# Estimation of Incoming Radiation From Extraterrestrial Radiation and Climatic Data

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# ESTIMATION OF INCOMING RADIATION FROM EXTRATERRESTRIAL RADIATION AND CLIMATIC DATA

by

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TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS . . . . . . . . . . . . . . ii

TABLE OF CONTENTS . . . . . . . . . . . . . . iii

LIST OF TABLES . . . . . . . . . . . . . . . vi

LIST OF FIGURES . . . . . . . . . . . . . . ix

NOTATIONS . . . . . . . . . . . . . . . . x

ABSTRACT . . . . . . . . . . . . . . . . . xii

INTRODUCTION . . . . . . . . . . . . . . . 1

OBJECTIVES . . . . . . . . . . . . . . . . 3

DEFINITION OF TERMS . . . . . . . . . . . . 4

Incoming Solar Radiation . . . . . . . . . . 4

Extraterrestrial Radiation . . . . . . . . . . 4

Solar Radiation Constant . . . . . . . . . . 4

Sunshine Percentage . . . . . . . . . . . 4

Sky Cover . . . . . . . . . . . . . . . . 5

LITERATURE REVIEW . . . . . . . . . . . . . 6

Radiation Formulas Using Incoming Solar Radiation in a Cloudless Day . . . . . . . . . 6

Angstrom's formula . . . . . . . . . 6

Fritz and MacDonald's formula . . . . . . . 7

Radiation Formulas Using Extraterrestrial Radiation . . . . . . . . . . . . . . 8

Page

Black's formula . . . . . . . . . . 8

Glover and McCullock's formula . . . . . 8

Fitzpatrick's formula . . . . . . . . 9

Morton's formula . . . . . . . . . 9

Bennett's formula . . . . . . . . . 10

Formula Using Average Incoming Solar Radiation . . . . . . . . . . . . . . . 10

Jensen and Haise's formula . . . . . . 10

DATA AND PROCEDURE . . . . . . . . . . 12

Dimensional Expression . . . . . . . . . . 12

Procedure . . . . . . . . . . . . . . 14

Procedure to Find Sunshine as a Function of Sky Cover . . . . . . . . . . . . . . 16

Comparison of Formulas . . . . . . . . . 16

PRESENTATION AND ANALYSIS OF THE RESULTS . . . 18

Development of Solar Radiation Formulas . . . . . 18

Sunshine coefficient . . . . . . . . . . 18

Elevation coefficient . . . . . . . . . 20

Sky cover coefficient with sunshine coefficient . . . . . . . . . . . 21

Sky cover coefficient without sunshine coefficient . . . . . . . . . . . 22

Humidity effect . . . . . . . . . . 23

Sunshine - sky cover relationship . . . . . . 23

Page

Radiation formulas . . . . . . . . . . . . 24

Test of the Formulas . . . . . . . . . . . . . 24

Comparison of Measured and Computed Radiation at Davis, California . . . . . . . . . . . . . 26

Comparison of Measured and Computed Radiation for Venezuela . . . . . . . . . . . . . . 26

Comparison of Several Formulas for Computing Radiation for Venezuela . . . . . . . . . . . 28

SUMMARY AND CONCLUSIONS . . . . . . . . . . . 41

LITERATURE CITED . . . . . . . . . . . . . . 43

APPENDIX . . . . . . . . . . . . . . . . . 45

# LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1. | List of solar radiation stations . . . . . . . . . . | 17 |
| 2a. | Average monthly values of measured and computed incoming solar radiation, for 32 solar radiation stations in the United States, in equivalent depth of evaporation, in inches . . . . . . . . . . . . . . . . | 36 |
| 2b. | Average monthly values of measured and computed incoming solar radiation, for 32 solar radiation stations in the United States, in equivalent depth of evaporation, in inches . . . . . . . . . . . . . . . . | 37 |
| 3. | Comparative average monthly values of measured and computed incoming solar radiation in langleys per day at Davis, California, (elevation = 50 feet, latitude 38.54°) for the period July 1959 to June 1961 . . . . | 38 |
| 4a. | Average values of measured and computed incoming solar radiation in langleys per day for 18 solar radiation stations in Venezuela (for RAP1 and RAP2) . . | 39 |
| 4b. | Average values of measured and computed incoming solar radiation in langleys per day for 18 solar radiation stations in Venezuela (for RAP3 and RAP4) . . | 40 |
| 5a. | Climatological data of selected incoming radiation stations for January . . . . . . . . . . . | 46 |
| 5b. | Climatological data of selected incoming radiation stations for February 1964 . . . . . . . . . . | 47 |
| 5c. | Climatological data of selecting incoming radiation stations for March 1964 . . . . . . . . . . | 48 |
| 5d. | Climatological data of selected incoming radiation stations for April 1964 . . . . . . . . . . | 49 |

| Table | | Page |
|---|---|---|
| 5e. | Climatological data of selected incoming radiation stations for May 1964 . . . . . . . . . . . | 50 |
| 5f. | Climatological data of selected incoming radiation stations for June 1964 . . . . . . . . . . . | 51 |
| 5g. | Climatological data of selected incoming radiation stations for July 1964 . . . . . . . . . . . | 52 |
| 5h. | Climatological data of selected incoming radiation stations for August 1964 . . . . . . . . . . | 53 |
| 5i. | Climatological data of selected incoming radiation stations for September 1964 . . . . . . . . | 54 |
| 5j. | Climatological data of selected incoming radiation stations for October 1964 . . . . . . . . . . | 55 |
| 5k. | Climatological data of selected incoming radiation stations for November 1964 . . . . . . . . . | 56 |
| 5l. | Climatological data of selected incoming radiation stations for December 1964 . . . . . . . . . | 57 |
| 6. | List of Venezuelan incoming solar radiation stations . . | 58 |
| 7a. | Comparison of computed values of radiation . . . . | 59 |
| 7b. | Comparison of computed values of radiation . . . . | 60 |
| 7c. | Comparison of computed values of radiation . . . . | 61 |
| 7d. | Comparison of computed values of radiation . . . . | 62 |
| 7e. | Comparison of computed values of radiation . . . . | 63 |
| 7f. | Comparison of computed values of radiation . . . . | 64 |
| 7g. | Comparison of computed values of radiation . . . . | 65 |
| 7h. | Comparison of computed values of radiation . . . . | 66 |
| 7i. | Comparison of computed values of radiation . . . . | 67 |

| Table | | Page |
|---|---|---|
| 7j. | Comparison of computed values of radiation . . . . . | 68 |
| 7k. | Comparison of computed values of radiation . . . . . | 69 |
| 7l. | Comparison of computed values of radiation . . . . . | 70 |

## LIST OF FIGURES


| Figure | | Page |
|---|---|---|
| 1. | Map of the United States showing radiation stations . . . | 18 |
| 2. | Ratio incoming solar radiation to extraterrestrial radiation vs. sunshine . . . . . . . . . . . . . | 29 |
| 3. | Relation between $Ra/(K_S R_t C_S)$ and elevation in 1000 ft . . . . . . . . . . . . . . . . . | 30 |
| 4. | Relation between $Ra/(K_S R_t C_S)$ and sky cover under the presence of sunshine . . . . . . . . . . . | 31 |
| 5. | Relation between $Ra/(R_S R_t C_E)$ and sky cover in absence of sunshine . . . . . . . . . . . . . | 32 |
| 6a. | Relation between ratio actual radiation to compute radiation vs. relative humidity . . . . . . . . | 33 |
| 6b. | Relation between ratio actual radiation to compute radiation vs. relative humidity . . . . . . . . | 34 |
| 7. | Relation between sunshine and sky cover . . . . . . . | 35 |

# NOTATIONS

| | |
|---|---|
| $C_E$ | = elevation coefficient |
| $C_S$ | = sunshine coefficient |
| $C_{SC}$ | = sunshine coefficient, from sunshine computed as a function of sky cover |
| $C_{SKC}$ | = sky cover coefficient |
| $C_{SKCS}$ | = sky cover coefficient obtained by using sunshine coefficient |
| E | = elevation, feet |
| $K_1$, $K_2$, $K_3$, $K_4$ | = empirical dimensionless constants |
| $K_E$ | = effect of elevation on $K_1$, $K_2$, $K_3$, or $K_4$ |
| $K_S$ | = effect of sunshine on $K_1$, $K_2$, $K_3$, or $K_4$ |
| $K_{SKC}$ | = effect of sky cover, without sunshine, on $K_2$ |
| $K_{SKCS}$ | = effect of sky cover, with sunshine, on $K_3$ |
| PD | = number of days of precipitation more than 1 mm |
| RABE | = incoming solar radiation computed by Bennett's formula, Equation (10) |
| RABL | = incoming solar radiation computed by Black's formula, Equation (3) |
| RAFP | = incoming solar radiation computed by Fitzpatrick's formula, Equation (8) |

RAGM = incoming solar radiation computed by Glover and McCulloch's formula, Equation (4)

RAMO = incoming solar radiation computed by Morton's formula, Equation (9)

RAP1 = Incoming solar radiation computed by Equation (29), using Rt, $C_S$, and $C_E$

RAP2 = incoming solar radiation computed by Equation (30), using Rt, $C_{SKC}$, and $C_E$

RAP3 = incoming solar radiation computed by Equation (31), using Rt, $C_S$, $C_{SKCS}$, and $C_E$

RAP4 = incoming solar radiation computed by Equation (32), using Rt, $C_{SC}$, and $C_E$

RALV = measured incoming solar radiation in Venezuela

Ra = actual incoming solar radiation

Ro = intensity of incoming solar radiation during a cloudless day

Rt = extraterrestrial radiation

S = sunshine percentage, usually expressed decimally

Sh = actual sunshine hours

Sho = possible sunshine hours, equivalent to day length

TA = minimum temperature, $^{o}F$

TM = mean temperature, $^{o}F$

TX = maximum temperature, $^{o}F$

W = wind speed, mph

Ø = latitude, degrees

# ABSTRACT

Estimation of Incoming Radiation

From Extraterrestrial Radiation

and Climatic Data

by

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Average monthly values of incoming radiation, extraterrestrial radiation, sunshine, and sky cover from 32 climatological stations in the United States were used as a basis to develop radiation equations.

Empirical relations between incoming radiation and more commonly available climatic and geographic variables, such as percent of relative sunshine, mean daily sky cover, station elevation and extraterrestrial radiation, were established using an empirical procedure used by Christiansen (1966, 1967) to compute his evaporation and evapotranspiration formulas.

The reliability of the equations developed was determined by comparing the computed values of incoming radiation with measured values at Davis, California[1] and for the Republic of Venezuela (Servicio de Meteorologia, 1965).

[1] Data furnished by Professor W. O. Pruitt to Professor J. E. Christiansen.

For comparison, the formulas developed in this study and formulas developed by Fitzpatrick (1965), Black (1954), Glover and McCulloch (cited by Fitzpatrick, 1965) Morton (1965), and Bennett (1965) were applied to Venezuelan incoming solar radiation stations.

(83 pages)

# INTRODUCTION

The amount of solar radiation reaching the earth's surface at any particular place and for any lapse of time has many important applications such as in Agriculture, Meteorology, Industry and so forth. From the Agricultural point of view incoming solar radiation or insolation is related to evaporation and evapotranspiration. Many formulas have been developed in order to estimate evaporation and evapotranspiration as a function of solar radiation (Turc, 1961; Pruitt, 1961; Jensen, 1963; Lane, 1965; Morton, 1965; Christiansen, 1967). In these equations solar radiation is considered the main source of energy for computing evaporation and evapotranspiration. Both solar radiation and evaporation or evapotranspiration can be expressed in the same units such as inches per day. However, solar radiation data are not always available at every place where an estimation of evaporation or evapotranspiration is needed.

The analysis of information from solar radiation stations has shown that there is a satisfactory relationship between incoming solar radiation and other climatological data such as percent of possible sunshine, sky cover, etc., and extraterrestrial radiation.

The empirical procedure used by Christiansen (1966, 1967) to develop evaporation and evapotranspiration formulas as a function of extraterrestrial radiation and climatological variables has been applied to the development of formulas for estimating incoming solar radiation in this thesis.

## OBJECTIVES

The objectives of this empirical solar radiation study are:

1. To develop equations for incoming solar radiation based on extraterrestrial radiation, climatological data, and geographical parameters.

2. To find a relationship between sunshine and sky cover. Such a relation can be used to estimate sunshine for use in formulas for solar radiation for locations where neither sunshine nor incoming radiation data are available.

3. To find the individual effect of each climatic parameter on the ratio of incoming solar radiation to extraterrestrial radiation. These effects are to be expressed as coefficient for each parameter.

4. To test the reliability of the empirical radiation equations by comparing computed values with measured values of incoming solar radiation in the United States and in Venezuela.

5. To compare the formulas developed in the present study with some of the formulas cited in the literature review.

## DEFINITION OF TERMS

### Incoming Solar Radiation

Incoming solar radiation, global or total radiation, or insolation is the amount of solar energy that reaches the earth's surface (short wave radiation 0.1 to 0.75 μ). It is made up of direct and diffused radiation and may be expressed in cal/cm$^2$/day on a horizontal surface (langleys per day) or as equivalent depth of evaporation per day in inches or mm.

### Extraterrestrial Radiation

Extraterrestrial radiation, theoretical radiation, or potential insolation is the amount of solar energy that reaches the outer atmosphere. It is expressed in the same units as incoming solar radiation.

### Solar Radiation Constant

The solar radiation constant is the amount of solar radiation at normal incidence upon a surface at the outer extremity of the earth's atmosphere when the earth is at the mean distance from the sun. It is estimated at 2.0 cal/cm$^2$/min.

## Sunshine Percentage

Sunshine percentage is the mean percentage of possible bright sunshine as reported by the U. S. Weather Bureau (1964). It can be expressed in decimal form, i. e., 80% = 0. 80.

## Sky Cover

Sky cover or cloud cover is the fraction of the sky that is covered by clouds. It is reported in tenths (U. S. A. ) or in eights (Latin American countries).

# LITERATURE REVIEW

Several investigators have studied the climatological data-solar radiation relationship in an attempt to compensate for lack of solar radiation information. These studies have included both theoretical and empirical procedures.

Bennett (1964, p. 218) states:

> Efforts to compute incoming solar radiation based on theoretical knowledge of the physical modification of solar energy by the atmosphere have produced uncertain results.
>
> Attempts to predict incoming solar radiation from empirically established relationships, as a rule, have been more rewarding than those built upon theoretical considerations.

## Radiation Formulas Using Incoming Solar Radiation in a Cloudless Day

### Angstrom's formula

One of the earliest works related to the estimation of solar radiation from climatological data was published by Angstrom in 1924 (cited by H. Masson, 1966) who suggested the existance of a relationship between daily values of sunshine duration and incoming solar radiation. He proposed the following formula:

$$Ra = Ro\ (a + b\ Sh/Sho) \qquad (1)$$

where

Ra = intensity of incoming solar radiation in langleys per day for a particular day.

Ro = intensity of incoming solar radiation during a cloudless day in langleys per day.

Sh = duration of sunshine in hours for a particular day.

Sho = theoretical value of the sunshine duration corresponding to Ro, in hours, equivalent to day length.

a and b are constants for a given region.

As can be seen, before the above expression can be used to estimate incoming solar radiation at any place and time, the radiation for a cloudless day for the specific location and time of year must be known, or estimated from reliable data.

Fritz and MacDonald's formula

Fritz and MacDonald, 1949 (cited by Waggoner, 1965) published the following empirical formula:

$$Ra = Ro\ (0.35 + 0.61\ S) \qquad (2)$$

where

Ra and Ro have the same meaning as in Angstrom's equation.

S = ratio of the number of hours of sunshine instrumentally recorded to total number of possible sunlight hours.

## Radiation Formulas Using Extraterrestrial Radiation

### Black's formula

Black, 1959 (cited by Waggoner, 1965) related incoming solar radiation to extraterrestrial radiation and sky cover and proposed the following formula:

$$Ra = Rt\ (0.803 - 0.340\ SKC - 0.456\ SKC^2) \qquad (3)$$

where

Ra = incoming daily solar radiation in langleys per day.

Rt = extraterrestrial radiation in langleys per day.

SKC = sky cover in tenths.

### Glover and McCullock's formula

Glover and McCulloch, 1958 (cited by Fitzpatrick, 1965) examined daily, every tenth day, and monthly data over a year (1940) from a tropical station, ($1^\circ$ 16' S. $36^\circ$ 45' E) at 6000 ft., using the following linear regression:

$$Ra = Rt\ (a + b\ Sh/Sho) \qquad (4)$$

where

Ra = incoming solar radiation.

Rt = extraterrestrial radiation.

Sh = duration of bright sunshine.

Sho = day length.

a = a function of latitude.

$\phi$ = latitude in degrees.

They found that

a = 0.29 cos $\phi$, and

b = 0.52.

There formula was, therefore,

$$Ra = Rt\,(0.29 \cos \phi + 0.52\, Sh/Sho) \tag{5}$$

Fitzpatrick's formula

Fitzpatrick (1965) has proposed a hyperbolic type of relation expressed in the following way:

$$Ra = Rt\,[(0.385\, Sh/Sho + 0.375) - 0.0042 / (Sh/Sho + 0.0154)] \tag{6}$$

Morton's formula

Morton (1965) has presented a formula for incoming solar radiation as follows:

$$Ra = 1.17\, Rt\,(0.18 + 0.55\, Sh/Sho) \tag{7}$$

Bennett's formula

Bennett (1965), using incoming solar radiation data from the United States and through regression analysis, developed the following formula for estimating solar radiation at locations lacking of this information:

$$Ra = 0.001\ Rt\ [(201.8 + 0.003658\ E) + S\,(2.755 - 0.000308\ E + 3.201 \cos \phi)] \quad (8)$$

where

Ra, Rt, $\phi$, and S have the same meaning as defined before.

E = elevation in feet.

Bennett (1964), using the same procedure, has developed specific regression equations for 10 locations in the United States.

## Formula Using Average Incoming Solar Radiation

### Jensen and Haise's formula

Jensen and Haise (1965) have proposed an expression for incoming solar radiation

$$Ra = \overline{Ra} + Kss\ (\overline{SKC} - SKC) \quad (9)$$

where

$\overline{Ra}$ = four-week long-time moving average solar radiation for the period.

Kss = correction coefficient.

SKC = mean sky cover from sunrise to sunset in tenths.

$\overline{SKC}$ = four-week long-time moving average of sky cover for the period in question.

Ra = incoming solar radiation.

The correction coefficient is expressed as a linear function of Ra as follows:

$$Kss = a + b\,\overline{Ra} \qquad (10)$$

where

a and b are constants that reflect the type of sky cover at a location and its effect on solar radiation.

(Values of a and b computed by Jensen and Haise will be published in a U. S. D. A. technical bulletin.)

## DATA AND PROCEDURE

For the study presented here, average monthly values of climatological data and incoming solar radiation data were obtained from the U. S. Weather Bureau, National Summary for the year 1964, at 32 stations. A list of all stations is given in Tables 1 and 5, and shown in Figure 1.

The data were punched in IBM computer cards and processed in the following forms:

1. Incoming solar radiation, Ra in langleys, as measured by the Eppley Pyrheliometer.
2. Extraterrestrial solar radiation, Rt in same units as Ra.
3. Percent of relative sunshine, S.
4. Sky cover, SKC in tenths, (clear = 0, cloudy = 10).
5. Elevation, E in feet.
6. Mean relative humidity, H, percentage.

### Dimensional Expression

The mathematical expression proposed can be written by the simple equation

$$Ra = Rt\ K\ C \qquad (11)$$

where

Ra = incoming solar radiation.

Rt = extraterrestrial radiation.

K = dimensionless constant found empirically from the processing of the data.

C = dimensionless coefficient relation to climatic parameters.

The product of K and C represents the ratio of the solar energy reaching the earth's surface to that received at the outer atmosphere; C is a product of subcoefficients which are functions of specific climatic parameters that are found to have a significant effect on incoming solar radiation.

Thus, C can be expressed by the equations of the type

$$C = C_E \, C_S$$

$$C = C_E \, C_{SKC}$$

$$C = C_S \, C_E \, C_{SKCS}$$

$$C = C_E \, C_{SC}$$

where

$C_E$, $C_{SKC}$, and $C_S$ represent the coefficients for elevation, sky cover and sunshine, respectively.

$C_{SC}$ is sunshine coefficient based on sunshine computed from sky cover

$C_{SKCS}$ is sky cover coefficient to be used with the sunshine coefficient, $C_S$.

Each coefficient is expressed by an equation that was found to best fit the data from which the equations were developed.

## Procedure

The procedure followed in this study was that used by Christiansen (1966, 1967) to develop his evaporation and evapotranspiration equations. In brief, it consists of tabulating the monthly average incoming solar radiation, extraterrestrial radiation for the month, the monthly average sky cover, the monthly average percent of relative sunshine, the average mean relative humidity, and the elevation. The first step was to divide the incoming solar radiation by extraterrestrial radiation and make this ratio a function of sunshine.

$$Ra/Rt = f(S)$$

For example from Figure 2,

$$Ra/Rt = 0.2134 + 0.668\,S - 0.16\,S^2$$

Assuming that

$$K_S\ C_S = Ra/Rt$$

$$K_S\ C_S = 0.2134 + 0.668\ S - 0.16\ S^2$$

for

$$S = 0.80,\ C_S = 1.0$$

then

$$K_S = 0.2134 + 0.668\ (0.80) - 0.16\ (0.80)^2$$

$$K_S = 0.2134 + 0.5344 - 0.1024 = 0.6454$$

$$C_S = 0.328 + 1.04\ S - 0.25\ S^2$$

The second step was to make the ratio:

$$Ra/(Rt\ C_S\ K_S) = f\ (E)$$

and the following relation for $C_E$ was found:

$$C_E = 0.97 + 0.00003\ E$$

This is the same value for $C_E$ used by Christiansen (1966) in his evaporation and evapotranspiration equations. The same procedure was applied for every parameter that was considered to have a possible effect on incoming solar radiation.

## Procedure to Find Sunshine as a Function of Sky Cover

From the original data, sunshine and sky cover values were tabulated; first according to sunshine and then according to sky cover. Two separate sets of results were obtained, plotted, and the best fit curve found was a second degree equation.

## Comparison of Formulas

Formulas (3), (5), (8), (9), (10), and the four formulas developed were applied to the data from 18 incoming solar radiation stations in Venezuela.

To achieve objective 5, a computer program was made up for the data arranged according to month.

