Micrometeorological Data for Railroad Valley, Nye County, Nevada, Summer 1992

By Guy A. DeMeo

U.S. GEOLOGICAL SURVEY

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LAS VEGAS VALLEY WATER DISTRICT

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CONVERSION FACTORS, VERTICAL DATUM, AND NUMERICAL ROUNDING

Multiply	By	To obtain
centimeter (cm)	0.3937	inch
erg	9.48451×10^{-11}	British thermal unit
kilometer (km)	0.6214	mile
kilopascal (kPa)	0.1450	pound-force per square inch
meter (m)	3.281	foot
meter per second (m/s)	2.237	mile per hour
micrometer (μm)	0.00003937	inch
millimeter (mm)	0.03937	inch
square kilometer (km^2)	0.3861	square mile
watts per square meter (W/m^2)	0.005287	British thermal unit per minute per square foot

Temperature: Degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the formula °F = [1.8(°C)]+32. Kelvin (K) can be converted to degrees Fahrenheit by using the formula °F=1.8(K-273.15)+32.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929, formerly called Sea-Level Datum of 1929), which is derived from a general adjustment of the first-order leveling networks of the United States and Canada.

Numerical rounding: Data tables in this report, including totals and mean values, are derived from computer spreadsheet programs. These programs display a defined number of digits following the decimal point, but retain the original number of digits in the spreadsheet cell. Each displayed number is rounded appropriately. However, the full number of digits is used for calculations, such as sums or means, and the resulting number, when rounded, may not equal exactly the sum or mean of the displayed digits. Any discrepancy generally will be in the least significant digit displayed. The sum or mean value, as displayed, is more accurate than the sum or mean of the individual displayed values.

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ABSTRACT

A field study designed to improve the accuracy of estimated ground-water discharge from evapotranspiration by phreatophytic communities in arid regions was made in Railroad Valley, a desert basin in east-central Nevada. Micrometeorological data were collected to determine evapotranspiration rates. Data in this report comprise air temperature, windspeed, net radiation, relative humidity, and calculated values of vapor pressure, soil-surface temperature, soil heat flux, and plant-canopy temperature of greasewood. Data were collected from June 21 through September 21, 1992.

Collected data were sampled at 1- or 10-second intervals. These values were then averaged at 20-minute intervals for final use. Values presented in this report are the averaged maximum or minimum for each 20-minute period; daily-mean values are the average of the 20-minute averages for each 24-hour period.

Daily mean air temperature ranged from 29.65 to 14.09°C (degrees Celsius) throughout the study period; the maximum and minimum were 39.20 and 5.94°C. Daily mean windspeed ranged from 5.34 to 1.03 meters per second; the maximum speed was 12.46 meters per second. Daily mean net radiation ranged from 166.4 to 35.4 watts per square meter; the maximum and minimum were 732.0 and -111.0 watts per square meter. Daily mean relative humidity ranged from 73.04 to 8.45 percent; the maximum and minimum were 95.05 and 3.3 percent. Daily mean vapor pressure ranged from 1.32 to 0.17 kilopascals; the maximum and minimum were 1.65 and 0.12 kilopascals. Daily mean soil-surface temperature ranged from 35.89 to 18.16°C; the maximum and minimum were 62.29 and 3.16°C. Daily mean soil heat flux values ranged from 15.34 to -19.44 watts per square meter; the maximum and minimum were 98.00 and -51.10 watts per square meter. Daily mean plant-canopy temperature ranged from 30.56 to 16.66°C; the maximum and minimum were 39.80 and 6.80°C.

INTRODUCTION

Ground-water-budget estimates for the basins of Nevada, can be improved by increasing the accuracy of estimates of water loss from evapotranspiration (ET) by phreatophytes. In an attempt to improve the accuracy of estimated ET rates, the U.S. Geological Survey, in cooperation with the Las Vegas Valley Water District, began a study in May 1992 in Railroad Valley, a basin in east-central Nevada.

Purpose and Scope

In an effort to improve the accuracy of estimated ground-water discharge from ET by phyeatophytes in Railroad Valley, micrometeorological data were collected from June 21 through September 21, 1992. This report presents the collected or calculated micrometeorological data, which include air temperature, windspeed, net radiation, relative humidity, vapor pressure, soil-surface temperature, soil heat flux, and plant-canopy temperature of greasewood. Data tables at the end of the report list the daily maximum, minimum, and mean values. Values from the tables were used to plot all graphs.

Geographical Setting

Micrometeorological data presented in this report were collected from three sites in the Railroad Valley Hydrographic Area[1]. These sites were approximately 5 km south of Lockes, Nev., which is 112 km west of Ely, Nev. (fig. 1). The study sites were approximately 1.2 km apart along an east-west transect. They were identified as Lockes West, Center, and East. Land-surface altitude is approximately 1,470 m above sea level at the center site; the west site was approximately 10 m higher and the east site approximately 10 m lower.

Railroad Valley is a hydrologically-closed basin with an area of about 8,945 km^2 in east-central Nevada from latitude 37°30′ to 39°15′N and longitude 115°15′ to 116°25′W. The valley axis trends northeast-southwest, extends for more than 175 km, and is from 20 to 40 km wide in an east-west direction. The basin is bounded on the east side by four mountain ranges, the White Pine, Horse, Grant, and Quinn Canyon; the Pancake Range dominates the west side (fig. 1). In the study area, Currant Mountain, in the White Pine Range, is the highest point at 3,510 m above sea level and a large playa, in the center of the basin, is the lowest point at 1,434 m above sea level (Van Denburgh and Rush, 1974, p. 7). The plant, *Sarcobatus vermiculatus* (greasewood), covers approximately 13 percent of the study sites.

The climate is arid. Average annual precipitation ranges from about 40.5 cm in the surrounding mountains to about 15.0 cm in the basin. Maximum mean temperature across the basin in July is about 35.0°C and minimum mean temperature in January is about -9.0°C (Houghton and others, 1975, p. 29).

INSTRUMENTATION

Data presented in this report comprise air temperature, windspeed, net radiation, relative humidity, vapor pressure, soil-surface temperature, soil heat flux, and plant-canopy temperature of greasewood.

Air temperature was sampled with a Type E Chromel-Constantan fine wire thermocouples at 1.5 m above land surface. Windspeed was sampled with a R.M. Young Model 12002 three-cup anemometers at 1.5 m above land surface. Net radiation was sampled with a Radiation Energy Balance Systems (REBS) Model Q6 Net Radiometer at 1.0 m above land surface. Relative humidity was sampled using a Rotronics Model MP-100 temperature-humidity probe at 1.5 m above land surface. Vapor pressure was calculated from relative-humidity and air temperature data. Soil heat flux was sampled with two soil heat flux plates (Campbell Scientific, Inc., 1988) at 5.0 cm below land surface. Soil-surface and plant-canopy temperatures were sampled with Everest Model 4000A Infrared Temperature Transducers (IRT). These sensors can make temperature measurements at up to 50 m away from their target. To obtain accurate temperatures, the IRT's were at 3.0 and 6.0 m above the plant canopy and soil, respectively (Everest Interscience, Inc., 1990).

All measurements were sampled at either 1- or 10-second intervals, then averaged and stored for final use every 20 minutes using a CSI Model 21X datalogger. The datalogger and all of the instrumentation were powered by a 12-volt deep-cycle marine battery that was recharged with a solar panel.

MICROMETEOROLOGICAL DATA

Micrometeorological data collected from three sites in Railroad Valley are documented in this report. These data comprise daily maxima, minima, and mean of air temperature, windspeed, net radiation, relative humidity, vapor pressure, soil-surface temperature, soil heat flux, and plant-canopy temperature of greasewood.

The three Lockes sites were not constructed at the same time and temporary modifications to instrumentation were made periodically. Because of this and intermittent problems with equipment, it was not possible to collect data from a single site over the period of record from June 21 to September 21, 1992. Therefore, data are presented from Lockes East from June 21 through August 2, Lockes Center from August 3 through August 9, and Lockes West from August 10 through September 21.

Because all of the data stored for final use are averaged over 20-minute intervals, the daily maxima and minima are not the instantaneous high and low

[1]Formal Hydrographic Areas in Nevada were delineated systematically by the U.S. Geological Survey and Nevada Division of Water Resources in the late 1960's for scientific and administrative purposes (Cardinalli and others, 1968; Rush, 1968). The official Hydrographic Area names, numbers, and geographic boundaries continue to be used in Geological Survey scientific reports and Division of Water Resources adminsitrative activities.

