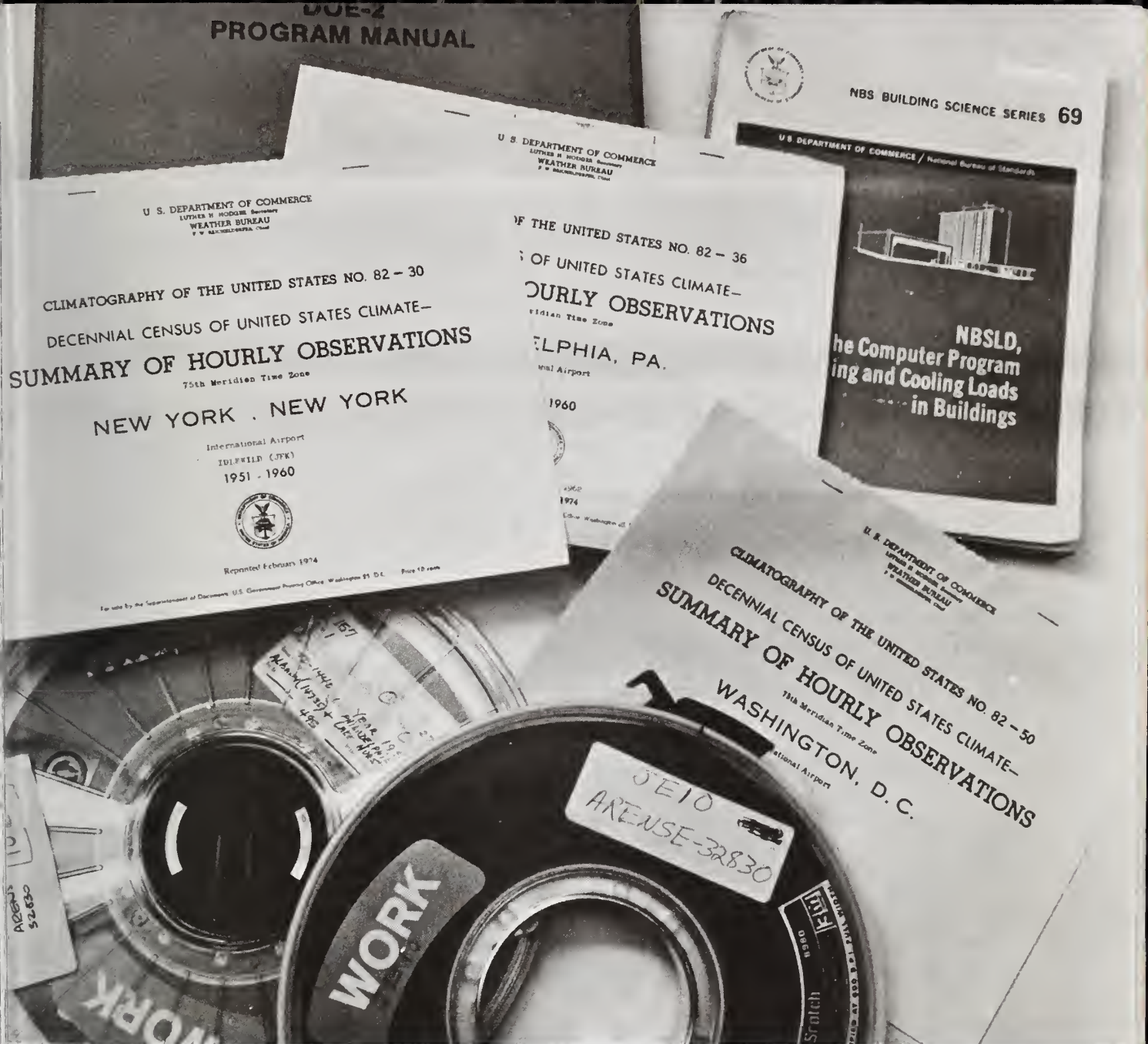
2. METHOD

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]

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and the Guide to Standard Weather Summaries and Climatic Services [7].
The chief sources are NOAA's Climatography of the States, Local Climato-
logical 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 genera-
tor 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 selec-
tion 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 repre-
sentative 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. Selec-
tion 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 selec-
ted 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 subtle-
ties of weather that may be important in determining the suitability of
a building's design to its location, but that would not be character-
ized 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 adjust-
ments 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 char-
acteristics are similar across the geographical distance. Chapter 4
discusses such concerns, and suggests that the user consult a metero-
logist when uncertain.

Third, the selection technique described here (as also the totally-arti-
ficial-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

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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

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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:

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

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

ΔDB = 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.

ΔCC = 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.

ΔMR = 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.

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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.

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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.

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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 seg-
ment 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 tempera-
tures 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

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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 distri-
bution 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.

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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 con-
    tracts each day's distribution of hourly temperatures.

° Dewpoint/wet bulb temperature

   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:

$$DPT_{AH} = DBT_{AH} - \frac{DD_M \text{ desired}}{DD_M \text{ source}} \times DD_H \text{ source} \tag{2}$$

   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 aver-
   age 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 tempera-
   tures from their original distribution to follow the hourly
   adjustments made to the dry bulb temperature.

° Wind

   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

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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 distribu-
tion of hourly velocities in the month.

Readily available climatological information will not pro-
vide information to define the wind velocity variability at
the input station. In view of this, and of the great sim-
plifications 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.

° <u>Cloud Cover</u>

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 radia-
tion 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 dis-
tributions 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 distribu-
tions are observed in Great Britain [20]. This means that
the application of a ratio to the data would alter the dis-
tribution significantly and perhaps cause the elimination

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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.

DISTRIBUTION OF HOURLY CLOUD VALUES FOR 1951

TENTH
SOLID=ALBANY AVG. 6.52   DOT=LAKEHURST AVG. 5.85
DASH=NEW YORK AVG. 5.85
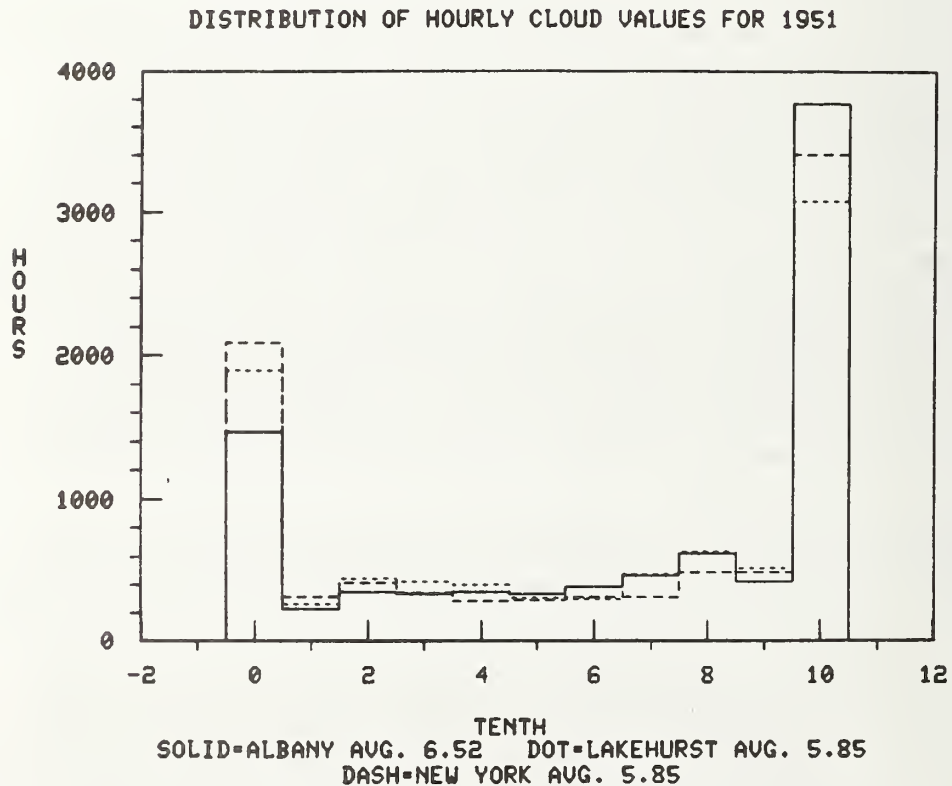
Figure 1.   Example Distributions of Cloud Cover, by Tenths.

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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 sun-
rise 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 day-
time 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 dis-
tribution 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 addi-
tional 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

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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.

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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 differ-
ences in the source data affect the weather data synthesized for remote
stations.

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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

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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 set-
tings 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 build-
ing 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).

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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 net-
work (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

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* 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.

MONTHLY LOADS FOR REAL 1951 YEARS, FORT MEYER OFFICE

DAILY LOADS FOR REAL 1951 YEARS, FORT MEYER

MONTH
DASH=ALBANY   SOLID=JERSEY CITY
DOT=NEW YORK   DASH3=PHILADELPHIA

Annual

DAY OF YEAR
DASH=ALBANY   SOLID=JERSEY CITY
DOT=NEW YORK DASH3=PHILADELPHIA

Transition Season

DAILY LOADS FOR REAL 1951 YEARS, FORT MEYER

DAILY LOADS FOR REAL 1951 YEARS, FORT MEYER

DAY OF YEAR
DASH=ALBANY   SOLID=JERSEY CITY
DOT=NEW YORK DASH3=PHILADELPHIA

Winter

DAY OF YEAR
DASH=ALBANY   SOLID=JERSEY CITY
DOT=NEW YORK DASH3=PHILADELPHIA

Summer

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

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MONTHLY WEATHER AVERAGES FOR ALBANY 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	-2.79	-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

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	2.41	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

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	2.23	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	4.59	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.
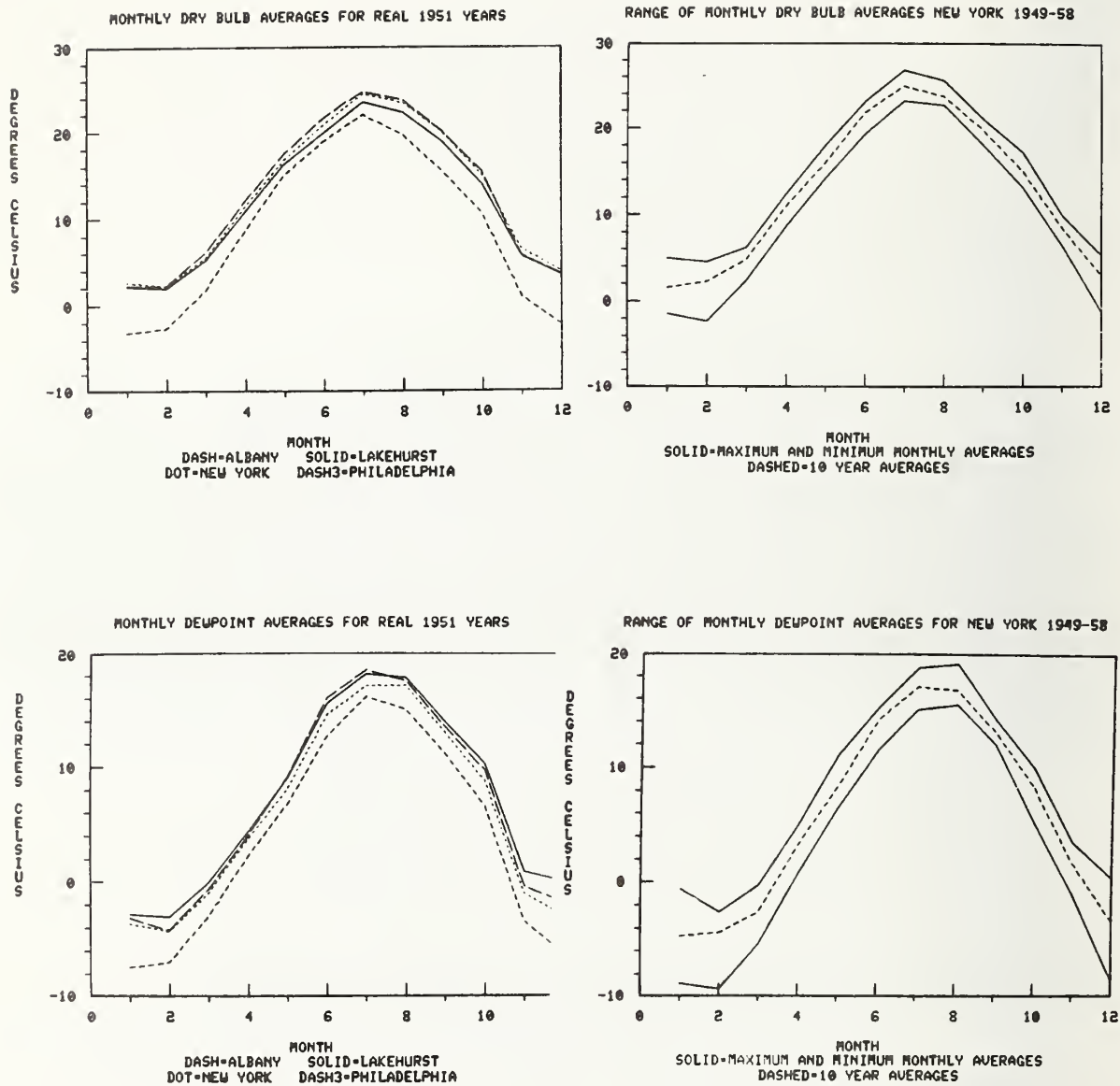
Figure 3.   Means and Ranges of Monthly Weather Averages 1949-1958.

MONTHLY DAYTIME CLOUD AVERAGES FOR REAL 1951 YEARS

MONTHLY DAYTIME CLOUD AVERAGES FOR NEW YORK 1949-58

MONTHLY WIND SPEED AVERAGES FOR REAL 1951 YEARS

RANGE OF MONTHLY WIND SPEED AVERAGES NEW YORK 1949-58
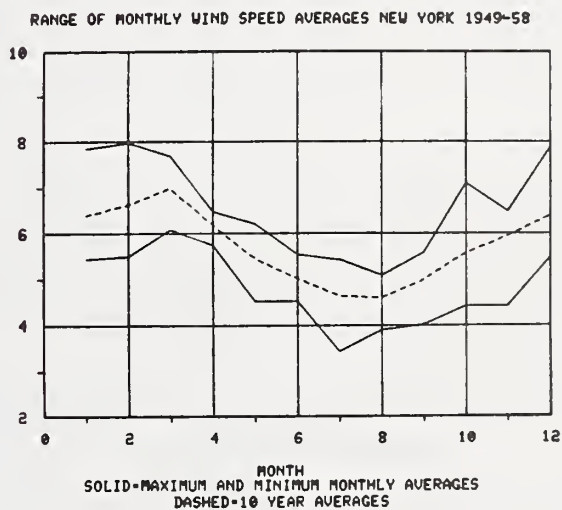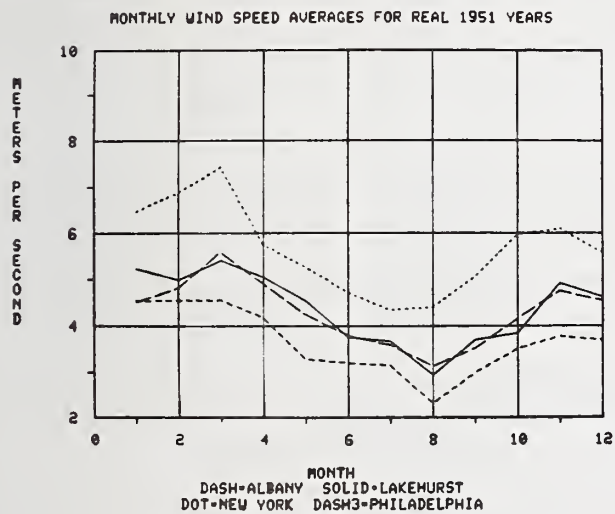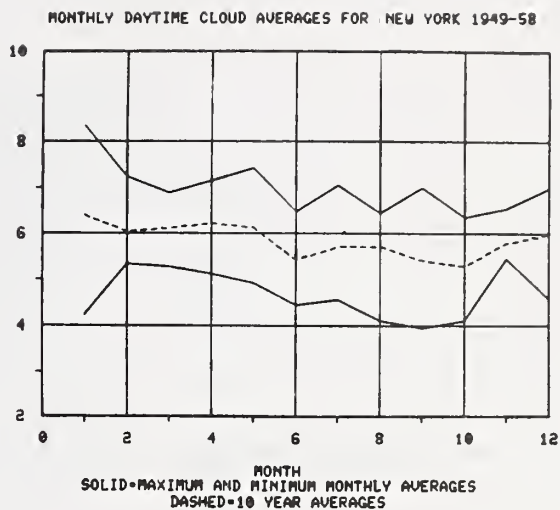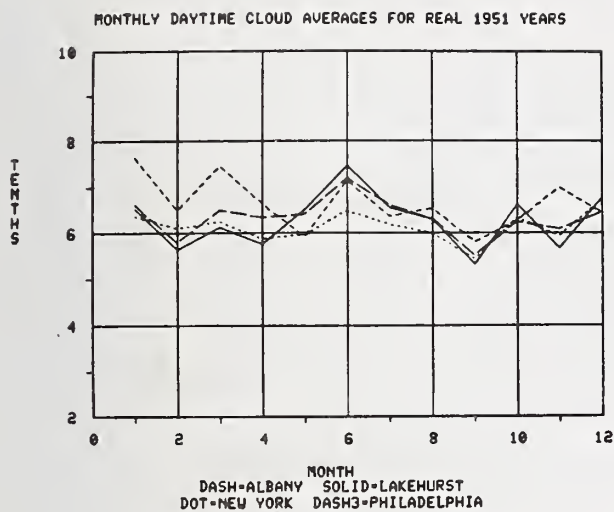
Figure 4.   Means and Ranges of Monthly Weather Averages 1949-1958.
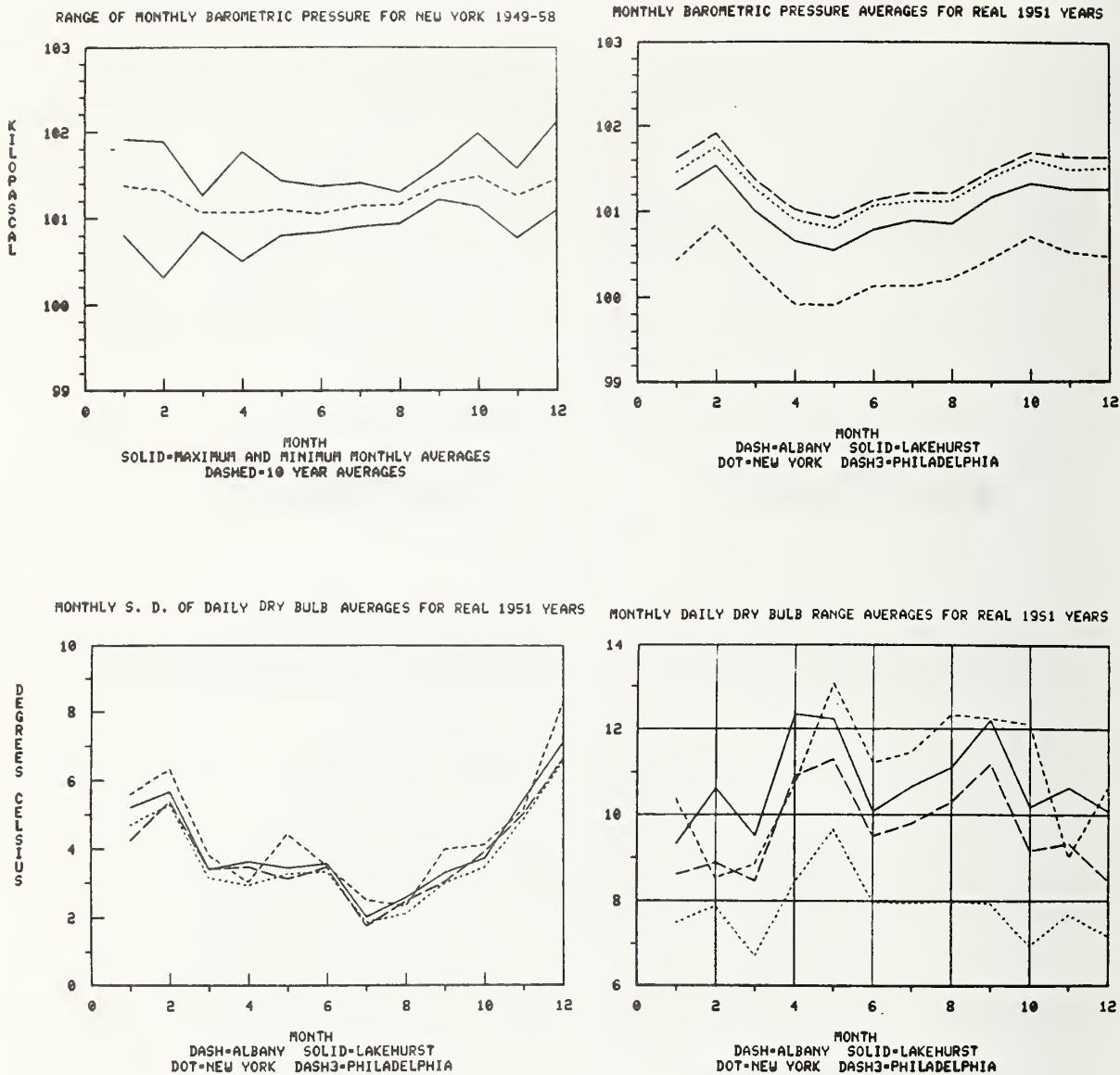
Figure 5.   Means and Ranges of Monthly Weather Averages 1949-1958.

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	2.45	5.58	7.69	6.55	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	7.69	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.