Table 1. List of solar radiation stations

| Name | No. | State | Latitude | Longitude | Elevation |
|---|---|---|---|---|---|
| Alburquerque | 1 | New Mexico | 35° 03' | 106° 37' | 5310 |
| Atlanta | 2 | Georgia | 33° 39' | 84° 25' | 975 |
| Bismark | 3 | North Dakota | 46° 46' | 100° 45' | 1650 |
| Boston | 4 | Massachusetts | 42° 21' | 71° 04' | 15 |
| Brownsville | 5 | Texas | 25° 54' | 97° 24' | 16 |
| Cape Hatteras | 6 | North Carolina | 35° 15' | 75° 40' | 9 |
| Charleston | 7 | South Carolina | 32° 54' | 80° 02' | 41 |
| Cleveland | 8 | Ohio | 41° 24' | 81° 51' | 787 |
| Columbia | 9 | Missouri | 38° 58' | 92° 22' | 778 |
| Dodge City | 10 | Kansas | 37° 46' | 99° 58' | 2594 |
| East Lansing | 17 | Michigan | 42° 42' | 84° 30' | 852 |
| Ely | 11 | Nevada | 39° 17' | 114° 51' | 6257 |
| Fort Worth | 12 | Texas | 32° 50' | 97° 03' | 544 |
| Fresno | 13 | California | 36° 46' | 119° 42' | 331 |
| Grand Junction | 14 | Colorado | 39° 07' | 108° 32' | 4849 |
| Great Falls | 15 | Montana | 47° 29' | 111° 21' | 3664 |
| Indianapolis | 16 | Indiana | 39° 44' | 84° 16' | 793 |
| Little Rock | 18 | Arkansas | 34° 44' | 92° 14' | 257 |
| Los Angeles | 19 | California | 33° 56' | 118° 23' | 312 |
| Nashville | 20 | Tennessee | 36° 07' | 86° 41' | 577 |
| New Omaho | 21 | Nebraska | 41° 17' | 95° 57' | 1323 |
| Iklahoma City | 22 | Oklahoma | 35° 24' | 97° 36' | 1280 |
| Phoenix | 23 | Arizona | 33° 26' | 112° 01' | 1109 |
| Portland | 24 | Maine | 43° 39' | 70° 19' | 61 |
| Rapid City | 25 | South Dakota | 44° 02' | 103° 03' | 3165 |
| Salt Lake City | 26 | Utah | 40° 42' | 111° 55' | 4220 |
| San Antonio | 27 | Texas | 29° 24' | 99° 26' | 792 |
| Sault Ste Marie | 28 | Michigan | 46° 28' | 84° 22' | 721 |
| Seattle | 29 | Washington | 47° 27' | 122° 18' | 14 |
| Shreveport | 30 | Louisiana | 32° 30' | 93° 47' | 252 |
| Tucson | 31 | Arizona | 32° 15' | 110° 57' | 2534 |
| Washington | 32 | D. C. | 38° 50' | 76° 57' | 14 |

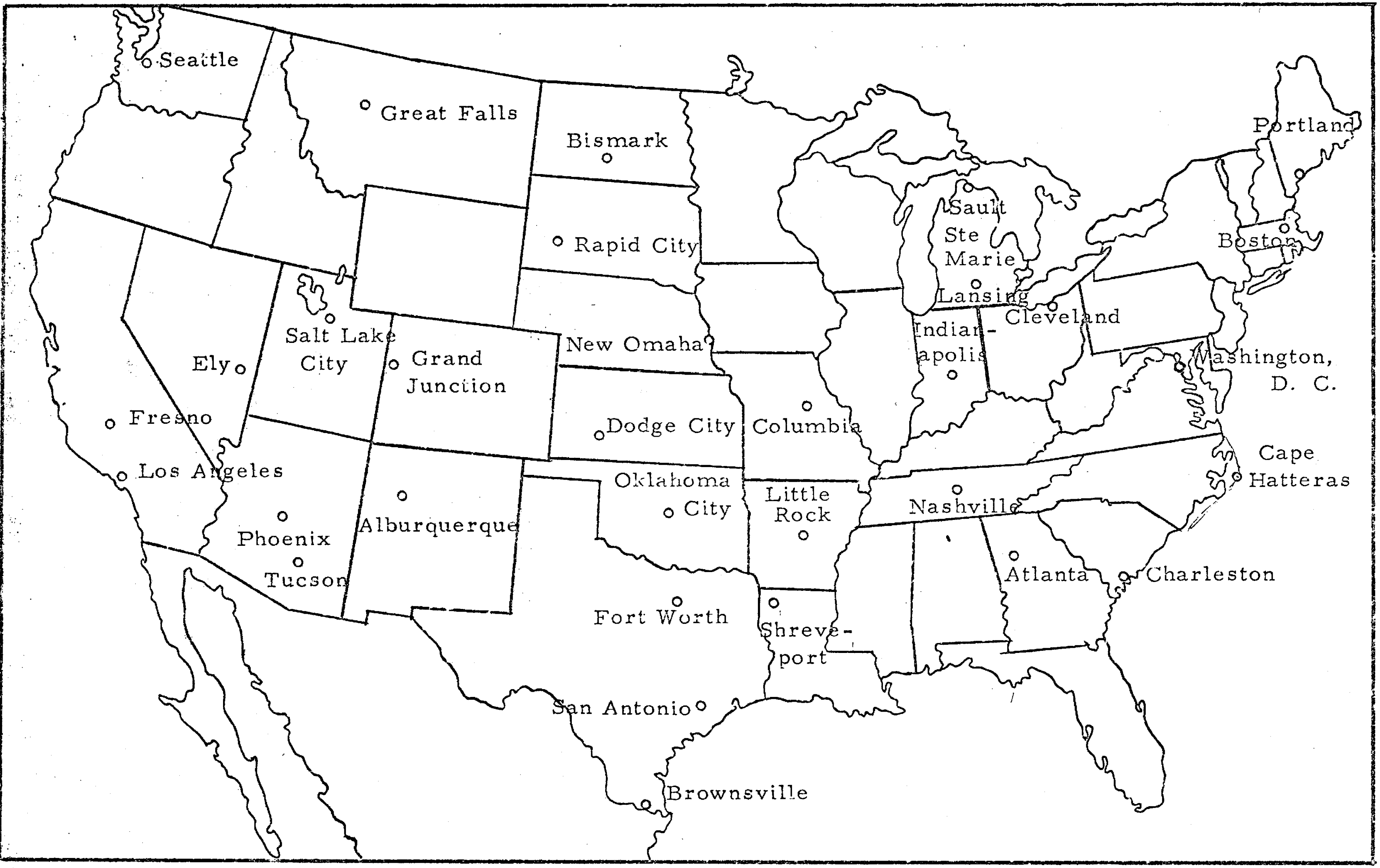


Figure 1. Map of the United States showing radiation stations

## PRESENTATION AND ANALYSIS OF THE RESULTS

The results of this study are shown in Figures 2 to 7 and Tables 2, 3, 4a, 4b, and 7.

### Development of Solar Radiation Formulas

#### Sunshine coefficient

Figure 2 shows the relation between the ratio of incoming solar radiation to theoretical radiation and percent of sunshine. Each point represents the centroid for 12 values arranged according to percentage of sunshine. This figure was used in order to determine the sunshine coefficient $C_S$. The equation of the line that best fits the data is:

$$Ra/Rt = 0.2134 + 0.668\ S - 0.16\ S^2 \qquad (12)$$

assuming that

$$K_S\ C_S = Ra/Rt$$

$$K_S\ C_S = 0.2134 + 0.688\ S - 0.16\ S^2$$

For

$$S = 80\% = 0.80; \quad C_S = 1.0$$

then

$$K_S (1) = 0.2134 + 0.668 (0.80) = 0.16 (0.80)^2$$

$$K_S = 0.2134 + 0.5344 - 0.1024 = 0.6454$$

and

$$C_S = 0.328 + 1.04 S - 0.25 S^2 \qquad (13)$$

Elevation coefficient

The effect of elevation on the development of the radiation formulas is shown in Figure 3. Each point represents the centroid of 12 values. The equation that best fits the data is:

$$R_a/(K_S \; Rt \; C_S) = 0.97 + 0.00003 E \qquad (14)$$

Assuming that

$$K_E \; C_E = Ra/(K_S \; Rt \; C_S)$$

$$K_E \; C_E = 0.97 + 0.00003 E$$

For

$$E = 1000; \quad C_E = 1.0$$

then

$$K_E (1) = 0.97 + 0.00003 (1000) = 1.0$$

therefore,

$$C_E = 0.97 + 0.00003 \text{ E} \qquad (15)$$

which says that there is a linear relation between incoming solar radiation and elevation.

The effect of sky cover on incoming solar radiation was determined under two different conditions. First with a coefficient for sunshine and second without a coefficient for sunshine.

Sky cover coefficient with sunshine coefficient

Figure 4 shows the influence of sky cover on the ratio Ra/ $(K_S K_E \text{ Rt } C_S C_E)$ which contains the sunshine coefficient. Each point represents the centroid of 12 values. The data were arranged according to sky cover. The equation of the line that best fits the relation is:

$$\text{Ra}/(K_S K_E \text{ Rt } C_S C_E) = 0.94 + 0.22 \text{ SKC} - 0.2 \text{ SKC}^2 \qquad (16)$$

Assuming that

$$K_{SKCS} C_{SKCS} = \text{Ra}/(K_S K_E \text{ Rt } C_S C_E)$$

$$K_{SKCS}\, C_{SKCS} = 0.94 + 0.22\ SKC - 0.2\ SKC^2$$

For

$$SKC = 0.5; \quad C_{SKCS} = 1.0$$

then

$$K_{SKCS}(1) = 0.94 + 0.22\ (0.5) + 0.2\ (0.25) = 1.0$$

therefore,

$$C_{SKCS} = 0.94 + 0.22\ SKC - 0.2\ SKC^2 \tag{17}$$

Sky cover coefficient without sunshine coefficient

Figure 5 shows the effect of sky cover on incoming solar radiation without a sunshine coefficient. Each point represents the centroid of 12 values. The data were arranged according to sky cover. The equation that best fits the data is:

$$RA/K_S\, K_E\, Rt\, C_E) = 1.00 + 0.32\ SKC - 0.9\ SKC^2 \tag{18}$$

Assuming that

$$K_{SKC}\, C_{SKC} = Ra/(K_S\, K_E\, Rt\, C_E)$$

$$K_{SKC}\, C_{SKC} = 1.00 + 0.32\, SKC - 0.9\, SKC^2$$

For

$$SKC = 0.0; \quad C_{SKC} = 1.0$$

then

$$K_{SKC} = 1.00$$

therefore

$$C_{SKC} = 1.00 - 0.32\, SKC - 0.9\, SKC^2 \qquad (19)$$

Humidity effect

Figure 6 a shows that the mean relative humidity does not have a perceptible effect on incoming solar radiation, due to the lack of slope of the best fit line. Figure 6b, 6c, and 6d reinforce the above statement.

Sunshine - sky cover relationship

The relationship between percentage of sunshine and sky cover is shown in Figure 7. Each point represents the centroid of 12 values. The points represented by $\Delta$s were obtained by arranging the data according to sunshine, and the points represented by $\odot$ were obtained by arranging the data according to sky cover. The equation of the line that best fits the data is:

$$S = 100 - 1.6\ SKC - 0.84\ SKC^2 \qquad (20)$$

Radiation formulas

As a result of the procedure that has been followed, four formulas for computing incoming solar radiation were developed.

$$RAP1 = K_1\ R_t\ C_S\ C_E \qquad (21)$$

$$RAP2 = K_2\ R_t\ C_{SKC}\ C_E \qquad (22)$$

$$RAP3 = K_3\ R_t\ C_S\ C_{SKCS}\ C_E \qquad (23)$$

$$RAP4 = K_4\ R_t\ C_{SC}\ C_E \qquad (24)$$

where

$K_1 = K_S\ K_E$

$K_2 = K_S\ K_E\ K_{SKC}$

$K_3 = K_S\ K_E\ K_{KSCS}$

$K_4 = K_S\ K_E$

## Test of the Formulas

The reliability of the formulas was tested with measured values of incoming solar radiation. An evaluation of the comparisons is presented in Tables 2, 3, 4a, and 4b.

Table 2 shows the measured values of incoming solar radiation expressed as equivalent depth of evaporation, in inches, for the 32 solar radiation stations in the United States. The formulas that best fit the measured values can be expressed as follows:

For values of Rt computed from a solar constant of 1.94 cal/cm$^2$/min.

$$RAP1 = 0.6399\ Rt\ C_S\ C_E \tag{25}$$

$$RAP2 = 0.6514\ Rt\ C_{SKC}\ C_E \tag{26}$$

$$RAP\ 3 = 0.6406\ Rt\ C_S\ C_{SKCS}\ C_E \tag{27}$$

$$RAP4 = 0.6489\ Rt\ C_{SC}\ C_E \tag{28}$$

For values of Rt computed from a solar constant of 2.0 cal/cm$^2$/min.

$$RAP1 = 0.6236\ Rt\ C_S\ C_E \tag{29}$$

$$RAP2 = 0.6348\ Rt\ C_{SKC}\ C_E \tag{30}$$

$$RAP3 = 0.6243\ Rt\ C_S\ C_{SKCS}\ C_E \tag{31}$$

$$RAP4 = 0.6235\ Rt\ C_{SC}\ C_E \qquad (32)$$

Comparison of Measured and Computed Radiation at Davis, California

A comparison of the measured and computed values of incoming solar radiation in langleys per day, using Equation (21) with $K_1 =$ 0.6399, for Davis, California, is presented in Table 3. The overall ratio of actual to computed radiation was 1.018 as given. A better fit for Davis, therefore, would be

$$RAP1 = 0.6514\ Rt\ C_S\ C_E \qquad (33)$$

for values of Rt computed from a solar constant of 1.94 cal/cm$^2$/min., and

$$RAP\ 1 = 0.6319\ Rt\ C_S\ C_E \qquad (34)$$

for values of Rt computed from a solar constant of 2.0 cal/cm$^2$/min.

Comparison of Measured and Computed Radiation for Venezuela

Tables 4a and 4b show the measured and computed values of incoming solar radiation for 18 solar radiation stations in Venezuela. The overall ratios of actual to computed radiation for the four formulas were 0.996, 1.048, 1.012, and 1.067 respectively. A better fit could be obtained with modified values of $K_1$, $K_2$, $K_3$, and $K_4$ as given in the Equations (35) to (42).

For values of Rt computed from a solar constant of 1.94 cal/cm$^2$/min.,

$$RAP1 = 0.6237\ Rt\ C_S\ C_E \quad (35)$$

$$RAP2 = 0.6828\ Rt\ C_{SKC}\ C_E \quad (36)$$

$$RAP3 = 0.6486\ Rt\ C_S\ C_{SKCS}\ C_E \quad (37)$$

$$RAP4 = 0.6929\ Rt\ C_{SC}\ C_E \quad (38)$$

For values of Rt computed from a solar constant of 2.0 cal/cm$^2$/min.,

$$RAP1 = 0.6236\ Rt\ C_S\ C_E \quad (39)$$

$$RAP2 = 0.6348\ Rt\ C_{SKC}\ C_E \quad (40)$$

$$RAP3 = 0.6243\ Rt\ C_S\ C_{SKCS}\ C_E \quad (41)$$

$$RAP4 = 0.6325\ Rt\ C_{SC}\ C_E \quad (42)$$

## Comparison of Several Formulas for Computing Radiation for Venezuela

Table 7a in the appendix shows a comparison between measured values of incoming solar radiation, in langleys per day, for January (Month 1) and the values from the four formulas developed here and from the formulas given by Equations (3), (5), (6), (7), and (8) as cited in the literature review. The notation on page xi gives the meaning of the symbols used in the tables. Tables 7b to 7l give similar comparisons for the other months. As can be seen in the last part of Table 7l, the overall ratio and the overall mean absolute error show how well the values computed from the four formulas developed in this study agree with the actual values in comparison with the values obtained with the other formulas.

It was gratifying to note that the two formulas developed here, using sunshine as a parameter, fitted the Venezuelan data somewhat better than any of those cited in the literature. Formulas based on sky cover [Equations (3), (22), and (24)] are not as good for estimating incoming solar radiation.

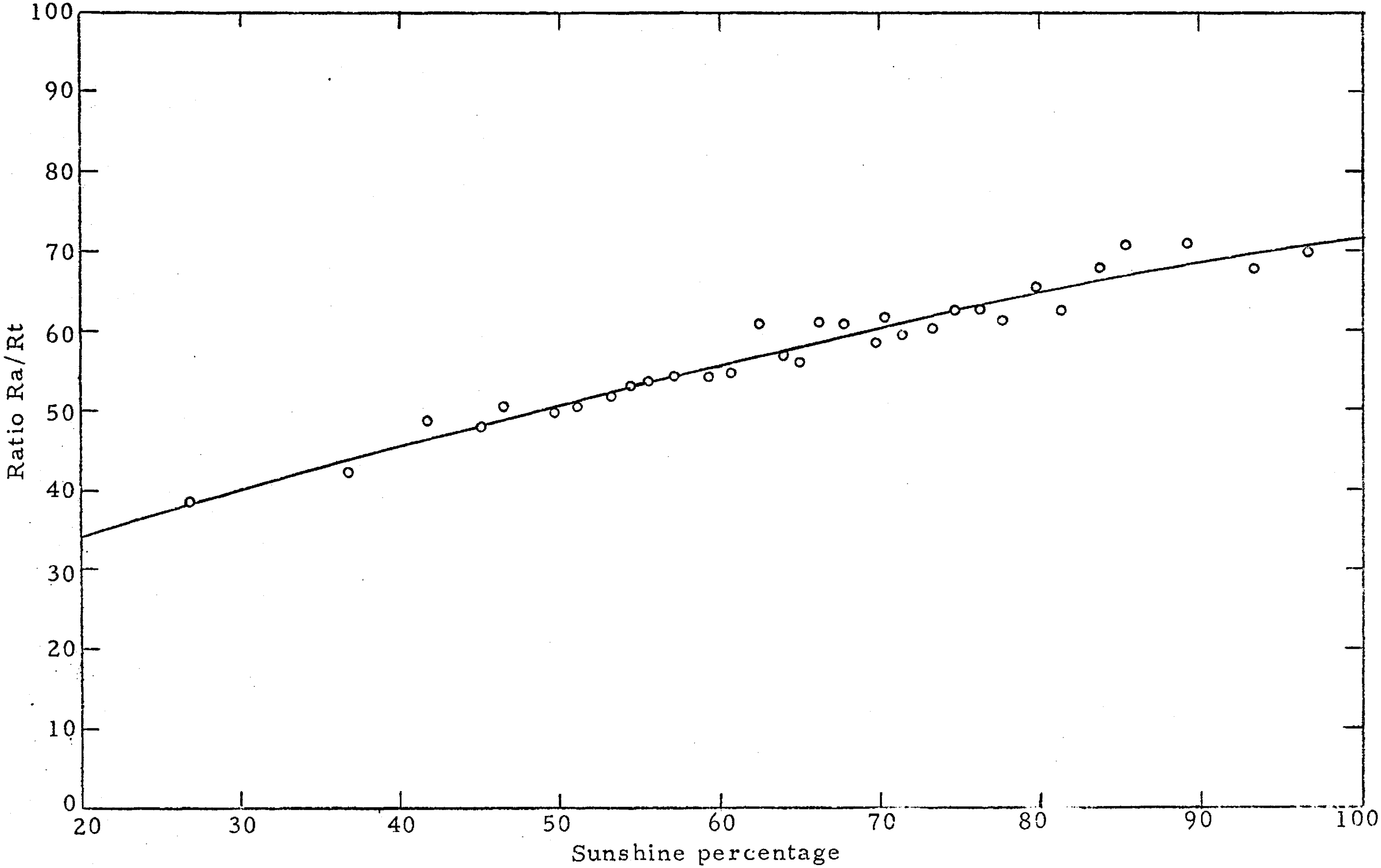


Figure 2. Ratio incoming solar radiation to extraterrestrial radiation vs. sunshine

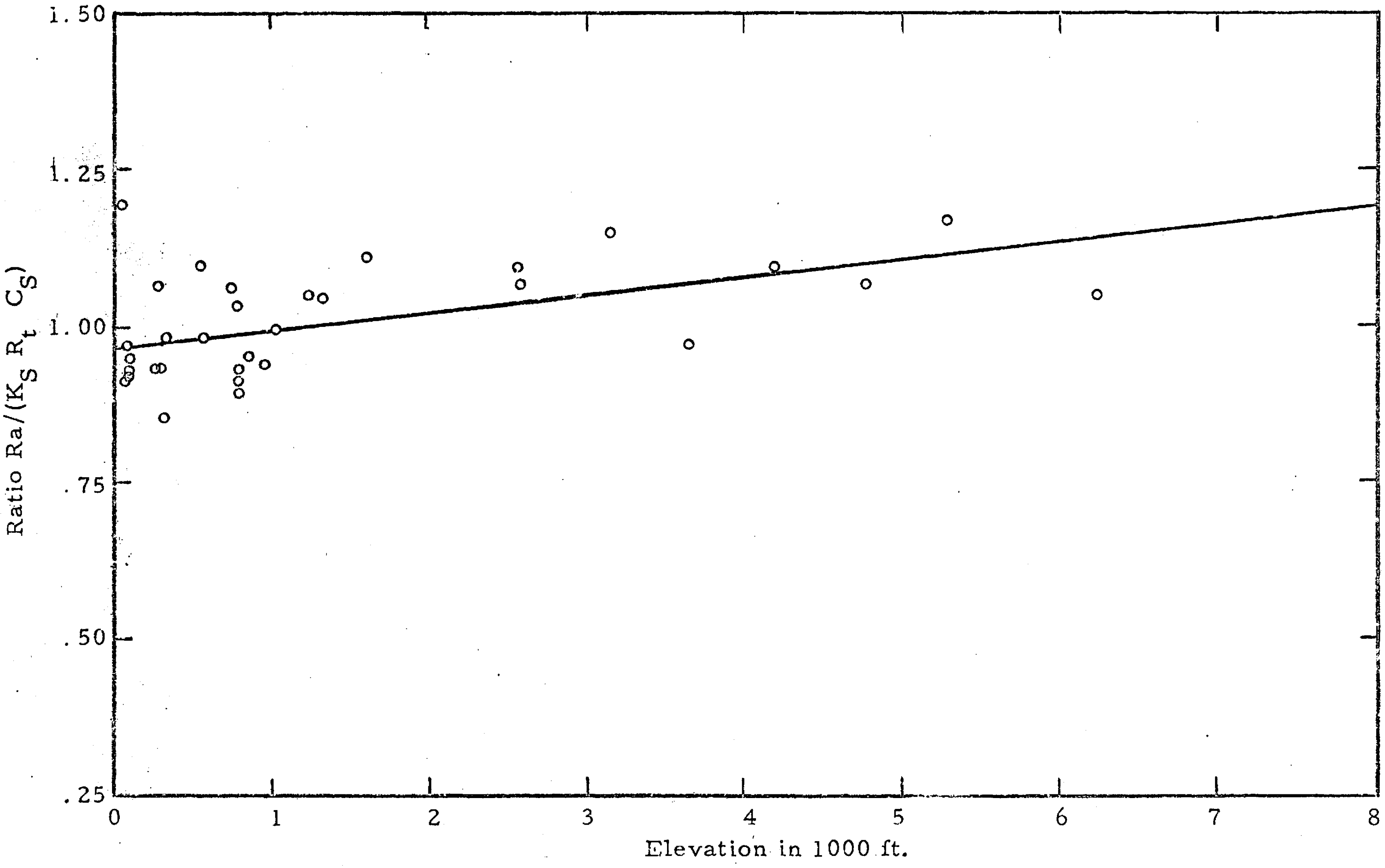


Figure 3. Rotation between $Ra/(K_S\ R_t\ \ C_S)$ and elevation in 1000 ft.