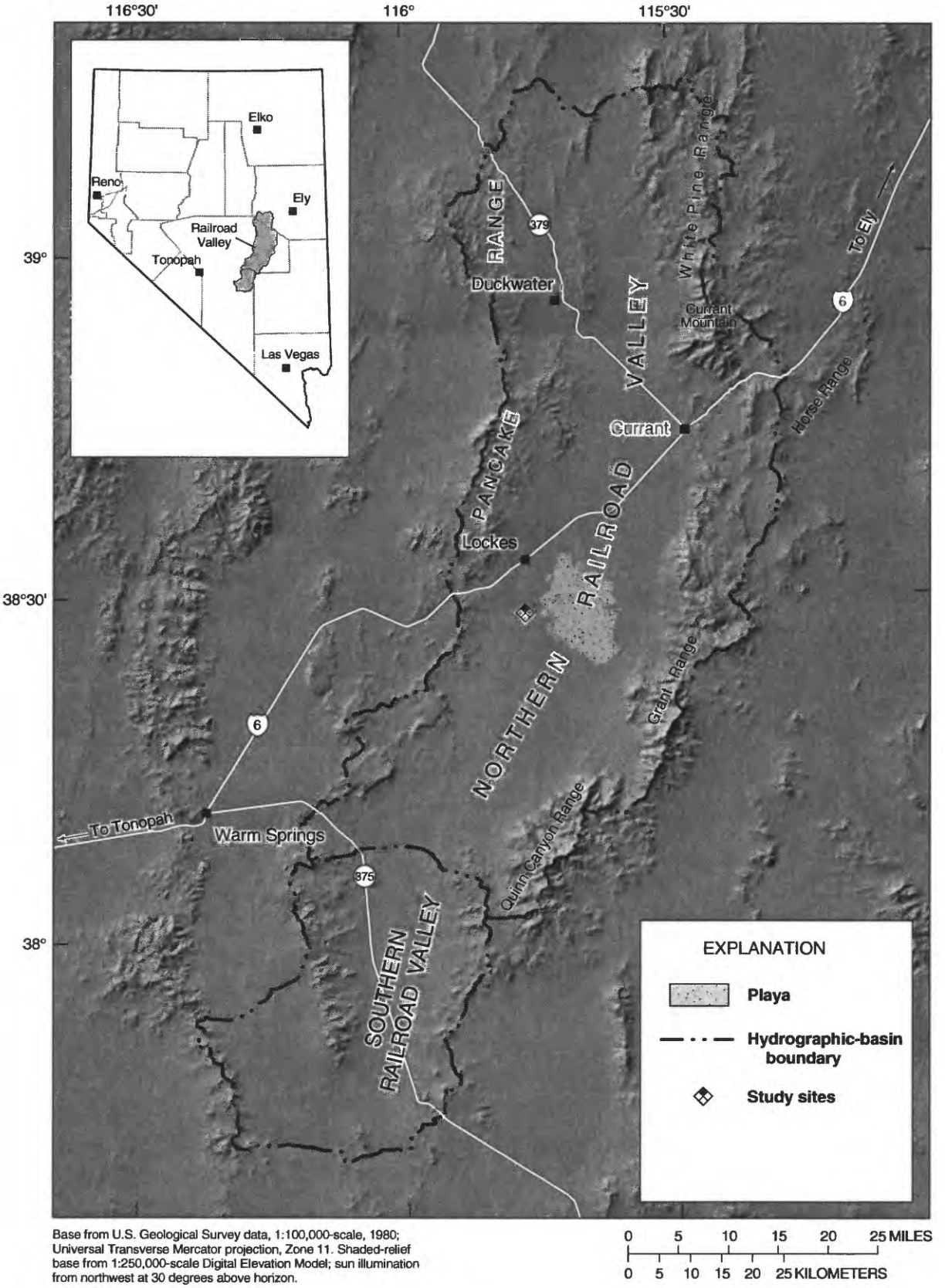

Figure 1. Location of Railroad Valley and study sites.

value for that day, but rather the highest or lowest 20-minute average for the day. Daily mean values are the average of all the 20-minute averaged values for that day.

Air Temperature

Daily mean air temperature at the study site ranged from 29.65 to 14.09°C throughout the period of record (fig. 2, table 1). Daily maximum and minimum air temperature were 39.20°C on August 5 and 5.94°C on August 27.

Windspeed

Extreme variability in windspeed resulting from effects such as diurnal heating and cooling, dust devils, and strong thunderstorm gusts is shown by many peaks in the data set (fig. 3, table 1).

Daily mean windspeed ranged from 5.34 to 1.03 m/s. Daily maximum was 12.46 m/s recorded during a thunderstorm on July 31. Minimum windspeed each day was zero.

Net Radiation

Net radiation is the algebraic sum of incoming and outgoing shortwave and longwave radiation. The shortwave component ranges from 0.3 to 3.0 μm and the longwave component ranges from 4.0 to 50.0 μm.

Daily mean net radiation ranged from 166.4 to 35.4 W/m^2 throughout the period of record (fig. 4, table 1). Daily maximum and minimum net radiation were 732.0 W/m^2 on July 12 and -111.0 W/m^2 on August 23.

Relative Humidity

Relative humidity is the ratio of the amount of water vapor in the atmosphere to the amount necessary for saturation at the same temperature. Relative humidity is expressed in terms of percent and is a measure of the percentage of saturation at a given temperature (Nevada Division of Water Planning, 1995, p. 221).

Relative-humidity data are not available from June 21 through July 21 because of equipment malfunction. Daily mean relative humidity ranged from 73.04 to 8.45 percent from July 22 to September 21 (fig. 5, table 2). Daily maximum relative humidity was 95.05 percent on September 19 during a nonconvective rainstorm and minimum was 3.3 percent on August 27.

Vapor Pressure

Vapor pressure is the partial pressure of water vapor in the atmosphere (Nevada Division of Water Planning, 1995, p. 293). It is a direct indicator of how much water vapor is in the atmosphere at a given time.

Vapor-pressure values in this report were calculated using data collected with the relative humidity-temperature probe. Because no relative-humidity data were available from June 21 to July 21, vapor pressure could not be calculated for those days. Vapor pressure is calculated using the following equations (Rogers and Yau, 1989, p. 16):

$$e=Rh*e_s(T_a) \quad (1)$$

where

$$e_s(T_a)=0.6112*\exp(17.67*T_a/T_a+243.5), \quad (2)$$

and where

e is vapor pressure, in kilopascals;

Rh is relative humidity, in percent;

$e_s(T_a)$ is saturation vapor pressure, in kilopascals; and

T_a is air temperature, in degrees Celsius.

Daily mean vapor pressure ranged from 1.32 to 0.17 kPa throughout the period of record (fig. 6, table 2). Daily maximum vapor pressure was 1.65 kPa on August 5 during a convective rainstorm and minimum was 0.12 kPa on August 27. A secondary maximum was 1.44 kPa on September 18 during a nonconvective rainstorm.

Soil-Surface Temperature

Daily mean soil-surface temperature ranged from 35.89 to 18.16°C throughout the period of record (fig. 7, table 2). Daily maximum and minimum soil-surface temperature were 62.29°C on July 29 and 31, and 3.16°C on August 27.

Soil Heat Flux

Positive soil heat flux values indicate that heat is being transferred downward from land surface, and negative values indicate that heat is being conducted upward toward land surface. The values presented here are the raw data measured directly from the heat flux plates and do not take heat storage of the top 5 cm of soil into account.

Daily mean soil heat flux ranged from 15.34 to -19.44 W/m^2 throughout the period of record (fig. 8, table 3). Daily maximum and minimum soil heat flux were 98.00 W/m^2 on September 20 and -51.10 W/m^2 on September 18.

Plant-Canopy Temperature

Daily mean plant-canopy temperature of greasewood ranged from 30.56 to 16.66°C throughout the period of record (fig. 9, table 3). Daily maximum and minimum plant-canopy temperature were 39.80°C on August 3 and 6.80°C on August 24.