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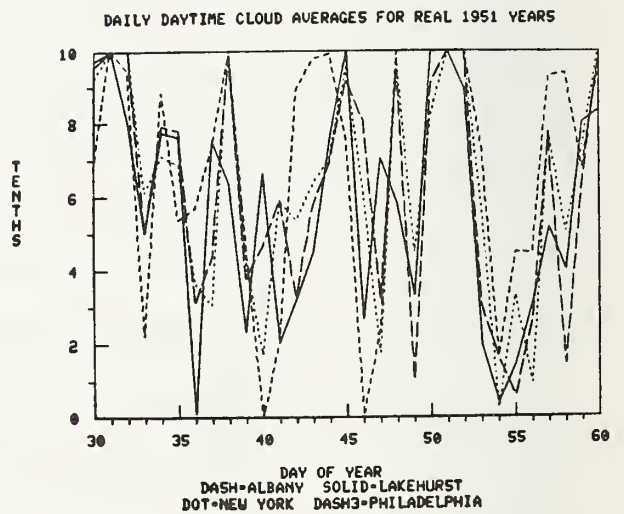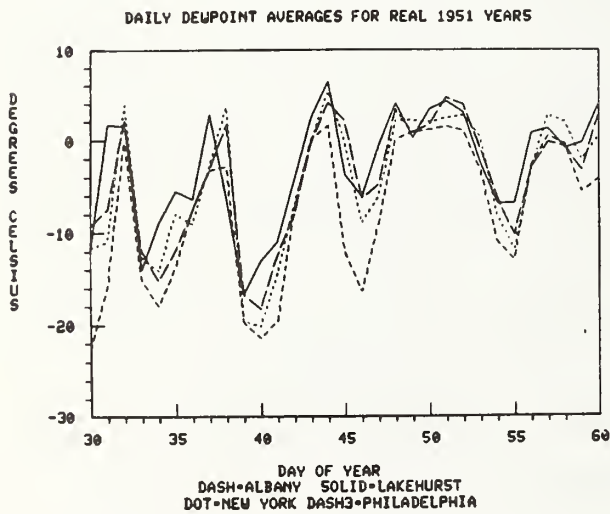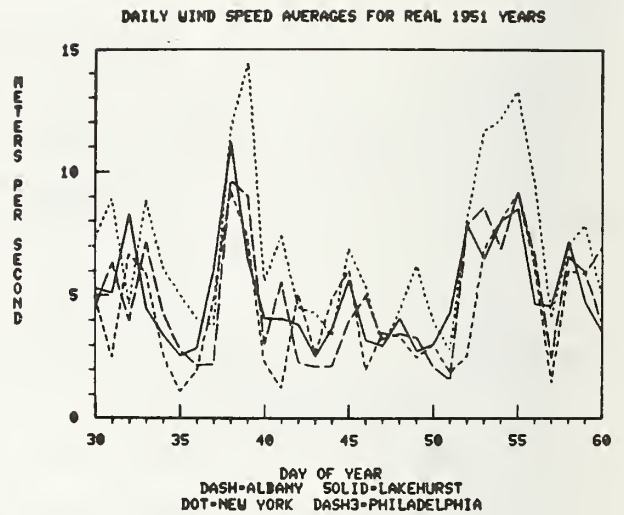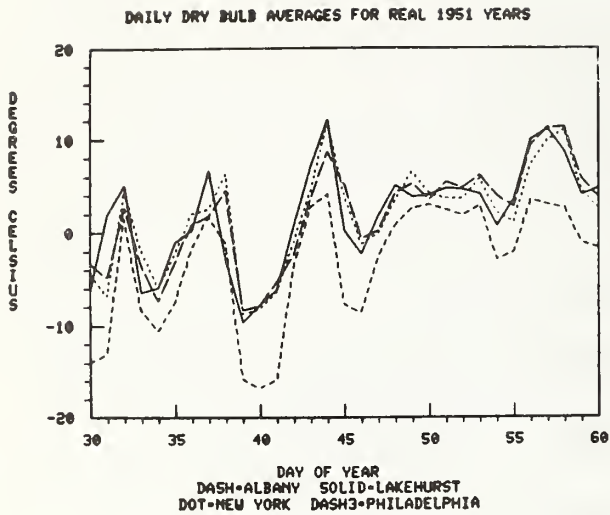
Figure 6.   Comparison of Daily Averages for Climate Elements in Winter.
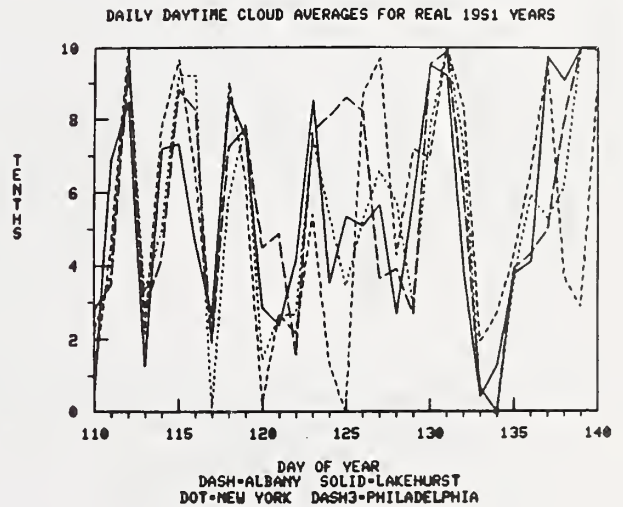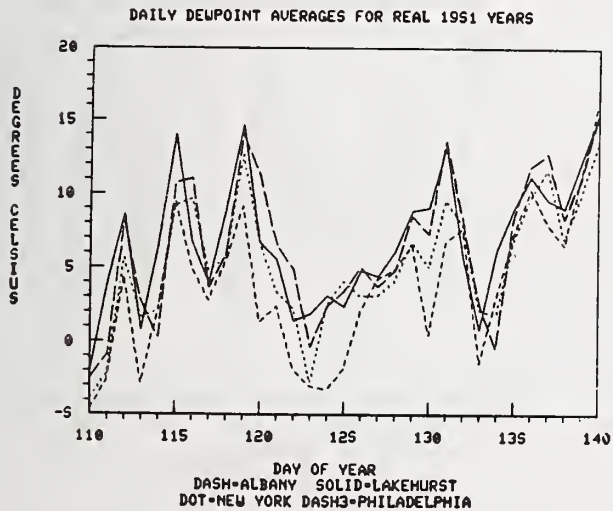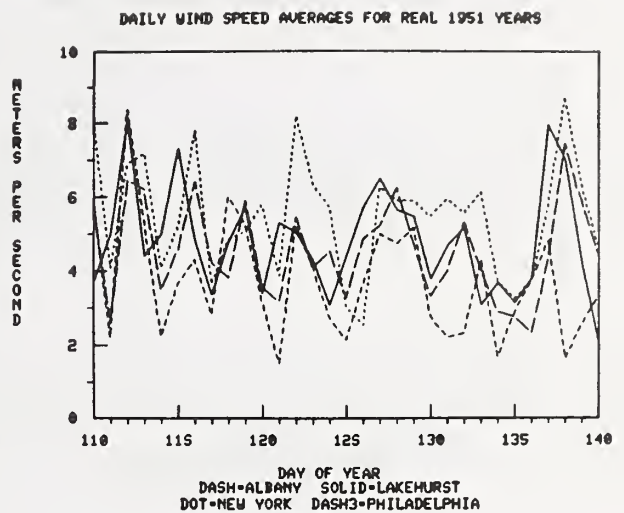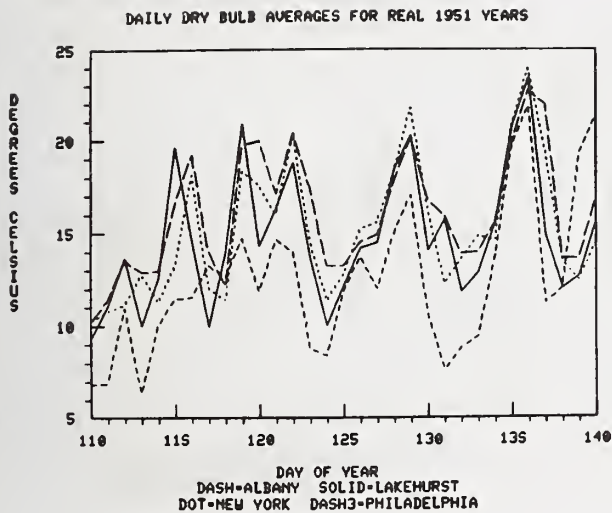
Figure 7.   Comparison of Daily Averages for Climate Elements in Spring.
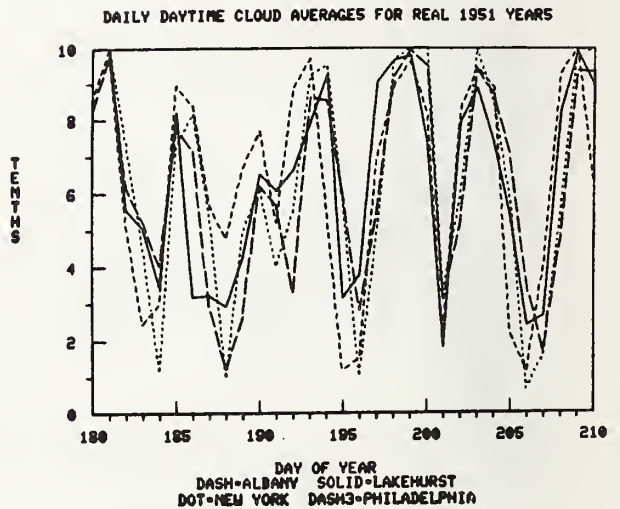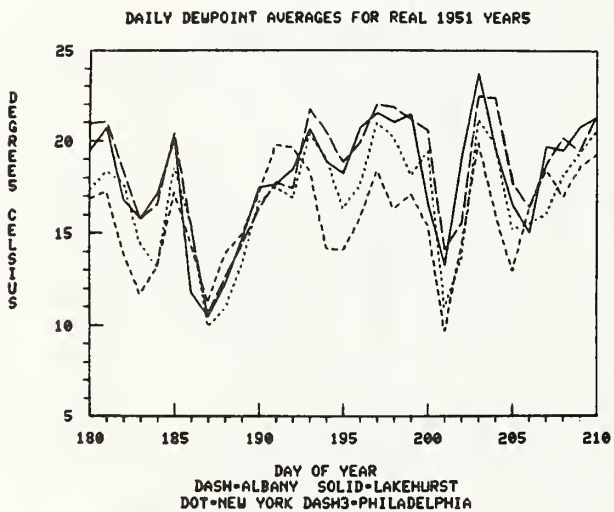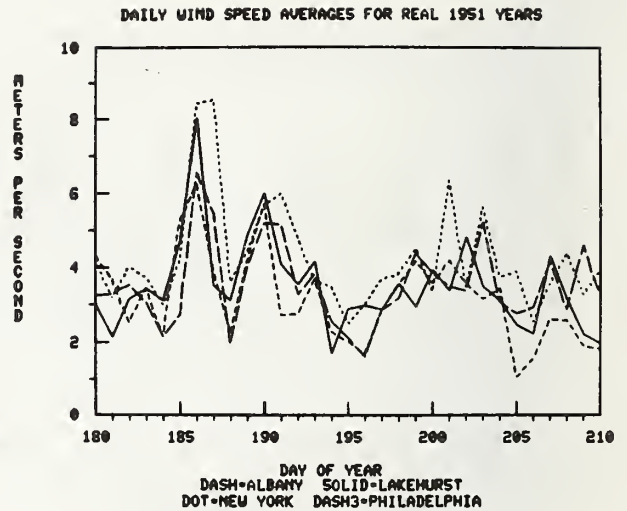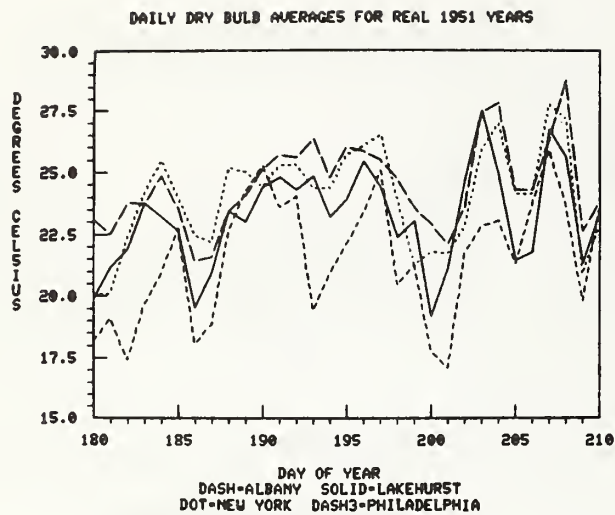
Figure 8.   Comparison of Daily Climate Elements in Summer.
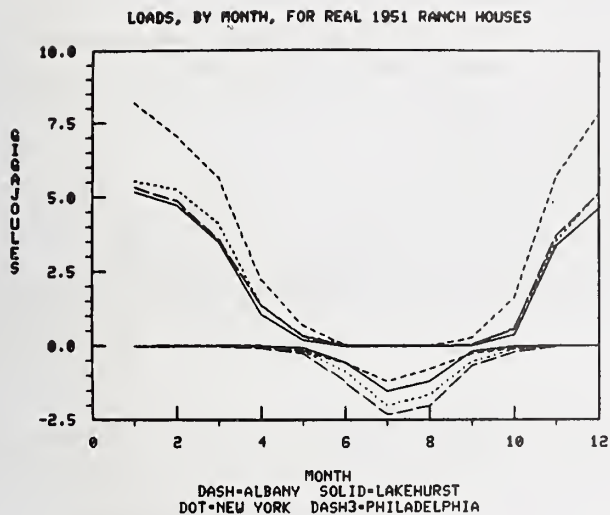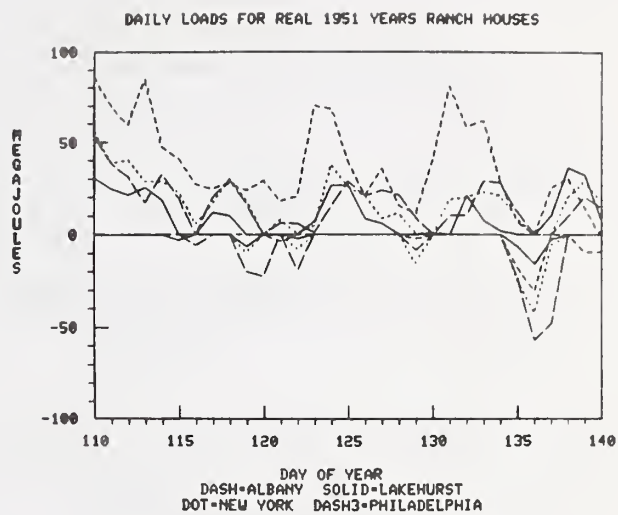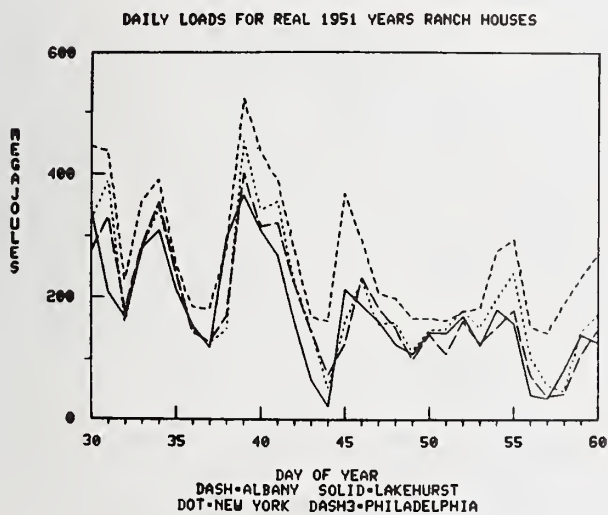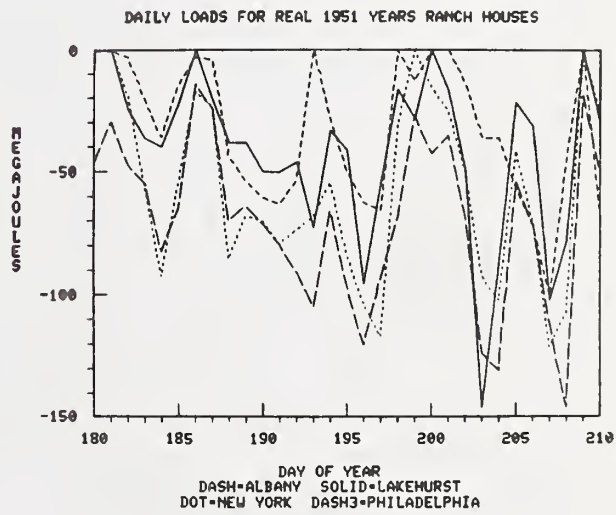
Figure 9. Heating and Cooling Requirements for Real Year Ranch Houses.
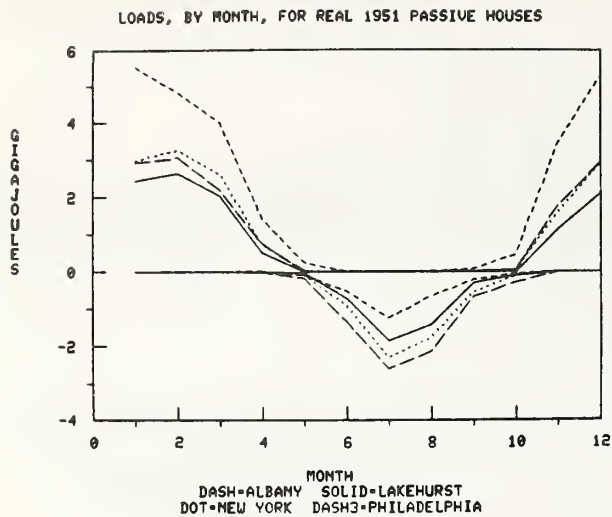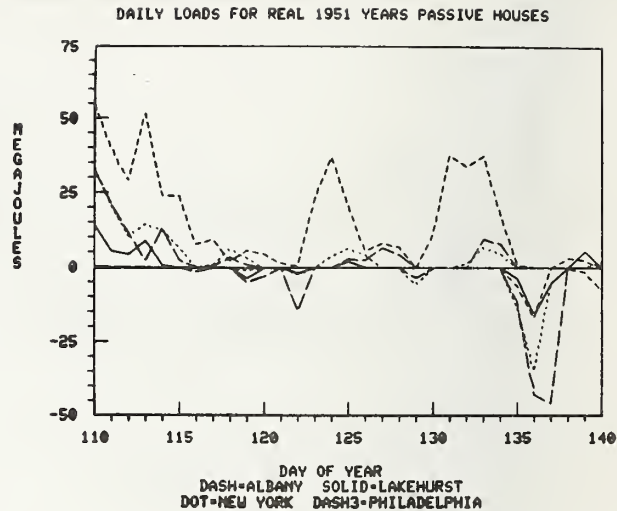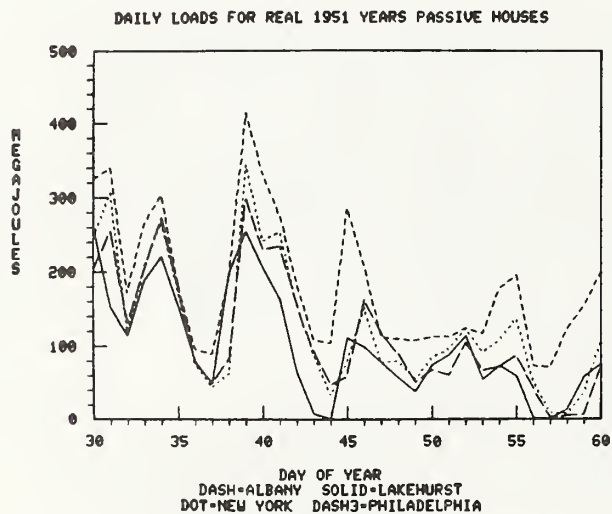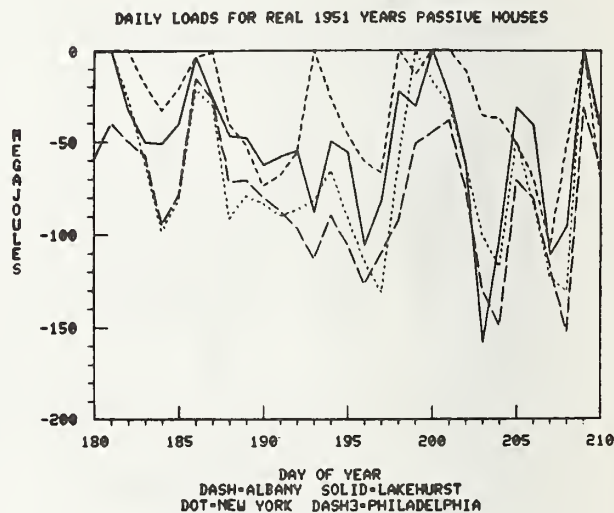
Figure 10.   Heating and Cooling Requirements for Real Year Passive Houses.

LOADS, BY MONTH, FOR REAL 1951 TOWNHOUSES

DASH=ALBANY   SOLID=LAKEHURST
DOT=NEW YORK   DASH3=PHILADELPHIA

Annual

DAILY LOADS FOR REAL 1951 YEARS TOWNHOUSES

DASH=ALBANY   SOLID=LAKEHURST
DOT=NEW YORK   DASH3=PHILADELPHIA

Transition Season

DAILY LOADS FOR REAL 1951 YEARS TOWNHOUSES

DASH=ALBANY   SOLID=LAKEHURST
DOT=NEW YORK   DASH3=PHILADELPHIA

Winter

DAILY LOADS FOR REAL 1951 YEARS TOWNHOUSES

DASH=ALBANY   SOLID=LAKEHURST
DOT=NEW YORK   DASH3=PHILADELPHIA

Summer

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 pro-
gram 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-

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[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.

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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

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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	-.145	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.

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.

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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.

MONTHLY HEATING LOADS FOR ALBANY OFFICE

GIGAJOULES REAL YEAR

GIGAJOULES SJ(ALB) YEAR
X=ACTUAL VALUES   SOLID=MODEL QR • QS
RESIDUAL STANDARD DEVIATION • 1.158

13A

MONTHLY HEATING LOADS FOR ALBANY OFFICE

GIGAJOULES SN(ALB) YEAR
X=ACTUAL VALUES   SOLID=MODEL QR • QS
RESIDUAL STANDARD DEVIATION • 1.637

13B

MONTHLY HEATING LOADS FOR ALBANY OFFICE

GIGAJOULES REAL YEAR

GIGAJOULES SJ(ALB)A(ALB) YEAR
X=ACTUAL VALUES   SOLID=MODEL QR • QS
RESIDUAL STANDARD DEVIATION • .437

13C

MONTHLY HEATING LOADS FOR ALBANY OFFICE

GIGJOULES SJ(JER)A(ALB) YEAR
X=ACTUAL VALUES   SOLID=MODEL QR • QS
RESIDUAL STANDARD DEVIATION • .411
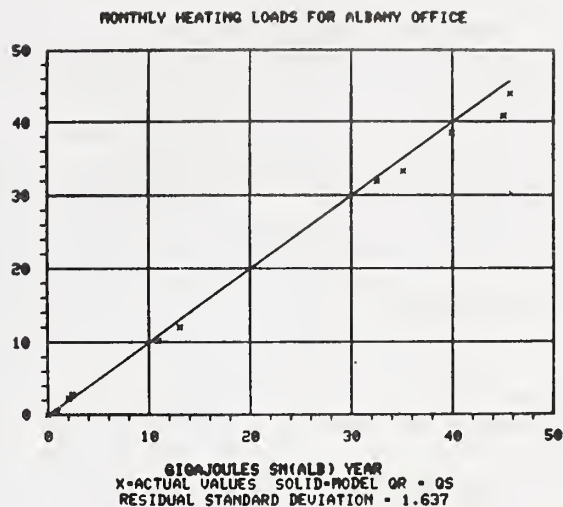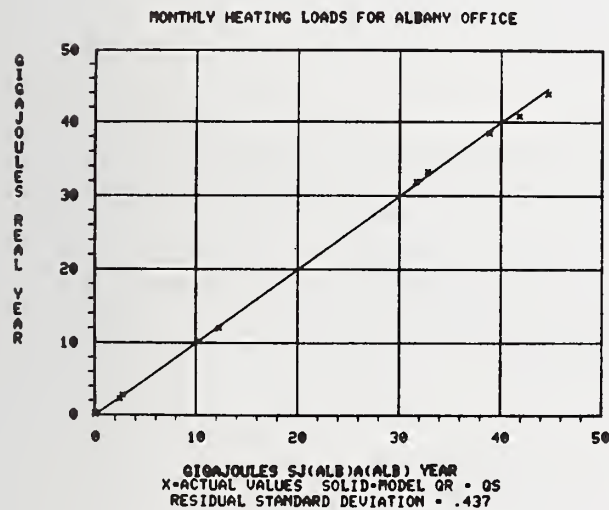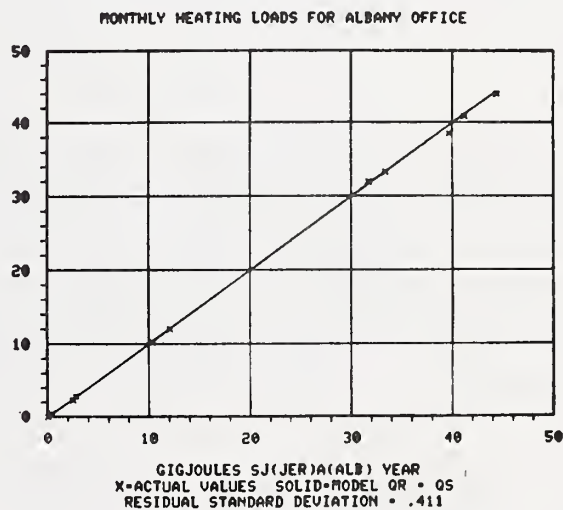
13D

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.

45
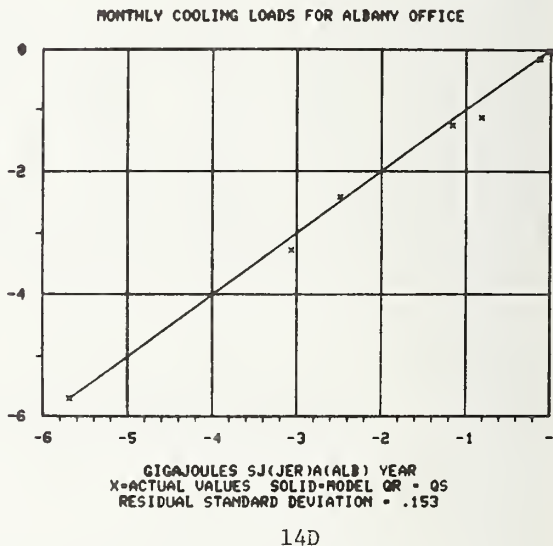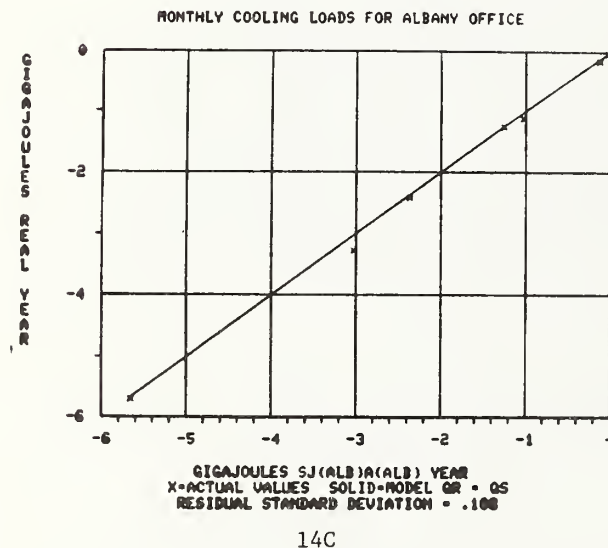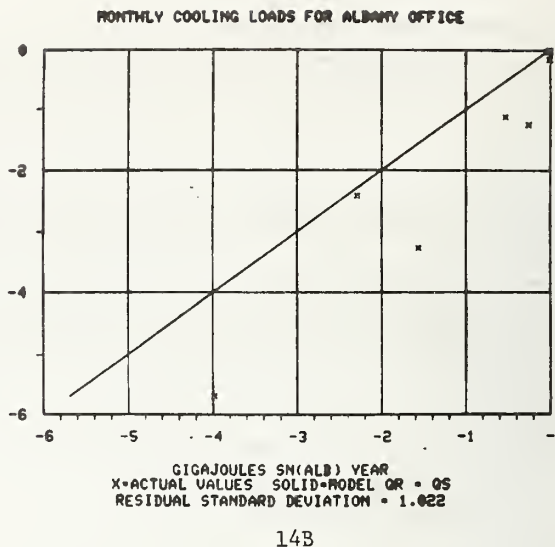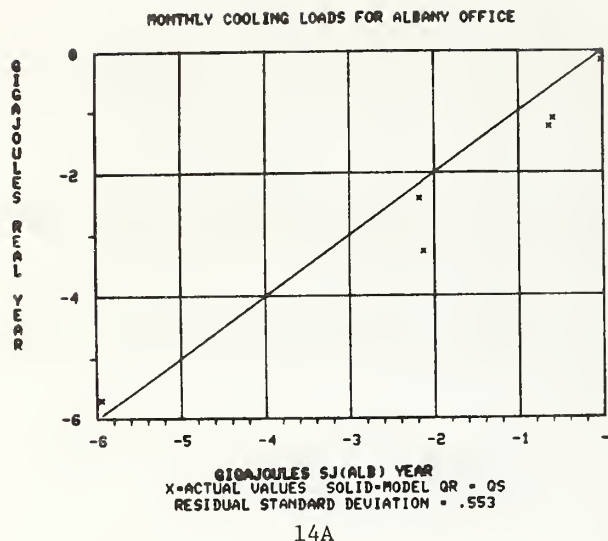
Figure 14.   Monthly Cooling Requirements for Albany Real Year
versus Synthetic Years, Using the Fort Meyer Office
Building.

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

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HEATING AND COOLING LOADS FOR PHILADELPHIA OFFICE.

MONTH	R(PHI)		R(JER)A(PHI)		R(NY)A(PHI)		SJ(JER)A(PHI)		SJ(PHI)A(PHI)	
	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.
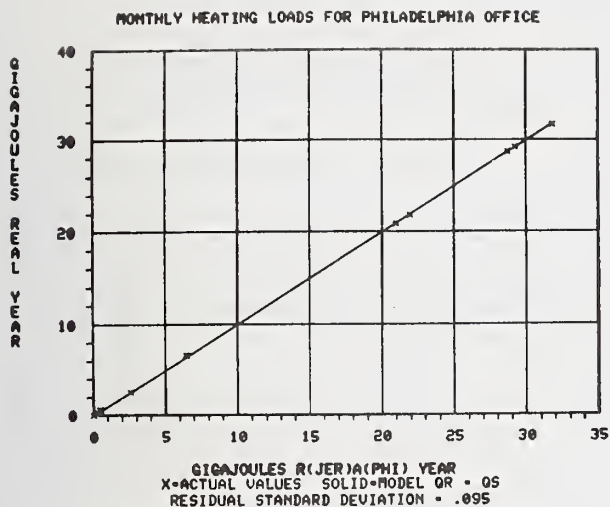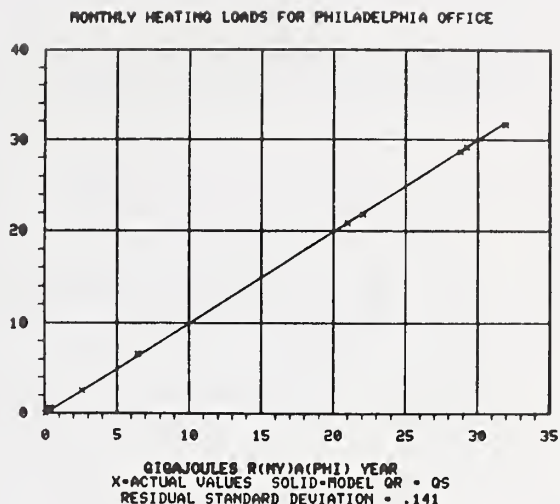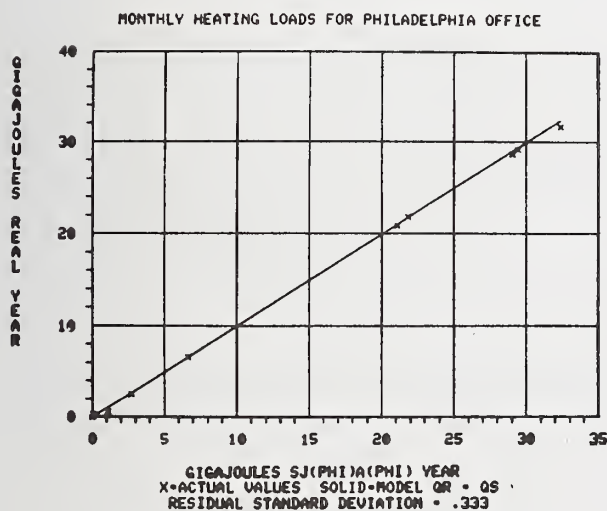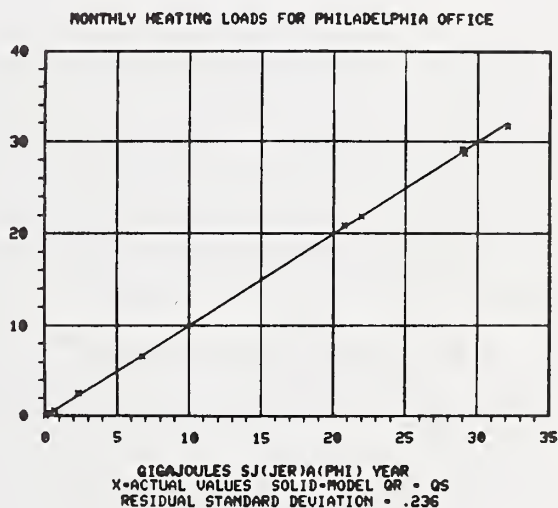
Figure 15. Monthly Heating Requirements for Philadelphia Real Year
versus Synthetic Years, Using the Fort Meyer Office
Building.

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.
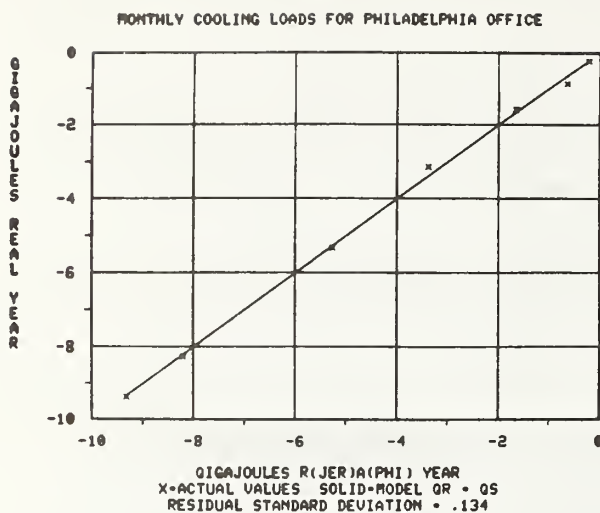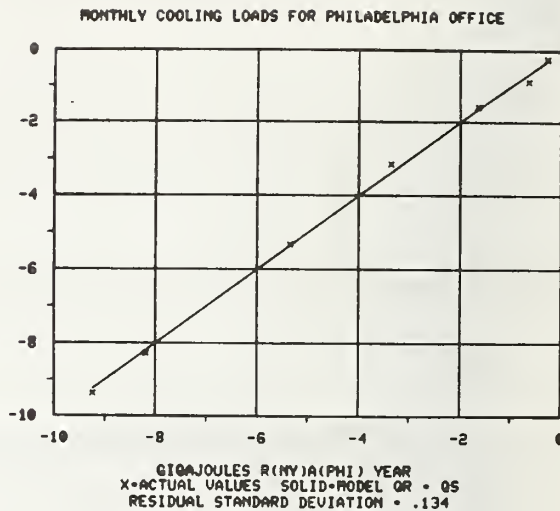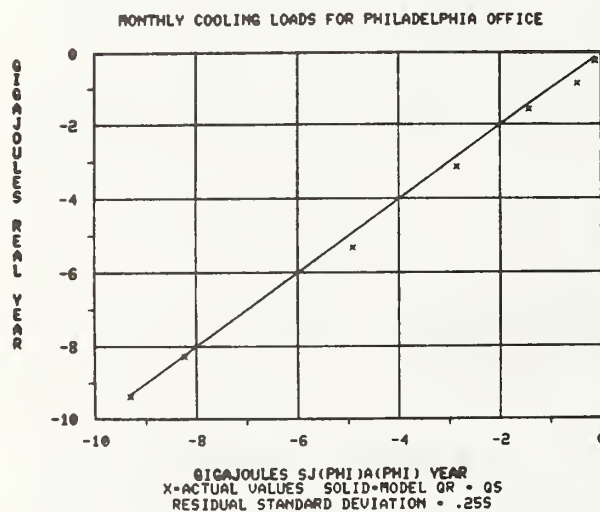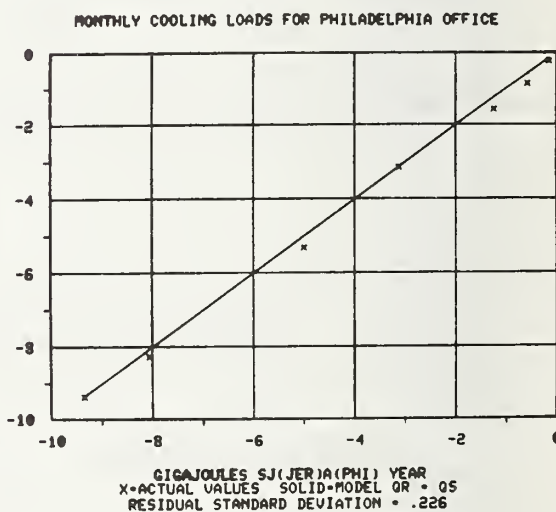
Figure 16. Monthly Cooling Requirements for Philadelphia Real Year
versus Synthetic Years, Using the Fort Meyer Office
Building.
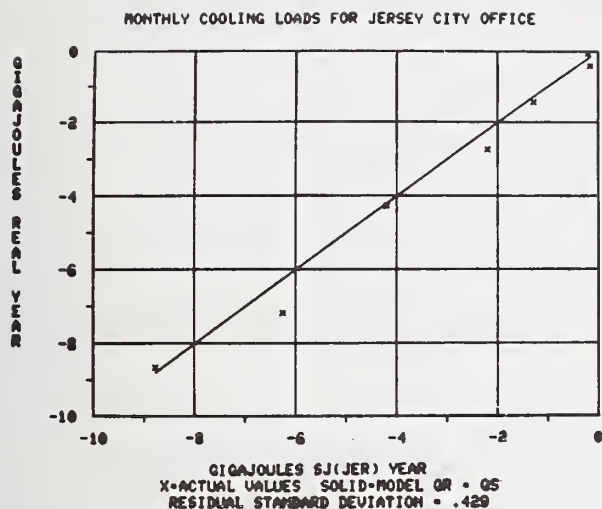
R   = Real 1951.
SJ = Selected Composite 1951 using Jersey City 1949-1958 as the source.
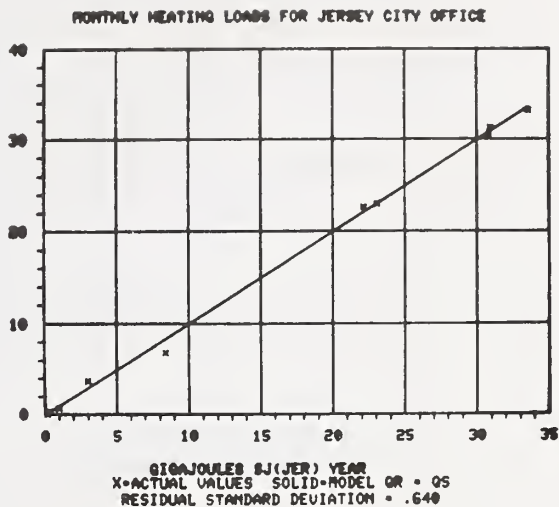SN = Selected Composite 1951 using New York 1949-1958 as the source.
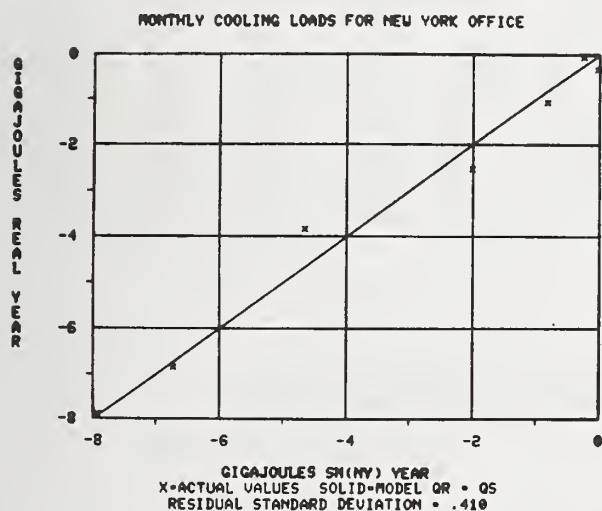JER = Jersey City 1951 averages used as input.
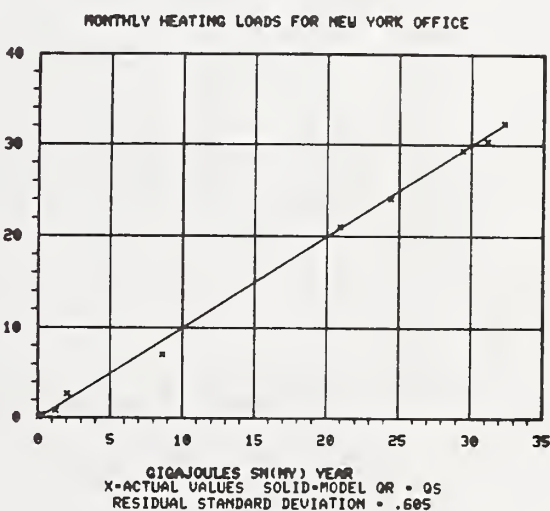NY = New York 1951 averages used as input.
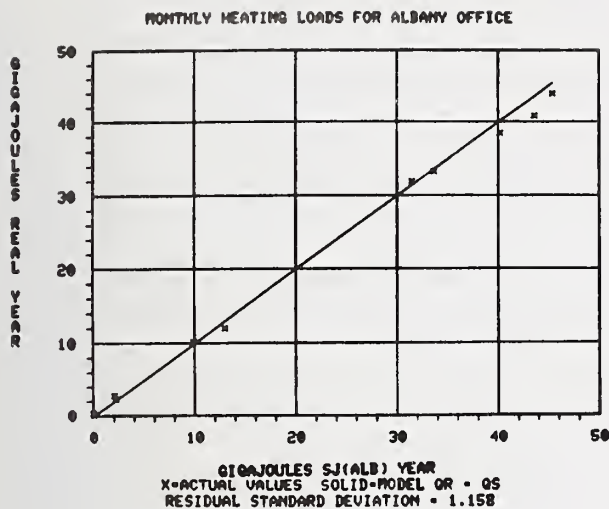ALB = Albany 1951 averages used as input.
PHI = Philadelphia 1951 averages used as input.
A   = Adjusted Synthetic 1951 made using prefix year.