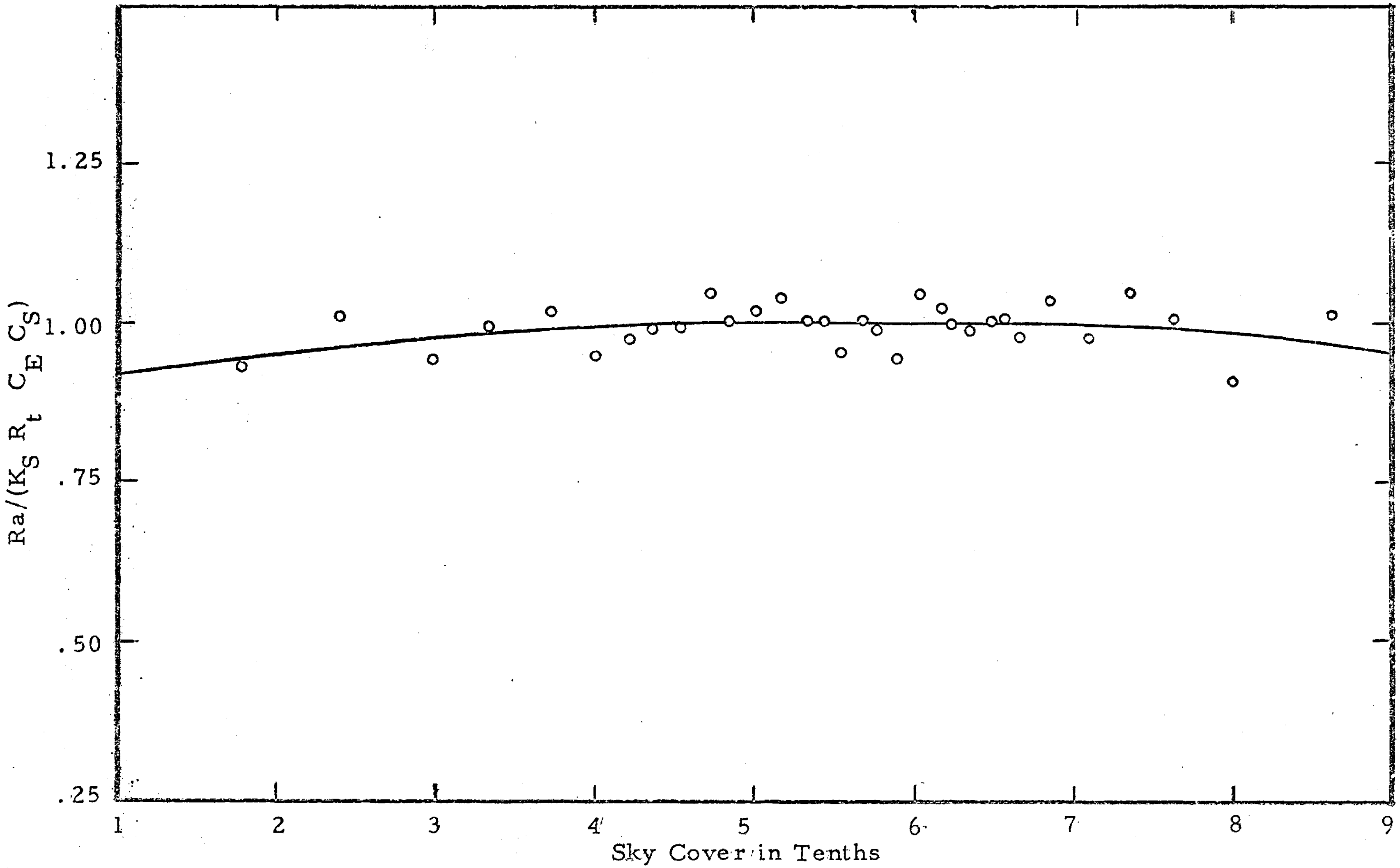


Figure 4. Relation between $Ra/(K_S\ R_t\ C_E\ C_S)$ and sky cover under the presence of sunshine

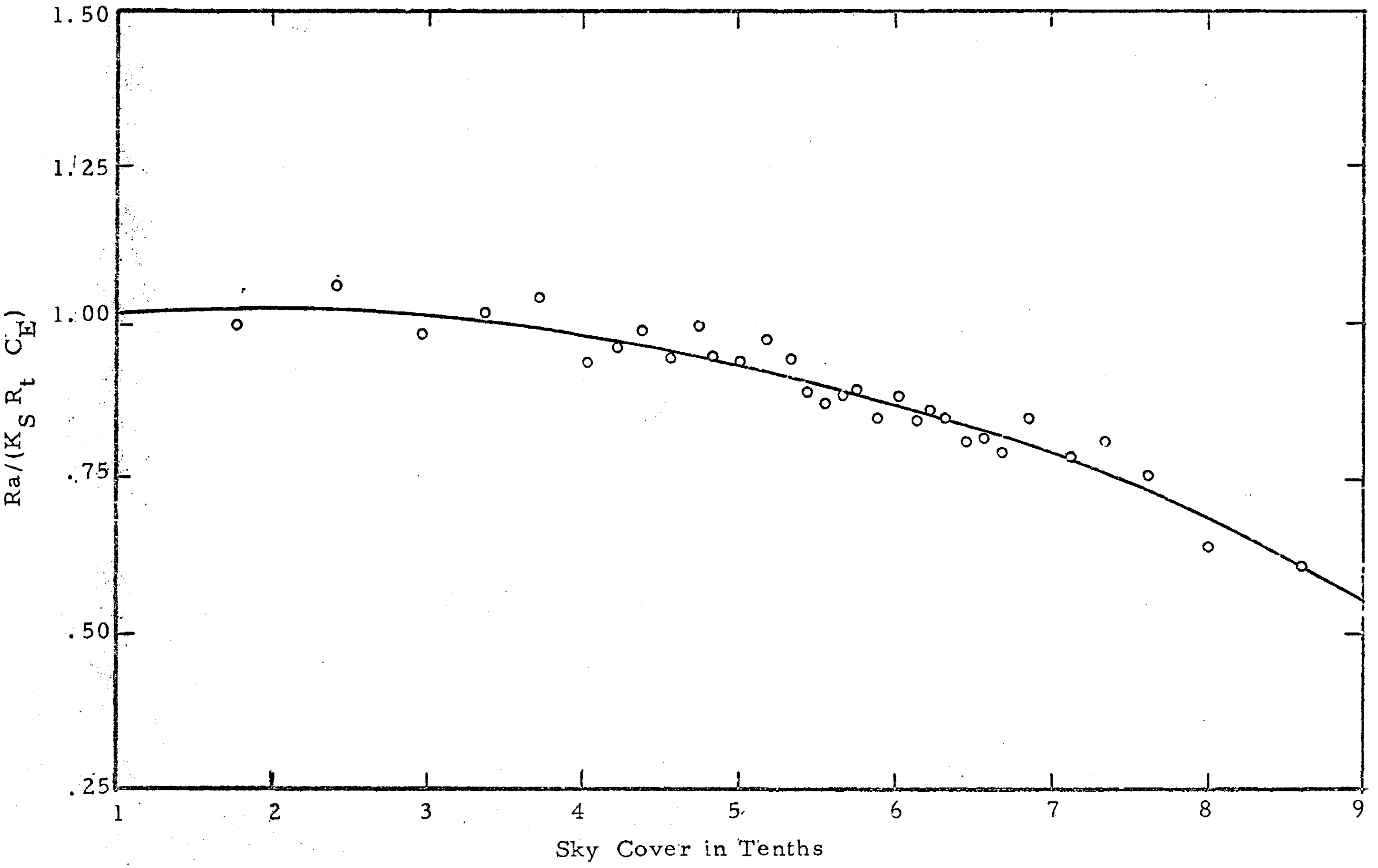


Figure 5. Relation between $Ra/(R_s R_t C_E)$ and sky cover in absence of sunshine

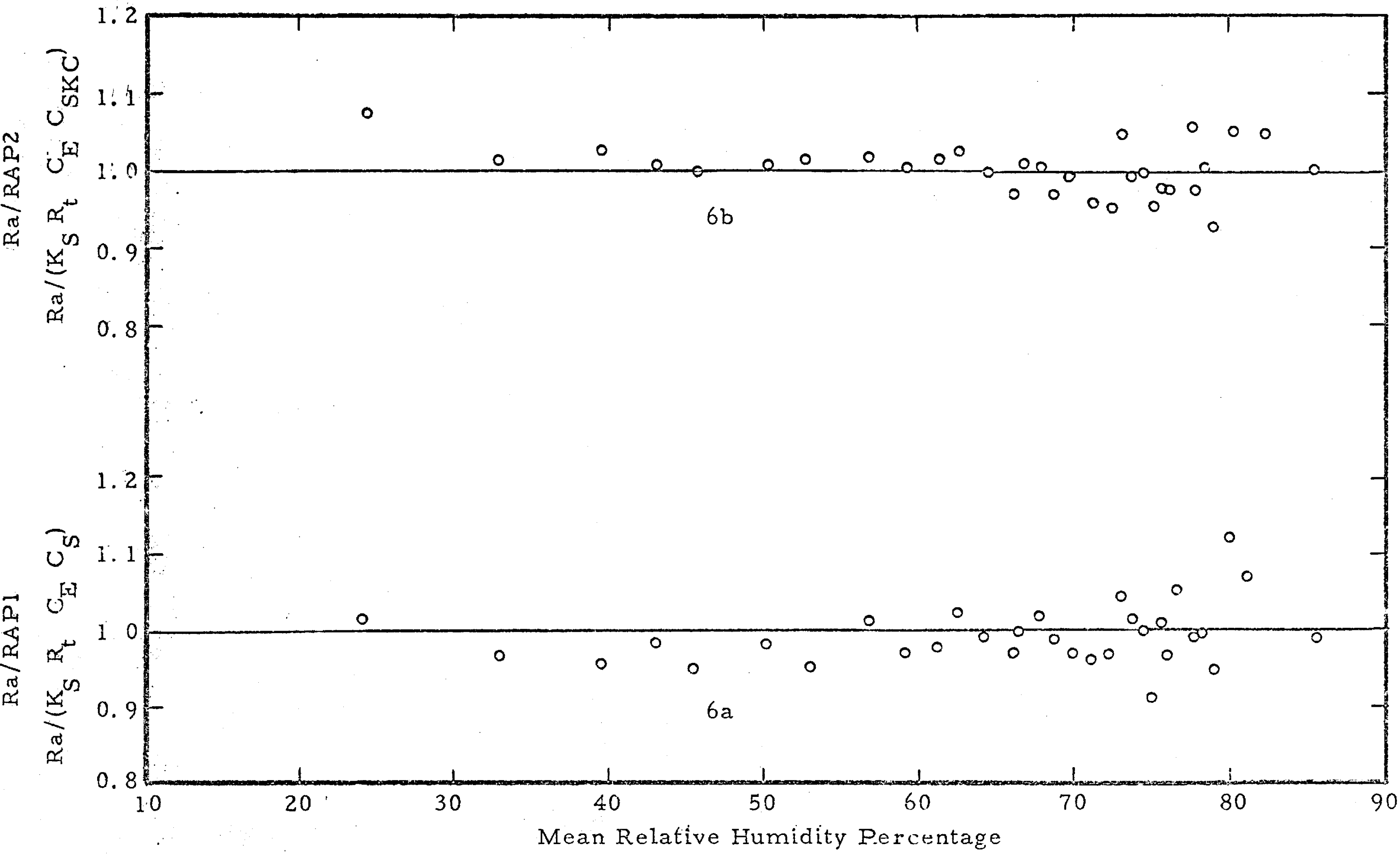


Figure 6a. Relation between ratio actual radiation to compute radiation vs. relative humidity

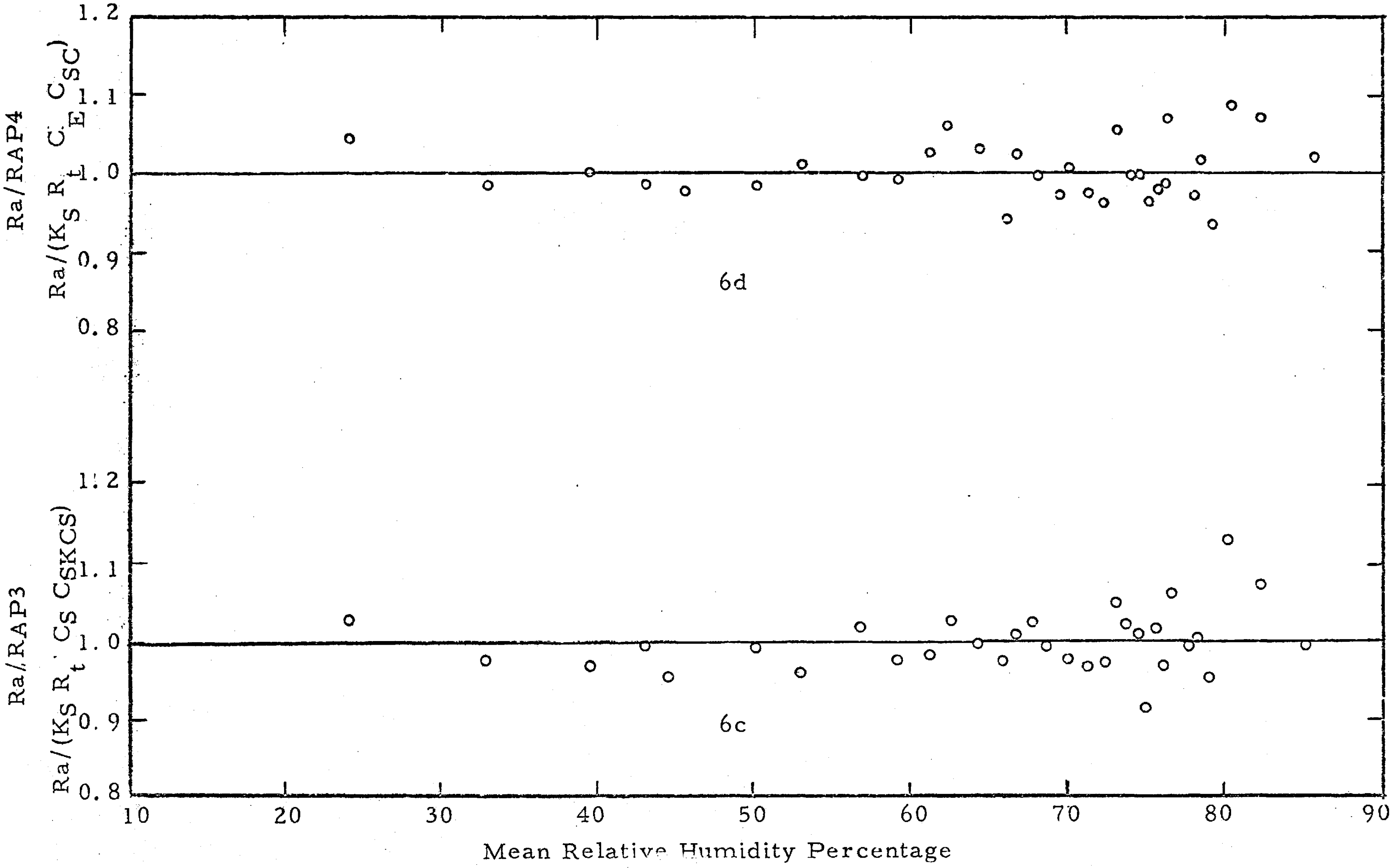


Figure 6b. Relation between ratio actual radiation to compute radiation vs. relative humidity

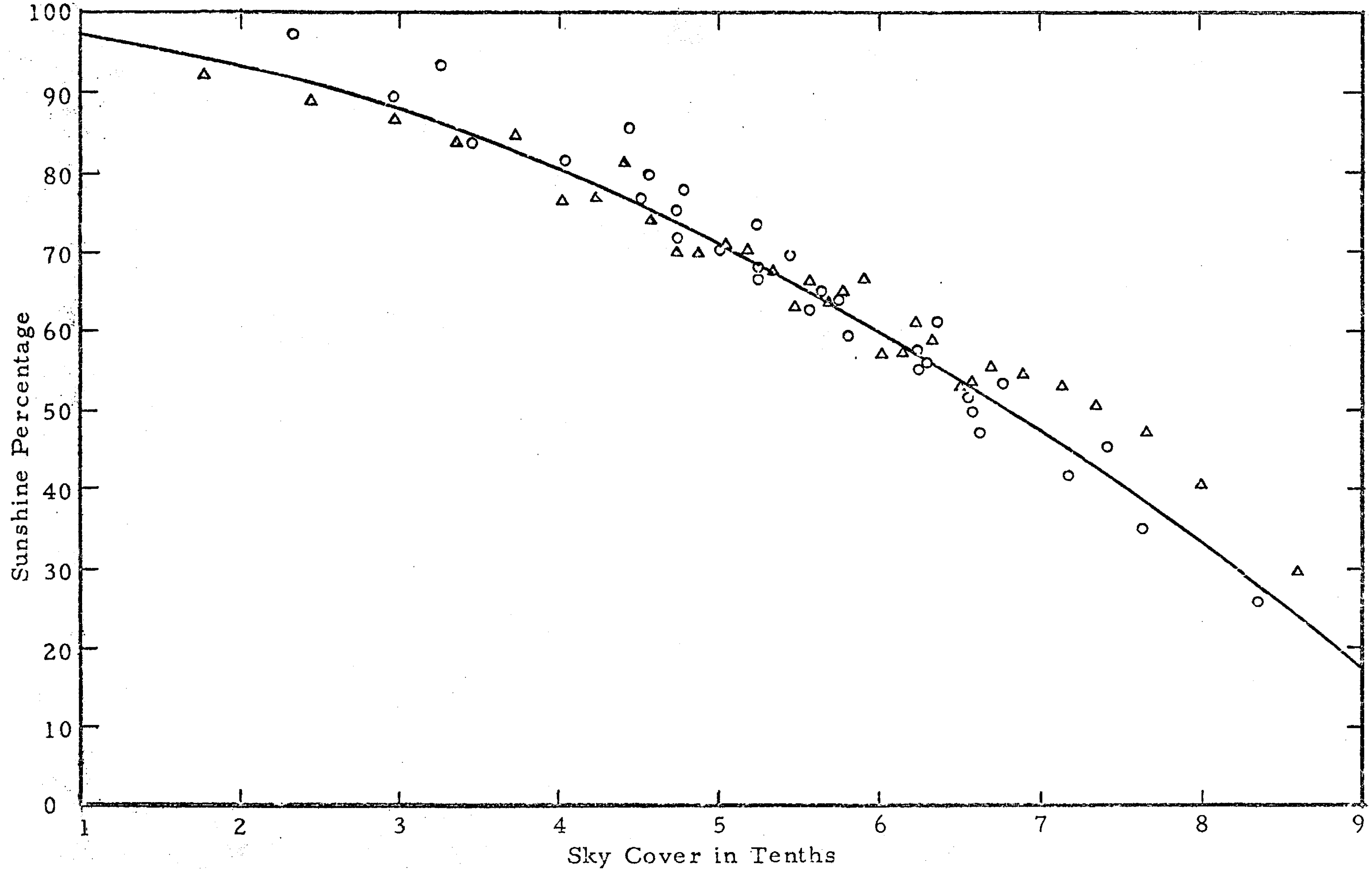


Figure 7. Relation between sunshine and sky cover

Table 2a. Average monthly values of measured and computed incoming solar radiation, for 32 solar radiation stations in the United States, in equivalent depth of evaporation, in inches

| Month | Ra Inches | RAP1 Inches | Error Inches | Error % | RAP2 Inches | Error Inches | Error % |
|---|---|---|---|---|---|---|---|
| January | 4.13 | 4.13 | 0.00 | 0.00 | 4.25 | -0.12 | -2.91 |
| February | 5.52 | 5.31 | 0.21 | 3.81 | 5.45 | +0.07 | +1.27 |
| March | 8.57 | 7.85 | 0.72 | 8.42 | 7.73 | +0.84 | +9.80 |
| April | 9.88 | 9.72 | 0.16 | 1.62 | 9.53 | +0.35 | +3.45 |
| May | 11.73 | 11.58 | 0.15 | 1.28 | 11.27 | +0.46 | +3.92 |
| June | 12.02 | 12.21 | -0.19 | -1.58 | 12.05 | -0.03 | -0.25 |
| July | 12.34 | 12.59 | -0.25 | -2.06 | 12.42 | -0.08 | -0.65 |
| August | 11.02 | 11.22 | -0.19 | -1.72 | 11.11 | -0.09 | -0.82 |
| September | 9.00 | 9.13 | -0.13 | -1.45 | 9.33 | -0.33 | -3.67 |
| October | 6.75 | 6.96 | -0.21 | -3.11 | 7.16 | -0.41 | -6.08 |
| November | 4.75 | 5.01 | -0.26 | -5.48 | 5.19 | -0.44 | -9.25 |
| December | 3.92 | 3.95 | -0.03 | -0.77 | 4.15 | -0.23 | -5.86 |
| Sum | 99.63 | 99.65 | 2.50 | 31.30 | 99.63 | 3.45 | 47.92 |
| Average | 8.30 | | | | | | |
| Mean absolute error | | | 0.21 | 2.64 | | 0.29 | 3.99 |

Table 2b. Average monthly values of measured and computed incoming solar radiation, for 32 solar radiation stations in the United States, in equivalent depth of evaporation, in inches

| Month | Ra Inches | RAP3 Inches | Error Inches | Error % | RAP4 Inches | Error Inches | Error % |
|---|---|---|---|---|---|---|---|
| January | 4.13 | 4.13 | +0.00 | +0.00 | 4.15 | -0.02 | -0.49 |
| February | 5.52 | 5.32 | +0.20 | +3.62 | 5.36 | +0.16 | +2.90 |
| March | 8.57 | 7.86 | +0.71 | +8.29 | 7.62 | +0.95 | +11.20 |
| April | 9.88 | 9.74 | +0.14 | +1.41 | 9.44 | +0.44 | +4.45 |
| May | 11.73 | 11.58 | +0.15 | +1.28 | 11.22 | +0.51 | +4.34 |
| June | 12.02 | 12.22 | -0.20 | -1.66 | 12.11 | +0.09 | +0.75 |
| July | 12.34 | 12.59 | -0.25 | -2.22 | 12.51 | -0.17 | -1.38 |
| August | 11.02 | 11.19 | -0.17 | -1.54 | 11.22 | -0.20 | -1.80 |
| September | 9.00 | 9.09 | -0.09 | -1.00 | 9.48 | -0.48 | -5.43 |
| October | 6.75 | 6.97 | -0.22 | -3.26 | 7.19 | -0.44 | -6.52 |
| November | 4.75 | 5.01 | -0.26 | -5.48 | 5.20 | -0.45 | -9.52 |
| December | 3.92 | 3.95 | -0.03 | -0.76 | 4.13 | -0.21 | -5.45 |
| Sum | 99.63 | 99.65 | 2.42 | 30.47 | 99.63 | 4.12 | 54.06 |
| Average | 8.30 | | | | | | |
| Mean absolute error | | | 0.209 | 2.54 | | 0.34 | 4.51 |