SUMMARY

In an effort to improve the accuracy of estimated evapotranspiration rates in arid regions, a project was begun in May 1992 in Railroad Valley. This report presents micrometeorological data that were collected in Railroad Valley from June 21 through September 21, 1992. Data include air temperature, windspeeds, net radiation, relative humidity, vapor pressure, soil-surface temperature, soil heat flux, and plant-canopy temperature of greasewood.

Collected data throughout the period of record show daily mean air temperature ranged from 29.65 to 14.09°C; the maximum and minimum were 39.20 on August 5 and 5.94°C on August 27. Daily mean windspeed ranged from 5.34 to 1.03 m/s; the maximum was 12.46 on July 31 and the minimum was zero on each day of record. Daily mean net radiation ranged from 166.4 to 35.4 W/m^2; the maximum and minimum were 732.0 W/m^2 on July 12 and -111.0 W/m^2 on August 23. Daily mean relative humidity ranged from 73.04 to 8.45 percent; the maximum and minimum were 95.05 percent on September 19 and 3.3 percent on August 27. Daily mean vapor pressure ranged from 1.32 to 0.17 kPa; the maximum and minimum were 1.65 kPa on August 5 and 0.12 kPa on August 27. A secondary maximum was 1.44 kPa on September 18. Daily mean soil-surface temperature ranged from 35.89 to 18.16°C; the maximum and minimum were 62.20°C on July 29 and 31, and 3.16°C on August 27. Daily mean soil heat flux ranged from 15.34 to -19.44 W/m^2; the maximum and minimum were 98.00 W/m^2 on September 20 and -51.10 W/m^2 on September 18. Daily mean plant-canopy temperature of greasewood ranged from 30.56 to 16.66°C; the maximum and minimum were 39.80°C on August 3 and 6.80°C on August 24.

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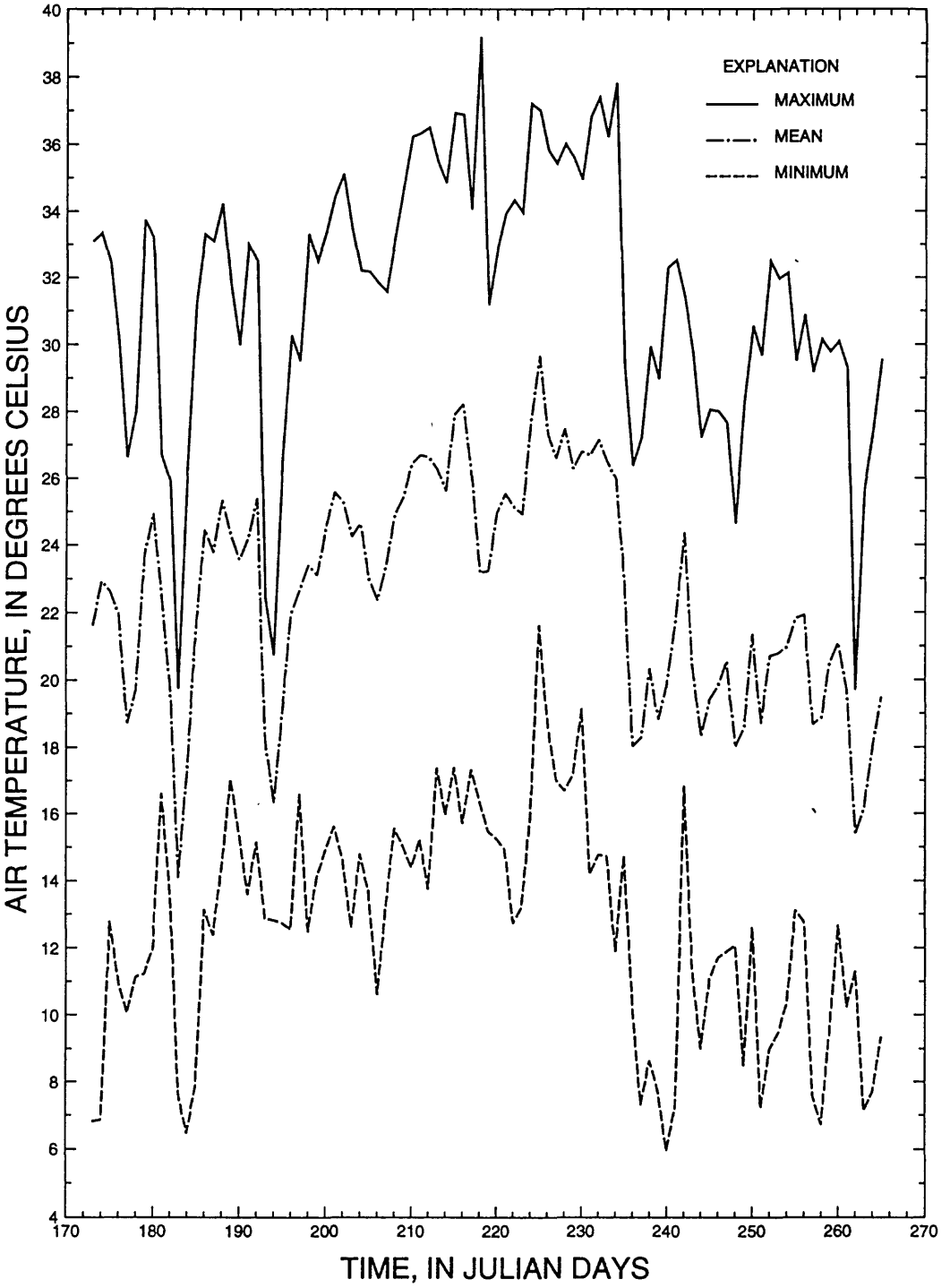

Figure 2. Daily maximum, mean, and minimum air temperatures from June 21 through September 21, 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