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 correspond-
ing 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 predic-
tion 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 stan-
dard 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 repre-
sentative composite year for Jersey City was adjusted to both Philadel-
phia 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

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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 sub-stantially 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 compo-site 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.

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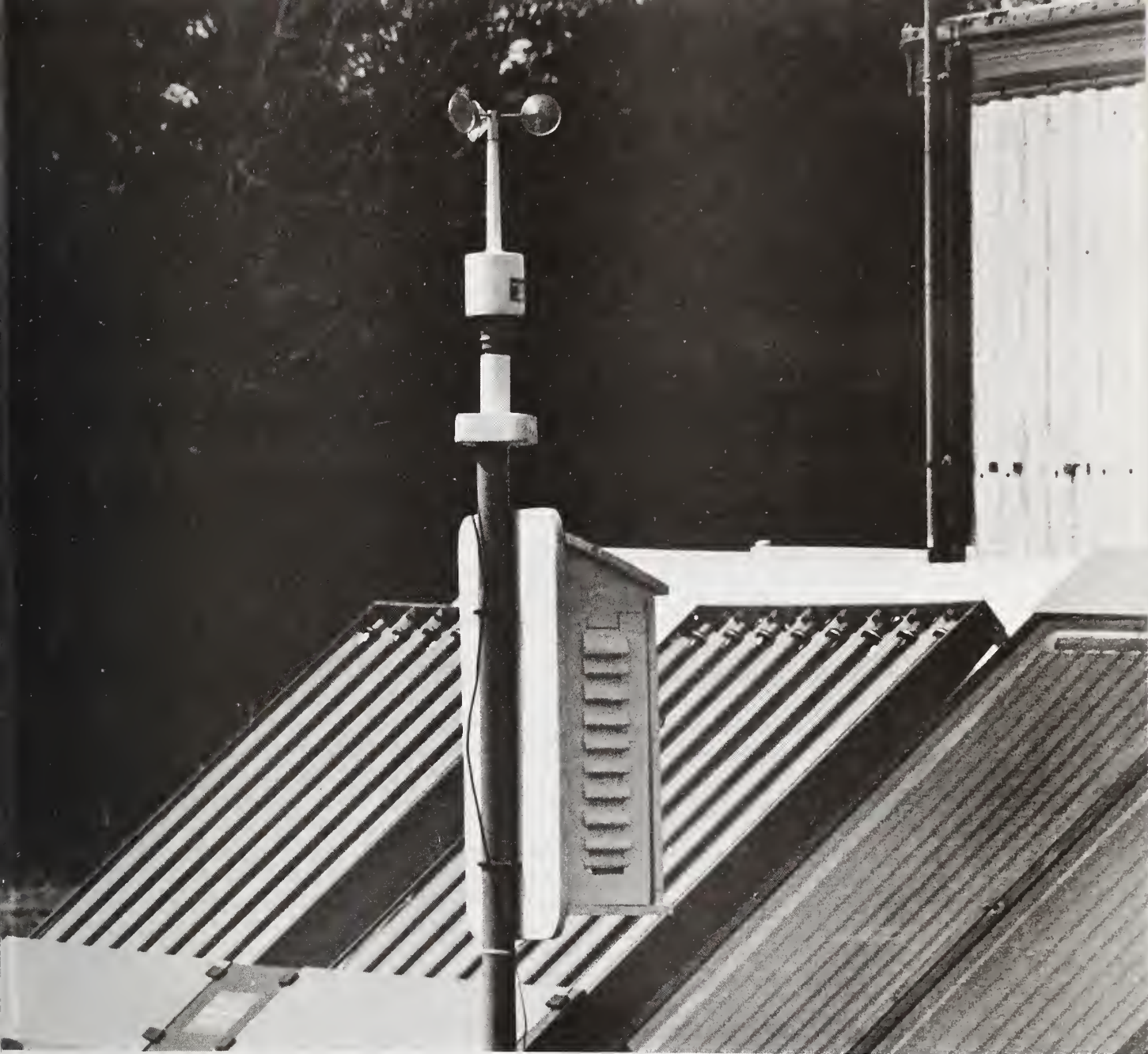
4. SYNTHESIZING CLIMATE DATA: CAVEATS

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 geographi-
cally 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 aver-
ages 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 stan-
dard 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 adjust-
ment of real weather data in the adjustment technique,
retains the naturally-occurring climate pattern, providing
the differences between the remote station's input aver-
ages and the source's averages are not excessive. The user
must, however, avoid extrapolations with excessive adjust-
ment, 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 adjust-
ment 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.