Table 3. Comparative average monthly values of measured and computed incoming solar radiation in langleys per day at Davis, California, (elevation = 50 feet, latitude 38.54°) for the period July 1959 to June 1961

| Month | Sunshine % | Rt Langley per day | Ra Langley per day | RAP1 Langley per day | Ra/RAP1 | Error Langley per day | Error % |
|---|---|---|---|---|---|---|---|
| July | 100 | 994.9 | 709 | 691.46 | 1.025 | +17.55 | +2.47 |
| August | 98 | 901.8 | 625 | 620.70 | 1.007 | +4.30 | +0.69 |
| September | 95 | 749.2 | 446 | 507.83 | 0.878 | -61.83 | -13.86 |
| October | 91 | 571.3 | 380 | 379.07 | 1.002 | +0.92 | +0.24 |
| November | 94 | 424.7 | 282 | 286.37 | 0.985 | -4.37 | -1.55 |
| December | 82 | 357.8 | 198 | 225.25 | 0.879 | -27.25 | -13.76 |
| January | 47 | 391.2 | 175 | 185.21 | 0.945 | -10.21 | -5.83 |
| February | 67 | 508.9 | 297 | 288.70 | 1.029 | +8.30 | +2.80 |
| March | 60 | 676.3 | 388 | 362.40 | 1.071 | +25.60 | +6.60 |
| April | 82 | 845.3 | 476 | 532.15 | 1.082 | +43.85 | +7.61 |
| May | 83 | 964.6 | 670 | 611.02 | 1.096 | +58.98 | +8.80 |
| June | 100 | 1015.6 | 750 | 705.84 | 1.062 | +44.16 | +5.89 |
| July | 99 | 994.9 | 693 | 688.10 | 1.007 | +4.90 | +0.71 |
| August | 100 | 901.8 | 636 | 626.75 | 1.015 | +9.25 | +1.45 |
| September | 95 | 749.2 | 505 | 507.83 | 0.994 | -2.83 | -0.56 |
| October | 95 | 571.3 | 354 | 387.24 | 0.914 | -33.24 | -9.93 |
| November | 55 | 424.7 | 207 | 217.65 | 0.951 | -10.65 | -5.14 |
| December | 50 | 357.8 | 167 | 174.71 | 0.956 | -7.71 | -4.62 |
| January | 18 | 391.2 | 140 | 122.94 | 1.139 | +17.06 | +12.19 |
| February | 67 | 508.9 | 298 | 288.70 | 1.032 | +9.30 | +3.12 |
| March | 67 | 676.3 | 382 | 383.66 | 0.996 | -1.66 | -0.44 |
| April | 92 | 845.3 | 573 | 563.94 | 1.016 | +9.06 | +1.58 |
| May | 87 | 964.6 | 673 | 625.77 | 1.075 | +47.23 | +7.09 |
| June | 94 | 1015.6 | 735 | 684.10 | 1.074 | +50.90 | +6.93 |
| Sum | . . | . | 10,859 | 10667.39 | | 511.11 | 123.86 |
| Average | 79.9 | 700.1 | 452.46 | 444.47 | 1.018 | | |
| Mean absolute error | | | | | | 21.30 | 5.16 |

Table 4a. Average values of measured and computed incoming solar radiation in langleys per day for 18 solar radiation stations in Venezuela (for $R_1$ and $R_2$)

| No. | Rt Langleys per day | S % | SKC tenths | Ra Langleys per day | RAP1 Langleys per day | Ra/ RAP1 | Error Langleys per day | Error % | RAP2 Langleys per day | Ra/ RAP2 | Error Langleys per day | Error % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 865.7 | 71.7 | 5.85 | 496.3 | 493.15 | 1.006 | +3.15 | +0.64 | 463.51 | 1.071 | +32.79 | +6.61 |
| 2 | 878.6 | 58.7 | 7.10 | 513.1 | 479.07 | 1.071 | +34.04 | +6.63 | 439.55 | 1.168 | +73.55 | +14.33 |
| 3 | 877.7 | 61.5 | 6.15 | 464.1 | 504.45 | 0.920 | -40.35 | -8.69 | 501.72 | 0.925 | -37.62 | -8.11 |
| 6 | 881.9 | 66.7 | 6.70 | 469.9 | 487.30 | 0.964 | -17.40 | -3.71 | 440.56 | 1.067 | +29.34 | +6.24 |
| 8 | 875.8 | 72.2 | 5.38 | 534.7 | 503.46 | 1.062 | +31.24 | +5.84 | 490.42 | 1.090 | +53.28 | +9.96 |
| 9 | 877.6 | 63.0 | 5.41 | 444.5 | 469.35 | 0.947 | -24.85 | -5.59 | 490.62 | 0.906 | -46.12 | -10.38 |
| 10 | 874.8 | 78.9 | 4.51 | 547.3 | 525.07 | 1.042 | +22.23 | +4.06 | 514.04 | 1.065 | +33.26 | +6.08 |
| 11 | 877.5 | 61.1 | 5.89 | 482.5 | 463.70 | 1.040 | +18.80 | +3.90 | 474.47 | 1.017 | +8.03 | +1.66 |
| 12 | 877.4 | 62.5 | 6.59 | 534.0 | 477.77 | 1.117 | +56.23 | +10.53 | 437.83 | 1.220 | +96.17 | +18.01 |
| 13 | 878.2 | 66.1 | 6.46 | 503.3 | 501.28 | 1.004 | +2.02 | +4.02 | 462.76 | 1.087 | +40.54 | +8.05 |
| 14 | 879.2 | 59.1 | 6.20 | 381.3 | 456.66 | 0.835 | -75.36 | -19.76 | 461.35 | 0.826 | -80.05 | -20.99 |
| 16 | 881.2 | 56.4 | 8.28 | 520.3 | 510.50 | 1.019 | +9.80 | +1.88 | 402.61 | 1.292 | +117.69 | +22.62 |
| 17 | 877.7 | 67.7 | 6.23 | 591.3 | 485.61 | 1.218 | +105.69 | +17.87 | 455.50 | 1.298 | +135.80 | +22.97 |
| 18 | 884.7 | 57.6 | 7.29 | 407.5 | 452.80 | 0.900 | -45.30 | -11.12 | 404.83 | 1.006 | +2.67 | +0.66 |
| 19 | 882.3 | 50.4 | 7.74 | 423.5 | 437.23 | 0.968 | -13.73 | -3.24 | 399.99 | 1.058 | +23.52 | +5.55 |
| 20 | 882.2 | 62.1 | 6.34 | 404.8 | 468.66 | 0.864 | -63.86 | -15.78 | 451.86 | 0.896 | -47.06 | -11.63 |
| 21 | 885.5 | 52.6 | 6.70 | 462.5 | 470.44 | 0.983 | -7.94 | -1.78 | 481.34 | 0.961 | -18.84 | -4.07 |
| 22 | 883.0 | 53.9 | 6.96 | 420.8 | 442.88 | 0.950 | -22.08 | -5.25 | 433.60 | 0.970 | -12.80 | -3.04 |
| Sum | | | | | 8629.33 | | 594.07 | 130.29 | 8206.56 | | 889.13 | 180.96 |
| Av. | 878.9 | 62.3 | 6.43 | 477.9 | 479.90 | 0.996 | | | 455.91 | 1.048 | | |
| Mean absolute error | | | | | | | 33.04 | 7.39 | | | 49.48 | 10.05 |

Table 4b. Average values of measured and computed incoming solar radiation in langleys per day for 18 solar radiation stations in Venezuela (for $R_3$ and $R_4$)

| No. | Rt Langleys per day | S % | SKC tenths | Ra Langleys per day | RAP3 Langleys per day | Ra/ RAP3 | Error Langleys per day | Error % | RAP4 Langleys per day | Ra/ RAP4 | Error Langleys per day | Error % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 865.7 | 71.7 | 5.85 | 496.3 | 492.98 | 1.007 | +3.32 | +0.67 | 459.71 | 1.079 | +36.59 | +7.37 |
| 2 | 878.6 | 58.7 | 7.10 | 513.1 | 476.90 | 1.076 | +36.20 | +7.05 | 426.94 | 1.201 | +86.16 | +16.79 |
| 3 | 877.7 | 61.5 | 6.15 | 446.1 | 504.20 | 0.885 | -58.10 | -13.02 | 496.01 | 0.899 | -49.91 | -11.19 |
| 6 | 881.9 | 66.7 | 6.70 | 469.9 | 486.33 | 0.966 | -16.43 | -3.50 | 431.66 | 1.088 | +38.24 | +8.17 |
| 8 | 875.8 | 72.2 | 5.38 | 534.7 | 503.70 | 1.061 | +31.00 | +5.80 | 489.48 | 1.092 | +45.22 | +8.46 |
| 9 | 877.6 | 63.0 | 5.41 | 444.5 | 469.86 | 0.946 | -25.36 | -5.71 | 489.38 | 0.908 | -44.88 | -10.10 |
| 10 | 874.8 | 78.9 | 4.51 | 547.3 | 424.99 | 1.287 | +122.31 | +22.35 | 518.13 | 1.056 | +29.17 | +5.33 |
| 11 | 877.5 | 61.1 | 5.89 | 482.5 | 464.10 | 1.040 | +18.40 | +3.81 | 470.57 | 1.025 | +11.93 | +2.47 |
| 12 | 877.4 | 62.5 | 6.59 | 534.0 | 466.28 | 1.145 | +67.72 | +12.68 | 429.25 | 1.244 | +104.75 | +19.62 |
| 13 | 878.2 | 66.1 | 6.46 | 503.3 | 500.03 | 1.006 | +3.27 | +6.51 | 454.79 | 1.106 | +48.51 | +9.64 |
| 14 | 879.2 | 59.1 | 6.20 | 381.3 | 456.46 | 0.835 | -75.16 | -19.72 | 455.39 | 0.837 | -74.09 | -19.43 |
| 16 | 881.2 | 56.4 | 8.28 | 520.3 | 503.20 | 0.994 | +17.10 | +3.29 | 376.86 | 1.381 | +143.44 | +27.56 |
| 17 | 877.7 | 67.7 | 6.23 | 591.3 | 485.24 | 1.218 | +106.06 | +17.94 | 449.36 | 1.316 | +141.94 | +24.01 |
| 18 | 884.7 | 57.6 | 7.29 | 407.5 | 499.21 | 0.907 | -41.71 | -1.02 | 389.63 | 0.956 | +17.87 | +4.39 |
| 19 | 882.3 | 50.4 | 7.74 | 423.5 | 433.43 | 0.977 | -9.93 | -2.34 | 382.89 | 1.106 | +40.61 | +9.59 |
| 20 | 882.2 | 62.1 | 6.34 | 404.8 | 467.37 | 0.866 | -62.57 | -15.46 | 444.73 | 0.910 | -39.93 | -9.86 |
| 21 | 885.5 | 52.6 | 6.70 | 462.5 | 469.76 | 0.984 | -7.26 | -1.57 | 471.78 | 0.980 | -9.28 | -2.01 |
| 22 | 883.0 | 53.9 | 6.96 | 420.8 | 441.47 | 0.953 | -20.67 | -4.91 | 422.71 | 0.995 | -1.91 | -0.46 |
| Sum | | | | | 8495.51 | | 722.57 | 147.35 | 8059.27 | | 964.43 | 196.45 |
| Av. | 878.9 | 62.3 | 6.43 | 477.9 | 471.97 | 1.012 | | | 447.47 | 1.067 | | |
| Mean absolute error | | | | | | | 40.28 | 8.20 | | | 53.59 | 10.91 |

# SUMMARY AND CONCLUSIONS

The purpose of the study reported in this thesis was to develop empirical formulas to estimate incoming solar radiation based on the relationship between incoming solar radiation and extraterrestrial radiation, climatological data and geographical parameters.

The procedure used by Christiansen (1966, 1967) to develop his evaporation and evapotranspiration formulas was applied to data from 32 solar radiation stations in the United States. From these data a relation between the percentage of sunshine and sky cover in tenths was established. Four formulas for estimating incoming solar radiation, depending upon the type of climatological data available, were developed.

The results presented in Tables 2, 3, 4a, and 4b, where the mean absolute error is less than, or in the neighborhood of 10%, show how well the measured and computed values of incoming solar radiation agree.

The outcome of this study gives evidence for the following conclusions:

1. There is a satisfactory relation between incoming solar radiation and extraterrestrial radiation, geographic parameters, and climatological data. Incoming solar radiation can, therefore, be estimated as a function of climatological information.

2. The results of this study, together with the comparison of

other formulas, indicate that sunshine is a better parameter for estimating incoming solar radiation than sky cover. For Venezuela the best results were obtained when both sunshine and sky cover data were applied, using Equations (29) and (31).

3. There is a fair relationship between percentage of sunshine and sky cover which can be used to estimate sunshine percentage.

4. The procedure followed has proved to be reliable for estimating incoming solar radiation.

5. The formulas for estimating incoming solar radiation developed in this study using only data from the United States proved more reliable than the other formulas developed by different procedures when they were applied to Venezuelan data.

6. The study indicated that humidity had a negligible effect on incoming solar radiation.

7. The elevation coefficient for incoming solar radiation was the same as the elevation coefficient for evaporation found by Christiansen (1966).

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# APPENDIX

Table 5a. Climatological data of selected incoming radiation stations for January 1964

| Station Name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 44 | 22 | 33.0 | 60 | 5 | 6.2 | 4.4 | 73 | 310 | 9.01 |
| Atlanta | 2 | 52 | 37 | 44.2 | 74 | 15 | 11.2 | 6.9 | 46 | 201 | 9.41 |
| Bismark | 3 | 21 | 1 | 11.0 | 77 | 5 | 11.8 | 7.6 | 44 | 159 | 5.53 |
| Boston | 4 | 37 | 25 | 30.9 | 65 | 10 | 14.5 | 5.9 | 59 | 158 | 6.85 |
| Brownsville | 5 | 70 | 54 | 61.7 | 77 | 4 | 10.3 | 8.1 | 29 | 243 | 11.72 |
| Cape Hatteras | 6 | 54 | 39 | 46.4 | 77 | 11 | 11.5 | 5.9 | 47 | 256 | 8.94 |
| Charleston | 7 | 59 | 39 | 49.2 | 75 | 12 | 8.3 | 6.3 | 70 | 218 | 9.71 |
| Cleveland | 8 | 38 | 25 | 31.3 | 80 | 15 | 10.5 | 8.8 | 12 | 98 | 7.10 |
| Columbia | 9 | 39 | 24 | 31.4 | 83 | 7 | 10.9 | 6.6 | 44 | 164 | 7.95 |
| Dodge City | 10 | 38 | 20 | 28.8 | 81 | 5 | 14.2 | 5.7 | 60 | 259 | 8.21 |
| East Lansing | 17 | 33 | 19 | 26.0 | 77 | 17 | 13.3 | 8.9 | 34 | 115 | 6.87 |
| Ely | 11 | 32 | 6 | 19.0 | 71 | 10 | 11.7 | 7.2 | 66 | 249 | 7.75 |
| Fort Worth | 12 | 33 | 35 | 44.1 | 75 | 10 | 12.1 | 6.1 | 50 | 262 | 9.70 |
| Fresno | 13 | 58 | 36 | 46.9 | 74 | 9 | 5.7 | 6.4 | 74 | 199 | 8.53 |
| Grand Junction | 14 | 35 | 19 | 26.6 | 70 | 9 | 6.2 | 7.5 | 60 | 220 | 7.78 |
| Great Falls | 15 | 31 | 15 | 22.8 | 66 | 8 | 8.9 | 6.3 | 64 | 132 | 5.32 |
| Indianapolis | 16 | 39 | 25 | 31.8 | 73 | 9 | 9.6 | 7.7 | 45 | 144 | 7.61 |
| Little Rock | 18 | 48 | 34 | 41.1 | 76 | 13 | 6.6 | 7.5 | 34 | 186 | 9.11 |
| Los Angeles | 19 | 63 | 47 | 54.6 | 62 | 7 | 7.0 | 5.0 | 75 | 264 | 9.92 |
| Nashville | 20 | 47 | 33 | 40.0 | 84 | 11 | 8.4 | 8.1 | 28 | 152 | 8.70 |
| New Omaha | 21 | 25 | 11 | 18.2 | 81 | 9 | 11.3 | 6.5 | 50 | 193 | 7.15 |
| Oklahoma City | 22 | 44 | 28 | 36.3 | 80 | 8 | 12.6 | 6.5 | 47 | 229 | 8.39 |
| Phoenix | 23 | 59 | 38 | 48.5 | 63 | 4 | 5.8 | 4.9 | 94 | 297 | 9.49 |
| Portland | 24 | 33 | 15 | 23.7 | 76 | 13 | 9.8 | 5.7 | 51 | 180 | 6.43 |
| Rapid City | 25 | 36 | 12 | 24.0 | 67 | 5 | 12.0 | 7.5 | 42 | 179 | 6.39 |
| Salt Lake City | 26 | 33 | 18 | 25.6 | 79 | 12 | 5.9 | 8.3 | 34 | 181 | 7.32 |
| San Antonio | 27 | 59 | 41 | 50.1 | 73 | 10 | 9.1 | 7.1 | 35 | 208 | 10.69 |
| Sault Ste Marie | 28 | 24 | 12 | 18.2 | 83 | 23 | 9.8 | 8.6 | 22 | 120 | 5.61 |
| Seattle | 29 | 46 | 39 | 42.2 | 72 | 20 | 5.8 | 9.0 | 20 | 70 | 5.30 |
| Shreveport | 30 | 54 | 38 | 45.9 | 72 | 10 | 10.3 | 6.7 | 51 | 217 | 9.78 |
| Tucson | 31 | 59 | 35 | 46.8 | 58 | 6 | 8.6 | 4.4 | 79 | 314 | 9.86 |
| Washington D.C. | 32 | 44 | 32 | 38.2 | 68 | 11 | 9.9 | 7.1 | 46 | 159 | 7.83 |

Table 5b. Climatological data of selected incoming radiation stations for February 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 48 | 25 | 36.5 | 49 | 4 | 10.0 | 5.7 | 63 | 390 | 10.80 |
| Atlanta | 2 | 53 | 34 | 43.8 | 68 | 13 | 13.0 | 6.6 | 51 | 305 | 11.13 |
| Bismark | 3 | 23 | 6 | 14.4 | 69 | 5 | 11.7 | 6.1 | 42 | 252 | 7.71 |
| Boston | 4 | 42 | 28 | 35.3 | 66 | 11 | 16.3 | 6.3 | 60 | 229 | 8.92 |
| Brownsville | 5 | 72 | 49 | 60.6 | 69 | 8 | 12.9 | 4.3 | 55 | 343 | 12.96 |
| Cape Hatteras | 6 | 55 | 39 | 46.8 | 62 | 12 | 13.3 | 5.4 | 65 | 362 | 10.75 |
| Charleston | 7 | 59 | 38 | 48.4 | 70 | 10 | 10.0 | 5.9 | 73 | 306 | 11.37 |
| Cleveland | 8 | 35 | 24 | 29.5 | 79 | 21 | 12.4 | 9.2 | 15 | 143 | 9.15 |
| Columbia | 9 | 35 | 21 | 28.2 | 78 | 9 | 12.6 | 7.2 | 46 | 257 | 9.80 |
| Dodge City | 10 | 34 | 17 | 25.1 | 84 | 10 | 16.2 | 6.6 | 54 | 277 | 10.12 |
| East Lansing | 17 | 31 | 15 | 23.0 | 80 | 14 | 14.0 | 8.4 | 26 | 222 | 8.94 |
| Ely | 11 | 36 | 11 | 23.3 | 66 | 10 | 11.3 | 7.4 | 74 | 316 | 9.71 |
| Fort Worth | 12 | 53 | 33 | 43.0 | 68 | 9 | 14.9 | 6.0 | 51 | 332 | 11.36 |
| Fresno | 13 | 59 | 40 | 49.5 | 77 | 10 | 6.0 | 6.6 | 54 | 250 | 10.39 |
| Grand Junction | 14 | 38 | 21 | 29.4 | 62 | 11 | 7.6 | 7.3 | 58 | 309 | 9.75 |
| Great Falls | 15 | 33 | 15 | 23.9 | 63 | 11 | 9.7 | 6.5 | 60 | 216 | 7.51 |
| Indianapolis | 16 | 35 | 21 | 28.1 | 62 | 10 | 10.6 | 8.3 | 45 | 196 | 9.61 |
| Little Rock | 18 | 48 | 32 | 39.9 | 71 | 12 | 8.6 | 6.7 | 43 | 262 | 10.89 |
| Los Angeles | 19 | 65 | 49 | 57.0 | 66 | 5 | 6.8 | 4.6 | 71 | 326 | 11.55 |
| Nashville | 20 | 44 | 27 | 35.6 | 81 | 12 | 8.7 | 7.7 | 31 | 223 | 10.53 |
| New Omaha | 21 | 24 | 10 | 16.9 | 77 | 13 | 13.2 | 6.0 | 54 | 309 | 9.20 |
| Oklahoma City | 22 | 43 | 26 | 34.5 | 76 | 9 | 14.0 | 6.6 | 55 | 304 | 10.71 |
| Phoenix | 23 | 63 | 40 | 51.5 | 46 | 2 | 6.9 | 4.7 | 93 | 392 | 11.20 |
| Portland | 24 | 38 | 20 | 28.8 | 78 | 11 | 11.4 | 6.3 | 51 | 261 | 8.55 |
| Rapid City | 25 | 29 | 9 | 19.1 | 76 | 11 | 10.5 | 6.8 | 55 | 295 | 8.45 |
| Salt Lake City | 26 | 37 | 20 | 28.7 | 75 | 13 | 7.5 | 8.1 | 53 | 270 | 9.34 |
| San Antonio | 27 | 62 | 38 | 49.9 | 66 | 9 | 11.8 | 5.4 | 53 | 316 | 12.16 |
| Sault Ste Marie | 28 | 25 | 10 | 17.3 | 80 | 16 | 10.1 | 6.2 | 47 | 248 | 7.79 |
| Seattle | 29 | 49 | 40 | 44.7 | 65 | 13 | 7.7 | 7.4 | 39 | 144 | 7.50 |
| Shreveport | 30 | 53 | 35 | 44.0 | 69 | 10 | 12.2 | 6.2 | 55 | 289 | 11.42 |
| Tucson | 31 | 61 | 34 | 47.8 | 45 | 4 | 9.3 | 3.6 | 86 | 440 | 11.50 |
| Washington D.C. | 32 | 45 | 31 | 38.3 | 59 | 10 | 12.6 | 6.3 | 52 | 272 | 9.79 |