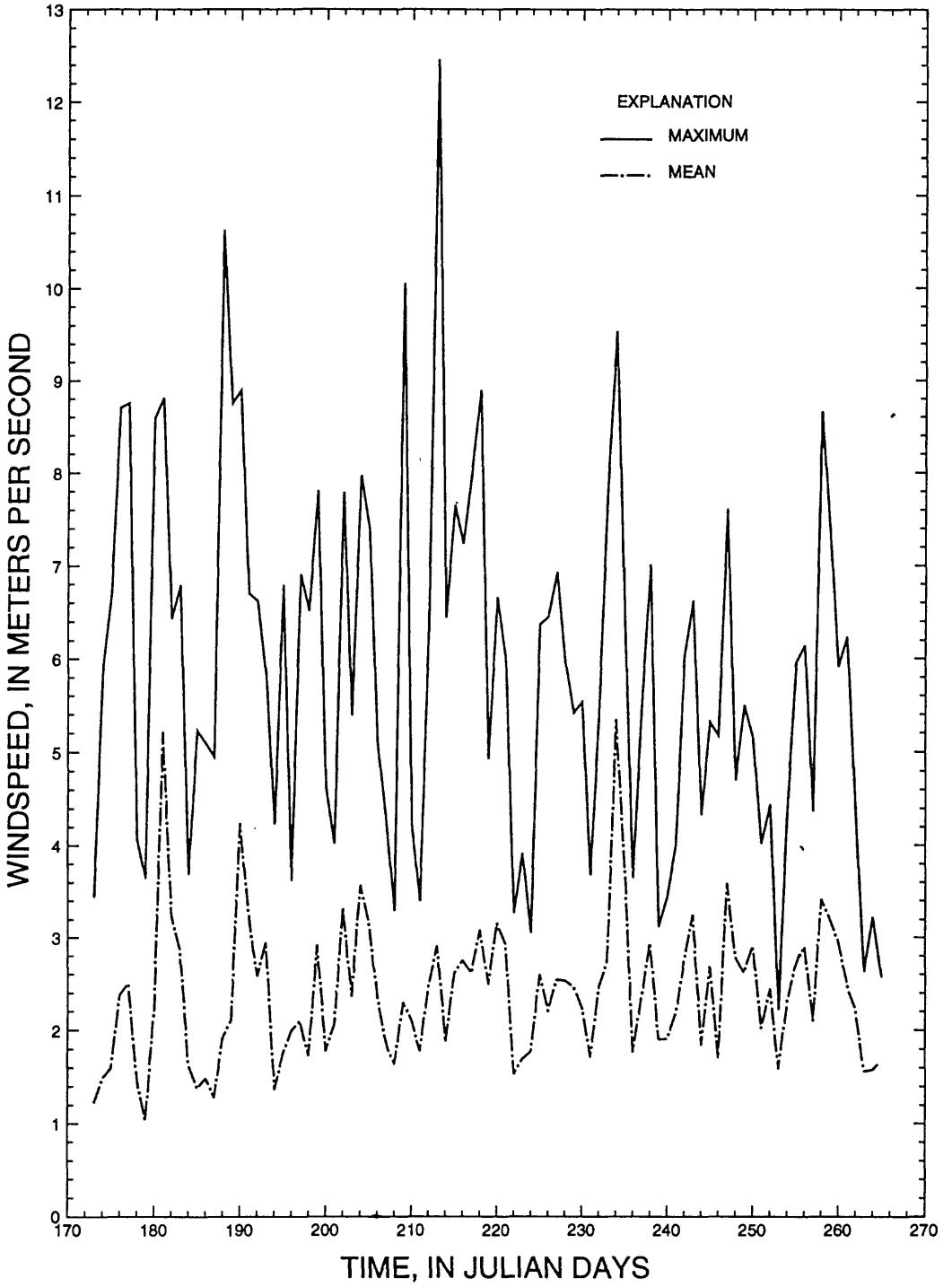

Figure 3. Daily maximum and mean windspeeds from June 21 through September 21, 1992, from 20-minute averages. Minimum windspeed each day was zero. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

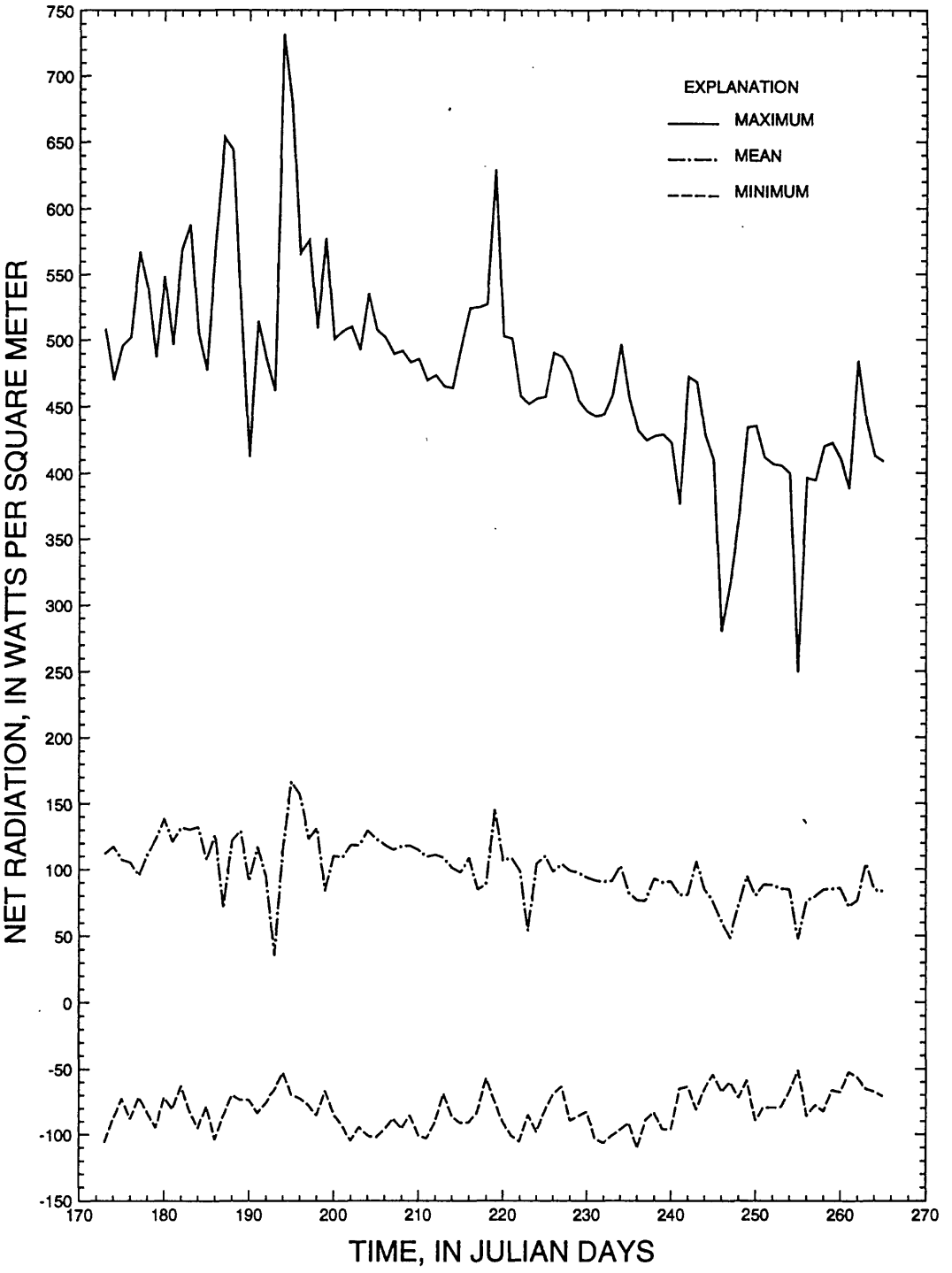

Figure 4. Daily maximum, minimum, and mean net radiation from June 21 through September 21, 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

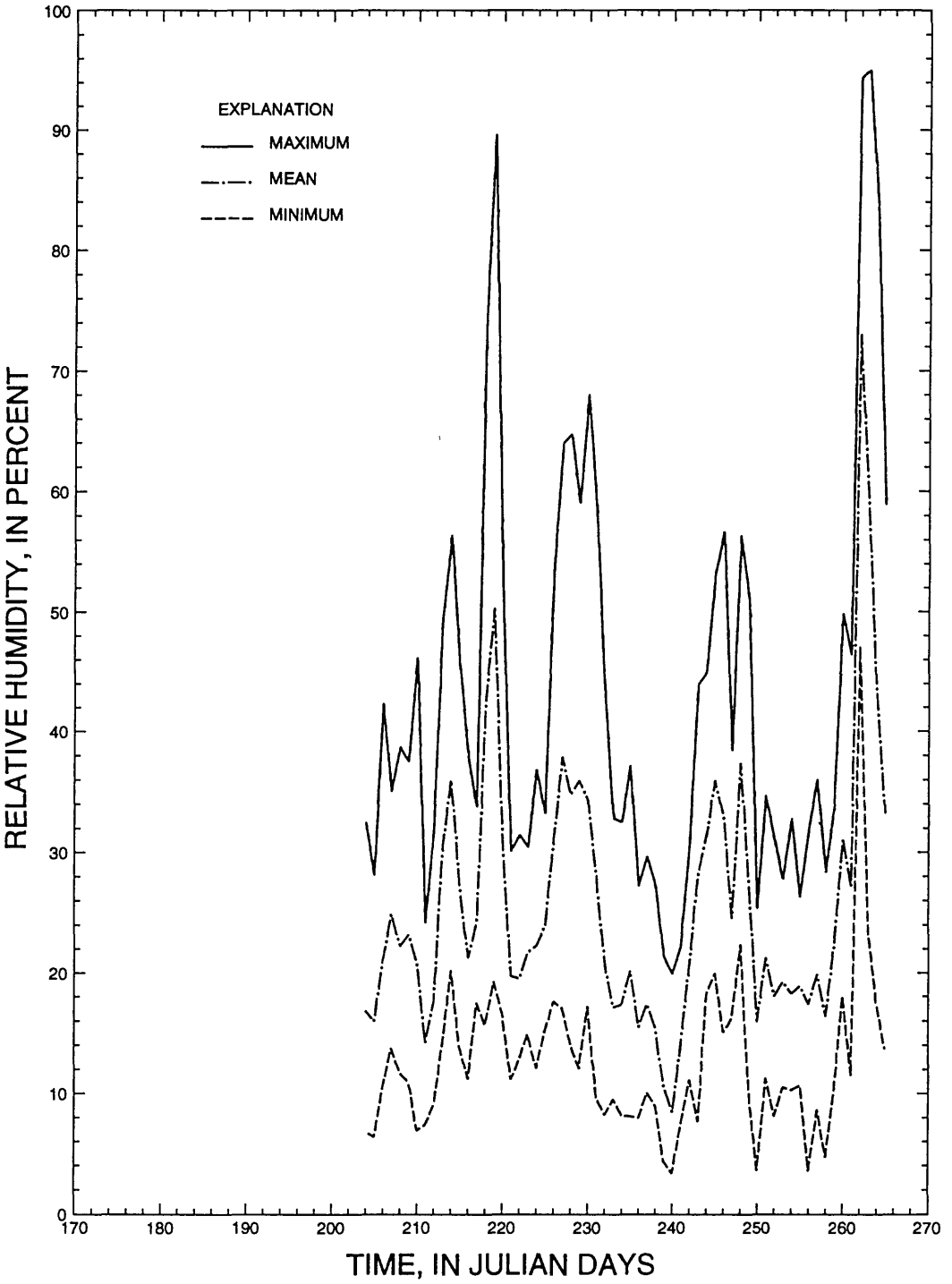

Figure 5. Daily maximum, mean, and minimum relative humidity from July 22 through September 21, 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 204(July 22) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