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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.

```
 1:   C
 2:   C                         SELECTED YEAR
 3:   C
 4:   C    MAIN ROUTINE OF A PROGRAM TO CREATE FULL YEAR WEATHER TAPES
 5:   C    FOR AREAS WHERE HOURLY DATA ARE NEEDED AND ONLY MONTHLY DATA ARE
 6:   C    AVAILABLE.   WEATHER DATA MUST BE IN NBSLD-DECODED FORMAT, AND
 7:   C    MAY BE ON TAPES OR IN FILES.   THE SELECTED YEAR IS CREATED BY
 8:   C    SELECTING 9, 10, OR 11 DAY SEGMENTS FROM AN INPUT SET OF YEARS.
 9:   C    UP TO TEN TAPES MAY BE USED TO DRAW ON TO CREATE A DEFINE FILE
10:   C    THREE TO TEN YEARS LONG.   THE SEGMENTS ARE CHOSEN FOR THEIR FIT
11:   C    WITH INPUT MONTHLY AVERAGES.   UP TO FOUR SETS OF MONTHLY
12:   C    AVERAGES MAY BE ENTERED WITH A FULL YEAR TAPE MADE FOR EACH.
13:   C    USE LOGICAL UNITS 15--24 FOR THE INPUT TAPES STARTING WITH 15.
14:   C    USE LOGICAL UNITS 11--14 FOR OUTPUT SELECTED YEARS STARTING WITH 11.
15:   C    THE FIT OF THE SEGMENTS IS BY USE OF A REGRESSION FORMULA, BASED
16:   C    ON THE ENERGY REQUIREMENTS OF THREE WIDELY DIFFERING BUILDINGS,
17:   C    WHICH USES A WEIGHTED SUM OF THE AVERAGE DRY BULB TEMPERATURE,
18:   C    DAYTIME CLOUD COVER, MOISTURE RATIO, AND WIND-SPEED-DRY-BULB
19:   C    CROSS-PRODUCT TO RANK THE SEGMENTS.   THE RANK IS AN ESTIMATE OF
20:   C    THE DIFFERENCE IN LOADS, IN MEGAJOULES PER DAY, BETWEEN THE
21:   C    SEGMENT AND ONE WITH THE INPUT MONTHLY AVERAGES, AS AVERAGED OVER THE
22:   C    THREE BUILDINGS.
23:   C    TEE SEGMENTS FOR A MONTH ARE SELECTED FROM THE SAME MONTH OR
24:   C    THE ADJACENT MONTH ON EITHER SIDE.
25:   C    A TEMPORARY FILE MUST BE ASSIGNED  TO HOLD A DEFINE FILE (3700,220,,).
26:   C    ASSIGN IT TO LOGICAL UNIT 10.
27:   C    SUBROUTINES:
28:   C                DAYW (MN,IDAY,DBTP,DRNG,CCAD,CCT,DDHT,DDCL,DEWP,WBTP,WNSP,
29:   C                      IYEAR,NUMDAY,INITYR,LOGUNI,DDBASH,DDBASC,BAPR)
30:   C                      READS DAY NUMDAY FROM THE TAPE ASSIGNED TO LOGUNI,
31:   C                      WRITES IT INTO OUR DEFINE FILE AND FINDS DAILY AVERAGES
32:   C                      AND OTHER VALUES AS ARE NEEDED IN THE MAIN PROGRAM.
33:   C                ORDER (RANKSP,ISEGDN,NUMBYR) ORDERS THE VALUES IN ARRAY RANKSP
34:   C                      IN INCREASING ORDER, PLACES SUBSCRIPTS OF THEIR ORIGINAL
35:   C                      POSITIONS IN ARRAY ISEGDN, NUMBYR IS THE NUMBER OF ENTRIES
36:   C                      IN RANKSP.
37:   C                SLYEAR (ICDT,LSEG,LOGUNI,IYRARR,RANKCH) WRITES OUT A SELECTED
38:   C                      YEAR INTO LOGICAL UNIT LOGUNI USING THE STARTING DAYS
39:   C                      IN ARRAY ICDT AND THE CORRESPONDING LENGTHS IN ARRAY
40:   C                      LSEG TO FIND THE CHOSEN SEGMENTS.   THE YEAR AND CITY
41:   C                      CODE FOR THE SELECTED YEAR MUST BE ENTERED BY THE USER.
42:   C                      ALSO WRITES THE YEAR AND RANK OF THE CHOSEN SEGMENTS
43:   C                      USING IYRARR AND RANKCH.
44:   C                SUNNY (RLATD,RLONG,TZN)
45:   C                      FINDS SUNRISE AND DAY LENGTH VALUES ON A MONTHLY
46:   C                      BASIS, WHEN GIVEN LATITUDE, LONGITUDE, AND TIME ZONE.
47:   C                DEWPNT (DBTP,WBTP,BPR,DEWP)
48:   C                      FINDS DEWPOINT WHEN SENT DRY BULB, WET BULB, AND
49:   C                      BAROMETRIC PRESSURE.
50:   C    FUNCTION:
51:   C        PVSF (DEWPIN OR DEWPSP) INPUTS A DEWPOINT TEMPERATURE AND RETURNS THE
52:   C              PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR, KILOPASCALS.
53:   C        DPF (VP)
54:   C              CALCULATES DEWPOINT FOR A GIVEN VAPOR PRESSURE.
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55:     C  VARIABLES:
56:     C     CCAD:   THE AVERAGE DAYTIME CLOUD COVER, FOUND IN DAYW, TENTHS.
57:     C     CCT:    THE AVERAGE TOTAL CLOUD COVER, FOUND IN DAYW, TENTHS.
58:     C     DBTP:   THE AVERAGE DRY BULB TEMPERATURE, FOUND IN DAYW, DEG. C.
59:     C     DRNG:   THE DAILY TEMPERATURE RANGE, FOUND IN DAYW, DEG. C.
60:     C     DEWP:   THE DEWPOINT TEMPERATURE, FOUND IN DAYW, DEG. C.
61:     C     WBTP:   THE WET BULB TEMPERATURE, FOUND IN DAYW, DEG. C.
62:     C     BAPR:   THE BAROMETRIC PRESSURE, FOUND IN DAYW, KILOPASCALS.
63:     C     WNSP:   THE WIND SPEED, FOUND IN DAYW,  M PER S.
64:     C     DDHT:   DEGREE DAYS HEATING BASED ON DDBASH.
65:     C     DDCL:   DEGREE DAYS COOLING BASED ON DDBASC.
66:     C     DADBTP(DAY):  THE STORED DBTP VALUE FOR EACH DAY.
67:     C     DBTPIN(MN):   THE INPUT DBTP VALUE TO BIAS OUR CHOICE OF
68:     C                   SEGMENTS, IN DEG. C. OR F.
69:     C     ZMDBTP:  STORES A DBTPIN VALUE SO WE CAN WORK WITH IT MORE EASILY.
70:     C     DBTPSL(YEAR,MN,LENGTH):  THE AVERAGE DBTP FOR OUR SELECTED SEGMENTS.
71:     C     DBTPSP(SEGMENT):  THE AVERAGE DBTP FOR THE SEGMENTS WE ARE CHOOSING
72:     C                       FROM FOR A MONTH.
73:     C     DBTPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
74:     C     YDBTP(MN):   THE AVERAGE DBTP FOR A MONTH FROM OUR INPUT SET.
75:     C     DBTPMN(N,MN):  THE MONTHLY AVERAGE DBTP FOR THE NTH INPUT YEAR.
76:     C     SLDBTP:  THE AVERAGE DBTP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
77:     C     DADEWP(DAY):  THE STORED DEWP VALUE FOR EACH DAY.
78:     C     DEWPIN(MN):   THE INPUT DEWP VALUE TO BIAS OUR CHOICE OF SEGMENTS.
79:     C     ZMWAMR:  STORES A MOISTURE RATIO VALUE SO WE CAN WORK WITH IT MORE EASILY
80:     C              COMPUTED FROM DEWPIN AND BAPRIN VALUES.
81:     C     DEWPSL(YEAR,MN,LENGTH):  THE AVERAGE DEWP FOR OUR SELECTED SEGMENTS.
82:     C     DEWPSP(SEGMENT):  THE AVERAGE DEWP FOR THE SEGMENTS WE ARE CHOOSING
83:     C                       FROM FOR A MONTH.
84:     C     DEWPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
85:     C     YDEWP(MN):   THE AVERAGE DEWP FOR A MONTH FROM OUR INPUT SET.
86:     C     DEWPMN(N,MN):  THE MONTHLY AVERAGE DEWP FOR THE NTH INPUT YEAR.
87:     C     SLDEWP:  THE AVERAGE DEWP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
88:     C     DAWBTP(DAY):  THE STORED WBTP VALUE FOR EACH DAY.
89:     C     WBTPSL(YEAR,MN,LENGTH):  THE AVERAGE WBTP FOR OUR SELECTED SEGMENTS.
90:     C     WBTPSP(SEGMENT):  THE AVERAGE WBTP FOR THE SEGMENTS WE ARE CHOOSING
91:     C                       FROM FOR A MONTH.
92:     C     WBTPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
93:     C     YWBTP(MN):   THE AVERAGE WBTP FOR A MONTH FROM OUR INPUT SET.
94:     C     WBTPMN(N,MN):   THE MONTHLY AVERAGE WBTP FOR THE NTH INPUT YEAR.
95:     C     SLWBTP:  THE AVERAGE WBTP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
96:     C     DAWNSP(DAY):  THE STORED WNSP VALUE FOR EACH DAY.
97:     C     WNSPIN(MN):   THE INPUT WNSP VALUE TO BIAS OUR CHOICE OF SEGMENTS,
98:     C                   IN METERS PER SEC. OR M.P.H.
99:     C     ZMWSDB:  STORES A WIND SPEED-DRY BULB PRODUCT VALUE SO WE CAN WORK WITH
100:    C              IT MORE EASILY COMPUTED FROM WNSPIN AND DBTPIN VALUES.
101:    C     WNSPSL(YEAR,MN,LENGTH):  THE AVERAGE WNSP FOR OUR SELECTED SEGMENTS.
102:    C     WNSPSP(SEGMENT):  THE AVERAGE WNSP FOR THE SEGMENTS WE ARE CHOOSING
103:    C                       FROM FOR A MONTH.
104:    C     WNSPX:  A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
105:    C     YWNSP(MN):   THE AVERAGE WNSP FOR A MONTH FROM OUR INPUT SET.
106:    C     WNSPMN(N,MN):  THE MONTHLY AVERAGE WNSP FOR THE NTH INPUT YEAR.
107:    C     SLWNSP:  THE AVERAGE WNSP FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
108:    C     DACCAD(DAY):  THE STORED CCAD VALUE FOR EACH DAY.
109:    C     CCADIN(MN):   THE INPUT CCAD VALUE TO BIAS OUR CHOICE OF SEGMENTS,
110:    C                   IN TENTHS.
111:    C     ZMCCT:  STORES A CCTIN OR CCADIN VALUE SO WE CAN WORK WITH IT MORE EASILY.
112:    C     CCADSL(YEAR,MN,LENGTH):  THE AVERAGE CCAD FOR OUR SELECTED SEGMENTS.
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113:     C          CCADSP(SEGMENT):   THE AVERAGE CCAD FOR THE SEGMENTS WE ARE CHOOSING
114:     C                             FROM FOR A MONTH.
115:     C          CCADX:   A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
116:     C          YCCAD(MN):   THE AVERAGE CCAD FOR A MONTH FROM OUR INPUT SET.
117:     C          CCADMN(N,MN):   THE MONTHLY AVERAGE CCAD FOR THE NTH INPUT YEAR.
118:     C          SLCCAD:   THE AVERAGE CCAD FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
119:     C          DACCT(DAY):   THE STORED CCT VALUE FOR EACH DAY.
120:     C          CCTIN(MN):   THE INPUT CCT VALUE TO BIAS OUR CHOICE OF SEGMENTS,
121:     C                       IN TENTHS.
122:     C          CCTSL(YEAR,MN,LENGTH):   THE AVERAGE CCT FOR OUR SELECTED SEGMENTS.
123:     C          CCTSP(SEGMENT):   THE AVERAGE CCT FOR THE SEGMENTS WE ARE CHOOSING
124:     C                             FROM FOR A MONTH.
125:     C          CCTX:   A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
126:     C          YCCT(MN):   THE AVERAGE CCT FOR A MONTH FROM OUR INPUT SET.
127:     C          CCTMN(N,MN):   THE MONTHLY AVERAGE CCT FOR THE NTH INPUT YEAR.
128:     C          SLCCT:   THE AVERAGE CCT FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
129:     C          DADRNG(DAY):   THE STORED DRNG VALUE FOR EACH DAY.
130:     C          DRNGSL(YEAR,MN,LENGTH):   THE AVERAGE DRNG FOR OUR SELECTED SEGMENTS.
131:     C          DRNGSP(SEGMENT):   THE AVERAGE DRNG FOR THE SEGMENTS WE ARE CHOOSING
132:     C                             FROM FOR A MONTH.
133:     C          DRNGX:   A SUMMING VARIABLE TO HELP FIND THE AVERAGES FOR THE SEGMENTS.
134:     C          YDRNG(MN):   THE AVERAGE DRNG FOR A MONTH FROM OUR INPUT SET.
135:     C          DRNGMN(N,MN):   THE MONTHLY AVERAGE DRNG FOR THE NTH INPUT YEAR.
136:     C          SLDRNG:   THE AVERAGE DRNG FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
137:     C          DADDHT(DAY):   THE STORED DDHT VALUE FOR EACH DAY.
138:     C          DDHTSL(YEAR,MN,LENGTH):   THE TOTAL DDHT FOR OUR SELECTED SEGMENTS.
139:     C          DDHTSP(SEGMENT):   THE TOTAL DDHT FOR THE SEGMENTS WE ARE CHOOSING
140:     C                             FROM FOR A MONTH.
141:     C          DDHTX:   A SUMMING VARIABLE TO HELP FIND THE TOTALS FOR THE SEGMENTS.
142:     C          YDDHT(MN):   THE TOTAL DDHT FOR A MONTH FROM OUR INPUT SET.
143:     C          DDHTMN(N,MN):   THE MONTHLY TOTAL DDHT FOR THE NTH INPUT YEAR.
144:     C          SLDDHT:   THE TOTAL DDHT FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
145:     C          DADDCL(DAY):   THE STORED DDCL VALUE FOR EACH DAY.
146:     C          DDCLSL(YEAR,MN,LENGTH):   THE TOTAL DDCL FOR OUR SELECTED SEGMENTS.
147:     C          DDCLSP(SEGMENT):   THE TOTAL DDCL FOR THE SEGMENTS WE ARE CHOOSING
148:     C                             FROM FOR A MONTH.
149:     C          DDCLX:   A SUMMING VARIABLE TO HELP FIND THE TOTALS FOR THE SEGMENTS.
150:     C          YDDCL(MN):   THE TOTAL DDCL FOR A MONTH FROM OUR INPUT SET.
151:     C          DDCLMN(N,MN):   THE MONTHLY TOTAL DDCL FOR THE NTH INPUT YEAR.
152:     C          SLDDCL:   THE TOTAL DDCL FOR OUR SELECTED YEAR, DONE FOR EACH MONTH.
153:     C          DDBASH:   THE BASE TEMPERATURE FOR THE DEGREE DAYS HEATING (DDHT), DEG. C.
154:     C          DDBASC:   THE BASE TEMPERATURE FOR THE DEGREE DAYS COOLING (DDCL), DEG. C.
155:     C          BAPRIN(MN):   INPUT MONTHLY BAROMETRIC PRESSURE KPASCAL, OR IN OF HG.
156:     C          DEWPIN(MN):   INPUT MONTHLY DEWPOINT TEMPERATURE DEG. C. OR F.
157:     C          PVS:   PARTIAL VAPOR PRESSURE CALCULATED FOR SEGMENT DEWPSP(I).
158:     C          ARRAY(216):   USED TO READ IN THE REAL VALUES FROM OUR WEATHER TAPES.
159:     C          ICDT(MN,1-3):   THE STARTING DAYS OF OUR CHOSEN SEGMENTS AS THEY ARE IN
160:     C                          THE DEFINE FILE.
161:     C          ICHYR(MN,1-3):   THE YEAR OF OUR CHOSEN SEGMENTS (IN TERMS OF WHEN
162:     C                           IT WAS READ IN).
163:     C          ICHYR1,ICHYR2,ICHYR3:   TEMPORARY STORING PLACE FOR ICHYR VALUES.
164:     C          LSEG(MN,1-3):   THE LENGTH OF THE SEGMENTS IN SELECTED YEAR.
165:     C          RLSEG:   REAL NUMBER VALUE FOR LSEG(MN,3).
166:     C          RAVG:   USED TO FIND THE PROPER WEIGHTING OF SEGMENTS IN AVERAGING.
167:     C          RANKSP(SEGMENT):   THE VALUE OF THE REGRESSION EQUATION FOR A SEGMENT.
168:     C          RANKCH(MONTH,TYPE):   THE RANK OF THE CHOSEN SEGMENTS.
169:     C          DLCCT:   THE DIFFERENCE BETWEEN THE INPUT MONTHLY CCT OR CCAD
170:     C                   (CCTIN(MN) NOW IN ZMCCT) AND THE AVERAGE CCT (CCTSP(I)).
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171:     C        DLDBTP(SEGMENT):   THE DIFFERENCE BETWEEN THE INPUT MONTHLY DBTP
172:     C                  (DBTPIN(MN) NOW IN ZMDBTP) AND THE AVERAGE DBTP (DBTPSP(I)).
173:     C        DLWAMR:   THE DIFFERENCE BETWEEN THE COMPUTED INPUT MONTHLY WAMR IN
174:     C                  ZMWAMR AND THE AVERAGE WAMRSP.
175:     C        DLWSDB:   THE DIFFERENCE BETWEEN THE COMPUTED INPUT MONTHLY WSDB IN
176:     C                  ZMWSDB AND THE AVERAGE WSDBSP .
177:     C        DBDVMN(MN):   THE AVERAGE DEVIATION OF THE DRY BULB AVERAGES OF THE SEGMENT
178:     C                  IN THE MONTHS IN OUR INPUT TAPE, TIMES 10, DEG. C.
179:     C        LEAPS:   THE NUMBER OF LEAP YEARS IN THE INPUT WEATHER TAPE.
180:     C        NEXTMN,NEXTYR:   THE MONTH AND YEAR OF THE MONTH AFTER THE ONE FOR
181:     C                  WHICH WE ARE FINDING THE SELECTED SEGMENT.
182:     C        INIDAY:   THE FIRST DAY OF OUR SELECTION FOR A MONTH.
183:     C        NENDAY:   THE LAST DAY OF OUR SELECTION RANGE.
184:     C        ISLDT(YEAR,MN,LENGTH TYPE):   THE STARTING DAY OF OUR SELECTED SEGMENTS.
185:     C        ISEG:   THE LENGTH OF THE SEGMENT WE ARE LOOKING FOR NOW.
186:     C        NUMRUN:   THE NUMBER OF SELECTED YEAR TAPES TO BE MADE.
187:     C        LOGUNI:   THE LOGICAL UNIT TO BE USED FOR THIS OPERATION.
188:     C        INTAPE:   THE NUMBER OF WEATHER TAPES TO BE DRAWN ON FOR OUR
189:     C                  SEGMENT SELECTION FILE.
190:     C        NSPAN:   THE NUMBER OF SEGMENTS AVAILABLE FOR A MONTH.
191:     C        L1DAY,L2DAY: USED TO KEEP TRACK OF INIDAY'S NEXT INCREASE.
192:     C        IDV:   USED TO SEE WHICH SEGMENT OF THE MONTH WE ARE DEALING WITH.
193:     C        IDVARR(IDV):   CONTAINS THE ORDER OF SEGMENT SELECTION.
194:     C        NEXTDV,LASTDV:   THE POSITION OF THE SEGMENTS SURROUNDING THE ONES
195:     C                  WE ARE PICKING./
196:     C        SIGNX:   USES THE ADJOINING MONTHS DRYBULB INPUT AVERAGES TO DECIDE THE
197:     C                  PLACEMENT OF THE SEGMENTS.
198:     C        IYRARR(NYR):   STORES THE A.D. YEAR OF OUR INPUT WEATHER YEARS.
199:     C        IDAY:   DAY OF MONTH OF DATA FROM DAY.
200:     C        NDAY(YEAR,MN):   THE NUMBER OF DAYS IN A MONTH.
201:     C        NDAYT(MN):   THE TOTAL NUMBER OF DAYS IN A MONTH SUMMED
202:     C                  FOR ALL THE INPUT YEARS.
203:     C        NUMBYR:   THE TOTAL NUMBER OF YEARS OF WEATHER TAPE INPUT.
204:     C        NUMDAY:   THE TOTAL NUMBER OF DAYS OF INPUT WEATHER TAPE.
205:     C        NODAY:   THE NUMBER OF DAYS TO BE TAKEN FROM AN INPUT FILE.
206:     C        NOYR:   THE NUMBER OF YEARS TO BE USED FROM AN INPUT FILE.
207:     C        INITYR:   THE FIRST YEAR TO BE USED FROM AN INPUT FILE.
208:     C        MN:   MONTH.
209:     C        ISIFLG:   THE FLAG FOR SIGNALING IF AVERAGES ARE TO BE ENTERED IN
210:     C                  NON-SI UNITS.
211:     C        IBPFLG:   THE FLAG FOR SIGNALING IF BAROMETRIC PRESSURE AVERAGES ARE TO BE
212:     C                  ENTERED OR IF THE INPUT TAPES AVERAGES SHOULD BE USED.
213:     C        IDBFLG:   1 FOR MAXIMUM MINIMUM AVERAGE USE, 0 FOR 24-AVERAGE USE.
214:     C        I1DBDV,I2DBDV,I3DBDV:   USED TO DETERMINE THE SEGMENTS USED IN THE
215:     C                  DEVIATION CALCULATIONS.
216:     C        IDAWN:   THE MONTHLY VALUES FOR SUNRISE.
217:     C        LENGTH:   THE MONTHLY VALUES FOR LENGTH OF DAYLIGTH.
218:     C
219:     C                  DECLARE THE DIMENSIONS (ALL TYPES BY NAME.).
220:     C
221:              DIMENSION ICDT(12,3), ISLDT(10,12,3), LSEG(12,3), WBTPSL(10,12,3),
222:             * NDAY(10,12), NDAYT(12), RANKSP(83), RANKSL(10,12,3), IDVARR(12,5),
223:             * ISEGDN(10), WARRAY(216), DRNGSL(10,12,3), DVAJIN(12), YDSD(12),
224:             * DACCT(3660), CCTSL(10,12,3), CCTSP(83), CCTIN(12,3), YWBTP(12),
225:             * DACCAD(3660), CCADSL(10,12,3), CCADSP(83), YCCAD(12), BAPRSP(83),
226:             * DADBTP(3660), DBTPSL(10,12,3), DBTPIN(12,3), DBTPSP(83),
227:             * CCTMN(10,12), YCCT(12), DBTPMN(10,12), YDBTP(12), YDDHT(12),
228:             * DRNGMN(10,12), YDRNG(12), DRNGSP(83), DBDVMN(12), BAPRIN(12),
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229:              * RANKCH(12,3),ICY(12,3),IYRARR(10),DABAPR(3660),DADRNG(3660),
230:              * DADDHT(3660),DDHTSL(10,12,3),DDHTSP(83),DDHTMN(10,12),
231:              * DADDCL(3660),DDCLSL(10,12,3),DDCLSP(83),DDCLMN(10,12),
232:              * CCTRN(12),BAPRMN(10,12),YDDCL(12),DBTPRN(13),SLDBTP(12),
233:              * DAWNSP(3660),DAWBTP(3660),DADEWP(3660),DEWPIN(12,3),WNSPIN(12,3),
234:              * WNSPRN(12),DEWPRN(12),DEWPSP(83),WNSPSP(83),YBAPR(12),WBTPSP(83),
235:              * WNSPSL(10,12,3),DEWPSL(10,12,3),WNSPMN(10,12),DEWPMN(10,12),
236:              * YWNSP(12),BAPRSL(10,12,3),YDEWP(12),WBTPMN(10,12),CCADMN(10,12)
237:                COMMON /DT/ IDAWN(12),LENGTH(12)
238:      C                        INITIALIZE VALUES.
239:                DATA LSEG /10,9,10,10,10,10,10,10,10,10,10,10,11,10,11,10,11,10,11
240:              * ,11,10,11,10,11,10,9,10,10,10,10,10,10,10,10,10,10/
241:                DEFINE FILE 10 (3660,220,V,NPLACE)
242:                CALL PGSIZE (3,64)
243:      C                        ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOLLOWED
244:      C                        BY THE NUMBER OF TAPES  USED TO INPUT WEATHER YEARS,
245:      C                        THE NUMBER OF SELECTED YEARS TO BE MADE,  THE BASE
246:      C                        TEMPERATURES FOR DEGREE DAYS CALCULATIONS AND THE
247:      C                        HEIGHT TO BE USED FOR THE INPUT STATION.
248:                PRINT 600
249:                READ (5,500) RLATD,RLONG,TZN,INTAPE,NUMRUN,H1,IDBFLG,DDBASH,DDBASC
250:                CALL SUNNY (RLATD,RLONG,TZN)
251:                NUMRUN=NUMRUN+10
252:                INTAPE=INTAPE+14
253:                NUMBYR=0
254:                NUMDAY=0
255:                IDAY=0
256:      C                        FOR EACH INPUT TAPE:  READ THE PROPER YEARS INTO
257:      C                        OUR DEFINE FILE AND INCREMENT OUR YEAR AND DAY
258:      C                        COUNTS AS NEEDED.   THE FIRST YEAR OF THE TAPE TO
259:      C                        BE USED AND THE NUMBER OF YEARS TO BE USED MUST
260:      C                        BE INPUT AS REQUESTED.
261:                DO 50 LOGUNI=15,INTAPE
262:                  PRINT 605 LOGUNI
263:                  READ (5,500) INITYR,NOYR
264:      C                        SEE IF WE ARE AT THE START OF THE PROPER YEAR, IF NOT
265:      C                        READ UNTIL WE GET THERE.
266:                  READ (LOGUNI) WARRAY,IYEAR,MN,ID,ICITY
267:                  REWIND LOGUNI
268:                  IF (IYEAR-INITYR) 10,20,20
269:           10   READ (LOGUNI) WARRAY,IYEAR,MN,ID,ICITY
270:                  IF (IYEAR-INITYR+MN+ID-42) 10,,
271:      C            FIND THE INCREMENT FOR OUR DAY AND YEAR COUNTS AND USE THEM
272:           20   LEAPS=(MOD(INITYR-1,4)+NOYR)/4
273:                  NODAY=365*NOYR+LEAPS
274:                  DO 30 I=1,NOYR
275:                    IYRARR(NUMBYR+I)=INITYR+I-1
276:           30     CONTINUE
277:                  INITYR=INITYR-NUMBYR
278:      C                        FOR EACH DAY OF WEATHER DATA CALL DAYW TO
279:      C                        GET THE DAILY AVERAGES AND OTHER NECESSARY
280:      C                        INFORMATION AND STORE IT IN THE DA ARRAYS
281:      C                        ALSO SUM THE VALUES IN OUR MONTHLY AVERAGE ARRAYS.
282:      C                        NOTE: DAYW WRITES INTO THE DEFINE FILE.
283:                  DO 40 K=1,NODAY
284:                    CALL DAYW (MN,ID,DBTP,DRNG,CCT,CCAD,DDHT,DDCL,DEWP,WBTP,
285:              *     WNSP,IYEAR,NUMDAY,INITYR,LOGUNI,DDBASH,DDBASC,BAPR,IDBFLG)
286:                    DACCT(NUMDAY)=CCT
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287:                  DACCAD(NUMDAY)=CCAD
288:                  CCTMN(IYEAR,MN)=CCTMN(IYEAR,MN)+CCT
289:                  CCADMN(IYEAR,MN)=CCADMN(IYEAR,MN)+CCAD
290:                  DADBTP(NUMDAY)=DBTP
291:                  DBTPMN(IYEAR,MN)=DBTPMN(IYEAR,MN)+DBTP
292:                  DADRNG(NUMDAY)=DRNG
293:                  DRNGMN(IYEAR,MN)=DRNGMN(IYEAR,MN)+DRNG
294:                  DADEWP(NUMDAY)=DEWP
295:                  DAWBTP(NUMDAY)=WBTP
296:                  DEWPMN(IYEAR,MN)=DEWPMN(IYEAR,MN)+DEWP
297:                  DAWNSP(NUMDAY)=WNSP
298:                  WNSPMN(IYEAR,MN)=WNSPMN(IYEAR,MN)+WNSP
299:                  DADDHT(NUMDAY)=DDHT
300:                  DDHTMN(IYEAR,MN)=DDHTMN(IYEAR,MN)+DDHT
301:                  DADDCL(NUMDAY)=DDCL
302:                  DDCLMN(IYEAR,MN)=DDCLMN(IYEAR,MN)+DDCL
303:                  DABAPR(NUMDAY)=BAPR
304:                  BAPRMN(IYEAR,MN)=BAPRMN(IYEAR,MN)+BAPR
305:                  WBTPMN(IYEAR,MN)=WBTPMN(IYEAR,MN)+WBTP
306:                  NDAY(IYEAR,MN)=ID
307:       40      CONTINUE
308:               NUMBYR=NUMBYR+NOYR
309:       50  CONTINUE
310:               PRINT 610
311:    C                          FOR EACH MONTH: GET THE FULL SET   MONTHLY AVERAGES
312:    C                          AND WRITE THEM OUT.
313:               DO 70 MN=1,12
314:    C                          FOR EACH YEAR: SUM THE MONTHLY TOTALS, GET THE MONTHLY
315:    C                          AVERAGES AND WRITE THEM OUT.
316:               DO 60 NYR=1,NUMBYR
317:               N=NDAY(NYR,MN)
318:               YCCT(MN)=YCCT(MN)+CCTMN(NYR,MN)
319:               YCCAD(MN)=YCCAD(MN)+CCADMN(NYR,MN)
320:               CCTMN(NYR,MN)=CCTMN(NYR,MN)/N
321:               CCADMN(NYR,MN)=CCADMN(NYR,MN)/N
322:               YDBTP(MN)=YDBTP(MN)+DBTPMN(NYR,MN)
323:               DBTPMN(NYR,MN)=DBTPMN(NYR,MN)/N
324:               YDRNG(MN)=YDRNG(MN)+DRNGMN(NYR,MN)
325:               DRNGMN(NYR,MN)=DRNGMN(NYR,MN)/N
326:               YDEWP(MN)=YDEWP(MN)+DEWPMN(NYR,MN)
327:               YWBTP(MN)=YWBTP(MN)+WBTPMN(NYR,MN)
328:               DEWPMN(NYR,MN)=DEWPMN(NYR,MN)/N
329:               WBTPMN(NYR,MN)=WBTPMN(NYR,MN)/N
330:               YWNSP(MN)=YWNSP(MN)+WNSPMN(NYR,MN)
331:               WNSPMN(NYR,MN)=WNSPMN(NYR,MN)/N
332:               YBAPR(MN)=YBAPR(MN)+BAPRMN(NYR,MN)
333:               BAPRMN(NYR,MN)=BAPRMN(NYR,MN)/N
334:               YDDHT(MN)=YDDHT(MN)+DDHTMN(NYR,MN)
335:               YDDCL(MN)=YDDCL(MN)+DDCLMN(NYR,MN)
336:               NDAYT(MN)=NDAYT(MN)+N
337:               PRINT 615 IYRARR(NYR),MN,DBTPMN(NYR,MN),DRNGMN(NYR,MN),
338:         *      DEWPMN(NYR,MN),WBTPMN(NYR,MN),CCTMN(NYR,MN),CCADMN(NYR,MN),
339:         *      WNSPMN(NYR,MN),BAPRMN(NYR,MN),DDHTMN(NYR,MN),DDCLMN(NYR,MN)
340:       60      CONTINUE
341:               IDVARR(MN,1)=2
342:               N=NDAYT(MN)
343:               YCCT(MN)=YCCT(MN)/N
344:               YCCAD(MN)=YCCAD(MN)/N
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345:              YDBTP(MN)=YDBTP(MN)/N
346:              YDRNG(MN)=YDRNG(MN)/N
347:              YDEWP(MN)=YDEWP(MN)/N
348:              YWBTP(MN)=YWBTP(MN)/N
349:              YWNSP(MN)=YWNSP(MN)/N
350:              YBAPR(MN)=YBAPR(MN)/N
351:              YDDCL(MN)=YDDCL(MN)/NUMBYR
352:              YDDHT(MN)=YDDHT(MN)/NUMBYR
353:              PRINT 620 MN,YDBTP(MN),YDRNG(MN),YDEWP(MN),YWBTP(MN),
354:         *      YCCT(MN),YCCAD(MN),YWNSP(MN),YBAPR(MN),YDDHT(MN),YDDCL(MN)
355:       70 CONTINUE
356:    C                        FOR EACH YEAR:
357:           DO 90 NYR=1,NUMBYR
358:    C                        FOR EACH MONTH:
359:            DO 90 MN=1,12
360:    C                        FIND THE DAILY STANDARD DEVIATION.
361:              N=NDAY(NYR,MN)
362:              DSDM=0.0
363:              DO 80 ND=1,N
364:                 IDAY=IDAY+1
365:                 DSDM=DSDM+(DBTPMN(NYR,MN)-DADBTP(IDAY))**2
366:       80     CONTINUE
367:              DSDM=SQRT(DSDM/(N-1))
368:        ·     YDSD(MN)=YDSD(MN)+DSDM/NUMBYR
369:       90 CONTINUE
370:    C                        FOR EACH SELECTED YEAR TO BE CREATED:
371:           DO 400 LOGUNI=11,NUMRUN
372:    C                        FIND HOW THE AVERAGES ARE TO BE ENTERED AND READ
373:    C                        THEM IN FOR EACH MONTH.  IF CALCULATIONS ARE NEEDED,
374:    C                        MAKE THEM.
375:              PRINT 625 LOGUNI
376:              READ (5,500) ISIFLG,IBPFLG,H2,IWBFLG,ICCFLG
377:              DELH=H2-H1
378:              PRINT 630
379:              IF (ISIFLG.EQ.1) PRINT 635
380:              IF (ISIFLG.EQ.0) PRINT 640
381:              DO 110 MN=1,12
382:                 PRINT 645 MN
383:                 READ (5,500) DBTPRN(MN),CCTRN(MN),WNSPRN(MN),
384:         *        DEWPRN(MN),BAPRIN(MN),DVAJIN(MN)
385:                 IF (ISIFLG.EQ.0) GO TO 100
386:                 DBTPRN(MN)=(DBTPRN(MN)-32.0)*5/9
387:                 DEWPRN(MN)=(DEWPRN(MN)-32.0)*5/9
388:                 WNSPRN(MN)=WNSPRN(MN)*1.609/3.6
389:                 BAPRIN(MN)=BAPRIN(MN)*101.1/29.921
390:       100       IF (IBPFLG.EQ.1) BAPRIN(MN)=YBAPR(MN)/10.**(DELH/(((DBTPRN(MN)
391:         *        +YDBTP(MN))/2.0+273.)*67.4072))
392:                 IF (IWBFLG.EQ.1) CALL DEWPNT(DBTPRN(MN),DEWPRN(MN),BAPRIN(MN),
393:         *        DEWPRN(MN))
394:       110     CONTINUE
395:              LASTMN=12
396:              DBTPRN(13)=DBTPRN(1)
397:    C                        FOR EACH MONTH:
398:              DO 130 MN=1,12
399:    C                        DECIDE THE ORDER OF SEGMENT SELECTION USING DRY BULB
400:    C                        DIFFERENCE.
401:                 NEXTMN=MN+1
402:                 IDVARR(MN,2)=1
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403:                    IDVARR(MN,3)=3
404:                    IDVARR(MN,4)=1
405:                    IDVARR(MN,5)=3
406:                    IF (ABS(DBTPRN(MN)-DBTPRN(LASTMN)).LT.ABS(DBTPRN(MN)
407:          *          -DBTPRN(NEXTMN))) GO TO 120
408:                    IDVARR(MN,2)=3
409:                    IDVARR(MN,3)=1
410:                    IDVARR(MN,4)=3
411:                    IDVARR(MN,5)=1
412:          120       DBTPIN(MN,2)=DBTPRN(MN)
413:                    DEWPIN(MN,2)=DEWPRN(MN)
414:                    CCTIN(MN,2)=CCTRN(MN)
415:                    WNSPIN(MN,2)=WNSPRN(MN)
416:                    LASTMN=MN
417:          130       CONTINUE
418:     C                       CHOOSE SEGMENTS FIVE TIMES:
419:     C                           FIRST BASED SOLELY ON THE INPUT AVERAGES.
420:     C                           SECOND BASED SOLELY ON THE DRY BULB AVERAGE + OR -
421:     C                           THE AVERAGE SEGMENT DEVIATION TIMES 10.
422:     C                           THIRD BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 2.
423:     C                           FOURTH BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 3.
424:     C                           FIFTH BASED ON THE AVERAGES TO BALANCE PICKS 1 AND 4.
425:                  DO 240  IDV=1,5
426:     C                       INITIALIZE THE STARTING AND ENDING DAYS FOR OUR PICKS.
427:                    L1DAY=0
428:                    L2DAY=0
429:                    INIDAY=0
430:                    NENDAY=31
431:     C                       FOR EACH YEAR:
432:                  DO 170 NYR=1,NUMBYR
433:     C                       FOR EACH MONTH:
434:                    DO 170 MN=1,12
435:     C                       FIND THE STARTING AND ENDING DAYS OF OUR AVAILABLE DATA.
436:     C                       FIND THE STARTING AND ENDING DAYS OF OUR SEGMENTS TO BE
437;     C                       USED IN THE TEN DAY DEVIATION CALCULATIONS.
438:                    I1DBDV=L2DAY-4
439:                    I2DBDV=I1DBDV+NDAY(NYR,MN)-6
440:                    IF (MN.EQ.1.AND.NYR.EQ.1) I1DBDV=I1DBDV+4
441:                    NEXTYR=NYR+MN/12
442:                    NEXTMN=MOD(MN,12)+1
443:                    IF (NUMBYR-NEXTYR) 140,,
444:                    NENDAY=NENDAY+NDAY(NEXTYR,NEXTMN)
445:                    I2DBDV=I2DBDV+6
446:          140       INIDAY=INIDAY+L1DAY
447:                    I3DBDV=((I2DBDV-I1DBDV+2)/2)*((I2DBDV-I1DBDV+1)/2)
448:                    NDV=IDVARR(MN,IDV)
449:                    ISEG=LSEG(MN,NDV)
450:     C                       MOVE THE MONTHLY AVERAGES TO BE USED IN THIS SELECTION
451:     C                       TO THE ZM VARIABLES.
452:                    ZMDBTP=DBTPIN(MN,NDV)
453:                    ZMCCT=CCTIN(MN,NDV)
454:                    ZMWAMR=62.2*PVSF(DEWPIN(MN,NDV))/(YBAPR(MN)-
455:          *          PVSF(DEWPIN(MN,NDV)))
456:                    ZMWSDB=WNSPIN(MN,NDV)*(55.0/3.0-DBTPIN(MN,NDV))
457:                    NSPAN=NENDAY-INIDAY-ISEG+1
458:                    ITEMP=1
459:                    CCTX=0.0
460:                    CCADX=0.0
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461:                         DBTPX=0.0
462:                         DRNGX=0.0
463:                         DEWPX=0.0
464:                         WBTPX=0.0
465:                         WNSPX=0.0
466:                         DDHTX=0.0
467:                         DDCLX=0.0
468:                         BAPRX=0.0
469:     C                        FOR EACH DAY OF THE FIRST SEGMENT ADD ITS VALUES
470:     C                        TO THE SEGMENT AVERAGING VARIABLES.
471:                         DO 150 J=1,ISEG
472:                           K=J+INIDAY
473:                           CCTX=CCTX+DACCT(K)
474:                           CCADX=CCADX+DACCAD(K)
475:                           DBTPX=DBTPX+DADBTP(K)
476:                           DRNGX=DRNGX+DADRNG(K)
477:                           DEWPX=DEWPX+DADEWP(K)
478:                           WBTPX=WBTPX+DAWBTP(K)
479:                           WNSPX=WNSPX+DAWNSP(K)
480:                           DDHTX=DDHTX+DADDHT(K)
481:                           DDCLX=DDCLX+DADDCL(K)
482:                           BAPRX=BAPRX+DABAPR(K)
483:     150                 CONTINUE
484:     C                        FOR EACH SEGMENT AVAILABLE TO THIS MONTH:
485:                         DO 160 I=1,NSPAN
486:     C                            FOR ALL THE SEGMENTS EXCEPT THE FIRST:
487:                           IF (I.EQ.1) GO TO 155
488:                           LP=K+I-1
489:     C                            ADJUST THE SUMMING VARIABLES BY ADDING THE NEXT
490:     C                            DAY AND SUBTRACTING THE FIRST ONE.
491:                           LM=LP-ISEG
492:                           CCADX=CCADX+DACCAD(LP)-DACCAD(LM)
493:                           CCTX=CCTX+DACCT(LP)-DACCT(LM)
494:                           DRNGX=DRNGX+DADRNG(LP)-DADRNG(LM)
495:                           DBTPX=DBTPX+DADBTP(LP)-DADBTP(LM)
496:                           DEWPX=DEWPX+DADEWP(LP)-DADEWP(LM)
497:                           WBTPX=WBTPX+DAWBTP(LP)-DAWBTP(LM)
498:                           WNSPX=WNSPX+DAWNSP(LP)-DAWNSP(LM)
499:                           BAPRX=BAPRX+DABAPR(LP)-DABAPR(LM)
500:                           DDHTX=DDHTX+DADDHT(LP)-DADDHT(LM)
501:                           DDCLX=DDCLX+DADDCL(LP)-DADDCL(LM)
502:     C                            DIVIDE BY THE SEGMENT LENGTH TO GET THE AVERAGES.
503:     155                   DBTPSP(I)=DBTPX/ISEG
504:                           DRNGSP(I)=DRNGX/ISEG
505:                           DEWPSP(I)=DEWPX/ISEG
506:                           WBTPSP(I)=WBTPX/ISEG
507:                           WNSPSP(I)=WNSPX/ISEG
508:                           CCTSP(I)=CCTX/ISEG
509:                           CCADSP(I)=CCADX/ISEG
510:                           BAPRSP(I)=BAPRX/ISEG
511:                           DDHTSP(I)=DDHTX
512:                           DDCLSP(I)=DDCLX
513:                           PVSFSP=PVSF(DEWPSP(I))
514:                           WAMRSP=62.2*PVSFSP/(BAPRSP(I)-PVSFSP)
515:                           WSDBSP=WNSPSP(I)*(55.0/3.0-DBTPSP(I))
516:                           DLCCT=CCTSP(I)-ZMCCT
517:                           IF (ICCFLG.EQ.1) DLCCT=CCADSP(I)-ZMCCT
518:                           DLDBTP=DBTPSP(I)-ZMDBTP
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519:                         DLWAMR=WAMRSP-ZMWAMR
520:                         DLWSDB=WSDBSP-ZMWSDB
521:       C                           FIND THE RANK AND SEE IF IT IS THE BEST FOR THIS
522:       C                           TYPE AND MONTH.
523:                         RANKSP(I)=14.299*ABS(DLDBTP)+4.90*ABS(DLCCT)+
524:            *             .37*ABS(DLWSDB)+96.6*ABS(DLWAMR)
525:                         IF (IDV.EQ.2) RANKSP(I)=ABS(DLDBTP)
526:                         IF (IDV.EQ.1.AND.LOGUNI.EQ.11.AND.I.GE.I1DBDV.AND.
527:            *             I.LE.I2DBDV) DBDVMN(MN)=ABS(DBTPSP(I)-
528:            *             DBTPMN(NYR,MN))*10.0/I3DBDV/NUMBYR+DBDVMN(MN)
529:                         IF (RANKSP(I).LT.RANKSP(ITEMP)) ITEMP=I
530:          160           CONTINUE
531:       C                     STORE THE WEATHER AVERAGES OF THE BEST SEGMENT IN THIS
532:       C                     MONTH FOR THIS TYPE (NDV) IN THE SL ARRAYS.
533:                         CCTSL(NYR,MN,NDV)=CCTSP(ITEMP)
534:                         CCADSL(NYR,MN,NDV)=CCADSP(ITEMP)
535:                         DBTPSL(NYR,MN,NDV)=DBTPSP(ITEMP)
536:                         BAPRSL(NYR,MN,NDV)=BAPRSP(ITEMP)
537:                         DRNGSL(NYR,MN,NDV)=DRNGSP(ITEMP)
538:                         DEWPSL(NYR,MN,NDV)=DEWPSP(ITEMP)
539:                         WBTPSL(NYR,MN,NDV)=WBTPSP(ITEMP)
540:                         WNSPSL(NYR,MN,NDV)=WNSPSP(ITEMP)
541:                         DDHTSL(NYR,MN,NDV)=DDHTSP(ITEMP)
542:                         DDCLSL(NYR,MN,NDV)=DDCLSP(ITEMP)
543:                         ISLDT(NYR,MN,NDV)=ITEMP+INIDAY
544:                         RANKSL(NYR,MN,NDV)=RANKSP(ITEMP)
545:                         L1DAY=L2DAY
546:                         L2DAY=NDAY(NYR,MN)
547:          170           CONTINUE
548:       C                     FOR EACH MONTH.
549:                     LASTMN=12
550:                     DO 220 MN=1,12
551:                      IF (IDV.NE.1) GO TO 180
552:       C                     ADJUST THE DRY BULB TO PREPARE FOR THE SECOND
553:       C                     SELECTION USING THE TEN DAY AVERAGE DEVIATION.
554:                     NEXTMN=MN+1
555:                     SIGNX=DBTPRN(LASTMN)-DBTPRN(NEXTMN)
556:                     LASTMN=MN
557:                     SIGNX=SIGNX/ABS(SIGNX)*1.0
558:                     DBTPIN(MN,1)=DBTPRN(MN)+SIGNX*DBDVMN(MN)*DVAJIN(MN)
559:                     DBTPIN(MN,3)=DBTPRN(MN)-SIGNX*DBDVMN(MN)*DVAJIN(MN)
560:          180        NDV=IDVARR(MN,IDV)
561:                     DO 190 I=1,NUMBYR
562:                       RANKSP(I)=RANKSL(I,MN,NDV)
563:          190        CONTINUE
564:       C                     INITIALIZE ISEGDN.
565:                     DO 200 I=1,10
566:                       ISEGDN(I)=I
567:          200        CONTINUE
568:       C                     CALL ORDER AND PLACE THE CHOSEN SEGMENT VALUES INTO THE CH
569:       C                     ARRAYS AVOIDING EXCESSIVE OVERLAP IN THE CHOSEN DAYS.
570:                     CALL ORDER (RANKSP,ISEGDN,NUMBYR)
571:                     ITEMP=ISEGDN(1)
572:                     ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
573:                     ICY(MN,NDV)=ITEMP
574:                     RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
575:                     ITEMP=2
576:                     IF (IDV.LT.4) GO TO 220
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```
577:                    IF (ABS(ICDT(MN,NDV)-ICDT(MN,2)).GT.5) GO TO 210
578:                    ITEMP=ISEGDN(2)
579:                    ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
580:                    ICY(MN,NDV)=ITEMP
581:                    RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
582:                    ITEMP=3
583:      210           IF (IDV.LT.5) GO TO 220
584:                    LASTDV=IDVARR(MN,IDV-1)
585:                    IF (ABS(ICDT(MN,NDV)-ICDT(MN,LASTDV)).GT.5) GO TO 220
586:                    ITEMP=ISEGDN(ITEMP)
587:                    ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
588:                    ICY(MN,NDV)=ITEMP
589:                    RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
590:                    IF (ABS(ICDT(MN,NDV)-ICDT(MN,2)).GT.5) GO TO 220
591:                    ITEMP=ISEGDN(3)
592:                    ICDT(MN,NDV)=ISLDT(ITEMP,MN,NDV)
593:                    ICY(MN,NDV)=ITEMP
594:                    RANKCH(MN,NDV)=RANKSL(ITEMP,MN,NDV)
595:      220           CONTINUE
596:                    IF (IDV.LT.2.OR.IDV.EQ.5) GO TO 240
597:      C                          ADJUST THE AVERAGES WE ARE USING TO SELECT THE NEXT
598:      C                          SEGMENT, TO BALANCE THE ERRORS IN AVERAGES
599:      C                          OF THE SEGMENTS WE HAVE ALREADY FOUND.
600:                    DO 230 I=1,12
601:                      NDV=IDVARR(I,IDV)
602:                      NEXTDV=IDVARR(I,IDV+1)
603:                      ICY1=ICY(I,NDV)
604:                      ICY2=ICY(I,2)
605:                      RLSEG=LSEG(I,3)
606:                      RAVG=LSEG(I,2)/RLSEG+2.0
607:                      DBTPIN(I,NEXTDV)=RAVG*DBTPIN(I,2)-DBTPSL(ICY2,I,2)*
608:           *          (RAVG-2.0)-DBTPSL(ICY1,I,NDV)
609:                      CCTIN(I,NEXTDV)=RAVG*CCTIN(I,2)-CCADSL(ICY2,I,2)*
610:           *          (RAVG-2.0)-CCADSL(ICY1,I,NDV)
611:                      IF (ICCFLG.EQ.0) CCTIN(I,NEXTDV)=RAVG*CCTIN(I,2)
612:           *          -CCTSL(ICY2,I,2)*(RAVG-2.0)-CCTSL(ICY1,I,NDV)
613:                      WNSPIN(I,NEXTDV)=RAVG*WNSPIN(I,2)-WNSPSL(ICY2,I,2)*
614:           *          (RAVG-2.0)-WNSPSL(ICY1,I,NDV)
615:                      DEWPIN(I,NEXTDV)=RAVG*DEWPIN(I,2)-DEWPSL(ICY2,I,2)*
616:           *          (RAVG-2.0)-DEWPSL(ICY1,I,NDV)
617:      230           CONTINUE
618:      240           CONTINUE
619:                    ITEMP=NDAY(1,2)
620:                    NDAY(1,2)=28
621:                    PRINT 650
622:      C                          FOR EACH MONTH GET THE SELECTED YEAR AVERAGES,
623:                    DO 250 I=1,12
624:                      N=NDAY(1,I)
625:                      L1=LSEG(I,1)
626:                      L2=LSEG(I,2)
627:                      L3=LSEG(I,3)
628:                      ICY1=ICY(I,1)
629:                      ICY2=ICY(I,2)
630:                      ICY3=ICY(I,3)
631:                      SLCCT=(CCTSL(ICY1,I,1)*L1+CCTSL(ICY2,I,2)
632:           *          *L2+CCTSL(ICY3,I,3)*L3)/N
633:                      SLCCAD=(CCADSL(ICY1,I,1)*L1+CCADSL(ICY2,I,2)
634:           *          *L2+CCADSL(ICY3,I,3)*L3)/N
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635:                SLBAPR=(BAPRSL(ICY1,I,1)*L1+BAPRSL(ICY2,I,2)
636:            *       *L2+BAPRSL(ICY3,I,3)*L3)/N
637:                SLDBTP(I)=(DBTPSL(ICY1,I,1)*L1+DBTPSL(ICY2,I,2)
638:            *       *L2+DBTPSL(ICY3,I,3)*L3)/N
639:                SLDRNG=(DRNGSL(ICY1,I,1)*L1+DRNGSL(ICY2,I,2)
640:            *       *L2+DRNGSL(ICY3,I,3)*L3)/N
641:                SLDEWP=(DEWPSL(ICY1,I,1)*L1+DEWPSL(ICY2,I,2)
642:            *       *L2+DEWPSL(ICY3,I,3)*L3)/N
643:                SLWBTP=(WBTPSL(ICY1,I,1)*L1+WBTPSL(ICY2,I,2)
644:            *       *L2+WBTPSL(ICY3,I,3)*L3)/N
645:                SLWNSP=(WNSPSL(ICY1,I,1)*L1+WNSPSL(ICY2,I,2)
646:            *       *L2+WNSPSL(ICY3,I,3)*L3)/N
647:                SLDDHT=DDHTSL(ICY1,I,1)+DDHTSL(ICY2,I,2)+
648:            *       DDHTSL(ICY3,I,3)
649:                SLDDCL=DDCLSL(ICY1,I,1)+DDCLSL(ICY2,I,2)+
650:            *       DDCLSL(ICY3,I,3)
651:        C              AND PRINT THEM OUT.
652:                PRINT 655 I,SLDBTP(I),SLDRNG,SLDEWP,SLWBTP,SLCCT,SLCCAD,SLWNSP
653:            *       ,SLDDHT,SLDDCL
654:                PRINT 660 DBTPSL(ICY1,I,1),DEWPSL(ICY1,I,1),WBTPSL(ICY1,I,1),
655:            *       CCTSL(ICY1,I,1),CCADSL(ICY1,I,1),WNSPSL(ICY1,I,1)
656:                PRINT 665 DBTPIN(I,1),DEWPIN(I,1),CCTIN(I,1),WNSPIN(I,1)
657:                PRINT 660 DBTPSL(ICY2,I,2),DEWPSL(ICY2,I,2),WBTPSL(ICY2,I,2),
658:            *       CCTSL(ICY2,I,2),CCADSL(ICY2,I,2),WNSPSL(ICY2,I,2)
659:                PRINT 665 DBTPIN(I,2),DEWPIN(I,2),CCTIN(I,2),WNSPIN(I,2)
660:                PRINT 660 DBTPSL(ICY3,I,3),DEWPSL(ICY3,I,3),WBTPSL(ICY3,I,3),
661:            *       CCTSL(ICY3,I,3),CCADSL(ICY3,I,3),WNSPSL(ICY3,I,3)
662:                PRINT 665 DBTPIN(I,3),DEWPIN(I,3),CCTIN(I,3),WNSPIN(I,3)
663:        250     CONTINUE
664:                NDAY(1,2)=ITEMP
665:        C                     USING SLYEAR WRITE OUR SELECTED YEAR AT LOGUNI.
666:                CALL SLYEAR (DADBTP,SLDBTP,ICDT,LSEG,LOGUNI,IYRARR,RANKCH)
667:        400     CONTINUE
668:                PRINT 670 DBDVMN,YDSD
669:                PRINT 680
670:        500 FORMAT ( )
671:        600 FORMAT (' ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOR ',
672:            * /,' THE DAYTIME CLOUD CALCULATIONS',/,' FOLLOWED BY',
673:            * ' THE NUMBER OF WEATHER TAPES YOU ARE DRAWING FROM ',
674:            * '1-10',/,' FOLLOWED BY THE NUMBER OF SELECTED YEARS YOU ARE ',
675:            * 'MAKING 1-4',/,' FOLLOWED BY THE HEIGHT IN METERS OF THE',
676:            * ' INPUT STATION',/,' FOLLOWED BY THE FLAG FOR DRY BULB AVERAGES '
677:            * ,/,' 1 IF THE AVERAGE OF THE MAXIMUM AND MINIMUM IS USED',
678:            * /,' 0 IF THE 24HR AVERAGE IS USED',/,'FOLLOWED BY THE BASE ',
679:            * 'TEMPERATURES FOR DEGREE DAY CALCULATIONS',/,' HEATING THEN ',
680:            * 'COOLING BOTH IN DEGREES CELSIUS')
681:        695 FORMAT (' ENTER THE FIRST YEAR YOU ARE USING FROM THE ',
682:            * ' WEATHER TAPE ASSIGNED TO ',/ ,' LOGICAL UNIT',I3,' AND ',
683:            * 'THE NUMBER OF CONSECUTIVE YEARS OF IT YOU ARE USING')
684:        610 FORMAT (' YEAR OF MONTHLY AVG. MONTH   DRY BULB   DAILY',
685:            * ' DEWPOINT    WET BULB   TOTAL DAYTIME WIND   BAROMETRIC ',
686:            * '  DEGREE DAYS',/,29X,
687:            * 'TEMPERATURE RANGE TEMPERATURE TEMPERATURE CLOUD  CLOUD  ',
688:            * 'SPEED   PRESSURE   HEATING COOLING',/,31X,'DEG. C.   DEG. C. ',
689:            * 'DEG. C.    DEG. C.    TENTHS TENTHS M./S.  KILOPASCAL DEG.',
690:            * ' C. * DAYS')
691:        615 FORMAT (4X,'AVG. OF ',I4,7X,I2,3X,3(F9.2),7X,F5.2,F8.2,F7.2,
692:            * F8.2,3X,3(F8.2))
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693:        620 FORMAT (/,' AVG. OF ALL YEARS',I7,3X,3(F9.2),7X,F5.2,F8.2,F7.2,
694:           * F8.2,3X,3(F8.2),//)
695:        625 FORMAT (' ENTER THE AVERAGES YOU ARE USING TO SELECT THE',
696:           * ' SELECTED YEAR ',/,' ASSIGNED TO LOGICAL UNIT',I3,
697:           * /,' ENTER THE SI FLAG:',/,' 0 FOR SI UNITS (DEG. C., M/SEC.,',
698:           * ' KPASCAL) ',/,
699:           * ' 1 FOR ENGLISH UNITS (DEG. F., IN. OF HG., M.P.H.)',
700:           * /,' FOLLOWED BY THE BP FLAG:',/,' IF YOU ARE UNABLE TO FIND ',
701:           * 'BAROMETRIC PRESSURE AVERAGES',/,' ENTER 1 AND THE HEIGHT OF ',
702:           * 'THE SELECTED LOCATION IN METERS',/,' ELSE ENTER 0 0.0',/,
703:           * ' FOLLOWED BY THE WB FLAG:',/,' IF YOU ARE ENTERING WET BULB '
704:           * 'INSTEAD OF DEWPOINT ENTER 1',/,' ELSE ENTER 0',/,' FOLLOWED BY '
705:           * ,'THE CCT FLAG:',/,' 1 IF USING DAYTIME CLOUD AVERAGES INSTEAD '
706:           * ,'OF FULL DAY AVERAGES ',/,' ELSE ENTER 0')
707:        630 FORMAT ( ' THE MONTH IS PRINTED FOR CONVENIENCE ONLY AND',
708:           * ' SHOULD NOT BE INPUT',
709:           * /,8X,' DRY BULB   MEAN SKY WIND   DEW POINT?WET BULB',
710:           * ' BAROMETRIC DEVIATION',/,8X,'TEMPERATURE  COVER   SPEED',
711:           * '      TEMPERATURE        PRESSURE   ADJUSTMENT')
712:        635 FORMAT (' MONTH    DEG. F.     TENTHS MI./HR.     DEG. F. ',
713:           * '     IN. OF HG.  ')
714:        640 FORMAT (' MONTH    DEG. C.     TENTHS M./S.     DEG. C. ',
715:           * '    KILOPASCAL')
716:        645 FORMAT (I4)
717:        650 FORMAT (/,'  AVERAGE OF THE SELECTED YEAR',
718:           * ///,3X,' MONTH  DRY BULB      DAILY        DEWPOINT '
719:           * ,'    WET BULB      TOTAL        DAYTIME       WIND   ',
720:           * '  DEGREES DAYS  DEGREES DAYS',/,9X,'TEMPERATURE       RANGE   ',
721:           * '  TEMPERATURE  TEMPERATURE    CLOUD         CLOUD   ',
722:           * '      SPEED       HEATING       COOLING')
723:        655 FORMAT (/,I6,9(4X,F9.3))
724:        660 FORMAT ('    CHOSEN',F9.3,17X,F9.3,2(4X,F9.3),4X,F9.3,4X,F9.3)
725:        665 FORMAT ('    DESIRED',F9.3,17X,F9.3,24X,F9.3,10X,F9.3)
726:        670 FORMAT (/,37X,'AVERAGE SEGMENT DEVIATION',/,' MONTH',6X,'1',7X,
727:           * '2',7X,'3',7X,'4',7X,'5',7X,'6',7X,'7',7X,'8',7X,'9',6X,'10',6X,
728:           * '11',6X,'12',/,' DEC. C.',12(F8.3),/,41X,'STANDARD DEVIATION'
729:           * ,/,' DEC. C.',12(F8.3))
730:        680 FORMAT (' FOR MORE COMPLETE DESIGN AND TEMPERATURE',
731:           * ' EXTREMES INFORMATION',/,' USE THE ADJUST PROGRAM IN',
732:           * ' AVERAGE FINDING MODE.').
733:            STOP
734:            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.

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2:      C
3:      C  MAIN PROGRAM    ADJUST
4:      C  ADJUSTS WEATHER TAPES ON AN HOURLY BASIS TO REPRESENT LOCATIONS
5:      C  WHICH HAVE NO WEATHER TAPES. READS IN THE YEAR FROM LOGICAL UNIT 8
6:      C  AND WRITES IT OUT AT LOGICAL UNIT 9.   THIS PROGRAM MAY ALSO BE USED
7:      C  TO FIND THE MONTHLY AVERAGES FOR A YEAR.   THEY ARE WRITTEN AT LOGICAL
8:      C  UNIT 7.
9:      C  THE PROGRAM READS TAPES IN ENGLISH UNITS.
10:     C
11:     C  SUBROUTINES:
12:     C              CLOUD(DAYS IN MONTHS,DELTA CLOUD,HOURLY CLOUD)
13:     C                  ADJUSTS CLOUD COVER ON AN MONTHLY BASIS FOR EACH HOUR
14:     C              SUNNY(LATITUDE,LONGITUDE,TIME ZONE)
15:     C                  GETS MONTHLY DAWN AND DAY LENGTH VALUES.
16:     C              DEWPNT(DRY BULB,WET BULB,BAROMETRIC PRESSURE,DEWPOINT)
17:     C                  FINDS HOURLY DEWPOINT TEMPERATURES.
18:     C              WETBLB(DRY BULB,WET BULB,BAROMETRIC PRESSURE,DEWPOINT)
19:     C                  FINDS HOURLY WET BULB TEMPERATURES.
20:     C  FUNCTIONS:
21:     C              PVSF(T)
22:     C                  FINDS THE PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR
23:     C                  FOR A GIVEN TEMPERATURE.
24:     C              DPF(P)
25:     C                  FINDS THE DEWPOINT TEMPERATURE FOR A GIVEN VAPOR PRESSURE
26:     C              WBF(H,PB)
27:     C                  APPROXIMATES WET BULB WHEN ENTHALPY IS GIVEN.
28:     C  DBT:   THE HOURLY DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
29:     C  DPT:   THE HOURLY DEWPOINT TEMPERATURE, DEGREES FAHRENHEIT.
30:     C  WBT:   THE HOURLY WET BULB TEMPERATURE, DEGREES FAHRENHEIT.
31:     C  WSP:   THE HOURLY WIND, SPEED KNOTS.
32:     C  BPR:   THE HOURLY BAROMETRIC PRESSURE, INCHES OF MERCURY.
33:     C  CCT:   THE HOURLY CLOUD COVER, TENTHS.
34:     C  TOC:   THE HOURLY TYPE OF CLOUD, OF THE LOWEST LAYER OF CLOUD.
35:     C          IN NBSLD FORMAT, NOAA'S TYPES  8 AND 9 (CIRRUS) ARE DECODED AS
36:     C          0.0, ALL OTHER TYPES DECODED AS 1.0
37:     C          THE DOE-2 FORMAT SAME AS ABOVE, EXCEPT THAT NOAA'S TYPE
38:     C          2 (STRATUS) IS DECODED AS 2.0.
39:     C  WSD:   THE HOURLY WIND DIRECTION, 16 POINTS.
40:     C  YY:    DUMMY FOR ENTERING CURRENTLY UNUSED DATA.
41:     C  IYEAR:  A.D. YEAR OF WEATHER TAPE.
42:     C  MN:   MONTH OF WEATHER TAPE.
43:     C  ID:   DAY OF MONTH OF WEATHER TAPE.
44:     C  IC:   CITY CODE OF WEATHER TAPE.
45:     C  DDBASH:  THE BASE FOR CALCULATION OF HEATING DEGREE DAYS, DEG. F.
46:     C  DDBASC:  THE BASE FOR CALCULATION OF COOLING DEGREE DAYS, DEG. F.
47:     C  DDHTRM:  MONTHLY HEATING DEGREE DAYS, (DEG. F.).
48:     C  DDCLRM:  MONTHLY COOLING DEGREE DAYS, (DEG. F.).
49:     C  DBTAD:   THE DAILY AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
50:     C  DBTD:   THE DAILY SUM OF HOURLY DRY BULB TEMPERATURES.
51:     C  DPTD:   THE DAILY SUM OF HOURLY DEWPOINT TEMPERATURES.
52:     C  WBTD:   THE DAILY SUM OF HOURLY WET BULB TEMPERATURES.
53:     C  WSPD:   THE DAILY SUM OF HOURLY WIND SPEEDS.
54:     C  BPRD:   THE DAILY SUM OF HOURLY BAROMETRIC PRESSURES.
55:     C  CCTD:   THE DAILY SUM OF HOURLY CLOUD COVERS.
56:     C  CCDD:   THE DAILY SUM OF HOURLY DAYTIME CLOUD COVERS.
57:     C  DBMAX:   THE MAXIMUM DRY BULB TEMPERATURE FOR A DAY, DEGREES FAHRENHEIT
58:     C  DBMIN:   THE MINIMUM DRY BULB TEMPERATURE FOR A DAY, DEGREES FAHRENHEIT.
59:     C  DBAD:   PSEUDONYM FOR ADBTAD
60:     C  DBMNAD:   THE MINIMUM HOURLY TEMPERATURE IN A GIVEN DAY
61:     C  DBMXAD:   THE MAXIMUM HOURLY TEMPERATURE IN A DAY
62:     C  DLDRMN:   THE FACTOR FOR ADJUSTING HOURLY TEMPERATURES,
63:     C              IF DRNGIM IS GREATER THAN DRNGRM. (THESE ARE LESS
64:     C              THAN THE DAILY AVERAGES)
65:     C  DLDRMX:   DLDRMN'S COUNTERPART FOR TEMPERATURES GREATER THAN
66:     C              THE DAILY AVERAGE.
67:     C  DBTRM:   THE MONTHLY AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT.
68:     C  DBTRM0:   THE MONTHLY 24HR-AVERAGE DRY BULB TEMPERATURE,
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 69:    C  DBTRM1:   THE MONTHLY MAXMIN-AVERAGE DRY BULB TEMPERATURE, DEGREES FAHRENHEIT
 70:    C  DBAMAX:   THE MONTHLY AVERAGE MAXIMUM DAILY TEMPERATURE, DEGREES FAHRENHEIT
 71:    C  DBAMIN:   THE MONTHLY AVERAGE MINIMUM DAILY TEMPERATURE, DEGREES FAHRE
 72:    C  DBMXRM:   THE MAXIMUM MONTHLY TEMPERATURE, DEGREES FAHRENHEIT.
 73:    C  DBMNRM:   THE MINIMUM MONTHLY TEMPERATURE, DEGREES FAHRENHEIT.
 74:    C  DPTRM:    THE MONTHLY AVERAGE DEWPOINT TEMPERATURE, DEGREES FAHRENHEIT.
 75:    C  WBTRM:    THE MONTHLY AVERAGE WET BULB TEMPERATURE, DEGREES FAHRENHEIT.
 76:    C  WSPRM:    THE MONTHLY AVERAGE WIND SPEED, KNOTS.
 77:    C  BPRRM:    THE MONTHLY AVERAGE BAROMETRIC PRESSURE, INCHES OF MERCURY.
 78:    C  CCTRM:    THE MONTHLY AVERAGE CLOUD COVER, TENTHS.
 79:    C  CCCTRM:   THE MONTHLY AVERAGE CIRRUS COVER, TENTHS.
 80:    C  CCSTRM:   THE MONTHLY AVERAGE STRATUS COVER, TENTHS.
 81:    C  CCOTRM:   THE MONTHLY AVERAGE OF OTHER CLOUD TYPES, TENTHS. ( INCLUDES
 82:    C              STRATUS IN NBSLD FORMAT)
 83:    C  CCDRM:    THE MONTHLY AVERAGE DAYTIME CLOUD COVER, TENTHS.
 84:    C  DSDRM:    THE MONTHLY AVERAGE DAILY STANDARD DEVIATION, DEGREES FAHRENHEIT
 85:    C  DRNGRM:   THE MONTHLY AVERAGE DAILY RANGE OF DRY BULB, DEGREES FAHRENHEIT
 86:    C  DBTIM:    THE INPUT MONTHLY AVERAGE DRY BULB TEMPERATURE.
 87:    C  DPTIM:    THE INPUT MONTHLY AVERAGE DEWPOINT TEMPERATURE.
 88:    C  WBTIM:    THE INPUT MONTHLY AVERAGE WET BULB TEMPERATURE.
 89:    C  WSPIM:    THE INPUT MONTHLY AVERAGE WIND SPEED.
 90:    C  BPRIM:    THE INPUT MONTHLY AVERAGE BAROMETRIC PRESSURE.
 91:    C  CCTIM:    THE INPUT MONTHLY AVERAGE CLOUD COVER.
 92:    C  CCDIM:    THE INPUT MONTHLY AVERAGE DAYTIME CLOUD COVER.
 93:    C  DSDIM:    THE INPUT MONTHLY AVERAGE DAILY STANDARD DEVIATION.
 94:    C  DRNGIM:   THE INPUT MONTHLY AVERAGE DAILY RANGE OF DRY BULB.
 95:    C  BPRADJ:   THE DIFFERENCE BETWEEN THE INPUT BAROMETRIC PRESSURE AND THE
 96:    C              REAL (TAPE) BAROMETRIC PRESSURE, ADDED TO EACH HOUR IN A MONTH
 97:    C  DH:  THE DIFFERENCE IN HEIGHT BETWEEN THE SOURCE STATION AND THE
 98:    C          ADJUSTED LOCATION.
 99:    C  DLCCTM:   THE DIFFERENCE BETWEEN THE INPUT CLOUD AVERAGE AND THE
100:    C              THE REAL CLOUD AVERAGE.
101:    C  DLCCCM:   SAME AS ABOVE, FOR CIRRUS CLOUDS.
102:    C  DLCCSM:   SAME AS ABOVE, FOR STRATUS CLOUDS.
103:    C  DLCCOM:   SAME AS ABOVE, FOR 'OTHER CLOUDS'.
104:    C  RATDPT:   THE RATIO OF THE INPUT DEWPOINT DEPRESSION TO THE REAL ONE.
105:    C  RATWBT:   THE RATIO OF THE INPUT WET BULB DEPRESSION TO THE REAL ONE.
106:    C  RATDSD:   THE RATIO OF THE INPUT DAILY STANDARD DEVIATION TO THE REAL
107:    C              STANDARD DEVIATION.
108:    C  RATDRN:   THE RATIO OF THE INPUT DAILY RANGE AND THE REAL ONE.
109:    C  RATWSP:   THE RATIO OF THE INPUT WIND SPEED AND THE REAL ONE.
110:    C  CCCARR:   HOLDS THE HOURLY CIRRUS  COVER VALUES SO CLOUD CAN ADJUST THEM
111:    C  CCSARR:   HOLDS THE HOURLY STRATUS VALUES SO CLOUD CAN ADJUST THEM.
112:    C  CCOARR:   HOLDS THE HOURLY ?'OTHER CLOUD' VALUES SO CLOUD CAN ADJUST THEM
113:    C  IDBCNT:   HOURS WITH TEMPERATURE 50 DEGREES LESS THAN DELIMETER.
114:    C  IADFLG:   THE FLAG FOR USING ADJUST TO GET AVERAGES ONLY.
115:    C  IBPFLG:   THE FLAG FOR USING THE HEIGHT TO DETERMINE THE BAROMETRIC
116:    C              PRESSURE ADJUSTMENT.
117:    C  IDBFLG:   THE FLAG FOR ENTERING DRY BULB AVERAGES WHICH ARE THE AVERAGES
118:    C              OF THE SITE.
119:    C              MAXIMUM AND MINIMUM DAILY TEMPERATURES.
120:    C  ICCFLG:   THE FLAG FOR DECIDING CLOUD AVERAGE ENTERING PROCEDURE.
121:    C  IDYFLG:   THE FLAG WHICH HAS THE NUMBER OF DAYS IN THE 12 MONTH PERIOD
122:    C  ISIFLG:   THE FLAG FOR ENTERING AVERAGES IN NON-SI UNITS.
123:    C  IWBFLG:   THE FLAG FOR DECIDING WET BULB DEWPOINT ENTERING PROCEDURE.
124:    C  ISKFLG:   THE FLAG WHICH HAS THE NUMBER OF DAYS SKIPPED BEFORE THE
125:    C              START OF THE 12 MONTH PERIOD.
126:    C  LENGTH:   THE NUMBER OF HOURS OF DAYLIGHT FOR A DAY IN A MONTH.
127:    C  IDAWN:    THE TIME OF SUNRISE FOR A DAY IN A MONTH.
128:    C  ISR:   TIME OF SUNRISE.
129:    C  ISS:   TIME OF SUNSET.
130:    C  RLONG:    THE LONGITUDE OF THE ADJUSTED LOCATION.
131:    C  RLATD:    THE LATITUDE OF THE ADJUSTED LOCATION.
132:    C  TZN:   THE TIME ZONE (STANDARD) OF THE ADJUSTED LOCATION.
133:    C  NDAY:   CONTAINS THE NUMBER OF DAYS IN EACH MONTH.
134:    C  IH:   THE HOUR OF THE DAY WE ARE ADJUSTING.
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135:     C  MH:   THE NUMBER OF HOURS ALREADY ADJUSTED THIS MONTH.
136:     C  IHTOT:   TOTAL NUMBER OF HOURS IN THE YEAR.
137:     C  IDBTOT:   NUMBER OF HOURS WITH A TEMPERATURE LESS THAN DELIMETER 49
138:     C  YCCS:   THE SUM OF MONTHLY AVERAGES FOR STRATUS TYPE CLOUD.
139:     C
140:            DIMENSION DBTAD( 12,31 ), DBTIM( 12 ), DBTRM0( 12 ), DBT( 24 ), DPTIM( 12 ),
141:           2 DBMXAD( 12,31 ), DBMNAD( 12,31 ), DPTRM( 12 ), DPT( 24 ), WBTIM( 12 ), WBTRM( 12 )
142:           3, CCDIM( 12 ), CCDRM( 12 ), CCT( 24 ), DRNGIM( 12 ), BPRIM( 12 ), BPRRM( 12 ),
143:           4 BPR( 24 ), WDR( 24 ), WSPIM( 12 ), WSP( 24 ), DSDIM( 12 ), DSDRM( 12 ), TOC( 24 ),
144:           5 YY( 24 ), NDAY( 12 ), WBT( 24 ), DRNGRM( 12 ), CCTRM( 12 ), WSPRM( 12 ),
145:           6 CCCARR( 12,745 ), DBAMAX( 12 ), DBAMIN( 12 ), DBMXRM( 12 ), DBMNRM( 12 ),
146:           7 IDBCNT( 180 ), DDHTRM( 12 ), DDCLRM( 12 ), DDHTAM( 12 ), DDCLAM( 12 ),
147:           8 DBTRM1( 12 ), DBMXAM( 12 ), DBMNAM( 12 ), DBTRM( 12 ), CCCDRM( 12 ),
148:           9 CCOARR( 12,745 ), DLCCCM( 12 ), CCCTRM( 12 ), CCODRM( 12 ), CCOTRM( 12 ),
149:           * DLCCOM( 12 ), CCSTRM( 12 ), CCSDRM( 12 ), CCSARR( 12,745 ), DLCCSM( 12 ),
150:           1 ALPHA( 6 )
151:           DATA ALPHA /'      AD', 'JUSTED', '  SUMM', 'ARIZED', 'DEG.C.', 'DEG.F.'/
152:           COMMON /DT/ IDAWN( 12 ), LENGTH( 12 )
153:           IHTOT=0
154:     C              READ IN THE LATITUDE, LONGITUDE, AND TIME ZONE AND
155:     C              CALL SUNNY TO GET DAWN AND DAY LENGTH DATA.
156:           PRINT 220
157:           READ ( 5,210 ) RLATD, RLONG, TZN
158:           CALL SUNNY ( RLATD, RLONG, TZN )
159:           DO 10 MN=1,12
160:              DBMXRM( MN )=-100.0
161:              DBMNRM( MN )=100.0
162:              DBMXAM( MN )=-100.0
163:              DBMNAM( MN )=100.0
164:              DO 10 MH=1,745
165:              CCCARR( MN, MH )=11.0
166:              CCOARR( MN, MH )=11.0
167:              CCSARR( MN, MH )=11.0
168:     10       CONTINUE
169:           DBMXYR=-100.0
170:           DBMNYR=100.0
171:           PRINT 230
172:           READ ( 5,210 ) ISKFLG, IDYFLG
173:           PRINT 240
174:           READ ( 5,210 ) IADFLG
175:           IF ( ISKFLG.EQ.0 ) GO TO 30
176:     C              READ THE SKIPPED PORTION OF THE TAPE.
177:           DO 20 IDAY=1, ISKFLG
178:              READ ( 8 ) DBT, DPT, WBT, WSP, BPR, CCT, TOC, WDR, YY, IYEAR, MN, ID, IC
179:     20       CONTINUE
180:     30       CONTINUE
181:           IF ( IADFLG.EQ.0 ) PRINT 250
182:           IF ( IADFLG.EQ.0 ) READ ( 5,210 ) IBFLG, DH
183:           IF ( IADFLG.EQ.0 ) PRINT 260
184:           IF ( IADFLG.EQ.0 ) READ ( 5,210 ) ISIFLG, ICCFLG
185:           IALP=6
186:           IF ( ISIFLG.EQ.0.AND.IADFLG.EQ.0 ) IALP=5
187:           PRINT 270, ALPHA( IALP )
188:           READ ( 5,210 ) IDBFLG, DDBASH, DDBASC
189:           IF ( IADFLG.NE.0.OR.ISIFLG.NE.0 ) GO TO 40
190:           DDBASH=DDBASH*1.8+32.0
191:           DDBASC=DDBASC*1.8+32.0
192:     C              FOR EACH DAY IN THE REAL YEAR:
193:     40       DO 70 IDAY=1, IDYFLG
194:              READ ( 8 ) DBT, DPT, WBT, WSP, BPR, CCT, TOC, WDR, YY, IYEAR, MN, ID, IC
195:              DBMAX=-100.0
196:              DBMIN=100.0
197:              DBTD=0.0
198:              BPRD=0.0
199:              DPTD=0.0
200:              CCCDD=0.0
201:              CCSDD=0.0
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202:                    CCODD=0.0
203:                    CCCTD=0.0
204:                    CCSTD=0.0
205:                    CCOTD=0.0
206:                    CCC=0.0
207:                    CCS=0.0
208:                    CCO=0.0
209:                    WBTD=0.0
210:                    WSPD=0.0
211:                    NDAY(MN)=ID
212:                    MH=ID*24-24
213:      C                   FOR EACH HOUR:
214:                    DO 50 IH=1,24
215:      C                       SUM THE HOURLY VALUES.
216:                       DBTD=DBTD+DBT(IH)
217:                       DPTD=DPTD+DPT(IH)
218:                       DBMAX=MAX(DBMAX,DBT(IH))
219:                       DBMIN=MIN(DBMIN,DBT(IH))
220:                       BPRD=BPRD+BPR(IH)
221:      C                   IN CLOUD ARRAYS, ALL TYPES GET 0'S IN CLEAR WEATHER.
222:      C                       EMPTY FIELDS KEEP 11'S.
223:                       CT=CCT(IH)
224:                       IF (TOC.EQ.0.0.OR.CT.EQ.0.0) CCCARR(MN,MH+IH)=CT
225:                       IF (TOC.EQ.1.0.OR.CT.EQ.0.0) CCOARR(MN,MH+IH)=CT
226:                       IF (TOC.EQ.2.0.OR.CT.EQ.0.0) CCSARR(MN,MH+IH)=CT
227:                       IF (TOC(IH).EQ.0.0) CCCTD=CCCTD+CT
228:                       IF (TOC(IH).EQ.1.0) CCOTD=CCOTD+CT
229:                       IF (TOC(IH).EQ.2.0) CCSTD=CCSTD+CT
230:                       WSPD=WSPD+WSP(IH)
231:                       WBTD=WBTD+WBT(IH)
232:                       IHTOT=IHTOT+1
233:                       IDB=DBT(IH)+50.5
234:                       IDBCNT(IDB)=IDBCNT(IDB)+1
235:      50           CONTINUE
236:                  DBMXAD(MN,ID)=DBMAX
237:                  DBMNAD(MN,ID)=DBMIN
238:                  ISR=IDAWN(MN)
239:                  ISS=ISR+LENGTH(MN)
240:      C                   FOR EACH DAYTIME HOUR:
241:                  DO 60 IH=ISR,ISS
242:      C                       SUM THE CLOUD VALUES.
243:                       IF (TOC(IH).EQ.0.0) CCCDD=CCCDD+CCT(IH)
244:                       IF (TOC(IH).EQ.2.0) CCSDD=CCSDD+CCT(IH)
245:                       IF (TOC(IH).EQ.1.0) CCODD=CCODD+CCT(IH)
246:      60           CONTINUE
247:      C                   ADD THE DAILY AVERAGE TO THE PROPER MONTHLY AVERAGE.
248:                  CCCDRM(MN)=CCCDRM(MN)+CCCDD/(ISS-ISR+1)
249:                  CCSDRM(MN)=CCSDRM(MN)+CCSDD/(ISS-ISR+1)
250:                  CCODRM(MN)=CCODRM(MN)+CCODD/(ISS-ISR+1)
251:                  DBTAD(MN,ID)=DBTD/24.0
252:                  IF (IDBFLG.EQ.1) DBTAD(MN,ID)=(DBMAX+DBMIN)/2.0
253:                  IF (DBTAD(MN,ID).LT.DDBASH) DDHTRM(MN)=DDHTRM(MN)-DBTAD(MN,ID)+D
254:      2DBASH
255:                  IF (DBTAD(MN,ID).GT.DDBASC) DDCLRM(MN)=DDCLRM(MN)+DBTAD(MN,ID)-D
256:      2DBASC
257:                  DBTRM0(MN)=DBTRM0(MN)+DBTD/24.0
258:                  DBTRM1(MN)=DBTRM1(MN)+(DBMAX+DBMIN)/2.0
259:                  DBAMAX(MN)=DBAMAX(MN)+DBMAX
260:                  DBAMIN(MN)=DBAMIN(MN)+DBMIN
261:                  DBMXRM(MN)=MAX(DBMAX,DBMXRM(MN))
262:                  DBMNRM(MN)=MIN(DBMIN.DBMNRM(MN))
263:                  DPTRM(MN)=DPTRM(MN)+DPTD/24.0
264:                  WSPRM(MN)=WSPRM(MN)+WSPD/24.0
265:                  CCCTRM(MN)=CCCTRM(MN)+CCCTD/24.0
266:                  CCSTRM(MN)=CCSTRM(MN)+CCSTD/24.0
267:                  CCOTRM(MN)=CCOTRM(MN)+CCOTD/24.0
268:                  DRNGRM(MN)=DRNGRM(MN)+DBMAX-DBMIN
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269:              WBTRM(MN)=WBTRM(MN)+WBTD/24.0
270:              BPRRM(MN)=BPRRM(MN)+BPRD/24.0
271:     70       CONTINUE
272:     C                  FOR EACH MONTH:
273:           DO 80 MN=1,12
274:     C              DIVIDE BY THE NUMBER OF DAYS IN THE MONTH TO GET THE AVER
275:              N=NDAY(MN)
276:              DBTRM0(MN)=DBTRM0(MN)/N
277:              DBTRM1(MN)=DBTRM1(MN)/N
278:              DBTRM(MN)=DBTRM0(MN)
279:              IF (IDBFLG.EQ.1) DBTRM(MN)=DBTRM1(MN)
280:              DBAMAX(MN)=DBAMAX(MN)/N
281:              DBAMIN(MN)=DBAMIN(MN)/N
282:              DBMXYR=MAX(DBMXRM(MN),DBMXYR)
283:              DBMNYR=MAX(DBMNRM(MN),DBMNYR)
284:              DPTRM(MN)=DPTRM(MN)/N
285:              BPRRM(MN)=BPRRM(MN)/N
286:              WSPRM(MN)=WSPRM(MN)/N
287:              WBTRM(MN)=WBTRM(MN)/N
288:              DRNGRM(MN)=DRNGRM(MN)/N
289:              CCCDRM(MN)=CCCDRM(MN)/N
290:              CCSDRM(MN)=CCSDRM(MN)/N
291:              CCODRM(MN)=CCODRM(MN)/N
292:              CCCTRM(MN)=CCCTRM(MN)/N
293:              CCSTRM(MN)=CCSTRM(MN)/N
294:              CCOTRM(MN)=CCOTRM(MN)/N
295:              CCTRM(MN)=CCCTRM(MN)+CCOTRM(MN)+CCSTRM(MN)
296:              CCDRM(MN)=CCCDRM(MN)+CCODRM(MN)+CCSDRM(MN)
297:     80       CONTINUE
298:           PRINT 280
299:     C              PRINT THE EXTREME TEMPERATURE DATA FOR THE REAL YEAR.
300:           DO 90 MN=1,12
301:              PRINT 290, DBAMAX(MN),DBAMIN(MN),DBMXRM(MN),DBMNRM(MN),DDHTRM(MN
302:          2),DDCLRM(MN)
303:     90       CONTINUE
304:     C              FIND THE SUMMER AND WINTER DESIGN STATISTICS.
305:           DO 100 I=1,180
306:              IDBTOT=IDBTOT+IDBCNT(I)
307:              IDBCNT(I)=0
308:              J=I-49
309:              IF (IDBTOT.LT.1) DBMNYR=J
310:              IF (IDBTOT.LT.10) DBDES2=J
311:              IF (IDBTOT.LT.50) DBDES3=J
312:              IF (IDBTOT.LT.200) DBDES4=J
313:              IF (IDBTOT.LT.500) DBDES5=J
314:              IF (IDBTOT.LT.(IHTOT-500)) DBDES6=J
315:              IF (IDBTOT.LT.(IHTOT-200)) DBDES7=J
316:              IF (IDBTOT.LT.(IHTOT-50)) DBDES8=J
317:              IF (IDBTOT.LT.(IHTOT-10)) DBDES9=J
318:              IF (IDBTOT.LT.IHTOT) DBMXYR=J
319:     100      CONTINUE
320:     C              PRINT THEM OUT.
321:           PRINT 300, DBMXYR,DBDES9,DBDES8,DBDES7,DBDES6,DBMNYR,DBDES2,DBDES3
322:          2,DBDES4,DBDES5
323:           REWIND 8
324:           IF (ISKFLG.EQ.0) GO TO 120
325:     C              READ THE SKIPPED PORTION OF THE TAPE.
326:           DO 110 IDAY=1,ISKFLG
327:              READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
328:     110      CONTINUE
329:     120      CONTINUE
330:     C                  FOR EACH MONTH:
331:           DO 140 MN=1,12
332:     C              FIND THE MONTHLY AVERAGE DAILY STANDARD DEVIATION.
333:              N=NDAY(MN)
334:              DO 130 IDAY=1,N
335:                 DSDRM(MN)=DSDRM(MN)+(DBTAD(MN,IDAY)-DBTRM(MN))**2
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336:        130          CONTINUE
337:                     DSDRM(MN)=SQRT(DSDRM(MN)/(N-1))
338:        140          CONTINUE
339:                IF (IADFLG.EQ.0)  PRINT 310
340:                IF (IADFLG.EQ.0)  READ (5,210) IWBFLG
341:                IF (IADFLG.EQ.0)  PRINT 320
342:                IF (IDBFLG.EQ.0)  PRINT 330
343:                IF (IDBFLG.EQ.1)  PRINT 340
344:                IF (IADFLG.EQ.0.AND.ISIFLG.EQ.0)  PRINT 350
345:                IF (IADFLG.EQ.1.OR.ISIFLG.EQ.1)  PRINT 360
346:                YCCS=0.0
347:     C                  FOR EACH MONTH:
348:                DO 150 MN=1,12
349:     C                  CHECK TO SEE IF THERE IS A CATEGORY FOR STRATUS.
350:                YCCS=YCCS+CCSTRM(MN)
351:     C                  READ IN THE AVERAGES FOR THE ADJUSTED YEAR.
352:     C                  IF CALCULATIONS ARE NEEDED, MAKE THEM.
353:                CCPRNT=CCDRM(MN)
354:                IF (ICCFLG.EQ.0)  CCPRNT=CCTRM(MN)
355:                WRITE (7,420)  MN,DBTRM0(MN),DBTRM1(MN),CCPRNT,WSPRM(MN),DPTRM(MN
356:             2),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
357:                IF (IDBFLG.EQ.0)  PRINT 370, MN,DBTRM0(MN),CCPRNT,WSPRM(MN),DPTRM
358:             2(MN),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
359:                IF (IDBFLG.EQ.1)  PRINT 370, MN,DBTRM1(MN),CCPRNT,WSPRM(MN),DPTRM
360:             2(MN),BPRRM(MN),DSDRM(MN),DRNGRM(MN),WBTRM(MN)
361:                IF (IADFLG.NE.0)  GO TO 150
362:                READ (5,210)  DBTIM(MN),CCDIM(MN),WSPIM(MN),DPTIM(MN),BPRIM(MN),D
363:             2SDIM(MN),DRNGIM(MN),WBTIM(MN)
364:                DLCCCM(MN)=(CCDIM(MN)-CCDRM(MN))*CCCTRM(MN)/CCDRM(MN)
365:                DLCCSM(MN)=(CCDIM(MN)-CCDRM(MN))*CCSTRM(MN)/CCDRM(MN)
366:                DLCCOM(MN)=(CCDIM(MN)-CCDRM(MN))*CCOTRM(MN)/CCDRM(MN)
367:                IF (DSDIM(MN).EQ.0.)DSDIM(MN)=DSDRM(MN)
368:                IF (ICCFLG.EQ.0)  DLCCCM(MN)=(CCDIM(MN)-CCTRM(MN))*CCCTRM(MN)/CCT
369:             2RM(MN)
370:                IF (ICCFLG.EQ.0)  DLCCSM(MN)=(CCDIM(MN)-CCTRM(MN))*CCSTRM(MN)/CCT
371:             2RM(MN)
372:                IF (ICCFLG.EQ.0)  DLCCOM(MN)=(CCDIM(MN)-CCTRM(MN))*CCOTRM(MN)/CCT
373:             2RM(MN)
374:                IF (ISIFLG.NE.0)  GO TO 150
375:                DBTIM(MN)=DBTIM(MN)*1.8+32.0
376:                DPTIM(MN)=DPTIM(MN)*1.8+32.0
377:                DRNGIM(MN)=DRNGIM(MN)*1.8
378:                WBTIM(MN)=WBTIM(MN)*1.8+32.0
379:                DSDIM(MN)=DSDIM(MN)*1.8+32.0
380:                WSPIM(MN)=WSPIM(MN)*3.6/1.853
381:                BPRIM(MN)=BPRIM(MN)*29.92/101.1
382:        150          CONTINUE
383:                IF (IADFLG.NE.0)  GO TO 200
384:     C                  CALL CLOUD TO ADJUST THE CLOUD VALUES FOR THE YEAR.
385:                CALL CLOUD (NDAY,DLCCCM,CCCARR)
386:                IF (YCCS.NE.0.0)  CALL CLOUD (NDAY,DLCCSM,CCSARR)
387:                CALL CLOUD (NDAY,DLCCOM,CCOARR)
388:                READ (8) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
389:     C                  FOR EACH MONTH:
390:                DO 170 M=1,12
391:     C                  GET THE MONTHLY RATIOS.
392:                RATDPT=(DBTIM(MN)-DPTIM(MN))/(DBTRM(MN)-DPTRM(MN))
393:                RATWBT=(DBTIM(MN)-WBTIM(MN))/(DBTRM(MN)-WBTRM(MN))
394:                BPRADJ=BPRIM(MN)-BPRRM(MN)
395:                RATWSP=WSPIM(MN)/WSPRM(MN)
396:                DLDBTM=DBTIM(MN)
397:                RATDSD=DSDIM(MN)/DSDRM(MN)
398:                DLDRNG=(DRNGIM(MN)-DRNGRM(MN))/2.0
399:                RATDRN=DRNGIM(MN)/DRNGRM(MN)
400:                N=NDAY(MN)
401:                DBAMAX(MN)=0.0
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402:                DBAMIN(MN)=0.0
403:       C                FOR EACH DAY:
404:                DO 170 IDAY=1,N
405:                DBAD=DBTAD(MN,ID)
406:       C                GET THE DAILY DRY BULB ADJUSTMENT.
407:                IF (DBAD.NE.DBMXAD(MN,ID)) DLDRMX=1+DLDRNG/(DBMXAD(MN,ID)-DBAD)
408:                IF (DBAD.NE.DBMNAD(MN,ID)) DLDRMN=1+DLDRNG/(DBAD-DBMNAD(MN,ID))
409:                DLDBTD=(DBAD-DBTRM(MN))*RATDSD+DLDBTM
410:                IF (DLDBTD.LT.DDBASH) DDHTAM(MN)=DDHTAM(MN)-DLDBTD+DDBASH
411:                IF (DLDBTD.GT.DDBASC) DDCLAM(MN)=DDCLAM(MN)+DLDBTD-DDBASC
412:                MH=IDAY*24-24
413:                DBMAX=-100.0
414:                DBMIN=100.0
415:       C                FOR EACH HOUR:
416:                DO 160 IH=1,24
417:       C            FIND THE HOURLY DRY BULB, DEWPOINT, AND WET BULB ADJUSTM
418:                DB=DBT(IH)
419:                DLDBTH=DB-DBAD
420:                DLWBTH=(WBT(IH)-DB)*RATWBT
421:                DLDPTH=(DPT(IH)-DB)*RATDPT
422:                IF (DLDRNG.LT.0.0) DLDBTH=DLDBTH*RATDRN
423:       C       IF DAILY RANGE MUST BE INCREASED, AN ADDITIVE
424:       C       ADJUSTMENT IS MADE TO THE DAILY EXTREMES.    OTHERWISE
425:       C       RATDRN IS USED.
426:                IF (DLDRNG.GT.0.0.AND.DLDBTH.GT.0.0) DLDBTH=DLDBTH*DLDRMX
427:                IF (DLDRNG.GT.0.0.AND.DLDBTH.LT.0.0) DLDBTH=DLDBTH*DLDRMN
428:                DB=DLDBTH+DLDBTD
429:       C            ADJUST THE HOURLY VALUES, IF NECESSARY CALL DEWPNT OR WET
430:                DBMAX=MAX(DB,DBMAX)
431:                DBMIN=MIN(DB,DBMIN)
432:                IDB=DB+50.5
433:                IDBCNT(IDB)=IDBCNT(IDB)+1
434:                WBT(IH)=DB+DLWBTH
435:                DPT(IH)=DB+DLDPTH
436:                IF (IBPFLG.EQ.0) BPR(IH)=BPR(IH)+BPRADJ
437:                IF (IBPFLG.EQ.1) BPR(IH)=BPR(IH)/10**(DH/((459.+(DBT(IH)+DB)/2
438:           2.)*122.8))
439:                DBT(IH)=DB
440:                IF (IWBFLG.EQ.0) CALL DEWPNT (DBT(IH),WBT(IH),BPR(IH),DPT(IH))
441:                IF (IWBFLG.EQ.1) CALL WETBLB (DBT(IH),DPT(IH),BPR(IH),WBT(IH))
442:                CCT(IH)=MOD((CCCARR(MN,MH+IH)+CCOARR(MN,MH+IH)+CCSARR(MN,MH+IH
443:           2)),11.0)
444:                WSP(IH)=WSP(IH)*RATWSP
445:       160        CONTINUE
446:       C            WRITE OUT A DAY OF OUR ADJUSTED YEAR.
447:                DBAMAX(MN)=DBAMAX(MN)+DBMAX
448:                DBAMIN(MN)=DBAMIN(MN)+DBMIN
449:                DBMXAM(MN)=MAX(DBMAX,DBMXAM(MN))
450:                DBMNAM(MN)=MIN(DBMIN,DBMNAM(MN))
451:                WRITE (9) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,IC
452:                READ (8,END=170) DBT,DPT,WBT,WSP,BPR,CCT,TOC,WDR,YY,IYEAR,MN,ID,
453:           2IC -
454:       170        CONTINUE
455:                 IDBTOT=0
456:       C            FIND THE DESIGN STATISTICS FOR THE ADJUSTED YEAR.
457:                 DO 180 I=1,180
458:                  IDBTOT=IDBTOT+IDBCNT(I)
459:                  J=I-49
460:                  IF (IDBTOT.LE.0) DBMNYR=J
461:                  IF (IDBTOT.LT.10) DBDES2=J
462:                  IF (IDBTOT.LT.50) DBDES3=J
463:                  IF (IDBTOT.LT.200) DBDES4=J
464:                  IF (IDBTOT.LT.500) DBDES5=J
465:                  IF (IDBTOT.LT.(IHTOT-500)) DBDES6=J
466:                  IF (IDBTOT.LT.(IHTOT-200)) DBDES7=J
467:                  IF (IDBTOT.LT.(IHTOT-50)) DBDES8=J
468:                  IF (IDBTOT.LT.(IHTOT-10)) DBDES9=J
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469:               IF ( IDBTOT.LT. IHTOT) DBMXYR=J
470:       180     CONTINUE
471:             PRINT 380, ALPHA(1),ALPHA(2)
472:             PRINT 390
473:             DO 190 MN=1,12
474:               N=NDAY(MN)
475:               DBAMAX(MN)=DBAMAX(MN)/N
476:               DBAMIN(MN)=DBAMIN(MN)/N
477:               PRINT 400, DBAMAX(MN),DBAMIN(MN),DBMXAM(MN),DBMNAM(MN),DDHTAM(MN
478:             2),DDCLAM(MN)
479:       190     CONTINUE
480:       C              PRINT THE EXTREME TEMPERATURE DATA FOR THE ADJUSTED YEAR.
481:             PRINT 410,  DBMXYR,DBDES9,DBDES8,DBDES7,DBDES6,DBMNYR,DBDES2,DBDES3
482:             2,DBDES4,DBDES5
483:       200   CONTINUE
484:             IF ( IADFLG.EQ.1) PRINT 380, ALPHA(3),ALPHA(4)
485:             STOP
486:       C
487:       C
488:       C
489:       C
490:       210   FORMAT ()
491:       220   FORMAT (' ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.')
492:       230   FORMAT (' ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START'
493:             2,/,' OF THE 12 MONTH PERIOD BEING USED',/' FOLLOWED BY THE ',
494:             3 'NUMBER OF DAYS IN IT')
495:       240   FORMAT (' ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1')
496:       250   FORMAT (' ENTER 0 0.0 IF BAROMETRIC PRESSURE DATA IS AVAILABLE',/,
497:             2 ' OTHERWISE ENTER 1 AND THE HEIGHT DIFFERENCE OF THE NEW ',/,
498:             3 ' AND OLD LOCATION --- H(NEW)-H(OLD) IN FEET')
499:       260   FORMAT (' ENTER 0 IF USING SI UNITS (FOR INPUT OF CLIMATE',/,
500:             2 ' VARIABLES ONLY), ELSE ENTER 1',/,' FOLLOWED BY THE CLOUD FLAG:'
501:             3,/,' 1 IF USING DAYTIME AVERAGES',/,
502:             4 ' 0 IF USING FULL DAY AVERAGES.')
503:       270   FORMAT (' ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE',/,
504:             2 ' USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED ',/,
505:             3 ' (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE',/,
506:             4 ' DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY',/,
507:             5 ' BULB CALCULATIONS)',/,
508:             6 ' THEN ENTER THE BASE TEMPERATURES'' TO BE USED IN ',/,
509:             7 ' THE DEGREE DAY CALCULATIONS IN ',A6,':',/,
510:             8 ' FIRST HEATING, THEN COOLING.',/)
511:       280   FORMAT (/,/,' INPUT YEAR SUMMARY',/,
512:             2 ' MAX. AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL')
513:       290   FORMAT (4F9.3,2F10.3)
514:       300   FORMAT (' SUMMER DESIGN 0 HRS:',F5.0,' 10 HRS:',F5.0,' 50 HRS:',
515:             2 F5.0,' 200 HRS:',F5.0,' 500 HRS:',F5.0,/,' WINTER DESIGN 0 HRS:',
516:             3 F5.0,' 10 HRS:',F5.0,' 50 HRS:',F5.0,' 200 HRS:',F5.0,' 500 HRS:'
517:             4,F5.0)
518:       310   FORMAT (' ENTER 0 IF USING WET BULB ONLY, AS FROM AIR FORCE',
519:             2 ' MANUAL 88/29',/,' ENTER 1 IF USING DEWPOINT ONLY, AS FROM',
520:             3 ' NOAA CLIMATIC ATLAS',/,' ENTER 2 IF USING BOTH')
521:       320   FORMAT (' ENTER THE WEATHER AVERAGES TO ADJUST THE TAPE.',/,
522:             2 ' EVEN IF VALUES CANNOT BE FOUND OR ARE NOT USED',/,
523:             3 ' SOMETHING MUST BE ENTERED FOR ALL 96 VALUES',/,
524:             4 ' ( ENTER ONLY ONE TYPE OF DRY BULB AVERAGE.)',/,
525:             5 ' IF NECESSARY ECHO THE VALUES FROM THE INPUT YEAR',/)
526:       330   FORMAT (' MONTH   DRY BULB   CLOUD    WIND   DEW  BAROMETRIC DAILY DA
527:             2ILY ',' WET',/,9X,' 24-HR   COVER   SPEED POINT  PRESSURE   S.D. '
528:             3,'RANGE  BULB')
529:       340   FORMAT (' MONTH   DRY BULB   CLOUD    WIND   DEW  BAROMETRIC DAILY DA
530:             2ILY ',' WET',/,9X,' MAXMIN   COVER   SPEED POINT  PRESSURE   S.D. '
531:             3,'RANGE  BULB')
532:       350   FORMAT (9X,' DEG.C.  TENTHS M/S DEG.C.   KPAS ',
533:             2 'DEG.C. DEG.C. DEG.C.')
534:       360   FORMAT (9X,' DEG.F.  TENTHS KNOTS DEG.F.   ',
```

```
535:              2 'IN.HG.  DEG.F.  DEG.F.  DEG.F.')
536:     370     FORMAT (I4,5X,F7.2,3X,F5.2,F7.2,F6.2,F9.2,F7.2,F7.2,F7.2)
537:     380     FORMAT (2A6,' YEAR COMPLETE.')
538:     390     FORMAT (/,/,' ADJUSTED YEAR SUMMARY',/,
539:              2 ' AVG.  MAX AVG.  MIN EXT.  MAX EXT.  MIN D.D.  HEAT D.D.  COOL')
540:     400     FORMAT (4F9.3,2F10.3)
541:     410     FORMAT (' SUMMER DESIGN 0 HRS:',F5.0,' 10 HRS:',F5.0,' 50 HRS:',
542:              2 F5.0,' 200 HRS:',F5.0,' 500 HRS:',F5.0,/,' WINTER DESIGN 0 HRS:',
543:              3 F5.0,' 10 HRS:',F5.0,' 50 HRS:',F5.0,' 200 HRS:',F5.0,' 500 HRS:'
544:              4,F5.0)
545:     420     FORMAT (I4,2F7.2,3X,F5.2,F7.2,F6.2,F9.2,F7.2,F7.2,F7.2)
546:     C
547:             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.