Table 5c. Climatological data of selected incoming radiation stations for March 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 63 | 36 | 49.9 | 39 | 4 | 8.6 | 4.4 | 78 | 580 | 14.72 |
| Atlanta | 2 | 51 | 36 | 41.8 | 66 | 9 | 12.6 | 6.4 | 51 | 345 | 14.98 |
| Bismark | 3 | 29 | 11 | 20.1 | 87 | 9 | 13.2 | 7.3 | 45 | 376 | 12.07 |
| Boston | 4 | 40 | 26 | 32.7 | 62 | 7 | 6.7 | 7.2 | 64 | 324 | 13.16 |
| Brownsville | 5 | 73 | 56 | 64.3 | 81 | 8 | 11.4 | 7.2 | 38 | 330 | 16.36 |
| Cape Hatteras | 6 | 49 | 36 | 42.5 | 63 | 13 | 13.1 | 5.4 | 66 | 455 | 14.68 |
| Charleston | 7 | 56 | 36 | 46.3 | 67 | 13 | 10.3 | 5.7 | 69 | 371 | 15.17 |
| Cleveland | 8 | 32 | 16 | 24.0 | 77 | 17 | 11.2 | 7.7 | 43 | 297 | 13.35 |
| Columbia | 9 | 37 | 21 | 28.7 | 74 | 14 | 11.7 | 6.5 | 60 | 414 | 13.91 |
| Dodge City | 10 | 45 | 24 | 34.1 | 79 | 10 | 16.7 | 6.3 | 63 | 435 | 14.17 |
| East Lansing | 17 | 33 | 11 | 22.0 | 76 | 14 | 13.0 | 6.7 | 51 | 392 | 13.17 |
| Ely | 11 | 53 | 25 | 39.3 | 52 | 4 | 11.0 | 5.9 | 85 | 506 | 13.85 |
| Fort Worth | 12 | 59 | 39 | 49.1 | 68 | 7 | 13.2 | 6.5 | 47 | 525 | 15.16 |
| Fresno | 13 | 70 | 44 | 56.8 | 67 | 4 | 6.7 | 5.7 | 74 | 420 | 14.39 |
| Grand Junction | 14 | 53 | 31 | 42.4 | 51 | 8 | 8.7 | 5.7 | 75 | 480 | 13.87 |
| Great Falls | 15 | 43 | 20 | 31.3 | 58 | 6 | 9.6 | 7.0 | 85 | 408 | 11.90 |
| Indianapolis | 16 | 35 | 18 | 26.2 | 70 | 11 | 10.0 | 6.7 | 69 | 391 | 13.75 |
| Little Rock | 18 | 50 | 33 | 41.3 | 67 | 9 | 9.6 | 6.5 | 51 | 376 | 14.80 |
| Los Angeles | 19 | 71 | 53 | 62.0 | 69 | 3 | 5.9 | 4.8 | 73 | 469 | 15.30 |
| Nashville | 20 | 45 | 27 | 36.3 | 75 | 14 | 8.6 | 6.9 | 47 | 354 | 14.51 |
| New Omaha | 21 | 29 | 13 | 21.0 | 79 | 14 | 12.4 | 7.5 | 38 | 393 | 13.39 |
| Oklahoma City | 22 | 49 | 34 | 39.7 | 74 | 11 | 13.3 | 6.8 | 47 | 383 | 14.65 |
| Phoenix | 23 | 79 | 51 | 65.1 | 40 | 1 | 6.6 | 4.4 | 95 | 551 | 15.03 |
| Portland | 24 | 36 | 19 | 27.4 | 73 | 11 | 10.5 | 6.9 | 58 | 358 | 12.83 |
| Rapid City | 25 | 39 | 17 | 28.0 | 73 | 12 | 12.5 | 7.2 | 56 | 425 | 12.74 |
| Salt Lake City | 26 | 54 | 31 | 42.5 | 63 | 13 | 18.2 | 6.6 | 61 | 427 | 13.52 |
| San Antonio | 27 | 67 | 46 | 56.1 | 71 | 8 | 10.3 | 6.6 | 46 | 355 | 15.78 |
| Sault Ste Marie | 28 | 27 | 9 | 18.2 | 73 | 8 | 8.6 | 6.0 | 64 | 424 | 12.15 |
| Seattle | 29 | 52 | 41 | 46.2 | 70 | 18 | 8.4 | 8.4 | 41 | 228 | 11.89 |
| Shreveport | 30 | 58 | 39 | 48.5 | 66 | 9 | 10.3 | 6.7 | 46 | 348 | 15.21 |
| Tucson | 31 | 77 | 45 | 61.0 | 34 | 3 | 9.0 | 3.7 | 93 | 610 | 15.26 |
| Washington D.C. | 32 | 43 | 28 | 35.6 | 61 | 8 | 12.8 | 5.7 | 62 | 392 | 13.90 |

Table 5d. Climatological data of selected incoming radiation stations for April 1964

| Stationname | No. | TX °F | TM °F | TA °F | R % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 73 | 43 | 57.9 | 24 | 3 | 8.7 | 4.6 | 62 | 664 | 17.11 |
| Atlanta | 2 | 74 | 53 | 63.7 | 61 | 7 | 10.0 | 5.7 | 64 | 431 | 17.24 |
| Bismark | 3 | 57 | 33 | 45.2 | 57 | 5 | 16.7 | 6.5 | 63 | 488 | 15.61 |
| Boston | 4 | 56 | 40 | 48.3 | 69 | 14 | 12.2 | 7.4 | 53 | 374 | 16.25 |
| Brownsville | 5 | 82 | 65 | 73.6 | 79 | 3 | 14.3 | 6.3 | 57 | 440 | 17.84 |
| Cape Hatteras | 6 | 69 | 56 | 62.4 | 77 | 7 | 12.9 | 4.7 | 66 | 586 | 17.09 |
| Charleston | 7 | 78 | 54 | 65.8 | 68 | 8 | 8.9 | 4.7 | 78 | 502 | 17.33 |
| Cleveland | 8 | 63 | 39 | 51.0 | 61 | 11 | 14.8 | 8.0 | 52 | 332 | 16.37 |
| Columbia | 9 | 68 | 47 | 57.3 | 62 | 11 | 13.3 | 7.0 | 52 | 448 | 16.68 |
| Dodge City | 10 | 70 | 44 | 57.2 | 56 | 9 | 19.0 | 5.3 | 80 | 562 | 17.82 |
| East Lansing | 17 | 59 | 38 | 48.7 | 71 | 12 | 14.8 | 8.0 | 42 | 335 | 16.26 |
| Ely | 11 | 60 | 26 | 43.2 | 42 | 7 | 11.9 | 5.5 | 63 | 598 | 16.64 |
| Fort Worth | 12 | 78 | 56 | 67.3 | 62 | 7 | 15.6 | 5.6 | 59 | 487 | 17.32 |
| Fresno | 13 | 73 | 47 | 60.1 | 58 | 3 | 8.4 | 4.2 | 84 | 516 | 16.93 |
| Grand Junction | 14 | 66 | 40 | 53.1 | 32 | 3 | 10.4 | 5.0 | 84 | 576 | 16.65 |
| Great Falls | 15 | 53 | 33 | 42.8 | 51 | 10 | 13.0 | 6.2 | 55 | 443 | 15.50 |
| Indianapolis | 16 | 66 | 43 | 54.8 | 60 | 9 | 10.4 | 7.0 | 68 | 429 | 16.59 |
| Little Rock | 18 | 76 | 54 | 64.9 | 55 | 5 | 9.7 | 5.3 | 70 | 512 | 17.15 |
| Loa Angeles | 19 | 75 | 55 | 65.3 | 63 | 2 | 6.9 | 3.9 | 83 | 591 | 17.39 |
| Nashville | 20 | 74 | 48 | 61.0 | 63 | 7 | 8.4 | 5.8 | 70 | 514 | 17.00 |
| New Omaha | 21 | 62 | 41 | 51.6 | 61 | 7 | 16.3 | 6.2 | 62 | 465 | 16.39 |
| Oklahoma City | 22 | 73 | 50 | 61.7 | 58 | 4 | 15.6 | 5.8 | 57 | 512 | 17.07 |
| Phoenix | 23 | 85 | 56 | 70.4 | 26 | - | 7.0 | 4.3 | 96 | 634 | 17.26 |
| Portland | 24 | 52 | 33 | 42.4 | 76 | 15 | 9.8 | 7.0 | 51 | 405 | 16.06 |
| Rapid City | 25 | 61 | 34 | 47.5 | 52 | 5 | 14.4 | 6.9 | 57 | 502 | 16.01 |
| Salt Lake City | 26 | 64 | 37 | 50.8 | 48 | 9 | 9.2 | 5.7 | 77 | 529 | 16.46 |
| San Antonio | 27 | 81 | 59 | 69.7 | 69 | 5 | 11.3 | 6.5 | 51 | 330 | 17.61 |
| Sault Ste Marie | 28 | 46 | 30 | 37.6 | 80 | 17 | 10.4 | 7.9 | 40 | 368 | 15.66 |
| Seattle | 29 | 59 | 45 | 52.4 | 65 | 13 | 9.4 | 8.5 | 46 | 389 | 15.50 |
| Shreveport | 30 | 79 | 56 | 67.3 | 61 | 6 | 12.3 | 5.5 | 61 | 504 | 17.35 |
| Tucson | 31 | 82 | 49 | 65.7 | 23 | 0 | 9.8 | 3.5 | 95 | 687 | 17.37 |
| Washington D.C. | 32 | 73 | 50 | 61.2 | 54 | 7 | 12.0 | 5.8 | 75 | 506 | 16.67 |

Table 5e. Climatological data of selected incoming radiation stations for May 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 78 | 51 | 64.7 | 28 | 3 | 8.5 | 4.2 | 80 | 700 | 19.69 |
| Atlanta | 2 | 79 | 58 | 68.9 | 59 | 2 | 11.1 | 4.6 | 75 | 504 | 19.69 |
| Bismark | 3 | 70 | 42 | 56.2 | 54 | 8 | 12.8 | 6.2 | 77 | 610 | 19.22 |
| Boston | 4 | 67 | 52 | 59.7 | 73 | 13 | 11.0 | 7.8 | 54 | 445 | 19.47 |
| Brownsville | 5 | 85 | 69 | 76.9 | 78 | 3 | 13.1 | 5.5 | 55 | 407 | 19.61 |
| Cape Hatteras | 6 | 75 | 61 | 68.2 | 80 | 8 | 10.9 | 5.2 | 68 | 655 | 19.68 |
| Charleston | 7 | 84 | 61 | 72.2 | 66 | 7 | 9.3 | 4.9 | 81 | 578 | 19.69 |
| Cleveland | 8 | 66 | 47 | 56.8 | 74 | 15 | 11.6 | 7.7 | 54 | 408 | 19.50 |
| Columbia | 9 | 75 | 51 | 62.8 | 67 | 11 | 11.1 | 4.9 | 73 | 593 | 19.60 |
| Dodge City | 10 | 75 | 50 | 62.7 | 62 | 11 | 16.3 | 5.4 | 75 | 632 | 19.63 |
| East Lansing | 17 | 67 | 46 | 56.4 | 75 | 16 | 12.9 | 7.7 | 50 | 413 | 19.47 |
| Ely | 11 | 68 | 32 | 50.3 | 38 | 4 | 10.4 | 6.9 | 85 | 703 | 19.59 |
| Fort Worth | 12 | 83 | 61 | 62.0 | 65 | 7 | 14.1 | 5.2 | 70 | 612 | 19.69 |
| Fresno | 13 | 81 | 51 | 66.1 | 46 | 1 | 9.5 | 2.8 | 96 | 604 | 19.65 |
| Grand Junction | 14 | 75 | 48 | 61.4 | 28 | 5 | 10.4 | 5.6 | 73 | 647 | 19.59 |
| Great Falls | 15 | 63 | 41 | 52.3 | 50 | 11 | 10.3 | 7.2 | 53 | 493 | 19.17 |
| Indianapolis | 16 | 68 | 49 | 58.8 | 76 | 14 | 8.5 | 7.2 | 53 | 441 | 19.58 |
| Little Rock | 18 | 81 | 56 | 68.4 | 69 | 6 | 8.6 | 5.2 | 67 | 583 | 19.69 |
| Los Angeles | 19 | 77 | 58 | 67.7 | 64 | 2 | 6.4 | 3.4 | 80 | 632 | 19.70 |
| Nashville | 20 | 78 | 54 | 65.7 | 68 | 9 | 7.8 | 5.4 | 70 | 552 | 19.66 |
| New Omaha | 21 | 71 | 49 | 60.4 | 61 | 12 | 13.2 | 5.7 | 66 | 559 | 19.68 |
| Oklahoma City | 22 | 77 | 56 | 66.5 | 69 | 11 | 13.2 | 5.2 | 65 | 605 | 19.69 |
| Phoenix | 23 | 93 | 63 | 77.8 | 23 | - | 6.8 | 2.5 | 98 | 721 | 19.69 |
| Portland | 24 | 65 | 44 | 54.4 | 82 | 14 | 9.4 | 6.9 | 55 | 12 | 19.40 |
| Rapid City | 25 | 71 | 43 | 56.9 | 52 | 8 | 12.9 | 6.2 | 57 | 588 | 19.38 |
| Salt Lake City | 26 | 74 | 44 | 58.7 | 44 | 2 | 8.5 | 5.7 | 80 | 664 | 19.54 |
| San Antonio | 27 | 84 | 64 | 74.1 | 70 | 8 | 10.5 | 5.5 | 62 | 517 | 19.69 |
| Sault Ste Marie | 28 | 61 | 42 | 51.6 | 75 | 14 | 9.4 | 7.4 | 42 | 445 | 19.24 |
| Seattle | 29 | 62 | 49 | 55.4 | 73 | 20 | 7.5 | 8.5 | 26 | 389 | 19.17 |
| Shreveport | 30 | 84 | 59 | 71.3 | 64 | 7 | 11.4 | 5.2 | 79 | 589 | 19.70 |
| Tucson | 31 | 89 | 55 | 71.9 | 22 | 1 | 9.2 | 1.9 | 97 | 749 | 19.70 |
| Washington | 32 | 73 | 55 | 63.7 | 66 | 13 | 11.1 | 7.0 | 47 | 444 | 19.59 |

Table 5f. Climatological data of selected incoming radiation stations for June 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 91 | 62 | 76.6 | 32 | 2 | 7.6 | 3.6 | 78 | 710 | 19.80 |
| Atlanta | 2 | 87 | 67 | 76.9 | 70 | 9 | 8.1 | 6.2 | 61 | 488 | 19.75 |
| Bismark | 3 | 74 | 52 | 63.2 | 61 | 13 | 12.2 | 5.5 | 73 | 559 | 19.85 |
| Boston | 4 | 78 | 61 | 69.6 | 64 | 10 | 11.8 | 5.6 | 71 | 560 | 19.89 |
| Brownsville | 5 | 93 | 74 | 82.9 | 76 | 4 | 10.1 | 4.5 | 81 | 592 | 19.33 |
| Cape Hatteras | 6 | 81 | 69 | 75.2 | 82 | 9 | 11.3 | 6.6 | 65 | 648 | 19.81 |
| Charleston | 7 | 87 | 68 | 77.5 | 83 | 9 | 7.8 | 6.7 | 79 | 504 | 19.71 |
| Cleveland | 8 | 77 | 55 | 65.8 | 68 | 11 | 10.1 | 5.5 | 74 | 526 | 19.89 |
| Columbia | 9 | 83 | 61 | 72.1 | 72 | 15 | 9.5 | 6.8 | 52 | 558 | 19.87 |
| Dodge City | 10 | 85 | 61 | 73.3 | 64 | 9 | 15.8 | 4.9 | 67 | 663 | 19.85 |
| East Lansing | 17 | 75 | 53 | 63.8 | 70 | 12 | 11.8 | 6.2 | 65 | 527 | 19.88 |
| Ely | 11 | 82 | 43 | 62.6 | 28 | 4 | 10.0 | 3.9 | 92 | 572 | 19.88 |
| Fort Worth | 12 | 94 | 72 | 82.9 | 61 | 7 | 12.7 | 4.0 | 75 | 651 | 19.71 |
| Fresno | 13 | 97 | 63 | 80.0 | 39 | 0 | 7.8 | 1.4 | 100 | 632 | 19.83 |
| Grand Junction | 14 | 90 | 60 | 74.6 | 21 | 3 | 10.7 | 3.4 | 90 | 726 | 19.87 |
| Great Falls | 15 | 75 | 49 | 62.2 | 43 | 9 | 10.1 | 5.4 | 69 | 593 | 19.84 |
| Indianapolis | 16 | 79 | 58 | 68.5 | 74 | 12 | 7.7 | 6.1 | 57 | 547 | 19.88 |
| Little Rock | 18 | 89 | 68 | 78.4 | 71 | 9 | 7.9 | 5.5 | 67 | 623 | 19.79 |
| Los Angeles | 19 | 79 | 61 | 70.1 | 74 | 0 | 5.4 | 3.4 | 70 | 620 | 19.68 |
| Nashville | 20 | 86 | 64 | 75.0 | 73 | 11 | 6.6 | 6.3 | 65 | 542 | 19.82 |
| New Omaha | 21 | 77 | 59 | 68.0 | 71 | 14 | 10.8 | 6.6 | 56 | 456 | 19.89 |
| Oklahoma City | 22 | 88 | 67 | 77.3 | 68 | 10 | 13.0 | 4.8 | 76 | 633 | 19.81 |
| Phoenix | 23 | 105 | 75 | 90.0 | 23 | 0 | 6.5 | 2.2 | 95 | 714 | 19.74 |
| Portland | 24 | 75 | 53 | 63.7 | 74 | 6 | 9.3 | 5.3 | 74 | 604 | 19.88 |
| Rapid City | 25 | 78 | 53 | 65.7 | 60 | 14 | 12.6 | 5.7 | 60 | 582 | 19.88 |
| Salt Lake City | 26 | 88 | 54 | 71.0 | 35 | 3 | 7.8 | 3.8 | 87 | 737 | 19.89 |
| San Antonio | 27 | 95 | 72 | 83.3 | 64 | 3 | 9.8 | 4.4 | 76 | 603 | 19.56 |
| Sault Ste Marie | 28 | 68 | 46 | 57.3 | 75 | 15 | 8.5 | 6.0 | 61 | 532 | 19.86 |
| Seattle | 29 | 70 | 53 | 61.6 | 66 | 4 | 7.0 | 5.6 | 59 | 490 | 19.84 |
| Shreveport | 30 | 91 | 69 | 80.0 | 67 | 7 | 9.5 | 4.7 | 86 | 595 | 19.70 |
| Tucson | 31 | 100 | 67 | 83.5 | 21 | 2 | 8.4 | 2.3 | 89 | 694 | 19.69 |
| Washington D.C. | 32 | 83 | 65 | 74.1 | 62 | 7 | 10.5 | 5.6 | 65 | 570 | 19.87 |

Table 5g. Climatological data of selected incoming radiation stations for July 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 91 | 66 | 78.7 | 43 | 6 | 8.5 | 4.5 | 77 | 690 | 20.00 |
| Atlanta | 2 | 90 | 71 | 80.3 | 69 | 4 | 7.9 | 5.8 | 65 | 462 | 19.97 |
| Bismark | 3 | 90 | 58 | 74.2 | 50 | 3 | 9.6 | 4.1 | 88 | 655 | 19.83 |
| Boston | 4 | 82 | 64 | 73.1 | 64 | 11 | 11.4 | 5.3 | 73 | 559 | 19.95 |
| Brownsville | 5 | 94 | 76 | 85.0 | 74 | 4 | 10.3 | 3.8 | 89 | 612 | 19.72 |
| Cape Hatteras | 6 | 84 | 71 | 77.7 | 82 | 13 | 9.0 | 7.2 | 56 | 589 | 20.00 |
| Charleston | 7 | 89 | 71 | 80.1 | 86 | 15 | 7.2 | 7.8 | 61 | 447 | 19.95 |
| Cleveland | 8 | 76 | 57 | 67.6 | 73 | 9 | 8.5 | 4.3 | 66 | 527 | 19.97 |
| Columbia | 9 | 85 | 64 | 74.9 | 72 | 7 | 7.9 | 5.9 | 75 | 559 | 20.00 |
| Dodge City | 10 | 90 | 64 | 77.1 | 59 | 6 | 13.8 | 4.8 | 70 | 599 | 20.00 |
| East Lansing | 17 | 81 | 55 | 67.8 | 78 | 9 | 10.4 | 4.4 | 80 | 581 | 19.95 |
| Ely | 11 | 88 | 48 | 68.0 | 28 | 6 | 9.9 | 5.1 | 79 | 617 | 20.00 |
| Fort Worth | 12 | 95 | 74 | 84.6 | 65 | 10 | 11.9 | 4.7 | 70 | 549 | 19.95 |
| Fresno | 13 | 99 | 66 | 82.9 | 74 | 0 | 7.6 | 2.1 | 95 | 555 | 20.00 |
| Grand Junction | 14 | 94 | 65 | 79.5 | 48 | 3 | 11.1 | 3.7 | 90 | 701 | 20.00 |
| Great Falls | 15 | 90 | 59 | 74.5 | 54 | 3 | 8.0 | 3.5 | 83 | 617 | 19.81 |
| Indianapolis | 16 | 82 | 62 | 71.6 | 75 | 6 | 4.9 | 5.0 | 75 | 557 | 20.00 |
| Little Rock | 18 | 91 | 71 | 80.7 | 75 | 8 | 6.6 | 5.1 | 71 | 623 | 20.00 |
| Los Angeles | 19 | 87 | 64 | 75.5 | 76 | 0 | 5.5 | 1.9 | 90 | 652 | 19.94 |
| Nashville | 20 | 89 | 68 | 78.3 | 76 | 8 | 4.9 | 6.1 | 72 | 560 | 20.00 |
| New Omaha | 21 | 86 | 65 | 75.8 | 68 | 5 | 8.5 | 4.2 | 80 | 627 | 19.97 |
| Oklahoma | 22 | 88 | 69 | 78.2 | 72 | 9 | 10.6 | 5.5 | 64 | 595 | 20.00 |
| Phoenix | 23 | 105 | 79 | 92.4 | 32 | 2 | 7.5 | 3.2 | 95 | 640 | 19.97 |
| Portland | 24 | 79 | 55 | 66.7 | 75 | 10 | 9.1 | 5.3 | 76 | 588 | 19.93 |
| Rapid City | 25 | 92 | 61 | 76.8 | 42 | 3 | 10.4 | 4.1 | 68 | 635 | 19.92 |
| Salt Lake City | 26 | 98 | 64 | 81.2 | 28 | 1 | 8.2 | 3.9 | 84 | 688 | 19.98 |
| San Antonio | 27 | 94 | 74 | 84.2 | 68 | 5 | 8.9 | 4.5 | 73 | 574 | 19.87 |
| Sault Ste Marie | 28 | 73 | 51 | 61.7 | 78 | 12 | 7.8 | 5.1 | 68 | 606 | 19.85 |
| Seattle | 29 | 79 | 56 | 67.6 | 58 | 0 | 6.7 | 3.2 | 78 | 582 | 19.81 |
| Shreveport | 30 | 93 | 73 | 82.9 | 68 | 7 | 8.5 | 4.3 | 81 | 590 | 19.95 |
| Tucson | 31 | 99 | 73 | 86.0 | 75 | 6 | 9.8 | 4.6 | 77 | 564 | 19.95 |
| Washington D.C. | 32 | 86 | 78 | 77.0 | 75 | 9 | 10.2 | 5.0 | 66 | 519 | 20.00 |