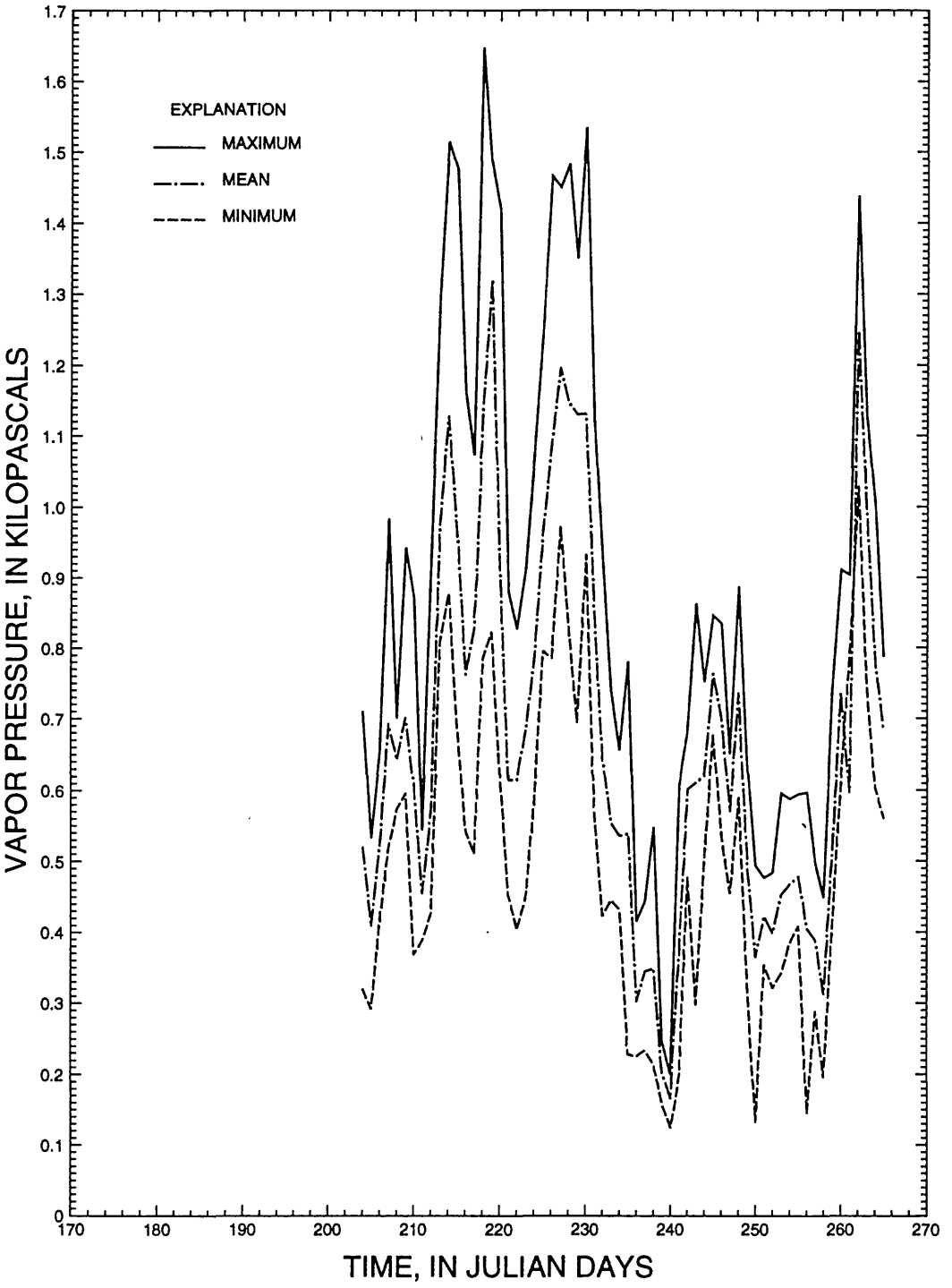

Figure 6. Daily maximum, mean and minimum vapor pressure from July 22 through September 21, 1992, computed from 20-minute averages. (Data are from Lockes East site from Julian day 204 (July 22) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

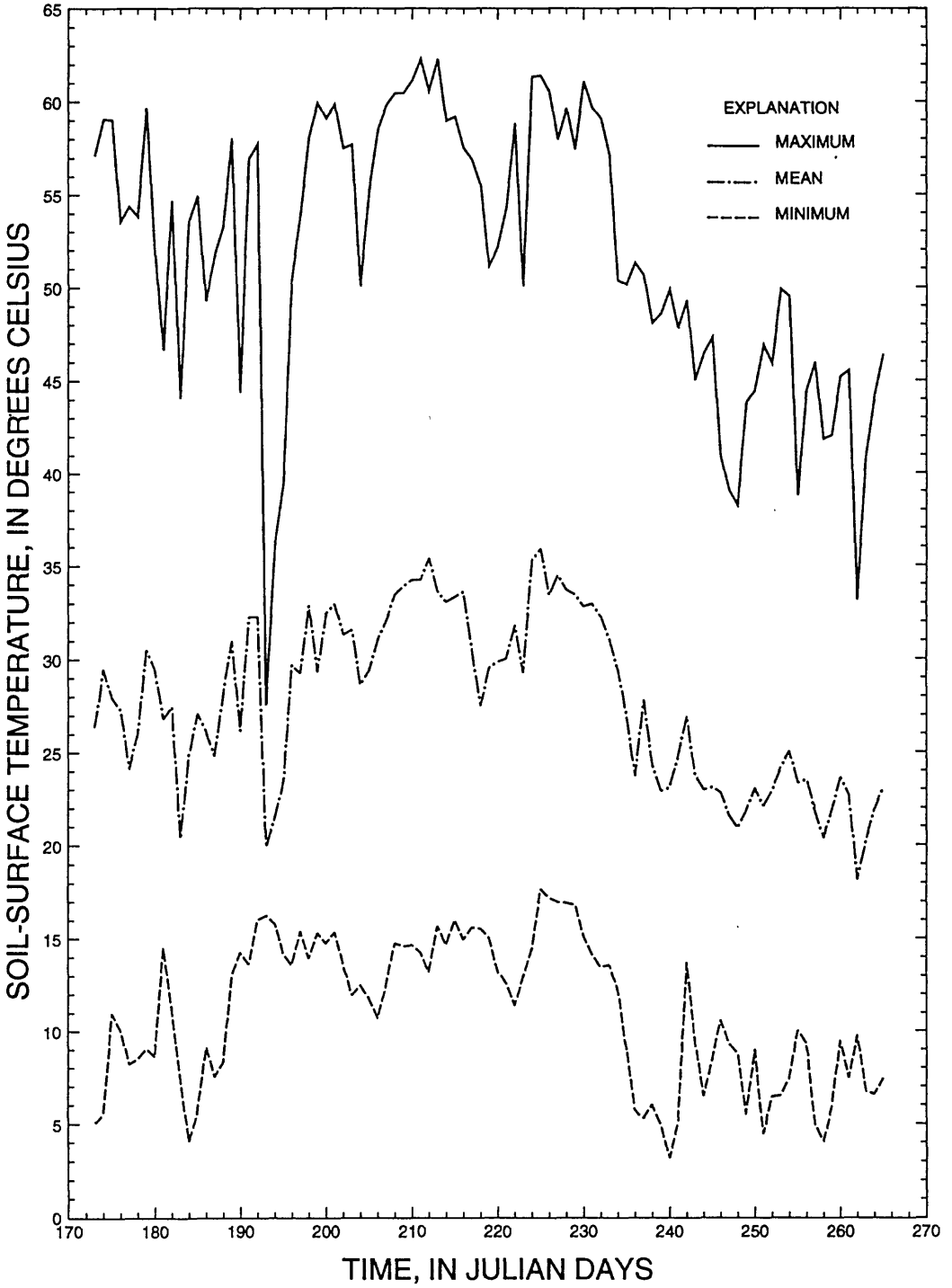

Figure 7. Daily maximum, mean, and minimum soil-surface temperatures from June 21 through September 21, 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