```
 1:
 2:    C  SUBROU
 3:    C  ADJUST                                                                                        G
 4:    C  UNITS
 5:    C  A RAND
 6:    C
 7:    C  INPUT
 8:    C        N
 9:    C        D
10:    C        C
11:    C  LOCAL
12:    C        N........17.   THE NUMBER OF THAT TYPE OF TENTHS.
13:    C        NTP(TYPE+1,NUMBER):   THE HOURLY POSITION OF THIS TENTH.
14:    C        NCP(TYPE+1,NUMBER):   THE RANDOM NTP.
15:    C        NUMBER:  THE NUMBER OF HOURS IN A MONTH.
16:    C        MN:  THE MONTH.
17:    C        CCT:  STORES A CLOUD VALUE FOR EASIER HANDLING.
18:    C        IADJ:   THE NUMBER OF UNIT ADJUSTMENTS WHICH MUST BE MADE TO
19:    C                CHANGE THE AVERAGE BY DELCCT, DIVIDED BY TEN.
20:    C
21:    C            DIMENSION THE ARRAYS ALL TYPES BY NAME.
22:          DIMENSION NTC(13),NTP(13,745),NCP(13,745),CCTARR(12,745),
23:        *    NDAY(12),DELCCT(12)
24:    C            FOR EACH MONTH:
25:        DO 190 MN=1,12
26:    C            FIND THE NUMBER OF HOURS AND THE ADJUSTMENT NEEDED.
27:          NUMBER=NDAY(MN)*24
28:          DELTAC=DELCCT(MN)
29:    C            INITIALIZE THE CLOUD TYPE COUNTER.
30:          DO 10 I=1,13
31:            NTC(I)=0
32:    10      CONTINUE
33:    C            FOR EACH HOUR:
34:          DO 70 I=1,NUMBER
35:    C            FIND THE TENTH OF CLOUD WE ARE DEALING WITH AND
36:    C            INCREMENT THE COUNT AND STORE THE HOUR.
37:          CCT=CCTARR(MN,I)
38:          IF (CCT.NE.10.0) GO TO 30
39:          IF (CCTARR(MN,I-1).NE.10..OR.CCTARR(MN,I+1).NE.10.)GO TO 20
40:          NTC(12)=NTC(12)+1
41:          I12=NTC(12)
42:          NTP(12,I12)=I
43:          GO TO 70
44:    20      NTC(11)=NTC(11)+1
45:          I11=NTC(11)
46:          NTP(11,I11)=I
47:          GO TO 70
48:    30      IF (CCT.NE.0.0) GO TO 50
49:          IF (CCTARR(MN,I-1).NE.0..OR.CCTARR(MN,I+1).NE.0.)GO TO 40
50:          NTC(13)=NTC(13)+1
51:          I13=NTC(13)
52:          NTP(13,I13)=I
53:          GO TO 70
54:    40      NTC(1)=NTC(1)+1
55:          I1=NTC(1)
56:          NTP(1,I1)=I
57:          GO TO 70
58:    50      DO 60 IC=2,10
59:            R=IC-1
```