Table 5h. Climatological data of selected incoming radiation stations for August 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 92 | 65 | 78.4 | 38 | 5 | 7.6 | 2.9 | 86 | 670 | 18.41 |
| Atlanta | 2 | 88 | 70 | 78.9 | 78 | 10 | 7.8 | 6.2 | 59 | 451 | 18.68 |
| Bismark | 3 | 86 | 56 | 70.7 | 52 | 11 | 11.3 | 5.2 | 78 | 508 | 17.30 |
| Boston | 4 | 80 | 64 | 72.1 | 88 | 7 | 10.4 | 6.0 | 66 | 443 | 17.79 |
| Brownsville | 5 | 92 | 77 | 84.4 | 78 | 7 | 10.3 | 6.1 | 77 | 427 | 18.80 |
| Cape Hatteras | 6 | 85 | 73 | 78.9 | 88 | 11 | 9.7 | 6.4 | 56 | 549 | 18.39 |
| Charleston | 7 | 89 | 71 | 80.1 | 86 | 12 | 6.8 | 6.0 | 70 | 524 | 18.53 |
| Cleveland | 8 | 80 | 60 | 69.8 | 79 | 8 | 8.3 | 5.8 | 59 | 427 | 17.87 |
| Columbus | 9 | 91 | 67 | 79.0 | 68 | 4 | 9.0 | 4.8 | 71 | 539 | 18.11 |
| Dodge City | 10 | 92 | 65 | 78.7 | 56 | 8 | 16.2 | 3.9 | 75 | 580 | 18.20 |
| East Lansing | 17 | 81 | 58 | 69.3 | 77 | 9 | 9.8 | 5.5 | 68 | 448 | 17.80 |
| Ely | 11 | 86 | 44 | 65.4 | 27 | 3 | 10.8 | 2.5 | 93 | 636 | 18.08 |
| Fort Worth | 12 | 94 | 74 | 84.0 | 67 | 5 | 11.2 | 4.5 | 66 | 545 | 18.53 |
| Fresno | 13 | 96 | 61 | 78.5 | 39 | 0 | 7.1 | 0.7 | 100 | 542 | 18.28 |
| Grand Junction | 14 | 92 | 61 | 76.6 | 23 | 4 | 10.7 | 2.8 | 93 | 635 | 18.09 |
| Great Falls | 15 | 78 | 53 | 65.5 | 44 | 10 | 10.2 | 5.1 | 71 | 487 | 17.21 |
| Indianapolis | 16 | 84 | 64 | 74.1 | 78 | 8 | 5.7 | 5.8 | 77 | 480 | 18.04 |
| Little Rock | 18 | 92 | 71 | 81.4 | 75 | 5 | 6.1 | 5.1 | 70 | 572 | 18.43 |
| Los Angeles | 19 | 83 | 63 | 73.2 | 73 | 0 | 5.4 | 2.4 | 84 | 627 | 18.57 |
| Nashville | 20 | 90 | 69 | 79.5 | 75 | 9 | 5.5 | 5.5 | 68 | 489 | 18.32 |
| New Omaha | 21 | 83 | 64 | 73.5 | 73 | 10 | 10.4 | 5.0 | 69 | 523 | 17.89 |
| Oklahoma | 22 | 89 | 69 | 79.3 | 71 | 8 | 12.5 | 4.0 | 85 | 594 | 18.37 |
| Phoenix | 23 | 102 | 78 | 89.7 | 42 | 5 | 6.6 | 3.0 | 97 | 591 | 18.49 |
| Portland | 24 | 79 | 54 | 66.2 | 78 | 9 | 8.4 | 5.5 | 70 | 495 | 17.65 |
| Rapid City | 25 | 87 | 58 | 72.4 | 43 | 9 | 12.1 | 3.3 | 77 | 563 | 17.61 |
| Salt Lake City | 26 | 91 | 57 | 74.2 | 34 | 3 | 10.2 | 2.7 | 85 | 625 | 17.95 |
| San Antonio | 27 | 93 | 75 | 83.6 | 75 | 8 | 9.1 | 6.5 | 61 | 491 | 18.70 |
| Sault Ste Marie | 28 | 76 | 54 | 64.6 | 76 | 10 | 7.8 | 5.3 | 71 | 511 | 17.34 |
| Seattle | 29 | 71 | 56 | 63.4 | 70 | 11 | 6.8 | 7.4 | 35 | 335 | 17.21 |
| Shreveport | 30 | 92 | 72 | 82.1 | 75 | 10 | 7.9 | 6.0 | 69 | 487 | 18.54 |
| Tucson | 31 | 96 | 72 | 84.2 | 48 | 8 | 8.8 | 4.8 | 79 | 636 | 18.56 |
| Washington D.C. | 32 | 87 | 70 | 78.5 | 76 | 13 | 9.6 | 6.6 | 62 | 475 | 18.10 |

Table 5i. Climatological data of selected incoming radiation stations for September 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 85 | 59 | 71.8 | 66 | 4 | 7.4 | 3.3 | 83 | 554 | 15.28 |
| Atlanta | 2 | 82 | 66 | 74.0 | 78 | 10 | 10.2 | 5.6 | 60 | 367 | 15.48 |
| Bismark | 3 | 75 | 44 | 59.5 | 54 | 4 | 10.6 | 4.4 | 83 | 454 | 13.14 |
| Boston | 4 | 71 | 57 | 63.7 | 73 | 9 | 11.4 | 6.1 | 61 | 353 | 14.02 |
| Brownsville | 5 | 88 | 70 | 78.7 | 78 | 10 | 7.5 | 4.0 | 70 | 464 | 16.53 |
| Cape Hatteras | 6 | 81 | 68 | 74.3 | 79 | 7 | 10.2 | 4.7 | 62 | 501 | 15.24 |
| Charleston | 7 | 86 | 66 | 75.9 | 84 | 9 | 9.0 | 5.9 | 67 | 422 | 15.62 |
| Cleveland | 8 | 75 | 55 | 65.0 | 81 | 8 | 8.3 | 6.0 | 44 | 399 | 14.18 |
| Columbia | 9 | 87 | 60 | 73.5 | 59 | 4 | 8.8 | 3.7 | 75 | 467 | 14.63 |
| Dodge City | 10 | 83 | 58 | 70.8 | 56 | 6 | 14.1 | 3.4 | 82 | 506 | 14.83 |
| East Lansing | 17 | 76 | 52 | 64.0 | 76 | 4 | 10.2 | 6.2 | 60 | 349 | 14.03 |
| Ely | 11 | 80 | 41 | 60.6 | 33 | 7 | 10.3 | 3.9 | 83 | 503 | 14.58 |
| Fort Worth | 12 | 91 | 68 | 79.6 | 56 | 7 | 10.9 | 2.6 | 72 | 502 | 15.61 |
| Fresno | 13 | 92 | 58 | 75.2 | 44 | 1 | 6.3 | 1.6 | 97 | 441 | 15.01 |
| Grand Junction | 14 | 83 | 56 | 69.2 | 35 | 8 | 10.3 | 3.1 | 90 | 512 | 14.59 |
| Great Falls | 15 | 73 | 47 | 60.2 | 39 | 4 | 10.1 | 4.4 | 84 | 408 | 13.00 |
| Indianapolis | 16 | 81 | 59 | 69.8 | 75 | 4 | 5.4 | 5.6 | 77 | 379 | 14.50 |
| Little Rock | 18 | 88 | 64 | 76.3 | 75 | 8 | 6.4 | 3.8 | 72 | 480 | 15.33 |
| Los Angeles | 19 | 86 | 65 | 75.6 | 66 | 0 | 4.9 | 2.2 | 87 | 533 | 15.73 |
| Nashville | 20 | 85 | 62 | 73.6 | 76 | 6 | 5.0 | 4.8 | 65 | 407 | 15.10 |
| New Omaha | 21 | 78 | 57 | 67.7 | 72 | 10 | 9.2 | 4.0 | 70 | 433 | 14.21 |
| Oklahoma City | 22 | 86 | 63 | 74.5 | 64 | 4 | 11.3 | 3.2 | 77 | 476 | 15.21 |
| Phoenix | 23 | 99 | 73 | 85.9 | 37 | 2 | 6.6 | 1.1 | 96 | 542 | 15.52 |
| Portland | 24 | 70 | 47 | 58.8 | 78 | 9 | 9.3 | 5.5 | 62 | 391 | 13.75 |
| Rapid City | 25 | 78 | 49 | 63.3 | 43 | 4 | 11.7 | 3.3 | 80 | 453 | 13.68 |
| Salt Lake City | 26 | 84 | 53 | 68.2 | 46 | 5 | 9.1 | 3.5 | 84 | 496 | 14.31 |
| San Antonio | 27 | 91 | 66 | 78.6 | 67 | 7 | 8.0 | 3.0 | 84 | 458 | 16.09 |
| Sault Ste Marie | 28 | 65 | 48 | 56.3 | 83 | 12 | 8.5 | 7.0 | 45 | 328 | 13.20 |
| Seattle | 29 | 67 | 53 | 60.2 | 76 | 6 | 5.7 | 6.2 | 47 | 302 | 12.98 |
| Shreveport | 30 | 88 | 67 | 77.5 | 71 | 7 | 6.9 | 3.2 | 80 | 446 | 15.66 |
| Tucson | 31 | 95 | 67 | 81.2 | 38 | 4 | 8.5 | 2.1 | 89 | 572 | 15.70 |
| Washington D.C. | 32 | 79 | 63 | 71.3 | 75 | 8 | 9.0 | 6.1 | 61 | 366 | 14.62 |

Table 5j. Climatological data of selected incoming radiation stations for October 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 68 | 45 | 56.5 | 51 | 6 | 6.5 | 3.0 | 75 | 426 | 12.64 |
| Atlanta | 2 | 75 | 56 | 65.7 | 79 | 9 | 8.3 | 4.9 | 65 | 324 | 12.95 |
| Bismark | 3 | 62 | 32 | 47.0 | 50 | 2 | 10.4 | 5.3 | 68 | 294 | 9.61 |
| Boston | 4 | 62 | 46 | 53.9 | 67 | 8 | 12.4 | 6.2 | 64 | 256 | 10.83 |
| Brownsville | 5 | 87 | 70 | 78.5 | 79 | 8 | 10.0 | 5.5 | 56 | 387 | 14.63 |
| Cape Hatteras | 6 | 72 | 58 | 64.9 | 80 | 11 | 9.2 | 6.3 | 54 | 362 | 12.59 |
| Charleston | 7 | 79 | 57 | 67.8 | 78 | 9 | 6.6 | 5.0 | 64 | 361 | 13.15 |
| Cleveland | 8 | 62 | 40 | 51.0 | 75 | 9 | 9.5 | 6.2 | 58 | 230 | 11.06 |
| Columbia | 9 | 70 | 48 | 59.1 | 69 | 11 | 9.8 | 5.0 | 57 | 316 | 11.70 |
| Dodge City | 10 | 70 | 47 | 58.7 | 66 | 6 | 14.8 | 5.2 | 64 | 353 | 12.00 |
| East Lansing | 17 | 62 | 38 | 50.0 | 73 | 7 | 10.5 | 6.5 | 49 | 244 | 10.85 |
| Ely | 11 | 62 | 30 | 46.3 | 44 | 3 | 11.4 | 4.1 | 81 | 377 | 11.62 |
| Fort Worth | 12 | 80 | 60 | 70.0 | 73 | 4 | 11.1 | 4.9 | 59 | 375 | 13.16 |
| Fresno | 13 | 78 | 48 | 63.1 | 51 | 1 | 6.0 | 2.2 | 93 | 340 | 12.25 |
| Grand Junction | 14 | 65 | 43 | 54.0 | 46 | 5 | 9.2 | 4.6 | 78 | 353 | 11.64 |
| Great Falls | 15 | 61 | 40 | 50.2 | 41 | 2 | 13.7 | 5.9 | 70 | 248 | 9.41 |
| Indianapolis | 16 | 67 | 43 | 54.7 | 72 | 6 | 7.1 | 5.9 | 65 | 278 | 11.51 |
| Little Rock | 18 | 74 | 56 | 63.5 | 85 | 9 | 6.1 | 5.8 | 54 | 328 | 12.73 |
| Los Angeles | 19 | 78 | 59 | 68.0 | 67 | 1 | 5.9 | 2.9 | 83 | 404 | 13.33 |
| Nashville | 20 | 73 | 51 | 61.6 | 78 | 9 | 5.1 | 6.3 | 55 | 294 | 12.39 |
| New Omaha | 21 | 66 | 44 | 54.8 | 66 | 4 | 9.8 | 4.1 | 73 | 304 | 11.10 |
| Oklahoma City | 22 | 75 | 53 | 64.4 | 73 | 9 | 11.8 | 4.7 | 66 | 373 | 12.55 |
| Phoenix | 23 | 82 | 59 | 70.6 | 51 | 5 | 5.8 | 3.4 | 81 | 379 | 13.01 |
| Portland | 24 | 58 | 35 | 46.2 | 76 | 8 | 9.8 | 5.8 | 56 | 265 | 10.46 |
| Rapid City | 25 | 67 | 37 | 51.8 | 41 | 0 | 12.0 | 4.0 | 76 | 332 | 10.36 |
| Salt Lake City | 26 | 65 | 38 | 51.6 | 54 | 5 | 9.5 | 4.3 | 76 | 361 | 11.25 |
| San Antonio | 27 | 83 | 64 | 73.3 | 76 | 14 | 9.0 | 6.7 | 52 | 317 | 13.90 |
| Sault Ste Marie | 28 | 54 | 38 | 45.6 | 81 | 11 | 9.4 | 8.1 | 37 | 196 | 9.69 |
| Seattle | 29 | 60 | 50 | 55.2 | 79 | 13 | 7.2 | 7.9 | 46 | 176 | 9.40 |
| Shreveport | 30 | 78 | 58 | 68.4 | 78 | 10 | 8.2 | 5.3 | 71 | 354 | 13.22 |
| Tucson | 31 | 81 | 54 | 67.3 | 44 | 3 | 8.1 | 2.2 | 89 | 469 | 13.28 |
| Washington D.C. | 32 | 67 | 50 | 58.7 | 72 | 10 | 8.5 | 6.1 | 54 | 270 | 11.63 |

Table 5k. Climatological data of selected incoming radiation stations for November 1964

| Station name | No. | TX °F | TM °F | TA °F | h % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 68 | 45 | 56.5 | 51 | 6 | 6.5 | 3.0 | 75 | 338 | 9.43 |
| Atlanta | 2 | 75 | 56 | 65.7 | 79 | 9 | 8.3 | 4.9 | 65 | 272 | 9.80 |
| Bismark | 3 | 62 | 32 | 47.0 | 50 | 2 | 10.4 | 5.3 | 68 | 167 | 6.08 |
| Boston | 4 | 62 | 46 | 53.9 | 79 | 8 | 12.4 | 6.2 | 64 | 175 | 7.37 |
| Brownsville | 5 | 87 | 70 | 78.5 | 79 | 8 | 10.0 | 5.5 | 56 | 282 | 11.88 |
| Cape Hatteras | 6 | 72 | 58 | 64.9 | 80 | 11 | 9.2 | 6.3 | 54 | 383 | 9.37 |
| Charleston | 7 | 79 | 57 | 67.8 | 78 | 9 | 6.6 | 5.0 | 64 | 291 | 10.07 |
| Cleveland | 8 | 62 | 40 | 51.0 | 75 | 9 | 9.5 | 6.2 | 58 | 133 | 7.62 |
| Columbia | 9 | 70 | 48 | 59.1 | 79 | 11 | 9.8 | 5.0 | 57 | 236 | 8.33 |
| Dodge City | 10 | 70 | 47 | 58.7 | 66 | 6 | 14.8 | 5.2 | 64 | 309 | 8.68 |
| East Lansing | 17 | 62 | 38 | 50.0 | 73 | 7 | 10.5 | 6.5 | 49 | 143 | 7.40 |
| Ely | 11 | 62 | 30 | 46.3 | 44 | 3 | 11.4 | 4.1 | 81 | 238 | 8.24 |
| Fort Worth | 12 | 80 | 60 | 70.0 | 73 | 4 | 11.1 | 4.9 | 59 | 297 | 10.06 |
| Fresno | 13 | 78 | 48 | 63.1 | 51 | 1 | 6.0 | 2.2 | 93 | 201 | 8.98 |
| Grand Junction | 14 | 65 | 43 | 54.0 | 46 | 5 | 9.2 | 4.6 | 78 | 263 | 8.27 |
| Great Falls | 15 | 71 | 40 | 50.2 | 41 | 2 | 13.7 | 5.9 | 70 | 151 | 5.87 |
| Indianapolis | 16 | 67 | 43 | 54.7 | 72 | 6 | 7.1 | 5.9 | 65 | 190 | 8.11 |
| Little Rock | 18 | 74 | 53 | 63.5 | 85 | 9 | 6.1 | 5.8 | 54 | 277 | 9.53 |
| Los Angeles | 19 | 78 | 59 | 68.0 | 67 | 1 | 5.9 | 2.9 | 83 | 274 | 10.26 |
| Nashville | 20 | 73 | 51 | 61.6 | 78 | 9 | 5.1 | 6.3 | 55 | 250 | 9.13 |
| New Omaha | 21 | 78 | 45 | 56.2 | 66 | 4 | 9.8 | 4.1 | 73 | 222 | 7.66 |
| Oklahoma City | 22 | 75 | 53 | 62.4 | 73 | 9 | 11.8 | 4.7 | 66 | 314 | 9.32 |
| Phoenix | 23 | 82 | 59 | 70.6 | 51 | 5 | 5.8 | 3.4 | 81 | 307 | 9.87 |
| Portland | 24 | 58 | 35 | 46.2 | 76 | 8 | 9.8 | 5.8 | 56 | 164 | 6.97 |
| Rapid City | 25 | 67 | 37 | 51.8 | 41 | 0 | 12.0 | 4.0 | 76 | 205 | 6.86 |
| Salt Lake City | 26 | 65 | 38 | 51.6 | 54 | 5 | 9.5 | 4.3 | 76 | 216 | 7.82 |
| San Antonio | 27 | 83 | 64 | 73.3 | 76 | 14 | 9.0 | 6.7 | 52 | 225 | 10.96 |
| Sault Ste Marie | 28 | 54 | 38 | 45.6 | 81 | 11 | 9.4 | 8.1 | 37 | 104 | 6.16 |
| Seattle | 29 | 60 | 50 | 55.2 | 79 | 13 | 7.2 | 7.9 | 46 | 94 | 5.86 |
| Shreveport | 30 | 78 | 58 | 68.4 | 78 | 10 | 8.2 | 5.3 | 71 | 259 | 10.12 |
| Tucson | 31 | 81 | 54 | 67.3 | 44 | 3 | 8.1 | 2.2 | 89 | 339 | 10.20 |
| Washington D.C. | 32 | 67 | 51 | 59.0 | 72 | 10 | 8.5 | 6.1 | 54 | 209 | 8.31 |

Table 51. Climatological data of selected incoming radiation stations for December 1964

| Station name | No. | TX °F | TM °F | TA °F | H % | PD | W mph | SKC | S % | Ra Ly | Rt In |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Albuquerque | 1 | 43 | 25 | 33.9 | 60 | 6 | 7.6 | 4.6 | 71 | 268 | 8.14 |
| Atlanta | 2 | 51 | 30 | 40.7 | 56 | 8 | 11.9 | 5.7 | 56 | 218 | 8.54 |
| Bismark | 3 | 27 | 6 | 16.9 | 69 | 11 | 11.4 | 7.5 | 43 | 124 | 4.70 |
| Boston | 4 | 37 | 22 | 29.5 | 59 | 8 | 13.9 | 4.1 | 71 | 153 | 6.00 |
| Brownsville | 5 | 66 | 51 | 58.6 | 85 | 13 | 9.8 | 7.9 | 34 | 195 | 10.90 |
| Cape Hatteras | 6 | 52 | 34 | 42.7 | 74 | 8 | 11.8 | 4.7 | 70 | 254 | 8.07 |
| Charleston | 7 | 58 | 30 | 43.7 | 74 | 5 | 8.5 | 4.6 | 80 | 258 | 8.84 |
| Cleveland | 8 | 31 | 15 | 22.9 | 75 | 13 | 13.6 | 7.9 | 39 | 111 | 6.25 |
| Columbia | 9 | 40 | 22 | 31 | 71 | 7 | 11.5 | 5.4 | 61 | 187 | 6.98 |
| Dodge City | 10 | 42 | 24 | 32.8 | 74 | 8 | 15.6 | 5.6 | 63 | 167 | 7.35 |
| East Lansing | 17 | 31 | 15 | 22.8 | 72 | 11 | 14.2 | 6.7 | 47 | 138 | 6.02 |
| Ely | 11 | 41 | 12 | 26.6 | 59 | 3 | 9.7 | 4.2 | 90 | 234 | 6.89 |
| Fort Worth | 12 | 52 | 35 | 43.7 | 76 | 12 | 12.6 | 6.8 | 46 | 197 | 8.84 |
| Fresno | 13 | 52 | 35 | 43.7 | 84 | 2 | 5.2 | 6.5 | 51 | 145 | 7.66 |
| Grand Junction | 14 | 41 | 19 | 30.0 | 63 | 3 | 7.3 | 4.4 | 84 | 235 | 6.92 |
| Great Falls | 15 | 38 | 22 | 30.2 | 57 | 6 | 12.1 | 6.8 | 57 | 102 | 4.50 |
| Indianapolis | 16 | 33 | 16 | 24.6 | 76 | 6 | 9.1 | 6.1 | 60 | 164 | 6.75 |
| Little Rock | 18 | 47 | 28 | 37.6 | 76 | 9 | 8.3 | 6.2 | 39 | 201 | 8.25 |
| Los Angeles | 19 | 69 | 49 | 58.7 | 56 | 2 | 6.4 | 2.3 | 92 | 287 | 9.06 |
| Nashville | 20 | 45 | 24 | 34.7 | 70 | 8 | 7.9 | 6.0 | 47 | 185 | 7.83 |
| New Omaha | 21 | 37 | 17 | 26.7 | 68 | 5 | 12.4 | 4.7 | 63 | 184 | 6.30 |
| Oklahoma City | 22 | 45 | 29 | 37.4 | 74 | 9 | 12.5 | 6.5 | 55 | 208 | 8.03 |
| Phoenix | 23 | 64 | 37 | 50.5 | 43 | 1 | 5.2 | 2.6 | 90 | 279 | 8.62 |
| Portland | 24 | 34 | 11 | 22.2 | 73 | 8 | 9.7 | 4.3 | 67 | 172 | 5.59 |
| Rapid City | 25 | 35 | 15 | 25.0 | 74 | 7 | 9.9 | 6.5 | 41 | 158 | 5.48 |
| Salt Lake City | 26 | 39 | 20 | 29.6 | 76 | 6 | 6.5 | 4.7 | 70 | 211 | 6.46 |
| San Antonio | 27 | 59 | 41 | 50.1 | 79 | 11 | 10.3 | 6.6 | 39 | 195 | 9.84 |
| Sault Ste Marie | 28 | 25 | 9 | 16.8 | 75 | 24 | 9.4 | 7.6 | 33 | 110 | 4.79 |
| Seattle | 29 | 48 | 39 | 43.0 | 84 | 14 | 6.0 | 8.5 | 32 | 68 | 4.49 |
| Shreveport | 30 | 53 | 36 | 44.6 | 76 | 10 | 10.5 | 7.2 | 51 | 171 | 8.91 |
| Tucson | 31 | 63 | 35 | 49.1 | 43 | 3 | 8.2 | 2.8 | 84 | 322 | 8.99 |
| Washington D.C. | 32 | 39 | 23 | 31.0 | 57 | 6 | 8.8 | 4.8 | 67 | 201 | 6.97 |