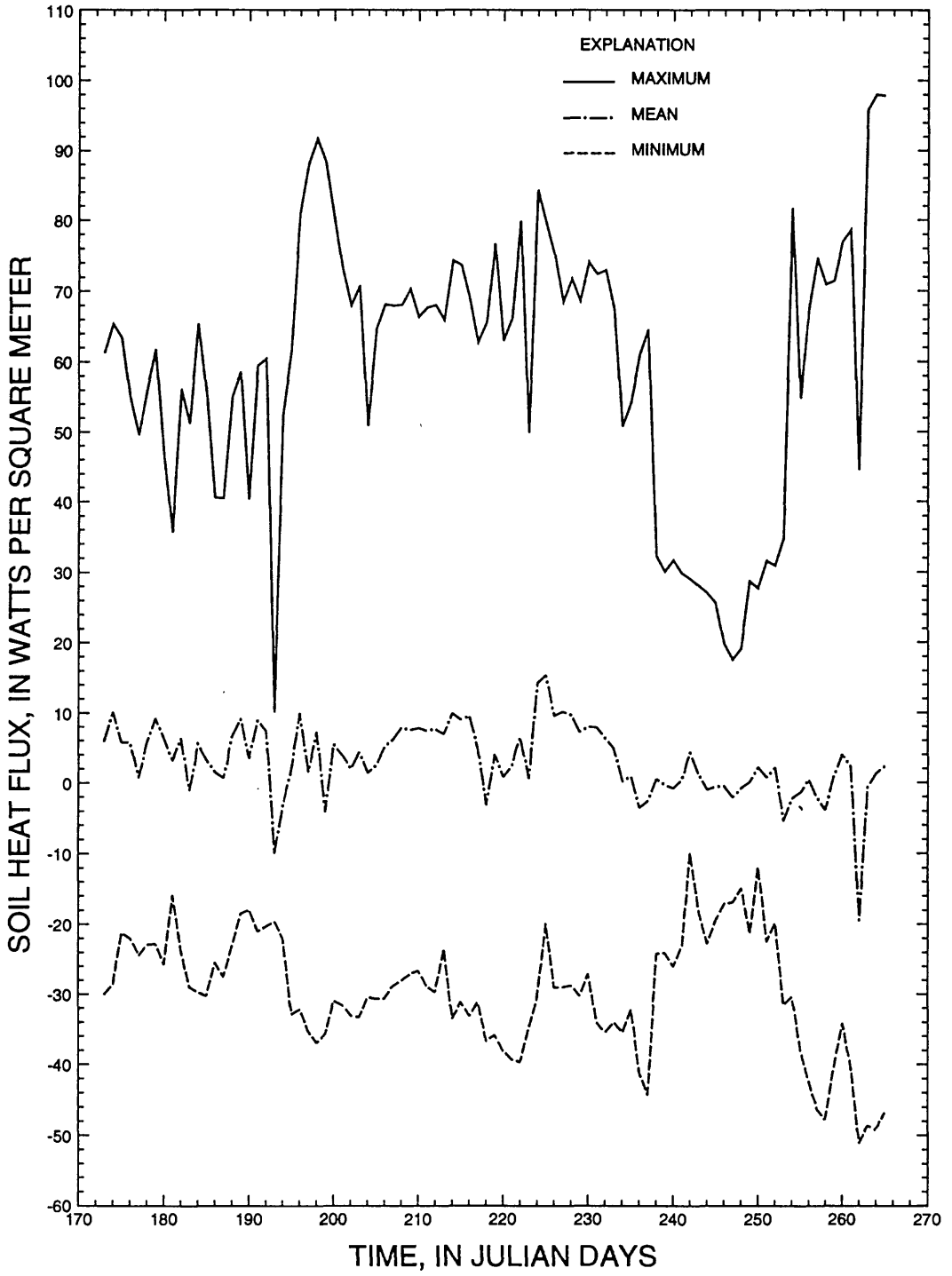

Figure 8. Daily maximum, mean, and minimum soil heat flux from June 21 through September 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

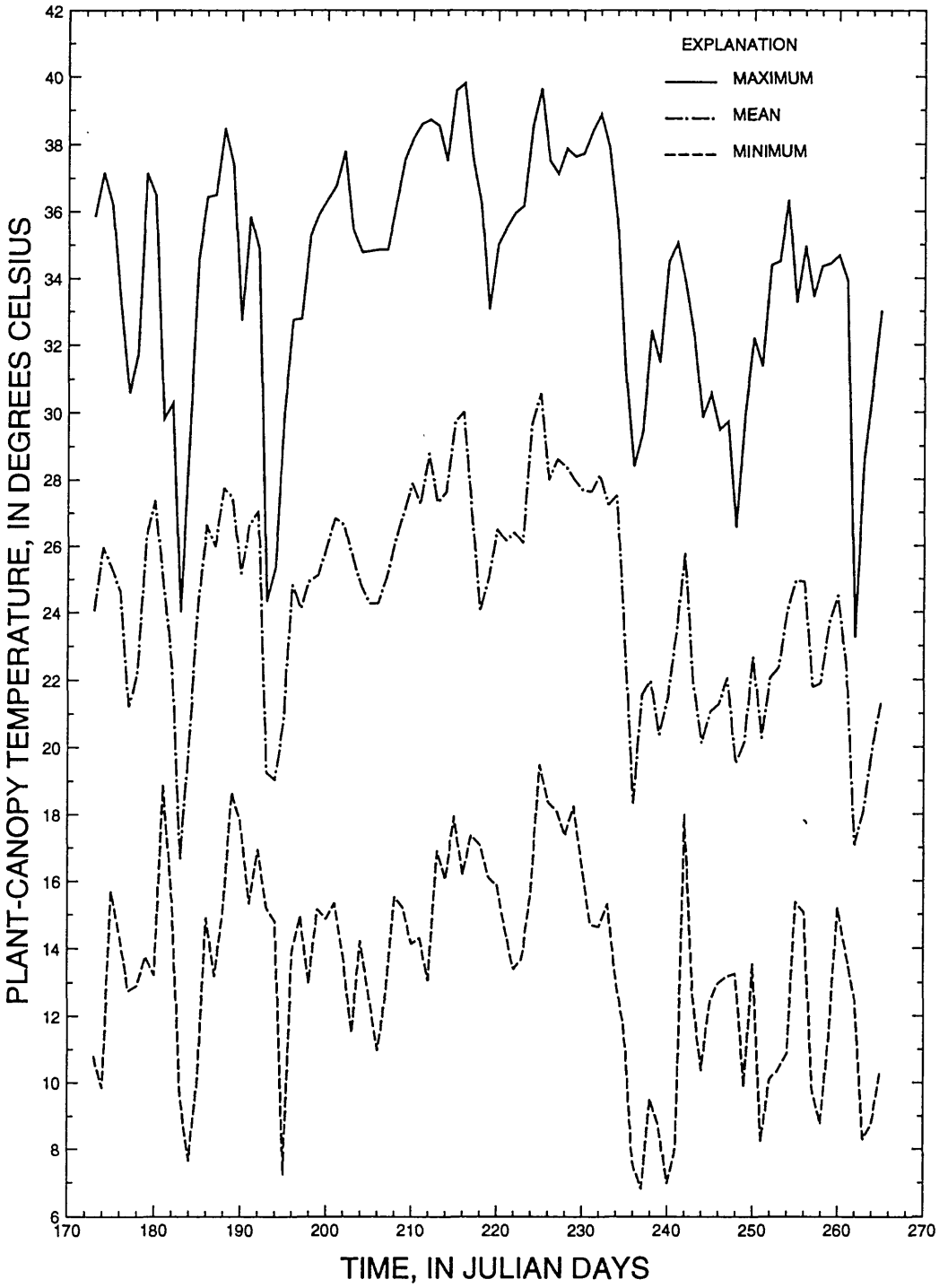

Figure 9. Daily maximum, mean, and minimum values for plant-canopy temperature from June 21 through September 21, 1992, from 20-minute averages. (Data are from Lockes East site from Julian day 173 (June 21) to 215, Lockes Center from day 216 (Aug. 3) to 222, and Lockes West from day 223 (Aug. 10) to 265.)