```
60:                               IF (CCT.NE.R) GO TO 60
61:                               NTC(IC)=NTC(IC)+1
62:                               IIC=NTC(IC)
63:                               NTP(IC,IIC)=I
64:                               GO TO 70
65:                60          60 CONTINUE
66:                70          70 CONTINUE
67:     C                         FOR EACH CLOUD TENTH TYPE:
68:                               DO 100 J=1,13
69:     C                             SEE HOW MANY OF THAT TYPE THERE ARE AND
70:     C                             PERMUTE THEIR POSITIONS (HOURS).
71:                               N=NTC(J)
72:                               IC=0
73:                               DO 75 I=1,N,7
74:                                   IC=IC+1
75:                                   NCP(J,I)=NTP(J,IC)
76:                75          75 CONTINUE
77:                               DO 80 I=2,N,7
78:                                   IC=IC+1
79:                                   NCP(J,I)=NTP(J,IC)
80:                80          80 CONTINUE
81:                               DO 85 I=3,N,7
82:                                   IC=IC+1
83:                                   NCP(J,I)=NTP(J,IC)
84:                85          85 CONTINUE
85:                               DO 90 I=4,N,7
86:                                   IC=IC+1
87:                                   NCP(J,I)=NTP(J,IC)
88:                90          90 CONTINUE
89:                               DO 95 I=5,N,7
90:                                   IC=IC+1
91:                                   NCP(J,I)=NTP(J,IC)
92:                95          95 CONTINUE
93:                               DO 96 I=6,N,7
94:                                   IC=IC+1
95:                                   NCP(J,I)=NTP(J,IC)
96:                96          96 CONTINUE
97:                               DO 100 I=7,N,7
98:                                   IC=IC+1
99:                                   NCP(J,I)=NTP(J,IC)
100:              100         100 CONTINUE
101:    C                         ADD ON THE STRING TENS AND ZEROES TO THE OTHERS
102:                               N1=NTC(11)
103:                               N2=NTC(12)
104:                               DO 110 I=1,N2
105:                                   N1=N1+1
106:                                   NCP(11,N1)=NCP(12,I)
107:              110         110 CONTINUE
108:                               NTC(11)=N1
109:                               N1=NTC(1)
110:                               N2=NTC(13)
111:                               DO 120 I=1,N2
112:                                   N1=N1+1
113:                                   NCP(1,N1)=NCP(13,I)
114:              120         120 CONTINUE
115:    C                         FIND HOW MANY ADJUSTMENTS MUST BE MADE.
116:                               NTC(1)=N1
117:                               IADJ=ABS(DELTAC*NUMBER/10.0)+.5
118:                               IF (DELTAC) ,180,150
119:                               IF (IADJ.GT.(NTC(11)/2)) PRINT 600 MN
120:                               DO 140 I=11,2,-1
121:                                   N2=NTC(I-1)
122:                                   N1=NTC(I)
```

C3

```
123:                         NADJ=MIN(IADJ,N1)
124:                         DO 130 J=1,NADJ
125:                           N2=N2+1
126:                           IP=NCP(I,J)
127:                           CCTARR(MN,IP)=I-2
128:                           NCP(I-1,N2)=IP
129:            130           CONTINUE
130:                         NTC(I-1)=N2
131:            140         CONTINUE
132:                       GO TO 180
133:            150       IF (IADJ.GT.(NTC(1)/2)) PRINT 600 MN
134:                     DO 170 I=1,10
135:                       N2=NTC(I+1)
136:                       N1=NTC(I)
137:                       NADJ=MIN(IADJ,N1)
138:                       DO 160 J=1,NADJ
139:                         N2=N2+1
140:                         IP=NCP(I,J)
141:                         CCTARR(MN,IP)=I
142:                         NCP(I+1,N2)=IP
143:            160         CONTINUE
144:                       NTC(I+1)=N2
145:            170       CONTINUE
146:            180     CONTINUE
147:            190   CONTINUE
148:            600 FORMAT (' !WARNING! CLOUD ADJUSTMENT FOR MONTH',I3,
149:                * /,' IS EXCESSIVE FOR THE ALGORITHM.')
150:                  RETURN
151:                  END
```

Subroutine DAYW(S)

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