Table 6. List of Venezuelan incoming solar radiation stations

| Station name | Number | Latitude | | Elevation | |
|---|---|---|---|---|---|
| | | Degree | Minutes | Meters | Feet |
| Barceloña | 1 | 10 | 07 | 7 | 23 |
| Barquisimeto | 2 | 10 | 04 | 590 | 1935 |
| Caracas La Carlota | 3 | 10 | 30 | 895 | 2936 |
| Ciudad Bolivar | 6 | 8 | 09 | 50 | 164 |
| Coro | 8 | 11 | 25 | 20 | 66 |
| Guiria | 9 | 10 | 35 | 8 | 26 |
| La Orchila | 10 | 11 | 49 | 3 | 10 |
| Maiquetia | 11 | 10 | 36 | 43 | 141 |
| Maracaibo | 12 | 10 | 39 | 40 | 131 |
| Maracay | 13 | 10 | 15 | 442 | 1450 |
| Maturin | 14 | 9 | 45 | 70 | 230 |
| Merida | 16 | 8 | 36 | 1479 | 4851 |
| Moron | 17 | 10 | 31 | 3 | 10 |
| Puerto Ayacucho | 18 | 5 | 41 | 99 | 325 |
| San Antonio | 19 | 7 | 51 | 404 | 1325 |
| San Fernando | 20 | 7 | 54 | 73 | 239 |
| Santa Elena | 21 | 4 | 36 | 907 | 2975 |
| Tumeremo | 22 | 7 | 18 | 180 | 590 |

TABLE 7a. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 450.4 | 449.5 | 450.6 | 451.7 | 506.3 | 414.1 | 536.9 | 533.3 | 496.3 | 467.0 |
| 2 | 1 | 433.5 | 440.5 | 434.1 | 437.1 | 468.1 | 343.1 | 483.4 | 470.6 | 464.4 | 510.0 |
| 3 | 1 | 439.5 | 475.7 | 440.1 | 476.1 | 461.9 | 388.7 | 475.7 | 462.6 | 470.6 | 454.0 |
| 6 | 1 | 423.0 | 411.7 | 423.1 | 405.9 | 481.9 | 318.2 | 498.5 | 483.8 | 454.0 | 445.0 |
| 8 | 1 | 422.5 | 448.8 | 422.1 | 452.8 | 477.4 | 426.1 | 499.3 | 492.5 | 458.5 | 478.0 |
| 9 | 1 | 400.0 | 449.1 | 400.0 | 451.9 | 458.7 | 418.1 | 471.6 | 458.0 | 427.0 | 391.0 |
| 10 | 1 | 430.6 | 454.5 | 429.0 | 461.4 | 485.2 | 449.8 | 511.2 | 507.5 | 471.3 | 508.0 |
| 11 | 1 | 381.9 | 437.4 | 382.4 | 437.7 | 441.7 | 388.1 | 448.0 | 430.4 | 403.5 | 440.0 |
| 12 | 1 | 424.6 | 450.0 | 424.7 | 452.8 | 479.7 | 417.6 | 500.9 | 492.5 | 459.8 | 495.0 |
| 13 | 1 | 456.0 | 474.5 | 455.8 | 478.2 | 493.0 | 427.7 | 518.6 | 512.2 | 492.9 | 483.0 |
| 14 | 1 | 411.7 | 437.5 | 412.4 | 436.6 | 468.4 | 377.9 | 483.1 | 469.5 | 440.8 | 371.0 |
| 16 | 1 | 486.4 | 409.3 | 483.2 | 394.8 | 483.1 | 229.7 | 501.2 | 488.0 | 520.4 | 509.0 |
| 17 | 1 | 439.4 | 443.1 | 439.7 | 444.6 | 495.3 | 403.8 | 522.4 | 517.3 | 481.2 | 558.0 |
| 18 | 1 | 509.7 | 495.3 | 509.2 | 499.8 | 564.8 | 466.6 | 609.4 | 608.5 | 570.8 | 449.0 |
| 19 | 1 | 397.5 | 400.1 | 396.3 | 390.4 | 448.5 | 272.3 | 451.8 | 428.6 | 423.0 | 448.0 |
| 20 | 1 | 459.0 | 472.2 | 459.1 | 475.2 | 514.3 | 436.8 | 543.3 | 535.6 | 502.3 | 426.0 |
| 21 | 1 | 432.5 | 458.6 | 432.1 | 450.4 | 466.6 | 315.3 | 470.4 | 443.8 | 468.9 | 448.0 |
| 22 | 1 | 370.1 | 382.6 | 368.5 | 371.3 | 434.4 | 254.7 | 431.4 | 403.5 | 388.8 | 360.0 |
| MEAN | | 431.6 | 443.9 | 431.2 | 442.7 | 479.4 | 374.9 | 497.6 | 485.5 | 466.3 | 457.8 |
| RATIO | | 1.061 | 1.031 | 1.062 | 1.034 | 0.955 | 1.221 | 0.920 | 0.943 | 0.982 | 1.000 |
| ERROR | | 9.45 | 9.63 | 9.49 | 9.66 | 8.83 | 19.61 | 10.40 | 9.38 | 8.55 | 0.0 |

TABLE 7b. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 504.1 | 498.5 | 503.3 | 503.8 | 564.4 | 478.8 | 604.4 | 604.5 | 562.1 | 509.0 |
| 2 | 2 | 469.1 | 465.7 | 469.5 | 460.7 | 506.4 | 352.3 | 523.2 | 509.4 | 502.6 | 518.0 |
| 3 | 2 | 511.4 | 534.4 | 511.2 | 538.5 | 530.1 | 461.5 | 556.9 | 549.7 | 547.5 | 517.0 |
| 6 | 2 | 473.3 | 455.8 | 473.8 | 451.7 | 534.2 | 369.0 | 559.5 | 548.3 | 513.7 | 475.0 |
| 8 | 2 | 475.4 | 494.6 | 474.4 | 500.6 | 534.4 | 479.2 | 564.1 | 560.1 | 521.0 | 543.0 |
| 9 | 2 | 449.0 | 490.0 | 448.8 | 493.8 | 511.1 | 461.1 | 530.4 | 519.0 | 483.5 | 430.0 |
| 10 | 2 | 498.1 | 504.8 | 494.4 | 516.0 | 557.5 | 518.6 | 597.0 | 599.4 | 556.0 | 566.0 |
| 11 | 2 | 444.6 | 481.6 | 445.0 | 483.3 | 505.7 | 437.2 | 522.9 | 510.2 | 477.1 | 510.0 |
| 12 | 2 | 464.4 | 484.7 | 464.6 | 487.0 | 523.9 | 445.0 | 548.3 | 540.0 | 504.0 | 537.0 |
| 13 | 2 | 508.7 | 513.4 | 508.5 | 517.3 | 547.6 | 462.8 | 581.0 | 577.5 | 553.1 | 531.0 |
| 14 | 2 | 459.5 | 483.8 | 460.0 | 484.9 | 519.0 | 433.1 | 540.4 | 528.9 | 495.9 | 405.0 |
| 16 | 2 | 521.4 | 446.3 | 518.6 | 431.8 | 517.9 | 257.0 | 537.4 | 523.2 | 557.9 | 537.0 |
| 17 | 2 | 496.1 | 468.8 | 496.9 | 468.6 | 556.3 | 412.7 | 593.6 | 592.8 | 550.9 | 596.0 |
| 18 | 2 | 515.3 | 501.2 | 516.0 | 501.6 | 573.7 | 442.2 | 611.6 | 605.2 | 568.8 | 445.0 |
| 19 | 2 | 430.3 | 407.2 | 428.0 | 394.0 | 483.7 | 258.9 | 489.0 | 465.3 | 458.3 | 454.0 |
| 20 | 2 | 498.9 | 516.6 | 497.8 | 522.8 | 557.5 | 497.8 | 591.8 | 585.7 | 548.8 | 454.0 |
| 21 | 2 | 470.8 | 488.0 | 470.6 | 480.3 | 502.9 | 341.5 | 511.7 | 486.7 | 508.5 | 479.0 |
| 22 | 2 | 410.0 | 432.4 | 409.4 | 423.8 | 475.4 | 313.0 | 477.0 | 450.3 | 432.4 | 391.0 |
| MEAN | | 477.8 | 481.6 | 477.3 | 481.1 | 527.9 | 412.3 | 552.2 | 542.0 | 519.0 | 494.3 |
| RATIO | | 1.034 | 1.026 | 1.036 | 1.027 | 0.936 | 1.199 | 0.895 | 0.912 | 0.952 | 1.000 |
| ERROR | | 8.00 | 9.89 | 8.09 | 9.96 | 9.15 | 18.89 | 11.78 | 10.23 | 8.56 | 0.0 |

TABLE 7c. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 541.7 | 518.2 | 542.2 | 520.0 | 606.5 | 472.1 | 649.6 | 649.9 | 604.3 | 548.0 |
| 2 | 3 | 509.3 | 469.5 | 508.5 | 460.2 | 548.5 | 326.5 | 568.4 | 554.8 | 546.0 | 545.0 |
| 3 | 3 | 543.7 | 559.4 | 544.3 | 560.6 | 564.8 | 462.5 | 591.2 | 582.1 | 581.9 | 537.0 |
| 6 | 3 | 512.8 | 493.7 | 513.5 | 490.7 | 576.6 | 411.1 | 607.5 | 598.0 | 559.8 | 517.0 |
| 8 | 3 | 527.4 | 532.9 | 526.6 | 538.5 | 591.1 | 511.2 | 628.1 | 626.7 | 582.5 | 590.0 |
| 9 | 3 | 492.6 | 517.2 | 493.0 | 518.9 | 558.8 | 471.1 | 582.8 | 572.4 | 533.0 | 484.0 |
| 10 | 3 | 542.5 | 548.4 | 538.5 | 560.6 | 607.1 | 563.4 | 650.6 | 653.6 | 606.2 | 607.0 |
| 11 | 3 | 481.5 | 497.8 | 482.3 | 496.1 | 547.1 | 425.8 | 566.5 | 553.3 | 517.3 | 517.0 |
| 12 | 3 | 494.0 | 492.9 | 494.8 | 490.5 | 558.6 | 416.3 | 582.5 | 572.2 | 534.3 | 526.0 |
| 13 | 3 | 550.0 | 513.7 | 550.9 | 511.3 | 591.6 | 417.0 | 628.7 | 625.6 | 598.7 | 570.0 |
| 14 | 3 | 497.6 | 505.6 | 498.4 | 504.6 | 561.0 | 436.8 | 585.8 | 574.7 | 538.5 | 423.0 |
| 16 | 3 | 544.8 | 441.2 | 539.6 | 420.7 | 543.2 | 226.8 | 560.9 | 544.1 | 584.8 | 562.0 |
| 17 | 3 | 501.8 | 476.4 | 502.4 | 472.0 | 567.7 | 387.5 | 595.2 | 586.8 | 546.0 | 632.0 |
| 18 | 3 | 516.9 | 484.5 | 517.3 | 479.3 | 578.9 | 384.6 | 610.3 | 598.8 | 563.9 | 459.0 |
| 19 | 3 | 440.9 | 392.7 | 436.1 | 372.7 | 500.2 | 215.5 | 501.5 | 473.6 | 468.9 | 413.0 |
| 20 | 3 | 529.9 | 518.3 | 530.6 | 518.7 | 591.9 | 458.5 | 628.8 | 622.7 | 583.4 | 486.0 |
| 21 | 3 | 491.2 | 506.6 | 491.0 | 498.5 | 524.0 | 354.5 | 533.8 | 508.4 | 530.3 | 509.0 |
| 22 | 3 | 443.2 | 474.5 | 443.2 | 467.8 | 510.3 | 362.0 | 515.3 | 489.2 | 468.8 | 422.0 |
| MEAN | | 509.0 | 496.9 | 508.5 | 493.4 | 562.7 | 405.7 | 588.2 | 577.0 | 552.7 | 519.3 |
| RATIO | | 1.020 | 1.045 | 1.021 | 1.052 | 0.923 | 1.280 | 0.883 | 0.900 | 0.940 | 1.000 |
| ERROR | | 7.13 | 9.64 | 7.19 | 10.09 | 10.13 | 22.16 | 14.08 | 12.49 | 8.45 | 0.0 |

TABLE 7d. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4 | 533.4 | 491.1 | 534.0 | 486.6 | 600.3 | 399.2 | 635.1 | 629.7 | 586.1 | 543.0 |
| 2 | 4 | 470.5 | 431.7 | 467.0 | 415.0 | 520.1 | 255.8 | 523.6 | 499.3 | 502.7 | 513.0 |
| 3 | 4 | 531.2 | 529.4 | 531.7 | 523.7 | 557.7 | 389.1 | 575.2 | 560.0 | 568.7 | 500.0 |
| 6 | 4 | 500.6 | 463.0 | 500.2 | 454.7 | 567.2 | 345.8 | 590.9 | 576.6 | 540.5 | 522.0 |
| 8 | 4 | 529.0 | 517.2 | 529.8 | 516.2 | 595.4 | 449.0 | 627.0 | 621.4 | 578.1 | 580.0 |
| 9 | 4 | 508.0 | 511.6 | 508.8 | 509.9 | 576.2 | 439.1 | 601.0 | 590.2 | 549.6 | 501.0 |
| 10 | 4 | 544.2 | 559.9 | 542.2 | 568.5 | 611.1 | 554.1 | 648.5 | 647.1 | 600.6 | 634.0 |
| 11 | 4 | 464.6 | 476.2 | 464.7 | 469.5 | 536.1 | 368.3 | 545.2 | 525.0 | 491.9 | 491.0 |
| 12 | 4 | 471.7 | 464.0 | 471.3 | 455.7 | 542.3 | 346.9 | 553.8 | 535.1 | 500.9 | 539.0 |
| 13 | 4 | 515.8 | 469.4 | 514.7 | 459.0 | 563.6 | 324.8 | 583.7 | 569.7 | 553.2 | 552.0 |
| 14 | 4 | 489.9 | 477.1 | 489.9 | 470.3 | 556.9 | 368.0 | 574.9 | 559.0 | 524.8 | 405.0 |
| 16 | 4 | 512.9 | 393.3 | 503.7 | 362.2 | 521.7 | 156.3 | 527.3 | 502.5 | 560.4 | 565.0 |
| 17 | 4 | 462.7 | 422.3 | 460.2 | 408.6 | 536.0 | 279.4 | 545.2 | 524.9 | 489.5 | 573.0 |
| 18 | 4 | 450.4 | 377.2 | 444.9 | 356.3 | 520.6 | 205.6 | 528.7 | 502.8 | 476.9 | 442.0 |
| 19 | 4 | 408.4 | 382.1 | 402.9 | 358.9 | 477.1 | 194.1 | 467.2 | 431.7 | 434.0 | 358.0 |
| 20 | 4 | 480.9 | 451.1 | 479.8 | 441.2 | 548.5 | 323.8 | 565.1 | 546.3 | 514.2 | 420.0 |
| 21 | 4 | 477.1 | 485.2 | 476.0 | 474.5 | 512.7 | 321.3 | 518.6 | 490.9 | 516.3 | 512.0 |
| 22 | 4 | 452.7 | 462.0 | 452.0 | 452.8 | 520.0 | 334.4 | 526.3 | 500.6 | 479.4 | 432.0 |
| MEAN | | 489.1 | 464.6 | 487.4 | 454.6 | 548.0 | 336.4 | 563.2 | 545.2 | 526.0 | 504.6 |
| RATIO | | 1.032 | 1.086 | 1.035 | 1.110 | 0.921 | 1.500 | 0.896 | 0.926 | 0.959 | 1.000 |
| ERROR | | 8.86 | 12.25 | 8.94 | 12.99 | 10.88 | 33.33 | 13.06 | 11.34 | 8.03 | 0.0 |

TABLE 7e. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 5 | 523.3 | 462.9 | 523.1 | 455.5 | 589.5 | 353.4 | 622.4 | 616.2 | 573.5 | 507.0 |
| 2 | 5 | 461.9 | 402.6 | 456.9 | 382.1 | 511.6 | 217.0 | 514.1 | 489.5 | 493.6 | 491.0 |
| 3 | 5 | 496.8 | 485.1 | 495.7 | 474.4 | 528.6 | 321.6 | 536.9 | 516.4 | 533.5 | 422.0 |
| 6 | 5 | 495.4 | 435.4 | 494.0 | 424.8 | 560.4 | 306.9 | 585.1 | 572.0 | 536.1 | 459.0 |
| 8 | 5 | 515.2 | 494.1 | 515.9 | 490.3 | 581.7 | 407.0 | 609.2 | 601.4 | 559.8 | 546.0 |
| 9 | 5 | 501.8 | 501.8 | 502.6 | 499.4 | 569.5 | 425.2 | 593.6 | 582.7 | 542.6 | 492.0 |
| 10 | 5 | 544.7 | 526.5 | 545.3 | 527.6 | 611.2 | 474.5 | 649.8 | 649.2 | 602.5 | 578.0 |
| 11 | 5 | 486.5 | 471.5 | 486.5 | 464.9 | 554.0 | 364.7 | 571.9 | 557.4 | 521.2 | 470.0 |
| 12 | 5 | 450.5 | 419.9 | 448.1 | 406.3 | 522.8 | 276.8 | 528.6 | 506.7 | 475.0 | 500.0 |
| 13 | 5 | 493.9 | 421.0 | 490.2 | 404.7 | 543.5 | 253.0 | 557.9 | 540.8 | 527.9 | 484.0 |
| 14 | 5 | 467.4 | 433.2 | 465.7 | 421.6 | 535.5 | 298.3 | 547.8 | 528.7 | 497.1 | 388.0 |
| 16 | 5 | 500.2 | 376.7 | 490.4 | 344.2 | 509.9 | 140.9 | 514.3 | 489.2 | 547.6 | 501.0 |
| 17 | 5 | 444.8 | 396.2 | 441.0 | 379.4 | 519.2 | 241.5 | 524.0 | 501.2 | 467.7 | 554.0 |
| 18 | 5 | 384.7 | 333.9 | 377.8 | 307.5 | 462.6 | 151.0 | 454.5 | 419.3 | 400.5 | 357.0 |
| 19 | 5 | 438.9 | 391.0 | 434.1 | 371.1 | 498.0 | 214.6 | 499.2 | 471.5 | 466.8 | 426.0 |
| 20 | 5 | 447.0 | 422.4 | 445.0 | 410.0 | 516.7 | 284.3 | 524.8 | 501.4 | 473.1 | 366.0 |
| 21 | 5 | 432.3 | 433.5 | 429.5 | 418.1 | 473.7 | 256.2 | 471.3 | 439.2 | 471.6 | 427.0 |
| 22 | 5 | 431.3 | 418.5 | 429.0 | 405.0 | 499.1 | 272.1 | 501.7 | 474.3 | 455.2 | 405.0 |
| MEAN | | 473.1 | 434.8 | 470.6 | 421.5 | 532.6 | 292.1 | 544.8 | 525.4 | 508.1 | 465.2 |
| RATIO | | 0.983 | 1.070 | 0.988 | 1.104 | 0.873 | 1.592 | 0.854 | 0.885 | 0.916 | 1.000 |
| ERROR | | 7.75 | 11.21 | 7.68 | 12.67 | 15.33 | 37.19 | 17.85 | 14.53 | 11.88 | 0.0 |

TABLE 7f. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMC | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 6 | 471.3 | 417.8 | 469.2 | 405.5 | 539.9 | 283.1 | 556.2 | 540.5 | 504.0 | 478.0 |
| 2 | 6 | 483.9 | 396.3 | 478.7 | 376.2 | 527.2 | 213.6 | 538.8 | 520.1 | 517.5 | 522.0 |
| 3 | 6 | 503.7 | 456.3 | 501.5 | 442.9 | 532.2 | 283.7 | 544.8 | 527.2 | 539.9 | 428.0 |
| 6 | 6 | 457.9 | 371.1 | 452.9 | 352.3 | 524.7 | 210.9 | 539.0 | 520.2 | 488.5 | 431.0 |
| 8 | 6 | 533.9 | 471.3 | 534.1 | 465.4 | 598.5 | 371.2 | 635.5 | 633.7 | 589.1 | 543.0 |
| 9 | 6 | 473.2 | 457.0 | 473.1 | 449.8 | 541.9 | 348.8 | 558.1 | 542.8 | 506.0 | 450.0 |
| 10 | 6 | 565.2 | 515.5 | 566.0 | 515.9 | 631.5 | 459.2 | 681.1 | 687.3 | 637.2 | 524.0 |
| 11 | 6 | 492.2 | 458.7 | 492.0 | 451.4 | 557.5 | 348.9 | 579.8 | 568.2 | 530.9 | 521.0 |
| 12 | 6 | 471.5 | 406.6 | 468.5 | 392.2 | 539.1 | 261.3 | 554.0 | 538.1 | 503.3 | 501.0 |
| 13 | 6 | 488.9 | 406.9 | 484.7 | 389.6 | 537.3 | 237.5 | 552.4 | 536.1 | 522.9 | 492.0 |
| 14 | 6 | 414.4 | 398.4 | 411.3 | 382.9 | 488.5 | 248.4 | 486.1 | 458.4 | 433.0 | 350.0 |
| 16 | 6 | 485.0 | 360.1 | 474.7 | 326.0 | 496.2 | 125.7 | 498.8 | 473.1 | 532.8 | 487.0 |
| 17 | 6 | 506.5 | 431.9 | 505.1 | 421.4 | 572.6 | 305.9 | 601.0 | 593.0 | 551.8 | 590.0 |
| 18 | 6 | 369.4 | 317.9 | 362.2 | 290.4 | 446.7 | 135.3 | 437.1 | 401.5 | 383.9 | 346.0 |
| 19 | 6 | 424.6 | 383.5 | 420.0 | 364.0 | 483.7 | 210.4 | 483.2 | 454.9 | 451.4 | 413.0 |
| 20 | 6 | 403.7 | 386.3 | 400.2 | 369.9 | 477.8 | 233.8 | 475.0 | 445.3 | 421.7 | 359.0 |
| 21 | 6 | 406.6 | 407.5 | 403.1 | 390.2 | 450.7 | 227.6 | 444.4 | 410.6 | 446.1 | 416.0 |
| 22 | 6 | 405.6 | 357.9 | 400.1 | 336.2 | 475.2 | 185.9 | 472.6 | 442.5 | 426.2 | 396.0 |
| MEAN | | 464.3 | 411.2 | 461.0 | 395.7 | 523.4 | 260.6 | 535.4 | 516.3 | 499.2 | 458.2 |
| RATIO | | 0.987 | 1.114 | 0.994 | 1.158 | 0.875 | 1.758 | 0.856 | 0.887 | 0.918 | 1.000 |
| ERROR | | 6.44 | 12.95 | 6.43 | 15.06 | 14.66 | 43.11 | 16.87 | 13.20 | 10.00 | 0.0 |