Table 1. Summary of air temperature, windspeed, and net radiation values, Railroad Valley, Nev., 1992

[Data are from Lockes East site from June 21 through August 2, Lockes Center from August 3 through August 9, and Lockes West for August 10 through September 21; values are from 20-minute averages]

Julian day	Calendar date	Air temperature, in degrees Celsius			Windspeed,[1] in meters per second		Net radiation, in watts per square meter		
		Maximum	Minimum	Mean	Maximum	Mean	Maximum	Minimum	Mean
173	June 21	33.09	6.82	21.63	3.44	1.23	508.4	-106.0	111.8
174	June 22	33.34	6.86	22.92	5.86	1.50	470.0	-87.3	117.5
175	June 23	32.46	12.79	22.63	6.69	1.60	495.8	-72.6	107.3
176	June 24	30.08	11.00	21.97	8.70	2.38	502.3	-88.0	105.3
177	June 25	26.63	10.06	18.72	8.75	2.50	567.4	-71.3	95.4
178	June 26	28.04	11.13	19.69	4.07	1.47	539.7	-83.2	111.5
179	June 27	33.73	11.22	23.73	3.64	1.03	487.2	-94.7	122.9
180	June 28	33.20	12.01	24.93	8.59	2.19	548.7	-71.7	138.5
181	June 29	26.69	16.61	22.53	8.81	5.21	496.4	-80.6	120.9
182	June 30	25.92	13.73	19.82	6.43	3.25	569.0	-63.0	131.8
183	July 1	19.74	7.63	14.09	6.79	2.87	588.0	-81.7	130.3
184	July 2	26.21	6.46	17.40	3.68	1.63	505.4	-95.2	132.0
185	July 3	31.22	7.88	21.54	5.23	1.38	477.3	-78.4	107.2
186	July 4	33.30	13.14	24.44	5.10	1.49	574.1	-103.8	126.3
187	July 5	33.09	12.38	23.78	4.95	1.28	653.3	-85.0	70.7
188	July 6	34.22	14.37	25.33	10.63	1.92	644.3	-69.8	122.1
189	July 7	31.73	17.05	24.30	8.75	2.11	521.8	-73.6	129.2
190	July 8	29.99	15.35	23.56	8.89	4.24	412.3	-73.5	90.9
191	July 9	32.99	13.58	24.18	6.70	3.24	514.5	-83.8	117.2
192	July 10	32.49	15.14	25.40	6.62	2.58	484.2	-75.9	94.3
193	July 11	22.44	12.88	18.11	5.82	2.95	461.7	-64.9	35.4
194	July 12	20.75	12.82	16.34	4.23	1.37	732.0	-52.9	117.9
195	July 13	26.69	12.73	19.16	6.79	1.74	679.3	-69.5	166.4
196	July 14	30.27	12.55	21.97	3.62	1.99	566.3	-72.2	157.2
197	July 15	29.52	16.59	22.66	6.91	2.10	575.9	-77.4	123.2
198	July 16	33.31	12.48	23.39	6.51	1.73	508.9	-85.3	131.1
199	July 17	32.49	14.07	23.10	7.81	2.92	577.4	-66.6	83.8
200	July 18	33.34	14.90	24.47	4.62	1.77	500.9	-83.8	110.4
201	July 19	34.44	15.62	25.58	4.02	2.06	506.7	-92.8	109.0
202	July 20	35.11	14.61	25.30	7.79	3.32	510.0	-105.1	118.3
203	July 21	33.48	12.61	24.24	5.39	2.36	492.3	-94.6	118.1
204	July 22	32.20	14.79	24.62	7.97	3.57	535.3	-101.1	129.2
205	July 23	32.16	13.64	22.99	7.40	3.15	507.7	-102.5	123.0
206	July 24	31.83	10.61	22.36	5.09	2.34	501.7	-96.2	118.7
207	July 25	31.57	13.17	23.38	4.27	1.86	489.3	-87.9	114.8
208	July 26	33.19	15.56	24.90	3.29	1.64	491.7	-95.9	117.6
209	July 27	34.71	15.01	25.44	10.05	2.30	483.0	-85.5	118.1
210	July 28	36.23	14.39	26.42	4.23	2.10	485.5	-100.4	114.8
211	July 29	36.33	15.23	26.68	3.39	1.77	469.7	-103.5	109.2
212	July 30	36.49	13.74	26.64	6.35	2.49	473.2	-90.7	110.9
213	July 31	35.49	17.38	26.27	12.46	2.90	465.0	-68.8	108.6
214	Aug. 1	34.85	15.96	25.63	6.44	1.87	463.6	-86.4	101.0
215	Aug. 2	36.92	17.39	27.89	7.65	2.61	495.0	-91.4	97.5
216	Aug. 3	36.88	15.71	28.22	7.24	2.75	524.4	-90.9	108.5
217	Aug. 4	34.05	17.33	26.22	8.03	2.61	524.6	-82.2	84.6

Table 1. Summary of air temperature, windspeed, and net radiation values, Railroad Valley, Nev., 1992—Continued