```
20:       C            WETB   THE AVERAGE WET BULB TEMPERATURE, DEG. C.
21:       C            BAPR   THE AVERAGE BAROMETRIC PRESSURE, KILOPASCAL.
22:       C    LOCAL VARIABLES:
23:       C            YY    USED TO READ IN UNUSED WEATHER DATA.
24:       C            DB    HOURLY DRY BULB TEMPERATURES DEG. F.
25:       C            CC    HOURLY CLOUD COVER VALUES.
26:       C            DPT   HOURLY DEWPOINT TEMPERATURES DEG. F.
27:       C            WBT   HOURLY WET BULB TEMPERATURES DEG. F.
28:       C            PBT   HOURLY BAROMETRIC PRESSURE VALUES INCHES OF HG.
29:       C            WST   HOURLY WIND SPEEDS KNOTS.
30:       C            IDAWN   APPROXIMATE HOUR OF DAWN FOR EACH MONTH.
31:       C            LENGTH   HOURS OF SUNLIGHT FOR EACH MONTH.
32:       C            DAYMIN   THE MINIMUM DRY BULB TEMPERATURE FOR THE DAY DEG. F.
33:       C            DAYMAX   THE MAXIMUM DRY BULB TEMPERATURE FOR THE DAY DEG. F.
34:       C            IDBFLG   1 IF THE MAX-MIN AVERAGE IS TO BE USED, 0 FOR 24HR
35:       C                     AVERAGE.
36:       C    INPUT VARIABLES:
37:       C            BH    THE BASE FOR THE DEGREE DAYS HEATING (DDHT), DEG. C.
38:       C            BC    THE BASE FOR THE DEGREE DAYS COOLING (DDCL), DEG. C.
39:       C            K   POSITION OF THE DAILY DATA IN OUR DEFINE FILE.
40:       C            INIYR   DIFFERENCE BETWEEN THE FIRST YEAR USED FROM THIS
41:       C                    TAPE AND THE NUMBER OF YEARS ALREADY USED.
42:       C            LOGUNI   LOGICAL UNIT FROM WHICH THE TAPE IS READ.
43:       C
44:       C            DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
45:             DIMENSION YY(72),DB(24),CC(24),PBT(24),WST(24),DPT(24),WBT(24)
46:             COMMON /DT/ IDAWN(12),LENGTH(12)
47:       C            READ IN THE RECORD FOR A FULL DAY AND WRITE IT IN
48:       C                   IN THE DEFINE FILE.
49:             READ (LOGUNI,END=30) DB,DPT,WBT,WST,PBT,CC,YY,IYEAR,MONTH,
50:            * IDAY,ICITY
51:             K=K+1
52:             IYEAR=IYEAR-INIYR+1
53:             WRITE (10'K) DB,DPT,WBT,WST,PBT,CC,YY,IYEAR,MONTH,IDAY,ICITY
54:       C            INITIALIZE THE SUMMING VARIABLES.
55:             WNSP=0.0
56:             DEWP=0.0
57:             WETB=0.0
58:             DBTP=0.0
59:             CCT=0.0
60:             CCAD=0.0
61:             DDHT=0.0
62:             DDCL=0.0
63:             BAPR=0.0
64:       C            FOR EACH HOUR:
65:       C                   ADD IN THE VALUES TO BE AVERAGED.
66:       C                   CHANGE THE MINIMUM AND MAXIMUM AS NECESSARY.
67:             DO 10 J=1,24
68:               DEWP=DPT(J)+DEWP
69:               WETB=WBT(J)+WETB
70:               BAPR=PBT(J)+BAPR
71:               DBTP=DBTP+DB(J)
72:               WNSP=WNSP+WST(J)
73:               CCT=CCT+CC(J)
74:               IF (J.EQ.1) DAYMAX=DB(J)
75:               IF (J.EQ.1) DAYMIN=DB(J)
76:               DAYMAX=MAX(DAYMAX,DB(J))
77:               DAYMIN=MIN(DAYMIN,DB(J))
78:          10 CONTINUE
79:       C            DIVIDE THE SUMS TO GET AVERAGES, FIND THE RANGE, AND
80:       C                   CONVERT TO SI UNITS.
81:             DRNG=(DAYMAX-DAYMIN)*5/9
82:             DBTP=(DBTP/24.0-32.0)*5/9
83:             IF (IDBFLG.EQ.1) DBTP=(DAYMIN+DAYMAX-64.0)*5/18
84:             CCT=CCT/24.0
85:             BAPR=(BAPR/24.0)*101.1/29.921
86:             DEWP=(DEWP/24.0-32.0)*5/9
87:             WETB=(WETB/24.0-32.0)*5/9
88:             WNSP=WNSP/24.0*1.853/3.6
```

C5

```
89:    C                    FOR EACH SUNLIT HOUR SUM THE CLOUD COVER.
90:            I1=IDAWN(MONTH)
91:            I2=I1+LENGTH(MONTH)
92:            DO 20 I=I1,I2
93:               CCAD=CCAD+CC(I)
94:        20  CONTINUE
95:            CCAD=CCAD/(LENGTH(MONTH)+1)
96:    C                    FIND THE DEGREE DAYS.
97:            IF (DBTP.GT.BC) DDCL=DBTP-BC
98:            IF (DBTP.LT.BH) DDHT=BH-DBTP
99:        30  RETURN
100:           END
```

<div align="center">Subroutine DEWPNT (A)</div>

```
1:            SUBROUTINE DEWPNT (DB,WB,PB,DP)
2:     C
3:     C      SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 32D.
4:     C
5:            PVP=PVSF(WB)
6:            IF (DB-WB) 10,10,
7:            WSTAR=0.622*PVP/(PB-PVP)
8:            IF (WB-32.)  ,,20
9:            PV=PVP-5.704E-4*PB*(DB-WB)/1.8
10:           GO TO 30
11:     10     PV=PVP
12:           GO TO 30
13:     20     CDB=(DB-32.)/1.8
14:            CWB=(WB-32.)/1.8
15:            HL=597.31+0.4409*CDB-CWB
16:            CH=0.2202+0.4409*WSTAR
17:            EX=(WSTAR-CH*(CDB-CWB)/HL)/0.622
18:            PV=PB*EX/(1.+EX)
19:     30     IF (PV.LE.0) GO TO 50
20:            IF (DB.NE.WB) GO TO 40
21:            DP=DB
22:            GO TO 50
23:     40     CONTINUE
24:            DP=DPF(PV)
25:     50     RETURN
26:            END
```

<div align="center">Subroutine DEWPNT (S)</div>

```
1:            SUBROUTINE DEWPNT (DB,WB,PB,DP)
2:     C
3:     C      SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 32D.
4:     C
5:            PVP=PVSF(WB)
6:            IF (DB-WB) 30,30,10
7:     10     WSTAR=0.622*PVP/(PB-PVP)
8:            IF (WB) 20,20,40
9:     20     PV=PVP-5.704E-4*PB*(DB-WB)
10:           GO TO 50
11:     C
12:     30     PV=PVP
13:            GO TO 50
```

<div align="center">C6</div>

```
14:     C
15:     40      HL=597.31+0.4409*DB-WB
16:             CH=0.2402+0.4409*WSTAR
17:             EX=(WSTAR-CH*(DB-WB)/HL)/0.622
18:             PV=PB*EX/(1.+EX)
19:     50      IF (PV.LE.0) GO TO 70
20:             IF (DB.NE.WB) GO TO 60
21:             DP=DB
22:             GO TO 70
23:     C
24:     60      CONTINUE
25:             PV=PV*29.92/101.1
26:             DP=(DPF(PV)-32.0)/1.8
27:     70      RETURN
28:     C
29:             END
```

Subroutine ORDER (S)

```
1:      C
2:      C               SUBROUTINE ORDER
3:      C
4:              SUBROUTINE ORDER(TEMP,IARRAY,N)
5:      C
6:      C       ORDERS TEMPS IN INCREASING VALUE-ORDERS ARRAY IARRAY ACCORDINGLY
7:      C
8:      C    INPUT VARIABLES:
9:      C        TEMP   AN ARRAY CONTAINING THE VALUES TO BE SORTED.
10:     C        IARRAY  STARTS OUT CONTAINING ITS SUBSCRIPTS IN
11:     C                CORRESPONDING POSITIONS.  IT IS ALTERED TO CONTAIN
12:     C                THE ORIGINAL POSITIONS OF THE ELEMENTS IN TEMP
13:     C                IN THEIR CORRESPONDING SORTED POSITIONS.
14:     C        N   THE NUMBER OF ELEMENTS  IN TEMP.
15:     C
16:     C    OUTPUT VARIABLES:
17:     C        TEMP   THE VALUES IN INCREASING ORDER.
18:     C        IARRAY  THE ORIGINAL POSITION OF THE VALUES IN TEMP.
19:     C
20:     C    LOCAL VARIABLES:
21:     C        AA   TEMPORARY STORAGE FOR SORTED TEMP.
22:     C        IA   TEMPORARY STORAGE FOR SORTED IAARAY.
23:     C        K   THE SMALLEST UNSORTED VALUE'S POSITION.
24:     C        BA   THE SMALLEST UNSORTED VALUE.
25:     C
26:     C               DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
27:             DIMENSION TEMP(N),IARRAY(N),AA(200),IA(200)
28:     C               FOR EACH PLACE.
29:             DO 50 I=1,N
30:               BA=2999.0
31:     C               FIND THE SMALLEST UNSORTED VALUE.
32:               DO 25 J=1,N
33:                 IF(BA-TEMP(J)) 25,25,
34:     C               STORE ITS LOCATION.
35:                 K=J
36:                 BA=TEMP(J)
37:     25        CONTINUE
38:     C               MOVE THE UNSORTED VALUE AND ITS LOCATION
39:     C               INTO THE NEXT POSITION IN OUR TEMPORARY
40:     C               ARRAYS.
41:               TEMP(K)=3000.0
42:               AA(I)=BA
43:               IA(I)=IARRAY(K)
44:     50 CONTINUE
```

C7

```
45:       C                    MOVE THE VALUES INTO OUR OUTPUT ARRAYS.
46:             DO 75 L=1,N
47:                TEMP(L)=AA(L)
48:                IARRAY(L)=IA(L)
49:          75 CONTINUE
50:             RETURN
51:             END
```

Subroutine SLYEAR (S)

```
 1:             SUBROUTINE SLYEAR(DADB,SLDB,ICDT,LSEG,LOGUNI,IYRARR,RANKCH)
 2:       C
 3:       C             SUBROUTINE SLYEAR
 4:       C
 5:       C     A SUBROUTINE TO CREATE A FULL YEAR TAPE FROM
 6:       C     SELECTED PIECES OF ANOTHER WEATHER TAPE.
 7:       C     REQUIRES FOUR INPUT ARRAYS AND READS THE TAPE
 8:       C     FROM LOGICAL UNIT 10 WHICH MUST BE A DEFINE
 9:       C     FILE 10(3700,220,U,N) AND WRITES IT AT LOGICAL
10:       C     UNIT LOGUNI.  ALSO FINDS THE AVERAGE DAILY
11:       C     STANDARD DEVIATION OF EACH MONTH IN THE SELECTED
12:       C     YEAR.
13:       C
14:       C
15:       C   INPUT VARIABLES:
16:       C        DADB   CONTAINS THE DRY BULB AVERAGE FOR EACH YEAR
17:       C               IN OUR DEFINE FILE.
18:       C        SLDBT · CONTAINS THE MONTHLY DRY BULB AVERAGES OF OUR
19:       C               SELECTED YEAR.
20:       C        ICDT   CONTAINS 36 ENTRIES (12,3) WHICH ARE
21:       C               THE STARTING DAYS OF OUR SELECTED SEGMENTS.
22:       C        LSEG   CONTAINS THE LENGTH OF EACH SEGMENT.
23:       C        LOGUNI  NUMBER OF THE LOGICAL UNIT ASSIGNED THE OUTPUT TAPE.
24:       C        IYRARR  CONTAINS THE A.D. YEAR OF THE INPUT WEATHER TAPES.
25:       C        RANKCH  CONTAINS THE RANKS OF THE SEGMENTS.
26:       C
27:       C   OUTPUT VARIABLE:
28:       C         SLDSD   THE DAILY STANDARD DEVIATION FOR EACH
29:       C                 MONTH IN THE SELECTED YEAR.
30:       C   LOCAL VARIABLES:
31:       C        ARRAY,IYEAR,MONTH,IDAY,ICITY
32:       C            READ IN FROM THE DEFINE FILE AND WITH SOME ALTERATIONS
33:       C            WRITTEN AT LOGUNI.
34:       C        NDAY   THE DAY OF THE MONTH IN OUR OUTPUT TAPE.
35:       C        NDIS   THE STARTING POINT OF A SEGMENT.
36:       C        IDIS   THE ENDPOINT OF THE SEGMENT.
37:       C        MOWARM  THE SIGNAL MONTH FOR THE WARMUP WEEK.
38:       C        NNNYR   THE YEAR GIVEN THE SELECTED YEAR.
39:       C        NCITY   THE CITY CODE GIVEN THE WHOLE YEAR.
40:       C
41:       C              DECLARE THE DIMENSIONS (ALL TYPES BY NAME).
42:             DIMENSION ARRAY(216),ICDT(12,3),LSEG(12,3),IYRARR(10),RANKCH(12,3)
43:           * ,DADB(3653),SLDSD(12),SLDB(12)
44:             PRINT 600 LOGUNI
45:             READ (5,500) NNNYR,NCITY
46:             MOWARM=2
47:             NCITY=LOGUNI
48:             NNNYR=1889+LOGUNI
49:       C              READ IN THE FIRST WEEK AND WRITE IT OUT AS
50:       C              OUR WARMUP WEEK.
51:             DO 20 NDAY=1,7
52:                READ(10'NDAY) ARRAY,IYEAR,MONTH,IDAY,ICITY
53:                WRITE (LOGUNI) ARRAY,NNNYR,MOWARM,NDAY,NCITY
54:          20 CONTINUE
```

C8

```
55:            PRINT 605
56:     C             FOR EACH MONTH.
57:            DO 80 M=1,12
58:              NDAY=0
59:              SLDSD(M)=0.0
60:     C             FOR EACH SEGMENT.
61:              DO 60 J=1,3
62:                NDAY=NDAY+1
63:                NDIS=ICDT(M,J)
64:     C                READ THE FIRST DAY OF THE SEGMENT AND
65:     C                PRINT OUT ITS DATE, LENGTH, AND CITY.
66:                READ(10'NDIS) ARRAY,IYEAR,MONTH,IDAY,ICITY
67:                SLDSD(M)=(SLDB(M)-DADB(NDIS))*(SLDB(M)-DADB(NDIS))+SLDSD(M)
68:                PRINT 610 M,J,IYRARR(IYEAR),MONTH,IDAY,LSEG(M,J),ICITY,
69:           *      RANKCH(M,J)
70:                IDIS=NDIS+LSEG(M,J)-1
71:                WRITE (LOGUNI)ARRAY,NNNYR,M,NDAY,NCITY
72:                NDIS=NDIS+1
73:     C                FOR EACH DAY OF THE SEGMENT READ AND
74:     C                WRITE THE DATA.
75:                DO 40 K=NDIS,IDIS
76:                  NDAY=NDAY+1
77:                  READ (10'K) ARRAY,IYEAR,MONTH,IDAY,ICITY
78:                  SLDSD(M)=(SLDB(M)-DADB(K))*(SLDB(M)-DADB(K))+SLDSD(M)
79:                  WRITE (LOGUNI) ARRAY,NNNYR,M,NDAY,NCITY
80:        40        CONTINUE
81:        60     CONTINUE
82:              SLDSD(M)=SQRT(SLDSD(M)/(NDAY-1))
83:              PRINT 615 M,SLDSD(M)
84:        80 CONTINUE
85:       500 FORMAT ( )
86:       600 FORMAT (' ENTER THE A.D. YEAR AND FIVE DIGIT CITY CODE FOR ',
87:           * /,' THE YEAR WRITTEN AT LOGICAL UNIT ',I2)
88:       605 FORMAT (' MONTH SEGMENT YEAR   MONTH   DAY   LENGTH  CITY ',
89:           * '   RANK')
90:       610 FORMAT (2(I6),2X,3(I6),2X,I6,2X,I6,F7.2)
91:       615 FORMAT (' THE DAILY STANDARD DEVIATION FOR MONTH',I4,' IS',F8.3)
92:            RETURN
93:            END
```


Subroutine SUNNY (A,S)


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

```
20:      C      SRT=SUN RISE TIME   (HOURS AFTER MIDNIGHT)
21:      C      SST=SUN SET TIME
22:      C      SDA=SUN DECLINATION ANGLE, DEGREES
23:      C      EOT=EQUATION OF TIME , HOURS
24:             PI=3.1415927
25:             DO 20 I=1,12
26:                X=2*PI/366.*IDYOYR(I)
27:                C1=COS(X)
28:                C2=COS(2*X)
29:                C3=COS(3*X)
30:                S1=SIN(X)
31:                S2=SIN(2*X)
32:                S3=SIN(3*X)
33:                SDA=.302-22.93*C1-.229*C2-.243*C3+3.851*S1+.002*S2-.055*S3
34:                EOT=.4197*C1-3.2265*C2-.0903*C3-7.351*S1-9.391*S2-.3361*S3-.0002
35:                EOT=EOT/60.
36:                MERID=15*TZN
37:                LOND=LONG-MERID
38:                Y=SDA*PI/180.
39:                YY=LATD*PI/180.
40:                HP=-TAN(Y)*TAN(YY)
41:                TR=12/PI*ACOS(HP)
42:                SRT=(12-TR)-EOT+LOND/15.
43:                IDAWN(I)=(SRT+.5)
44:                SST=SRT+2.*TR
45:                LENGTH(I)=(SST+.5)-IDAWN(I)
46:         20 CONTINUE
47:             RETURN
48:             END
```

Subroutine WETBLB (A)

```
 1:             SUBROUTINE WETBLB (DB,DP,PB,WB)
 2:      C
 3:      C      SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 33D.
 4:      C
 5:      C   THIS SUBROUTINE CALCULATES THE FOLLOWINGS WHEN DRY-BULB TEMPERATURE
 6:      C   (DB),DEW-POINT TEMPERATURE(DP),AND BAROMETRIC PRESSURE(PB) ARE GIVEN
 7:      C   WB     WET-BULB TEMPERATURE
 8:             IF (DP-DB) 20,,
 9:             DP=DB
10:         20 PV=PVSF(DP)
11:             PVS=PVSF(DB)
12:             W=0.622*PV/(PB-PV)
13:             H=0.24*DB+(1061+0.444*DB)*W
14:             IF (H) ,,40
15:             WB=DP
16:             RETURN
17:      C
18:         40 WB=WBF(H,PB)
19:             RETURN
20:      C
21:             END
```

Function DPF (A,S)

```
 1:              FUNCTION DPF (PV)
 2:      C
 3:      C       SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 27D.
 4:      C
 5:      C       THIS SUBROUTINE CALCULATES DEW-POINT TEMPERATURE FOR
 6:      C       GIVEN VAPOR PESSURE.
 7:              IF (PV) 10,10,20
 8:      10      GO TO 40
 9:      C
10:      20      CONTINUE
11:              Y=LOG(PV)
12:              IF (PV.GT.0.1836) GO TO 30
13:              DPF=71.98+24.873*Y+0.8927*Y*Y
14:              GO TO 40
15:      C
16:      30      DPF=79.047+30.579*Y+1.8893*Y*Y
17:      40      RETURN
18:      C
19:              END
```

FUNCTION PVSF (A)

```
 1:              FUNCTION PVSF(X)
 2:      C
 3:      C       SEE NBS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 33D.
 4:      C
 5:      C       FUNCTION PSYCHROMETRIC SUBROUTINE FOR CALCULATION OF
 6:      C       PARTIAL VAPOUR PRESSURE OF WATER AT A GIVEN TEMPERATURE
 7:      C       FOR A SATURATED CONDITION.
 8:      C
 9:      C  INPUTS X, A TEMPERATURE, DEG F., AND RETURNS PVSF, THE SATURATED
10:      C  PARTIAL VAPOR PRESSURE OF WATER IN MOIST AIR, INCHES OF MERCURY.
11:      C
12:              DIMENSION A(6) /-7.90298,5.02808,-1.3816E-7,11.344,
13:             2 8.1328E-3,-3.49149/ ,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
14:             3 ,P(4)
15:              T=(X+459.688)/1.8
16:              IF(T.LT.273.16) GOTO 10
17:              Z=373.16/T
18:              P(1)=A(1)*(Z-1)
19:              P(2)=A(2)*LOG10(Z)
20:              Z1=A(4)*(1-1/Z)
21:              P(3)=A(3)*(10**Z1-1)
22:              Z1=A(6)*(Z-1)
23:              P(4)=A(5)*(10**Z1-1)
24:              GOTO 20
25:      10      Z=273.16/T
26:              P(1)=B(1)*(Z-1)
27:              P(2)=B(2)*LOG10(Z)
28:              P(3)=B(3)*(1-1/Z)
29:              P(4)=LOG10(B(4))
30:      20      SUM=0.
31:              DO 30 I=1,4
32:                 SUM=SUM+P(I)
33:      30      CONTINUE
34:              PVSF=29.921*10**SUM
35:              RETURN
36:              END
```

Function PVSF (S)

.

```
1:     C      FUNCTION PSYCHROMETRIC SUBROUTINE FOR CALCULATION OF
2:     C      PARTIAL VAPOUR PRESSURE OF WATER AT A GIVEN TEMPERATURE
3:     C      FOR A SATURATED CONDITION.   SEE NBS BUILDING SCIENCE
4:     C      SERIES 69, NBSLD, PAGE 156A.
5:     C
6:     C  INPUTS X, A TEMPERATURE, AND RETURNS PVSF, THE SATURATED PARTIAL VAPOR
7:     C  PRESSURE OF WATER IN MOIST AIR.
8:     C  X:   IN DEG CELSIUS.
9:     C  PVSF:   IN KILOPASCAL.
10:    C
11:           FUNCTION PVSF(X)
12:           DIMENSION A(6) /-7.90298,5.02808,-1.3816E-7,11.344,
13:          2 8.1328E-3,-3.49149/ ,B(4)/-9.09718,-3.56654,0.876793,0.0060273/
14:          3 ,P(4)
15:           T=X+273.16
16:           IF(T.LT.273.16) GOTO 10
17:           Z=373.16/T
18:           P(1)=A(1)*(Z-1)
19:           P(2)=A(2)*LOG10(Z)
20:           Z1=A(4)*(1-1/Z)
21:           P(3)=A(3)*(10**Z1-1)
22:           Z1=A(6)*(Z-1)
23:           P(4)=A(5)*(10**Z1-1)
24:           GOTO 20
25:    10     Z=273.16/T
26:           P(1)=B(1)*(Z-1)
27:           P(2)=B(2)*LOG10(Z)
28:           P(3)=B(3)*(1-1/Z)
29:           P(4)=LOG10(B(4))
30:    20     SUM=0.
31:           DO 30 I=1,4
32:             SUM=SUM+P(I)
33:      30 CONTINUE
34:           PVSF=101.1*10**SUM
35:           RETURN
36:           END
```

Function WBF (A)

```
1:            FUNCTION WBF (H,PB)
2:     C
3:     C      SEE NDS BUILDING SCIENCE SERIES 69, NBSLD, PAGE 57D.
4:     C
5:     C      THIS PROGRAM APPROXIMATES THE WET-BULB TEMPERATURE WHEN
6:     C      ENTHALPY IS GIVEN.
7:            IF (H) 30,30,10
8:     10     Y=LOG(H)
9:            IF (H.GT.11.758) GO TO 20
10:           WBF=0.6041+3.4841*Y+1.3601*Y*Y+0.97307*Y*Y*Y
11:           GO TO 100
12:    C
13:    20     WBF=30.9185-39.68200*Y+20.5841*Y*Y-1.758*Y*Y*Y
14:           GO TO 100
15:    C
16:    30     WB1=150.
17:           PV1=PVSF(WB1)
18:           W1=0.622*PV1/(PB-PV1)
19:           X1=0.24*WB1+(1061+0.444*WB1)*W1
20:           Y1=H-X1
21:    40     WB2=WB1-1
22:           PV2=PVSF(WB2)
23:           W2=0.622*PV2/(PB-PV2)
24:           X2=0.24*WB2+(1061+0.444*WB2)*W2
25:           Y2=H-X2
26:           IF (Y1*Y2) 90,60,50
27:    50     WB1=WB2
28:           Y1=Y2
29:           GO TO 40
30:    C
```

```
31:      60    IF (Y1) 80,70,80
32:      70    WBF=WB1
33:            GO TO 100
34:    C
35:      80    WBF=WB2
36:            GO TO 100
37:    C
38:      90    Z=ABS(Y1/Y2)
39:            WBF=(WB2*Z+WB1)/(1+Z)
40:     100    RETURN
41:    C
42:            END
```

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