TABLE 7g. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7 | 504.2 | 446.9 | 503.5 | 438.1 | 570.7 | 329.2 | 597.8 | 588.3 | 547.9 | 502.0 |
| 2 | 7 | 505.0 | 407.3 | 500.1 | 388.4 | 545.7 | 227.1 | 563.1 | 547.7 | 540.9 | 553.0 |
| 3 | 7 | 543.8 | 507.6 | 543.9 | 500.4 | 566.1 | 361.6 | 590.6 | 580.1 | 581.9 | 477.0 |
| 6 | 7 | 494.9 | 410.9 | 492.2 | 397.6 | 558.8 | 270.6 | 584.9 | 572.9 | 536.8 | 461.0 |
| 8 | 7 | 563.7 | 495.6 | 564.5 | 492.5 | 629.0 | 413.9 | 677.1 | 681.7 | 633.0 | 568.0 |
| 9 | 7 | 502.8 | 497.8 | 503.6 | 495.4 | 569.6 | 421.8 | 595.3 | 585.6 | 545.2 | 475.0 |
| 10 | 7 | 564.3 | 480.0 | 564.8 | 474.9 | 630.8 | 384.7 | 678.8 | 683.9 | 634.1 | 547.0 |
| 11 | 7 | 521.1 | 489.6 | 521.8 | 485.9 | 585.1 | 402.3 | 617.0 | 611.0 | 570.0 | 534.0 |
| 12 | 7 | 517.9 | 416.6 | 515.1 | 403.1 | 582.3 | 274.6 | 612.9 | 606.2 | 565.4 | 544.0 |
| 13 | 7 | 516.5 | 453.6 | 515.0 | 442.6 | 562.0 | 307.6 | 585.3 | 573.8 | 555.4 | 517.0 |
| 14 | 7 | 446.6 | 436.1 | 445.3 | 425.5 | 516.5 | 306.8 | 523.2 | 500.9 | 471.7 | 356.0 |
| 16 | 7 | 521.3 | 392.5 | 512.7 | 364.1 | 524.3 | 164.6 | 536.0 | 515.7 | 563.8 | 521.0 |
| 17 | 7 | 528.3 | 459.9 | 528.1 | 452.5 | 594.0 | 351.2 | 629.7 | 625.8 | 581.9 | 665.0 |
| 18 | 7 | 372.8 | 329.7 | 366.1 | 303.6 | 451.0 | 149.1 | 441.2 | 405.1 | 387.4 | 359.0 |
| 19 | 7 | 439.1 | 402.5 | 435.4 | 385.4 | 496.6 | 235.8 | 499.3 | 472.7 | 467.2 | 407.0 |
| 20 | 7 | 428.9 | 389.7 | 425.2 | 373.1 | 499.9 | 235.9 | 503.7 | 477.9 | 451.5 | 381.0 |
| 21 | 7 | 438.6 | 449.2 | 437.0 | 437.1 | 476.4 | 285.3 | 477.4 | 448.0 | 476.7 | 442.0 |
| 22 | 7 | 460.0 | 334.7 | 455.5 | 366.9 | 521.7 | 223.3 | 534.8 | 514.4 | 490.7 | 442.0 |
| MEAN | | 492.8 | 436.1 | 490.5 | 423.7 | 548.9 | 297.0 | 569.3 | 555.1 | 533.4 | 486.2 |
| RATIO | | 0.987 | 1.115 | 0.991 | 1.147 | 0.886 | 1.637 | 0.854 | 0.876 | 0.911 | 1.000 |
| ERROR | | 6.66 | 13.71 | 6.61 | 15.43 | 14.70 | 38.92 | 17.91 | 15.32 | 11.89 | 0.0 |

TABLE 7h. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8 | 502.3 | 455.2 | 501.5 | 446.2 | 570.8 | 335.2 | 594.2 | 582.1 | 542.4 | 507.0 |
| 2 | 8 | 520.9 | 453.8 | 518.6 | 440.4 | 561.4 | 290.4 | 581.2 | 566.8 | 558.4 | 549.0 |
| 3 | 8 | 544.5 | 540.5 | 545.2 | 536.4 | 568.6 | 409.1 | 590.6 | 578.1 | 582.6 | 490.0 |
| 6 | 8 | 516.5 | 434.8 | 514.6 | 423.1 | 581.3 | 300.0 | 611.6 | 601.4 | 563.1 | 486.0 |
| 8 | 8 | 560.3 | 517.5 | 561.2 | 516.5 | 626.3 | 449.2 | 670.2 | 672.0 | 624.3 | 581.0 |
| 9 | 8 | 496.5 | 511.1 | 497.3 | 509.4 | 565.6 | 438.7 | 586.4 | 573.2 | 534.1 | 476.0 |
| 10 | 8 | 569.2 | 512.4 | 570.2 | 510.7 | 636.5 | 440.0 | 684.0 | 688.4 | 638.4 | 574.0 |
| 11 | 8 | 531.6 | 508.1 | 532.5 | 505.7 | 596.7 | 429.0 | 629.7 | 624.0 | 582.0 | 526.0 |
| 12 | 8 | 521.8 | 416.4 | 518.4 | 401.6 | 587.5 | 267.6 | 616.8 | 608.9 | 568.1 | 563.0 |
| 13 | 8 | 517.5 | 454.8 | 515.6 | 442.6 | 564.9 | 301.9 | 585.8 | 572.4 | 555.4 | 511.0 |
| 14 | 8 | 466.1 | 463.9 | 465.7 | 455.6 | 535.9 | 345.8 | 546.2 | 525.7 | 494.5 | 387.0 |
| 16 | 8 | 533.4 | 420.7 | 526.1 | 395.2 | 536.4 | 193.6 | 548.4 | 527.7 | 576.9 | 544.0 |
| 17 | 8 | 526.1 | 461.8 | 525.6 | 453.5 | 593.4 | 346.5 | 625.2 | 618.7 | 575.5 | 635.0 |
| 18 | 8 | 406.4 | 322.7 | 397.8 | 292.2 | 482.9 | 128.2 | 478.7 | 445.5 | 424.7 | 401.0 |
| 19 | 8 | 477.5 | 412.6 | 473.4 | 395.1 | 531.5 | 241.7 | 542.7 | 520.7 | 509.9 | 440.0 |
| 20 | 8 | 433.0 | 414.3 | 430.2 | 399.6 | 506.9 | 265.3 | 508.7 | 480.9 | 454.7 | 366.0 |
| 21 | 8 | 472.5 | 499.5 | 472.3 | 491.6 | 507.4 | 349.5 | 513.6 | 486.4 | 511.3 | 465.0 |
| 22 | 8 | 497.5 | 439.1 | 495.7 | 427.3 | 557.6 | 299.0 | 579.7 | 563.8 | 535.7 | 490.0 |
| MEAN | | 505.2 | 457.7 | 503.4 | 446.8 | 561.8 | 323.9 | 583.0 | 568.7 | 546.2 | 499.5 |
| RATIO | | 0.989 | 1.091 | 0.992 | 1.118 | 0.889 | 1.542 | 0.857 | 0.878 | 0.914 | 1.000 |
| ERROR | | 6.01 | 13.82 | 6.01 | 15.19 | 13.56 | 35.15 | 16.93 | 14.58 | 10.68 | 0.0 |

TABLE 7i. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9 | 514.6 | 475.0 | 514.9 | 469.2 | 581.4 | 374.7 | 610.8 | 602.5 | 561.1 | 516.0 |
| 2 | 9 | 506.8 | 450.0 | 504.5 | 436.7 | 548.5 | 287.9 | 564.9 | 548.7 | 542.6 | 534.0 |
| 3 | 9 | 524.8 | 517.2 | 525.1 | 510.8 | 551.0 | 374.4 | 568.3 | 553.2 | 561.9 | 480.0 |
| 6 | 9 | 524.7 | 467.0 | 524.5 | 459.6 | 589.1 | 355.0 | 622.4 | 614.0 | 574.6 | 487.0 |
| 8 | 9 | 532.7 | 500.5 | 533.5 | 498.1 | 597.8 | 423.5 | 633.2 | 630.3 | 586.1 | 576.0 |
| 9 | 9 | 485.0 | 505.6 | 485.8 | 503.9 | 554.0 | 434.0 | 572.3 | 558.0 | 520.0 | 469.0 |
| 10 | 9 | 574.7 | 532.7 | 574.8 | 536.0 | 641.7 | 496.2 | 694.8 | 703.0 | 651.6 | 582.0 |
| 11 | 9 | 506.4 | 492.5 | 507.1 | 488.8 | 571.9 | 404.7 | 597.4 | 587.3 | 548.5 | 504.0 |
| 12 | 9 | 476.3 | 404.4 | 472.8 | 388.7 | 544.9 | 252.9 | 559.6 | 543.3 | 508.2 | 615.0 |
| 13 | 9 | 510.0 | 457.5 | 508.5 | 446.4 | 557.3 | 310.3 | 577.1 | 563.2 | 547.0 | 520.0 |
| 14 | 9 | 485.4 | 484.0 | 485.8 | 478.8 | 551.8 | 385.2 | 569.6 | 553.9 | 520.0 | 391.0 |
| 16 | 9 | 523.2 | 410.6 | 515.4 | 383.4 | 528.6 | 180.8 | 537.9 | 515.6 | 568.2 | 542.0 |
| 17 | 9 | 532.7 | 505.4 | 533.6 | 503.7 | 598.9 | 434.0 | 635.1 | 631.4 | 587.1 | 655.0 |
| 18 | 9 | 450.1 | 409.7 | 446.8 | 393.8 | 520.9 | 254.7 | 528.3 | 502.1 | 476.3 | 392.0 |
| 19 | 9 | 477.9 | 428.9 | 474.8 | 413.7 | 532.1 | 265.9 | 543.1 | 520.9 | 510.2 | 460.0 |
| 20 | 9 | 469.5 | 443.0 | 468.2 | 432.2 | 538.1 | 311.5 | 551.4 | 530.7 | 500.0 | 391.0 |
| 21 | 9 | 546.6 | 544.9 | 547.5 | 541.5 | 569.5 | 417.7 | 596.1 | 580.8 | 587.5 | 502.0 |
| 22 | 9 | 515.8 | 496.7 | 516.4 | 492.1 | 574.7 | 396.9 | 602.5 | 589.9 | 559.2 | 499.0 |
| MEAN | | 508.7 | 473.6 | 507.8 | 465.4 | 564.0 | 353.3 | 586.9 | 573.8 | 550.6 | 506.4 |
| RATIO | | 0.995 | 1.069 | 0.997 | 1.088 | 0.898 | 1.433 | 0.863 | 0.882 | 0.920 | 1.000 |
| ERROR | | 8.56 | 12.60 | 8.65 | 13.27 | 14.44 | 30.22 | 17.65 | 15.99 | 12.55 | 0.0 |

TABLE 7j. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 10 | 477.1 | 453.8 | 477.5 | 448.9 | 540.7 | 363.5 | 565.2 | 555.3 | 517.3 | 487.0 |
| 2 | 10 | 449.2 | 410.9 | 446.3 | 396.3 | 493.7 | 250.2 | 499.8 | 478.8 | 480.0 | 485.0 |
| 3 | 10 | 470.9 | 462.7 | 470.2 | 453.5 | 500.1 | 312.7 | 509.0 | 490.3 | 505.4 | 438.0 |
| 6 | 10 | 493.7 | 440.7 | 493.3 | 432.8 | 555.8 | 329.1 | 584.6 | 574.8 | 538.2 | 460.0 |
| 8 | 10 | 459.8 | 444.1 | 460.1 | 438.6 | 523.2 | 349.8 | 541.8 | 530.4 | 494.2 | 491.0 |
| 9 | 10 | 447.7 | 462.0 | 448.3 | 458.5 | 513.5 | 381.0 | 527.7 | 512.4 | 477.7 | 413.0 |
| 10 | 10 | 511.0 | 486.8 | 511.6 | 487.8 | 572.5 | 438.7 | 611.2 | 612.4 | 568.2 | 533.0 |
| 11 | 10 | 430.1 | 442.9 | 430.1 | 436.7 | 496.8 | 342.5 | 504.6 | 485.4 | 454.9 | 453.0 |
| 12 | 10 | 416.7 | 373.5 | 413.1 | 357.6 | 485.5 | 226.8 | 489.0 | 467.2 | 438.1 | 531.0 |
| 13 | 10 | 468.8 | 418.3 | 466.6 | 406.0 | 515.1 | 271.5 | 529.7 | 514.1 | 501.3 | 467.0 |
| 14 | 10 | 447.6 | 458.0 | 448.0 | 453.1 | 511.9 | 364.6 | 524.8 | 507.5 | 476.9 | 379.0 |
| 16 | 10 | 474.4 | 363.3 | 465.2 | 331.8 | 485.9 | 135.8 | 488.0 | 462.5 | 521.7 | 492.0 |
| 17 | 10 | 472.1 | 457.1 | 472.6 | 452.9 | 535.9 | 371.8 | 558.8 | 548.7 | 510.8 | 596.0 |
| 18 | 10 | 451.2 | 375.1 | 446.3 | 356.1 | 517.7 | 212.1 | 529.5 | 506.9 | 480.0 | 426.0 |
| 19 | 10 | 439.5 | 380.7 | 434.7 | 361.4 | 494.7 | 208.9 | 499.5 | 474.8 | 468.0 | 437.0 |
| 20 | 10 | 468.0 | 424.1 | 466.7 | 413.8 | 531.5 | 298.2 | 550.5 | 534.5 | 502.7 | 399.0 |
| 21 | 10 | 513.4 | 503.3 | 513.5 | 496.2 | 539.3 | 358.2 | 558.6 | 539.6 | 552.2 | 479.0 |
| 22 | 10 | 472.2 | 460.9 | 472.3 | 454.4 | 531.3 | 351.7 | 549.7 | 532.7 | 506.8 | 447.0 |
| MEAN | | 464.6 | 434.3 | 463.1 | 424.2 | 519.2 | 309.3 | 534.6 | 518.2 | 499.7 | 467.4 |
| RATIO | | 1.006 | 1.076 | 1.009 | 1.102 | 0.900 | 1.511 | 0.874 | 0.902 | 0.935 | 1.000 |
| ERROR | | 8.39 | 12.21 | 8.46 | 13.38 | 13.73 | 33.83 | 16.35 | 14.37 | 11.26 | 0.0 |

TABLE 7k. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RAGE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 11 | 444.8 | 439.0 | 445.5 | 437.5 | 502.8 | 376.9 | 527.7 | 520.1 | 484.3 | 453.0 |
| 2 | 11 | 430.5 | 414.8 | 429.9 | 406.6 | 468.3 | 288.5 | 479.4 | 463.5 | 460.5 | 456.0 |
| 3 | 11 | 430.4 | 429.9 | 430.0 | 422.3 | 457.4 | 295.9 | 465.2 | 447.9 | 462.0 | 419.0 |
| 6 | 11 | 453.1 | 415.5 | 452.9 | 408.9 | 511.2 | 315.8 | 535.7 | 525.2 | 491.9 | 455.0 |
| 8 | 11 | 427.5 | 422.5 | 428.2 | 419.9 | 484.5 | 352.9 | 504.6 | 496.1 | 462.0 | 467.0 |
| 9 | 11 | 403.0 | 435.9 | 403.7 | 434.5 | 464.2 | 374.2 | 474.8 | 459.3 | 428.4 | 385.0 |
| 10 | 11 | 451.6 | 460.2 | 450.9 | 465.1 | 507.5 | 442.2 | 537.6 | 535.8 | 497.3 | 461.0 |
| 11 | 11 | 384.1 | 405.7 | 384.1 | 399.9 | 446.6 | 313.7 | 450.5 | 431.0 | 404.2 | 427.0 |
| 12 | 11 | 403.9 | 389.6 | 403.3 | 381.9 | 463.7 | 286.0 | 474.2 | 458.8 | 429.4 | 524.0 |
| 13 | 11 | 449.3 | 413.4 | 448.9 | 406.1 | 489.3 | 297.1 | 509.0 | 498.6 | 482.9 | 465.0 |
| 14 | 11 | 411.4 | 431.3 | 411.9 | 428.0 | 470.7 | 353.4 | 482.2 | 466.1 | 438.1 | 366.0 |
| 16 | 11 | 461.4 | 354.7 | 453.8 | 329.0 | 466.5 | 148.7 | 474.3 | 454.3 | 501.4 | 492.0 |
| 17 | 11 | 428.2 | 436.2 | 428.9 | 434.7 | 487.1 | 374.6 | 506.5 | 496.2 | 462.0 | 556.0 |
| 18 | 11 | 466.7 | 401.8 | 464.9 | 391.0 | 524.7 | 275.8 | 549.9 | 537.0 | 506.3 | 411.0 |
| 19 | 11 | 410.0 | 369.3 | 406.5 | 353.6 | 461.4 | 216.3 | 465.9 | 442.9 | 436.5 | 419.0 |
| 20 | 11 | 461.5 | 438.2 | 462.0 | 434.2 | 518.4 | 353.9 | 545.2 | 535.8 | 502.7 | 410.0 |
| 21 | 11 | 472.0 | 472.3 | 471.8 | 464.7 | 499.6 | 330.5 | 513.0 | 491.9 | 508.4 | 456.0 |
| 22 | 11 | 423.3 | 431.2 | 423.4 | 425.1 | 481.1 | 329.0 | 492.1 | 472.5 | 451.0 | 400.0 |
| MEAN | | 434.0 | 420.1 | 433.4 | 413.5 | 483.6 | 318.1 | 499.3 | 485.2 | 467.2 | 445.7 |
| RATIO | | 1.027 | 1.061 | 1.028 | 1.078 | 0.922 | 1.401 | 0.893 | 0.919 | 0.954 | 1.000 |
| ERROR | | 8.13 | 10.80 | 8.26 | 11.63 | 12.37 | 28.63 | 14.96 | 12.92 | 10.22 | 0.0 |

TABLE 71. COMPARISON OF COMPUTED VALUES OF RADIATION

| STA | MO | RAP1 | RAP2 | RAP3 | RAP4 | RAFP | RABL | RAGM | RAMO | RABE | RALV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 12 | 422.7 | 424.1 | 423.3 | 423.9 | 477.7 | 373.2 | 501.5 | 494.5 | 460.5 | 438.0 |
| 2 | 12 | 404.0 | 414.6 | 404.2 | 409.5 | 440.6 | 308.8 | 449.7 | 433.7 | 431.9 | 481.0 |
| 3 | 12 | 406.0 | 390.5 | 404.8 | 381.0 | 432.0 | 253.7 | 438.8 | 422.0 | 435.9 | 407.0 |
| 6 | 12 | 417.9 | 397.1 | 417.8 | 390.8 | 474.9 | 301.8 | 492.8 | 479.5 | 449.7 | 441.0 |
| 8 | 12 | 386.5 | 406.8 | 387.2 | 405.4 | 441.9 | 348.8 | 454.7 | 443.1 | 413.1 | 453.0 |
| 9 | 12 | 377.3 | 420.4 | 377.9 | 420.2 | 435.9 | 369.9 | 444.4 | 428.8 | 400.0 | 368.0 |
| 10 | 12 | 389.9 | 438.6 | 388.8 | 444.6 | 444.8 | 429.9 | 459.8 | 450.0 | 418.5 | 453.0 |
| 11 | 12 | 353.7 | 406.4 | 354.2 | 403.9 | 414.6 | 338.6 | 415.1 | 394.6 | 370.5 | 397.0 |
| 12 | 12 | 393.9 | 409.9 | 394.5 | 408.0 | 449.2 | 346.2 | 463.1 | 450.8 | 421.5 | 533.0 |
| 13 | 12 | 426.9 | 429.8 | 427.6 | 427.7 | 464.7 | 348.9 | 483.7 | 473.9 | 458.9 | 448.0 |
| 14 | 12 | 383.7 | 414.1 | 384.3 | 411.6 | 441.1 | 344.1 | 449.6 | 432.8 | 407.1 | 355.0 |
| 16 | 12 | 458.0 | 370.2 | 453.0 | 351.4 | 458.6 | 184.0 | 471.2 | 455.3 | 493.5 | 492.0 |
| 17 | 12 | 380.4 | 383.4 | 380.4 | 378.0 | 438.8 | 297.7 | 448.3 | 433.2 | 403.9 | 486.0 |
| 18 | 12 | 451.2 | 430.9 | 451.6 | 426.2 | 507.0 | 342.0 | 531.9 | 519.8 | 490.0 | 403.0 |
| 19 | 12 | 384.7 | 366.5 | 382.2 | 353.5 | 435.3 | 227.2 | 437.4 | 413.9 | 409.2 | 407.0 |
| 20 | 12 | 445.1 | 448.0 | 445.7 | 448.3 | 499.3 | 396.3 | 526.4 | 518.1 | 486.0 | 400.0 |
| 21 | 12 | 431.4 | 462.2 | 431.4 | 455.7 | 463.4 | 328.9 | 469.0 | 444.0 | 466.8 | 415.0 |
| 22 | 12 | 367.8 | 386.1 | 366.7 | 376.7 | 429.6 | 268.6 | 428.3 | 402.1 | 386.9 | 365.0 |
| MEAN | | 404.5 | 411.1 | 404.2 | 406.5 | 452.7 | 322.7 | 464.8 | 449.4 | 433.5 | 430.1 |
| RATIO | | 1.063 | 1.046 | 1.064 | 1.058 | 0.950 | 1.333 | 0.925 | 0.957 | 0.992 | 1.000 |
| ERROR | | 9.84 | 11.27 | 9.94 | 11.69 | 11.05 | 25.02 | 12.18 | 10.55 | 9.68 | 0.0 |
| AVERAGES FOR ALL STATIONS AND MONTHS | | | | | | | | | | | |
| MEAN | | 471.2 | 447.2 | 469.9 | 439.1 | 525.3 | 333.9 | 543.3 | 528.5 | 508.5 | 477.9 |
| RATIO | | 1.014 | 1.069 | 1.017 | 1.088 | 0.910 | 1.431 | 0.880 | 0.904 | 0.940 | 1.000 |
| ERROR | | 7.91 | 11.67 | 7.95 | 12.59 | 12.40 | 30.48 | 15.03 | 12.94 | 10.14 | 0.0 |