```
1 @ASG,A JBR10.
2 READY
3 @USE 15.,JBR10.
4 READY
5 @ASG,A SJPEI.
6 READY
7 @USE 11.,SJPEI.
8 READY
9 @ASG,A 10.,///500
10 READY
11 @MAP,W WCOLBYEAR.XSELECT
12 MAP 29R1 SL73R1 08/27/79 23:35:09
13 IN WCOLBYEAR.SELECT,.DAY,.DEWPNT,.ORDER,.PVSF,.SLYEAR
14 IN ADJUST.DPF.,SUNNY
15 END
16 START 016714, PROG SIZE(I/D)=9676/48197
17 SYS$-RLIB$. LEVEL
18 END MAP. ERRORS : NONE
19 @XQT WCOLBYEAR.XSELECT
20 ENTER THE LATITUDE, LONGITUDE AND TIME ZONE FOR
21 THE DAYTIME CLOUD CALCULATIONS
22 FOLLOWED BY THE NUMBER OF WEATHER TAPES YOU ARE DRAWING FROM 1-10
23 FOLLOWED BY THE NUMBER OF SELECTED YEARS YOU ARE MAKING 1-4
24 FOLLOWED BY THE HEIGHT IN METERS OF THE INPUT STATION
25 FOLLOWED BY THE BASE TEMPERATURES FOR DEGREE DAY CALCULATIONS
26 HEATING THEN COOLING, BOTH IN DEGREES CELSIUS
27 39.5 75.2 5.0 1 1 20.0 11.333 18.0
28 ENTER THE FIRST YEAR YOU ARE USING FROM THE WEATHER TAPE ASSIGNED TO
29 LOGICAL UNIT 15 AND THE NUMBER OF CONSECUTIVE YEARS OF IT YOU ARE USING
30 1949 9
31 YEAR OF MONTHLY AVG. MONTH
```

		DRY BULB TEMPERATURE DEG. C	DAILY RANGE DEG. C	DEWPOINT TEMPERATURE DEG. C	WET BULB TEMPERATURE DEG. C	TOTAL CLOUD TENTHS	DAYTIME CLOUD TENTHS	WIND SPEED M./S.	BAROMETRIC PRESSURE KILOPASCAL	DEGREE DAYS HEATING DEG. C	DEGREE DAYS COOLING DEG. C * DAYS
34	AVG. OF 1949 1	3.23	7.35	-1.70	1.45	6.82	7.06	4.59	101.82	251.17	.00
35	AVG. OF 1950 1	4.69	8.03	-.82	2.72	7.78	8.21	4.63	102.02	215.11	.00
36	AVG. OF 1951 1	1.91	8.67	-4.27	-.16	6.07	6.79	4.95	101.57	292.21	.00
37	AVG. OF 1952 1	1.98	7.96	-3.43	.25	5.90	5.97	4.71	101.58	290.11	.00
38	AVG. OF 1953 1	2.43	6.95	-1.88	.91	7.00	7.39	3.98	101.27	276.03	.00
39	AVG. OF 1954 1	-1.35	8.21	-6.61	-2.81	6.24	6.69	4.99	101.65	393.14	.00
40	AVG. OF 1955 1	-.88	6.56	-9.25	-3.16	4.51	5.08	5.56	101.17	378.74	.00
41	AVG. OF 1956 1	.10	6.11	-5.75	-1.65	5.96	5.47	6.46	101.00	348.16	.00
42	AVG. OF 1957 1	-1.90	7.90	-6.97	-3.26	6.21	6.44	4.24	101.87	410.31	.00
44	AVG. OF ALL YEARS 1	1.13	7.53	-4.52	-.64	6.28	6.68	4.90	101.55	317.22	.00
47	AVG. OF 1949 2	3.42	8.79	-2.69	1.27	5.83	5.94	4.61	101.72	224.70	.00
48	AVG. OF 1950 2	-.24	7.20	-6.13	-1.93	6.18	7.28	5.54	101.71	323.98	.00
49	AVG. OF 1951 2	1.93	8.39	-4.86	-.29	5.83	6.28	5.56	101.86	263.24	.00
50	AVG. OF 1952 2	1.95	6.88	-4.83	-.30	5.29	5.51	5.36	101.07	272.18	.00
51	AVG. OF 1953 2	3.19	8.37	-4.01	.69	5.34	6.04	4.74	101.30	231.11	.00
52	AVG. OF 1954 2	4.06	8.87	-2.27	1.74	5.63	5.92	4.60	101.05	206.38	.00
53	AVG. OF 1955 2	1.14	8.63	-4.90	-.75	5.28	5.71	4.87	101.98	285.39	.00
54	AVG. OF 1956 2	2.32	6.99	-3.36	.37	6.11	6.77	4.91	101.32	261.35	.00
55	AVG. OF 1957 2	2.50	7.64	-3.00	.58	6.22	7.09	4.12	101.75	247.22	.00
57	AVG. OF ALL YEARS 2	2.25	7.97	-4.01	.15	5.74	6.28	4.93	101.53	257.28	.00

#		N											
58													
59													
60	AVG. OF 1949	3	5.64	9.77	-2.35	2.69	5.64	5.77	5.66	101.21	203.53	2.14
61	AVG. OF 1950	3	2.40	9.34	-5.53	-.09	5.60	6.17	6.27	101.16	279.88	.00
62	AVG. OF 1951	3	5.44	7.90	-1.67	2.72	6.07	6.05	5.92	101.37	182.63	.00
63	AVG. OF 1952	3	4.10	7.42	-2.07	1.77	6.34	7.03	5.18	101.21	224.23	.00
64	AVG. OF 1953	3	5.99	7.19	.25	3.82	6.39	6.72	4.51	101.37	170.51	.00
65	AVG. OF 1954	3	5.09	8.55	-3.65	1.96	4.98	5.71	5.75	100.95	197.84	.00
66	AVG. OF 1955	3	5.02	8.71	-2.96	2.10	5.25	5.69	5.63	101.05	201.28	.00
67	AVG. OF 1956	3	2.78	7.80	-3.81	.48	5.95	6.33	5.35	101.28	265.04	.00
68	AVG. OF 1957	3	5.20	8.42	-2.63	2.20	5.51	5.83	4.40	101.05	192.14	.00
69													
70	AVG. OF ALL YEARS	3	4.63	8.34	-2.71	1.96	5.75	6.15	5.41	101.18	213.01	.24
71													
72													
73	AVG. OF 1949	4	11.49	10.81	3.07	7.54	5.48	5.80	5.40	101.02	43.29	2.29
74	AVG. OF 1950	4	9.09	9.98	.85	5.62	6.59	7.26	4.95	101.23	91.01	.11
75	AVG. OF 1951	4	11.50	9.74	3.39	7.68	5.61	6.04	5.08	101.00	30.30	1.04
76	AVG. OF 1952	4	12.20	9.04	4.59	8.54	7.15	7.57	4.72	101.11	42.78	7.99
77	AVG. OF 1953	4	10.80	8.02	3.00	7.21	6.70	6.96	5.01	100.62	46.22	1.49
78	AVG. OF 1954	4	11.44	10.54	4.52	8.20	5.15	5.32	4.92	101.85	61.24	3.59
79	AVG. OF 1955	4	11.36	9.83	4.29	7.98	6.95	7.10	5.28	101.06	43.86	1.57
80	AVG. OF 1956	4	8.63	9.06	1.40	5.49	5.54	6.22	4.99	100.92	108.33	3.58
81	AVG. OF 1957	4	11.34	10.70	4.06	7.99	6.09	6.38	4.46	101.62	69.11	10.13
82													
83	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
84													
85													
86	AVG. OF 1949	5	16.50	11.51	9.71	12.77	6.35	6.67	4.37	101.33	.00	32.37
87	AVG. OF 1950	5	14.58	9.12	8.28	11.30	7.25	7.42	4.29	101.38	7.28	3.96
88	AVG. OF 1951	5	17.16	10.57	8.53	12.56	5.98	6.39	4.39	100.89	.00	31.06
89	AVG. OF 1952	5	15.45	9.84	6.49	10.98	5.70	6.13	4.58	100.91	.00	9.31
90	AVG. OF 1953	5	16.67	8.62	11.51	13.72	7.35	7.59	3.70	101.03	5.47	20.64
91	AVG. OF 1954	5	15.08	8.44	7.27	11.01	6.75	7.21	4.56	101.03	3.59	16.76
92	AVG. OF 1955	5	17.97	11.25	8.48	12.89	5.87	6.02	4.61	101.18	1.31	44.27
93	AVG. OF 1956	5	14.69	10.68	6.13	10.44	5.40	5.59	4.95	101.52	10.19	15.79
94	AVG. OF 1957	5	16.81	11.43	8.38	12.28	5.00	5.34	5.05	101.34	7.63	40.92
95													
96	AVG. OF ALL YEARS	5	16.10	10.16	8.31	12.00	6.12	6.43	4.50	101.16	3.94	23.90
97													
98													
99	AVG. OF 1949	6	22.97	10.54	15.23	18.15	4.34	4.80	4.64	101.42	.00	152.91
100	AVG. OF 1950	6	21.47	11.47	13.14	16.43	5.36	5.96	4.64	101.12	7.28	111.34
101	AVG. OF 1951	6	20.86	8.93	14.85	17.10	6.29	6.82	3.79	101.16	.00	97.95
102	AVG. OF 1952	6	22.76	9.89	14.76	17.78	5.38	5.63	4.06	100.94	.00	147.89
103	AVG. OF 1953	6	22.57	11.39	14.04	17.35	4.58	4.89	4.19	101.29	.00	145.31
104	AVG. OF 1954	6	21.46	10.39	13.10	16.40	4.94	5.53	4.79	101.04	.00	107.69
105	AVG. OF 1955	6	20.34	9.57	13.23	15.98	6.10	6.29	4.42	100.98	.00	88.51
106	AVG. OF 1956	6	21.89	9.80	14.31	17.16	5.40	5.59	3.63	101.24	.00	126.33
107	AVG. OF 1957	6	23.23	9.57	16.27	18.77	5.44	5.71	3.71	101.18	.00	161.27
108													
109	AVG. OF ALL YEARS	6	21.95	10.15	14.33	17.24	5.31	5.69	4.21	101.15	.00	126.58
110													
111													
112	AVG. OF 1949	7	25.84	10.13	18.88	21.15	6.46	6.86	4.07	101.26	.00	243.09
113	AVG. OF 1950	7	23.95	10.50	16.18	18.96	6.56	7.04	3.99	101.33	.00	184.48
114	AVG. OF 1951	7	24.41	10.20	17.39	19.81	5.74	6.30	3.52	101.22	.00	198.64
115	AVG. OF 1952	7	25.93	10.43	18.24	20.82	4.65	5.02	2.65	101.51	.00	245.82

Row	Label	Group										
116	AVG. OF 1953	7	24.86	9.78	16.08	19.24	4.44	4.73	3.94	101.31	.00	212.81
117	AVG. OF 1954	7	24.11	10.68	14.64	18.18	4.54	4.91	4.04	100.99	.00	189.41
118	AVG. OF 1955	7	26.51	9.73	18.62	21.18	5.01	5.43	4.56	101.20	.00	263.76
119	AVG. OF 1956	7	22.57	8.48	16.22	18.52	6.65	7.12	3.96	101.07	.00	146.52
120	AVG. OF 1957	7	25.06	10.90	15.09	18.78	5.04	5.32	4.41		.00	219.01
121												
122	AVG. OF ALL YEARS	7	24.81	10.09	16.82	19.63	5.45	5.86	3.95	101.24	.00	211.50
123												
124												
125	AVG. OF 1949	8	24.21	10.45	17.28	19.72	5.39	6.19	3.76	101.26	.00	192.39
126	AVG. OF 1950	8	22.51	9.64	16.48	18.66	5.81	6.53	3.40	101.37	.00	139.92
127	AVG. OF 1951	8	23.19	9.34	17.17	19.32	5.05	5.86	3.31	101.23	.00	160.96
128	AVG. OF 1952	8	23.15	8.46	17.68	19.63	5.85	6.12	2.59	101.38	.00	159.88
129	AVG. OF 1953	8	23.69	10.30	15.75	18.61	4.22	4.40	3.41	101.39	.00	176.24
130	AVG. OF 1954	8	22.24	9.46	14.76	17.63	5.48	6.09	4.30	101.10	.00	131.42
131	AVG. OF 1955	8	24.97	8.53	18.89	20.93	5.82	5.99	4.85	101.23	.00	215.98
132	AVG. OF 1956	8	23.05	8.84	16.45	18.80	5.18	5.73	3.52	101.15	.00	157.75
133	AVG. OF 1957	8	22.76	9.95	14.31	17.53	5.38	5.74	4.07	101.35	.00	147.60
134												
135	AVG. OF ALL YEARS	8	23.31	9.44	16.53	18.98	5.35	5.85	3.69	101.27	.00	164.68
136												
137												
138	AVG. OF 1949	9	18.17	10.24	11.92	14.59	5.11	5.58	4.42	101.45	.00	36.78
139	AVG. OF 1950	9	17.77	8.50	12.66	14.80	6.97	7.19	3.65	101.51	4.03	43.31
140	AVG. OF 1951	9	19.51	10.76	12.96	15.67	4.99	5.93	3.64	101.49	.70	66.62
141	AVG. OF 1952	9	19.94	10.80	13.91	16.26	3.89	4.54	3.09	101.54	.00	72.40
142	AVG. OF 1953	9	20.34	10.00	13.14	16.05	4.05	4.13	4.13	101.37	.00	92.56
143	AVG. OF 1954	9	18.98	8.61	13.35	15.63	5.04	5.45	4.14	101.30	.00	57.30
144	AVG. OF 1955	9	19.45	8.33	13.17	15.80	5.29	5.72	4.14	101.69	.00	61.32
145	AVG. OF 1956	9	17.49	8.89	12.21	14.48	5.93	6.48	4.04	101.51	.71	45.81
146	AVG. OF 1957	9	20.77	9.70	13.76	16.65	6.15	6.26	3.99	101.52	.45	109.59
147												
148	AVG. OF ALL YEARS	9	19.16	9.54	13.01	15.55	5.27	5.70	3.92	101.49	.65	65.30
149												
150												
151	AVG. OF 1949	10	16.11	10.20	9.47	12.54	5.63	6.06	4.25	101.84	6.27	24.07
152	AVG. OF 1950	10	14.72	9.75	9.15	11.73	5.14	5.42	3.72	101.53	8.45	9.21
153	AVG. OF 1951	10	14.24	8.67	9.12	11.50	5.85	6.25	4.38	101.71	11.40	12.73
154	AVG. OF 1952	10	11.70	11.36	4.03	8.08	3.10	4.09	3.84	101.43	41.74	1.14
155	AVG. OF 1953	10	14.59	10.54	7.95	11.07	4.04	4.18	3.71	101.50	5.79	4.10
156	AVG. OF 1954	10	15.43	9.34	8.96	12.05	4.78	5.45	5.10	101.43	19.57	48.53
157	AVG. OF 1955	10	14.63	9.35	9.41	11.87	4.92	5.49	4.51	101.22	11.68	8.47
158	AVG. OF 1956	10	13.93	9.09	8.51	11.13	4.63	5.08	4.06	102.07	13.18	2.25
159	AVG. OF 1957	10	13.12	9.28	6.21	9.69	5.23	5.50	4.50	101.63	25.27	2.16
160												
161	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
162												
163												
164	AVG. OF 1949	11	6.96	9.35	.19	4.15	5.01	5.53	4.81	100.87	141.14	.00
165	AVG. OF 1950	11	8.47	9.30	2.35	5.80	6.01	6.44	4.99	101.18	123.96	5.04
166	AVG. OF 1951	11	5.45	8.85	-.59	3.15	5.45	6.16	4.77	101.60	189.33	.00
167	AVG. OF 1952	11	8.12	7.54	2.27	5.64	5.63	6.12	3.61	101.66	107.97	.00
168	AVG. OF 1953	11	8.32	9.96	2.74	5.78	5.11	5.59	3.57	101.66	106.83	.00
169	AVG. OF 1954	11	7.01	7.80	1.41	4.71	5.24	5.89	5.11	101.43	137.07	.00
170	AVG. OF 1955	11	6.30	7.63	.10	3.82	4.90	5.10	4.90	101.09	157.70	.00
171	AVG. OF 1956	11	7.72	7.98	2.17	5.37	5.46	6.18	4.31	101.47	140.10	.31
172	AVG. OF 1957	11	9.03	8.11	2.49	6.25	6.11	6.04	4.52	101.41	57.49	.00
173												

174											
175	AVG. OF ALL YEARS	11	7.49	8.50	1.46	4.96	5.44	5.90	4.51	101.37	133.51	.59
176												
177	AVG. OF 1949	12	3.60	8.33	-2.30	1.57	5.39	5.36	4.51	102.21	245.01	.00
178	AVG. OF 1950	12	1.08	6.76	-4.44	-.70	5.78	6.30	4.74	101.34	318.29	.00
179	AVG. OF 1951	12	2.80	7.67	-2.72	.99	5.70	6.77	4.62	101.63	272.27	.00
180	AVG. OF 1952	12	2.82	6.47	-2.31	1.02	6.00	6.52	4.29	101.51	263.90	.00
181	AVG. OF 1953	12	4.07	8.58	-1.75	1.96	5.25	5.84	4.75	101.32	225.01	.00
182	AVG. OF 1954	12	1.82	6.99	-4.75	-.31	5.87	6.49	6.32	101.21	294.97	.00
183	AVG. OF 1955	12	-1.39	7.31	-8.46	-3.33	4.58	5.16	5.13	101.74	394.27	.00
184	AVG. OF 1956	12	4.36	7.63	.96	3.03	6.91	7.24	4.08	101.33	218.13	.00
185	AVG. OF 1957	12	4.13	6.76	-1.13	2.18	6.29	6.78	4.45	101.50	226.63	.00
186												
187	AVG. OF ALL YEARS	12	2.59	7.39	-2.99	.71	5.75	6.27	4.77	101.53	273.16	.00

188
189

190 ENTER THE AVERAGES YOU ARE USING TO SELECT THE SELECTED YEAR
191 ASSIGNED TO LOGICAL UNIT 11
192 ENTER THE SI FLAG:
193 0 FOR SI UNITS (DEG. C., M/SEC., KPASCAL)
194 1 FOR ENGLISH UNITS (DEG. F.,MPH, IN. OF HG., KNOTS)
195 FOLLOWED BY THE EP FLAG:
196 IF YOU ARE UNABLE TO FIND BAROMETRIC PRESSURE AVERAGES
197 ENTER 1 AND THE HEIGHT OF THE SELECTED LOCATION IN METERS
198 ELSE ENTER 0 0.0
199 FOLLOWED BY THE WB FLAG:
200 IF YOU ARE ENTERING WET BULB INSTEAD OF DEWPOINT ENTER 1
201 ELSE ENTER 0
202 FOLLOWED BY THE CCT FLAG:
203 1 IF USING DAYTIME CLOUD AVERAGES INSTEAD OF FULL DAY AVERAGES
204 ELSE ENTER 0
205 1 0 0.0 0 1
206 THE MONTH IS PRINTED FOR CONVENIENCE ONLY AND SHOULD NOT BE INPUT

	MONTH	DRY BULB TEMPERATURE DEG. F.	MEAN SKY COVER TENTHS	WIND SPEED MI./HR.	DEW POINT?WET BULB TEMPERATURE DEG. P.	BAROMETRIC PRESSURE IN. OF HG.	DEVIATION ADJUSTMENT
211	1	36.01	6.33	8.79	26.47	30.08	1.0
213	2	36.06	5.79	9.38	24.52	30.16	1.0
215	3	43.00	6.33	10.88	30.87	30.00	1.0
217	4	53.56	6.07	9.54	39.27	29.90	1.0
219	5	63.56	6.14	8.25	46.39	29.87	1.0
221	6	70.85	6.67	7.38	60.74	29.93	1.0
223	7	76.45	5.95	6.99	65.29	29.96	1.0
225	8	74.63	5.35	6.10	63.67	29.95	1.0
227	9	68.19	4.97	6.85	56.26	30.03	1.0
229	10	59.78	6.28	8.08	49.46	30.09	1.0
231	11	42.38	5.83	9.24	31.37	30.08	1.0

`12     38.44     6.01     8.85     26.65     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	.280	6.075	5.790	4.916		
DESIRED	2.256		-4.156			7.055	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	36.365	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	16.968		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	9.786	18.449	20.537	5.733	6.172	3.203	.000	207.532

```
290   CHOSEN    24.035   20.472    7.417    6.798    1.969
291   DESIRED   24.034   20.613    5.720    6.600    3.192
292   CHOSEN    24.672   18.013    5.950             3.611
293   DESIRED   24.694   18.494    4.063    5.950    3.598
294   CHOSEN    25.380   16.905    4.387             3.989
295   DESIRED   25.379   17.046    3.698             5.213
296                      21.572             7.487            .000      177.176
297   8         23.675   17.608    5.137    5.553    3.980
298   CHOSEN    24.986   18.829    4.971    5.253    4.851
299   DESIRED   25.053   18.913    4.943    5.266    2.920
300   CHOSEN    23.615   17.582    5.350    5.648    3.238
301   DESIRED   23.683   17.594    5.350             3.140
302   CHOSEN    22.428   16.417    5.517    5.747    3.925
303   DESIRED   22.455   16.374    5.118             1.320
304                      20.217   20.866                               .000       75.949
305   9         20.082   13.468    4.539    5.179    3.978
306   CHOSEN    22.620   14.593    5.312    6.140    4.023
307   DESIRED   22.692   14.623    4.867    5.513    2.668
308   CHOSEN    20.014   13.495             5.431    4.184
309   DESIRED   20.106   13.478    4.970    4.970    3.526
310   CHOSEN    17.611   12.315    3.438    3.967    3.725
311   DESIRED   17.682   12.345    5.808             2.370
312                      16.218                                        4.995        9.338
313   10        15.385    9.797    5.864    6.465    3.268
314   CHOSEN    17.059   12.711    5.262    6.285    2.608
315   DESIRED   17.732   12.598    6.462    6.773    4.915
316   CHOSEN    15.421    9.674             5.293    3.568
317   DESIRED   15.433    9.700    6.280    6.280    4.159
318   CHOSEN    12.870    7.019    5.808    6.308    3.599
319   DESIRED   13.022    6.718    5.733             6.360
320                                                            179.962          .000
321   11         5.776    -.380    5.276    5.852    4.733
322   CHOSEN     8.722    2.942    5.042    5.255    4.242
323   DESIRED    8.694    3.031    5.804    6.682    4.310
324   CHOSEN     5.914     .111                      4.875
325   DESIRED    5.767    -.350    5.830    5.830    4.756
326   CHOSEN     2.692   -4.192    4.983    5.618    5.083
327   DESIRED    2.934   -4.059    4.526                      5.194
328                                                               .000       248.383
329   12         3.569   -2.038    5.707    6.194    4.696
330   CHOSEN     6.282     .688    5.250    5.827    4.748
331   DESIRED    6.309    1.235    6.288    6.504    4.312
332   CHOSEN     3.721   -1.915                      4.439
333   DESIRED    3.578   -1.861    6.010    6.010    4.555
334   CHOSEN      .690   -4.898    5.525    6.218    4.926
335   DESIRED     .716   -4.74             5.649                 .000
336   ENTER THE A.D. YEAR AND FIVE DIGIT CITY CODE FOR
337   THE YEAR WRITTEN AT LOGICAL UNIT 11
338   1951 14732
339   MONTH INTERVAL YEAR  MONTH  DAY  LENGTH  CITY   RANK
340     1      1    1956     2     8     10    14734  5.34
341     1      1    1949    12     4     11    14734  2.96
342     1      3    1950     1    30     10    14734  1.99
343   THE DAILY STANDARD DEVIATION FOR MONTH  1 IS   3.368
344     2      1    1952     1    24      9    14734  5.22
345     2      2    1951     1     2     10    14734  3.64
346     2      3    1953     2    17      9    14734  4.74
347   THE DAILY STANDARD DEVIATION FOR MONTH  2 IS   5.790
```

D7

348	3	1	1952	3	13	10	14734	4.43
349	3	2	1950	3	22	11	14734	.28
350	3	3	1949	4	1	10	14734	8.85
351	THE DAILY STANDARD DEVIATION FOR MONTH 3 IS							3.640
352	4	1	1952	3	29	10	14734	5.01
353	4	2	1949	4	11	10	14734	2.23
354	4	3	1956	5	18	10	14734	1.25
355	THE DAILY STANDARD DEVIATION FOR MONTH 4 IS							3.756
356	5	1	1955	5	6	10	14734	4.91
357	5	2	1949	5	3	11	14734	7.21
358	5	3	1951	6	2	10	14734	5.35
359	THE DAILY STANDARD DEVIATION FOR MONTH 5 IS							3.744
360	6	1	1953	5	8	10	14734	7.09
361	6	2	1956	7	3	10	14734	4.98
362	6	3	1949	7	4	10	14734	7.71
363	THE DAILY STANDARD DEVIATION FOR MONTH 6 IS							3.414
364	7	1	1952	8	3	10	14734	6.80
365	7	2	1949	8	9	11	14734	5.20
366	7	3	1953	6	19	10	14734	6.20
367	THE DAILY STANDARD DEVIATION FOR MONTH 7 IS							2.843
368	8	1	1955	8	17	10	14734	7.53
369	8	2	1956	8	12	11	14734	3.25
370	8	3	1953	8	3	10	14734	6.42
371	THE DAILY STANDARD DEVIATION FOR MONTH 8 IS							3.058
372	9	1	1957	8	10	10	14734	4.15
373	9	2	1955	9	12	11	14734	2.18
374	9	3	1955	10	3	10	14734	2.32
375	THE DAILY STANDARD DEVIATION FOR MONTH 9 IS							2.923
376	10	1	1952	9	18	10	14734	3.36
377	10	2	1953	10	18	11	14734	1.70
378	10	3	1951	10	20	10	14734	8.89
379	THE DAILY STANDARD DEVIATION FOR MONTH 10 IS							3.075
380	11	1	1955	11	8	10	14734	1.49
381	11	2	1951	11	14	10	14734	3.86
382	11	3	1949	11	21	10	14734	6.00
383	THE DAILY STANDARD DEVIATION FOR MONTH 11 IS							5.323
384	12	1	1956	11	15	10	14734	3.99
385	12	2	1952	11	26	11	14734	4.57
386	12	3	1950	12	10	10	14734	4.89
387	THE DAILY STANDARD DEVIATION FOR MONTH 12 IS							4.970

AVERAGE INTERVAL DEVIATION

390	MONTH	1	2	3	4	5	6	7	8	9	10	11	12
391	DBG. 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

| 393 | DBG. 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 out-
    put 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.

```
 1:       @ASG,A ADOUT.
 2:       >READY

 3:       @ASG,A NY51.
 4:       READY

 5:       @ASG,A NYADPHI.
 6:       READY

 7:       @USE 7.,ADOUT.
 8:       READY

 9:       @USE 8.,NY51.
10:       READY

11:       @USE 9.,NYADPHI.
12:       >READY

13:       @XQT ADJUST.ADJUST2
14:        ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.
15:       >39.5 75.2 5.0
16:        ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START
17:        OF THE 12 MONTH PERIOD BEING USED
18:        FOLLOWED BY THE NUMBER OF DAYS IN IT
19:       >0 365
20:        ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1
21:       >0
22:        ENTER 0 0.0 IF BAROMETRIC PRESSURE DATA IS AVAILABLE
23:        OTHERWISE ENTER 1 AND THE HEIGHT DIFFERENCE OF THE NEW
24:        AND OLD LOCATION --- H(NEW)-H(OLD) IN FEET
25:       >0 0.0
26:        ENTER 0 IF USING SI UNITS (FOR INPUT OF CLIMATE
27:        VARIABLES ONLY), ELSE ENTER 1
28:        FOLLOWED BY THE CLOUD FLAG:
29:        1 IF USING DAYTIME AVERAGES
30:        0 IF USING FULL DAY AVERAGES.
31:       >1 0
32:        ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE
33:        USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED
34:        (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE
35:        DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY
36:        BULB CALCULATIONS)
37:        THEN ENTER THE BASE TEMPERATURES' TO BE USED IN
38:        THE DEGREE DAY CALCULATIONS IN DEG.F.:
39:        FIRST HEATING, THEN COOLING.
40:       >1 55. 75.
41:
42:
43:
44:        INPUT YEAR SUMMARY
45:        AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
46:          43.645    30.129    64.000    12.000    561.500       .000
47:          43.714    29.536    65.000    11.000    514.500       .000
48:          48.290    36.194    61.000    25.000    395.500       .000
49:          61.000    45.833    83.000    39.000     95.500       .000
50:          71.645    54.226    90.000    46.000      1.500       .000
51:          77.000    62.633    90.000    53.000       .000     15.500
52:          83.710    69.387    93.000    63.000       .000     77.500
53:          82.226    67.839    93.000    60.000       .000     57.500
54:          76.033    61.167    84.000    46.000      4.000      2.500
55:          65.677    53.161    83.000    44.000     26.000      1.000
56:          51.033    37.200    67.000    22.000    340.000       .000
57:          45.645    32.710    64.000     9.000    498.500       .000
58:        SUMMER DESIGN 0 HRS:  93. 10 HRS:  90. 50 HRS:  87. 290 HRS: 83. 500 HRS:  79.
59:        WINTER DESIGN 0 HRS:   9. 10 HRS:  12. 50 HRS:  16. 200 HRS: 22. 500 HRS:  28.
```

```
60:          ENTER 0 IF USING WET BULB ONLY, AS FROM AIR FORCE MANUAL 88/29
61:          ENTER 1 IF USING DEWPOINT ONLY, AS FROM NOAA CLIMATIC ATLAS
62:          ENTER 2 IF USING BOTH
63:       >2
64:       ENTER THE WEATHER AVERAGES TO ADJUST THE TAPE.
65:       EVEN IF VALUES CANNOT BE FOUND OR ARE NOT USED
66:       SOMETHING MUST BE ENTERED FOR ALL 96 VALUES
67:       ( ENTER ONLY ONE TYPE OF DRY BULB AVERAGE.)
68:       IF NECESSARY ECHO THE VALUES FROM THE INPUT YEAR
69:
70:       MONTH   DRY BULB  CLOUD   WIND  DEW  BAROMETRIC DAILY DAILY  WET
71:               MAX MIN   COVER   SPEED POINT PRESSURE   S.D.  RANGE  BULB
72:               DEG.F.    TENTHS  KNOTS DEG.F.  IN.HG.  DEG.F. DEG.F. DEG.F.
73:          1    36.89      6.09   14.48 25.55    30.03   8.56  13.52  33.00
74:       >         36.01  6.33 8.79  26.47 30.08  7.66   15.52  32.66
75:          2    36.62      6.00   15.38 24.37    30.11   9.58  14.18  32.32
76:       >         36.06  5.79 9.38  24.52 30.16  9.75   16.04  32.19
77:          3    42.24      6.33   16.60 30.24    29.97   5.80  12.10  37.45
78:       >         43.00  6.33 10.88 30.87 30.00  6.16   15.23  38.26
79:          4    53.42      5.72   12.87 38.77    29.86   5.89  15.17  46.09
80:       >         53.56  6.07 9.54  39.27 29.90  6.27   19.63  46.70
81:          5    62.94      6.21   11.79 46.57    29.83   5.98  17.42  53.98
82:       >         63.56  6.14 8.25  48.39 29.87  5.64   20.35  55.37
83:          6    69.82      6.38   10.55 58.10    29.91   5.92  14.37  62.47
84:       >         70.85  6.67 7.38  60.74 29.93  6.28   17.13  64.42
85:          7    76.55      6.02    9.70 62.75    29.93   3.69  14.32  67.47
86:       >         76.45  5.95 6.99  65.29 29.96  3.18   17.65  69.04
87:          8    75.03      5.17    9.86 62.82    29.93   4.29  14.39  66.93
88:       >         74.63  5.35 6.10  63.67 29.95  4.49   18.55  67.52
89:          9    68.60      5.01   11.31 55.40    30.01   5.85  14.87  60.77
90:       >         68.19  4.97 6.85  56.26 30.03  5.52   20.13  61.15
91:         10    59.42      5.94   13.36 47.86    30.07   6.50  12.52  53.22
92:       >         59.78  6.28 8.08  49.46 30.09  7.09   16.52  54.11
93:         11    44.12      5.49   13.65 30.18    30.04   8.46  13.83  38.58
94:       >         42.38  5.83 9.24  31.37 30.08  9.09   16.80  38.14
95:         12    39.18      5.80   12.50 26.81    30.04  11.60  12.94  34.97
96:       >         38.44  6.01 8.85  28.65 30.08 11.91   15.26  35.11
97:          ADJUSTED YEAR COMPLETE.
98:
99:
100:      ADJUSTED YEAR SUMMARY
101:      AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
102:        43.770   28.250   62.489   11.838   588.690     .000
103:        44.080   28.040   65.648    9.155   530.320     .000
104:        50.615   35.385   63.774   23.588   372.486     .000
105:        63.375   43.745   86.280   36.339    96.736     .000
106:        73.735   53.385   91.427   45.643      .000     .000
107:        79.415   62.285   92.883   51.993      .000   26.461
108:        85.275   67.625   94.023   61.931      .000   69.255
109:        83.905   65.355   94.982   57.164      .000   53.729
110:        78.255   58.125   85.948   43.857     3.079    1.121
111:        68.040   51.520   86.857   41.375    28.718    2.855
112:        50.780   33.980   68.009   17.724   389.804     .000
113:        46.070   30.810   64.920    6.465   520.606     .000
114:      SUMMER DESIGN 0 HRS:  95. 10 HRS:  92. 50 HRS:  88. 200 HRS:  85. 500 HRS:  80.
115:      WINTER DESIGN 0 HRS:   6. 10 HRS:  10. 50 HRS:  15. 200 HRS:  21. 500 HRS:  27.
```

E3

RUNSTREAM B. Summary of hourly data.

```
1:      @ASG,A ADOUT.
2:      >READY
        `
3:      @ASG,A NYADPHI.
4:      >READY

5:      @ASG,A NYOUT.
6:      >READY

7:      @USE 7.,ADOUT.
8:      READY

9:      @USE 8.,NYADPHI.
10:     READY

11:     @USE 9.,NYOUT.
12:     READY

13:     @XQT ADJUST.ADJUST2
14:      ENTER THE LATITUDE, LONGITUDE, AND THE TIME ZONE.
15:     >39.5 75.2 5.0
16:      ENTER THE NUMBER OF DAYS TO BE SKIPPED BEFORE THE START
17:      OF THE 12 MONTH PERIOD BEING USED
18:      FOLLOWED BY THE NUMBER OF DAYS IN IT
19:     >0 365
20:      ENTER 0 IF AN ADJUSTED YEAR IS TO BE MADE ELSE ENTER 1
21:     >1
22:      ENTER 0 IF THE 24-HOUR DRY BULB AVERAGE IS TO BE
23:      USED ENTER 1 IF THE MAX-MIN AVERAGE IS TO BE USED
24:      (THE AVERAGE WHICH IS CHOSEN WILL BE USED IN THE
25:      DEGREE DAY , DAILY STANDARD DEVIATION AND ALL OTHER DRY
26:      BULB CALCULATIONS)
27:      THEN ENTER THE BASE TEMPERATURES' TO BE USED IN
28:      THE DEGREE DAY CALCULATIONS IN DEG.F.:
29:      FIRST HEATING, THEN COOLING.
30:     >0 55. 75.

33:
34:      INPUT YEAR SUMMARY
35:      AVG. MAX AVG. MIN EXT. MAX EXT. MIN D.D. HEAT D.D. COOL
36:         43.770    28.250    62.489    11.838    589.253       .000
37:         44.080    28.040    65.648     9.155    547.455       .000
38:         50.615    35.385    63.774    23.588    386.218       .000
39:         63.375    43.745    86.280    36.339    108.879       .000
40:         73.735    53.385    91.427    45.643      1.786       .100
41:         79.415    62.285    92.883    51.993       .000     25.937
42:         85.275    67.625    94.023    61.931       .000     47.904
43:         83.905    65.355    94.982    57.164       .000     27.851
44:         78.255    58.125    85.948    43.857      2.669       .000
45:         68.040    51.520    86.857    41.375     27.923       .390
46:         50.780    33.980    68.009    17.724    407.641       .000
47:         46.070    30.810    64.920     6.465    527.217       .000
48:      SUMMER DESIGN 0 HRS:  95. 10 HRS:  92. 50 HRS:  88. 200 HRS:  85. 500 HRS:  80.
49:      WINTER DESIGN 0 HRS:   6. 10 HRS:  10. 50 HRS:  15. 200 HRS:  21. 500 HRS:  27.
```

MONTH	DRY BULB 24-HR DEG.F.	CLOUD COVER TENTHS	WIND SPEED KNOTS	DEW POINT DEG.F.	BAROMETRIC PRESSURE IN.HG.	DAILY S.D. DEG.F.	DAILY RANGE DEG.F.	WET BULB 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

```
65:      SUMMARIZED YEAR COMPLETE.
```

FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date			02. Summary prepared by (Name and Phone)	03. Summary action		
Yr.	Mo.	Day	Edward Arens (301) 921-3595	New	Replacement	Deletion
7 9				☒	☐	☐

05. Software title
Fortran V Programs: SELECT and ADJUST

Previous Internal Software ID

04. Software date		
Yr.	Mo.	Day
7 9		

07. Internal Software ID

06. Short title

08. Software type	09. Processing mode	10. Application area

08. Software type
- ☐ Automated Data System
- ☒ Computer Program
- ☐ Subroutine/Module

09. Processing mode
- ☒ Interactive   or
- ☒ Batch
- ☐ Combination

10. Application area

General
- ☐ Computer Systems Support/Utility
- ☒ 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
- ☒ Available
- ☐ Limited
- ☐ In-house only

25. Documentation availability
- ☒ Available
- ☐ Inadequate
- ☐ In-house only

26. FOR SUBMITTING ORGANIZATION USE

185–101

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

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

5. Publication Date

August 1980

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

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, DC 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS *(Street, City, State, ZIP)*

Same

13. Type of Report & Period Covered

Final

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 com-
posite 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 [X] Unlimited	19. SECURITY CLASS (THIS REPORT)	21. NO. OF PRINTED PAGES
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