Julian day	Calendar date	Air temperature, in degrees Celsius			Windspeed,[1] in meters per second		Net radiation, in watts per square meter		
		Maximum	Minimum	Mean	Maximum	Mean	Maximum	Minimum	Mean
218	Aug. 5	39.20	16.40	23.16	8.89	3.08	527.1	-57.3	88.5
219	Aug. 6	31.17	15.48	23.22	4.93	2.49	629.3	-74.4	145.5
220	Aug. 7	32.80	15.24	24.95	6.66	3.15	502.6	-91.0	106.5
221	Aug. 8	33.91	14.93	25.54	6.01	2.93	500.8	-101.0	108.5
222	Aug. 9	34.34	12.73	25.14	3.26	1.53	457.9	-105.6	98.8
223	Aug. 10	33.96	13.21	24.92	3.92	1.69	451.9	-85.0	53.6
224	Aug. 11	37.21	16.03	27.65	3.04	1.77	455.8	-98.3	104.1
225	Aug. 12	37.01	21.62	29.65	6.36	2.60	457.2	-81.8	110.0
226	Aug. 13	35.82	18.63	27.30	6.45	2.21	490.1	-69.5	98.0
227	Aug. 14	35.41	17.01	26.58	6.93	2.54	487.1	-63.4	103.9
228	Aug. 15	36.01	16.69	27.47	5.96	2.53	475.8	-89.6	98.7
229	Aug. 16	35.59	17.19	26.28	5.41	2.46	454.1	-86.0	97.5
230	Aug. 17	34.94	19.15	26.79	5.53	2.25	446.2	-82.8	93.8
231	Aug. 18	36.81	14.17	26.68	3.68	1.72	442.6	-103.3	91.7
232	Aug. 19	37.39	14.76	27.13	5.41	2.47	443.9	-106.7	90.4
233	Aug. 20	36.21	14.71	26.48	7.85	2.74	458.7	-101.0	90.9
234	Aug. 21	37.82	11.88	25.98	9.53	5.34	496.4	-96.7	102.5
235	Aug. 22	29.36	14.73	22.93	6.50	3.81	456.5	-91.4	82.1
236	Aug. 23	26.37	10.25	18.03	3.64	1.76	432.2	-111.0	76.6
237	Aug. 24	27.20	7.31	18.28	5.46	2.35	424.3	-88.9	76.3
238	Aug. 25	29.94	8.63	20.34	7.01	2.94	427.9	-83.0	93.0
239	Aug. 26	28.97	7.73	18.82	3.12	1.90	428.8	-96.3	90.0
240	Aug. 27	32.28	5.94	19.85	3.44	1.91	422.5	-96.2	90.7
241	Aug. 28	32.50	7.23	21.75	3.99	2.18	376.3	-65.2	80.6
242	Aug. 29	31.41	16.82	24.34	6.01	2.74	472.1	-63.7	80.7
243	Aug. 30	29.73	11.26	20.37	6.62	3.25	468.2	-81.3	106.0
244	Aug. 31	27.21	8.98	18.31	4.33	1.84	428.6	-65.0	84.8
245	Sept. 1	28.04	11.08	19.40	5.31	2.68	409.9	-54.5	75.6
246	Sept. 2	28.00	11.70	19.80	5.17	1.70	279.7	-67.6	61.3
247	Sept. 3	27.65	11.89	20.56	7.61	3.58	316.8	-60.2	48.1
248	Sept. 4	24.63	12.07	18.00	4.70	2.78	366.7	-72.1	72.5
249	Sept. 5	28.23	8.47	18.56	5.49	2.62	434.4	-58.8	94.7
250	Sept. 6	30.54	12.62	21.35	5.16	2.90	435.3	-89.5	80.1
251	Sept. 7	29.67	7.22	18.70	4.02	2.02	411.8	-79.1	88.5
252	Sept. 8	32.47	8.97	20.70	4.44	2.44	406.5	-79.8	88.0
253	Sept. 9	31.95	9.46	20.78	2.22	1.59	405.4	-79.1	85.3
254	Sept. 10	32.12	10.36	20.97	4.39	2.32	399.5	-67.1	84.7
255	Sept. 11	29.51	13.11	21.81	5.95	2.71	249.1	-50.9	47.6
256	Sept. 12	30.88	12.78	21.92	6.14	2.90	396.4	-86.0	76.2
257	Sept. 13	29.18	7.57	18.67	4.36	2.10	394.4	-77.6	79.4
258	Sept. 14	30.15	6.71	18.87	8.66	3.41	419.9	-82.6	84.7
259	Sept. 15	29.78	9.51	20.50	7.38	3.20	422.4	-66.5	85.0
260	Sept. 16	30.09	12.67	21.09	5.91	2.95	410.4	-67.7	86.0
261	Sept. 17	29.31	10.23	19.70	6.23	2.49	388.1	-52.7	71.8
262	Sept. 18	19.70	11.30	15.36	4.37	2.21	484.1	-56.6	76.7
263	Sept. 19	25.65	7.12	16.13	2.63	1.56	438.8	-65.7	104.0
264	Sept. 20	27.37	7.70	18.08	3.22	1.58	412.8	-67.6	84.6
265	Sept. 21	29.56	9.34	19.48	2.57	1.67	408.5	-70.9	83.3

[1] All minimum windspeed values equal zero.

Table 2. Summary of relative humidity, vapor pressure, and soil-surface temperature values, Railroad Valley, Nev., 1992

[Data are from Lockes East site from June 21 through August 2, Lockes Center from August 3 through August 9, and Lockes West for August 10 through September 21; values are from 20-minute averages; --, no data]

Julian day	Calendar date	Relative humidity, in percent			Vapor pressure, in kilopascals			Soil-surface temperature, in degrees Celsius		
		Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
173	June 21	--	--	--	--	--	--	57.13	5.06	26.37
174	June 22	--	--	--	--	--	--	59.07	5.51	29.49
175	June 23	--	--	--	--	--	--	59.03	10.98	27.94
176	June 24	--	--	--	--	--	--	53.54	10.08	27.30
177	June 25	--	--	--	--	--	--	54.39	8.23	24.14
178	June 26	--	--	--	--	--	--	53.84	8.51	26.01
179	June 27	--	--	--	--	--	--	59.68	9.07	30.50
180	June 28	--	--	--	--	--	--	52.21	8.61	29.48
181	June 29	--	--	--	--	--	--	46.65	14.53	26.83
182	June 30	--	--	--	--	--	--	54.69	11.12	27.47
183	July 1	--	--	--	--	--	--	44.06	7.41	20.40
184	July 2	--	--	--	--	--	--	53.52	4.06	24.86
185	July 3	--	--	--	--	--	--	54.93	5.64	27.08
186	July 4	--	--	--	--	--	--	49.28	9.15	26.18
187	July 5	--	--	--	--	--	--	51.67	7.53	24.81
188	July 6	--	--	--	--	--	--	53.22	8.30	28.12
189	July 7	--	--	--	--	--	--	58.03	13.02	30.98
190	July 8	--	--	--	--	--	--	44.38	14.25	26.17
191	July 9	--	--	--	--	--	--	56.95	13.63	32.27
192	July 10	--	--	--	--	--	--	57.74	16.02	32.27
193	July 11	--	--	--	--	--	--	27.56	16.26	19.92
194	July 12	--	--	--	--	--	--	36.05	15.81	21.48
195	July 13	--	--	--	--	--	--	39.46	14.19	23.41
196	July 14	--	--	--	--	--	--	50.31	13.56	29.70
197	July 15	--	--	--	--	--	--	53.84	15.40	29.24
198	July 16	--	--	--	--	--	--	58.10	13.92	32.88
199	July 17	--	--	--	--	--	--	59.93	15.29	29.32
200	July 18	--	--	--	--	--	--	59.10	14.75	32.46
201	July 19	--	--	--	--	--	--	59.84	15.34	32.96
202	July 20	--	--	--	--	--	--	57.50	13.66	31.31
203	July 21	--	--	--	--	--	--	57.70	11.95	31.58
204	July 22	32.52	6.8	16.81	0.71	0.32	0.52	50.05	12.48	28.63
205	July 23	28.12	6.4	15.95	.53	.29	.41	55.26	11.78	29.38
206	July 24	42.32	10.7	21.12	.65	.42	.52	58.53	10.72	31.06
207	July 25	35.06	13.7	24.87	.98	.52	.69	59.83	12.61	32.11
208	July 26	38.65	11.6	22.22	.70	.57	.64	60.46	14.75	33.47
209	July 27	37.53	11.0	23.19	.94	.60	.70	60.46	14.59	33.91
210	July 28	46.14	6.9	20.79	.87	.37	.60	61.13	14.64	34.23
211	July 29	24.18	7.4	14.18	.54	.39	.45	62.29	14.24	34.23
212	July 30	31.91	9.2	17.66	.93	.43	.57	60.59	13.18	35.40
213	July 31	49.48	14.0	30.47	1.29	.81	.98	62.29	15.67	33.63
214	Aug. 1	56.39	20.2	35.99	1.51	.88	1.13	58.97	14.64	33.06
215	Aug. 2	45.65	13.9	27.24	1.48	.69	.96	59.20	16.02	33.32
216	Aug. 3	37.92	11.2	21.28	1.16	.54	.76	57.53	14.94	33.60
217	Aug. 4	33.78	17.5	24.17	1.07	.51	.83	56.90	15.60	30.47

Table 2. Summary of relative humidity, vapor pressure, and soil-surface temperature values, Railroad Valley, Nev., 1992—Continued

Julian day	Calendar date	Relative humidity, in percent			Vapor pressure, in kilopascals			Soil-surface temperature, in degrees Celsius		
		Maximum	Minimum	Mean	Maximum	Minimum	Mean	Maximum	Minimum	Mean
218	Aug. 5	74.35	15.6	42.48	1.65	0.78	1.13	55.50	15.53	27.50
219	Aug. 6	89.63	19.3	50.30	1.49	.82	1.32	51.14	15.02	29.52
220	Aug. 7	51.91	16.6	30.88	1.42	.62	.90	52.10	13.22	29.85
221	Aug. 8	30.10	11.2	19.74	.88	.45	.61	54.22	12.60	30.02
222	Aug. 9	31.43	12.8	19.51	.83	.40	.61	58.83	11.40	31.80
223	Aug. 10	30.44	14.9	21.75	.91	.45	.68	50.05	12.95	29.25
224	Aug. 11	36.84	12.1	22.25	1.07	.59	.78	61.34	14.39	35.30
225	Aug. 12	33.25	15.1	23.91	1.25	.80	.97	61.40	17.65	35.89
226	Aug. 13	53.81	17.6	31.03	1.47	.78	1.09	60.54	17.22	33.43
227	Aug. 14	63.96	17.0	37.89	1.45	.97	1.20	57.97	16.95	34.47
228	Aug. 15	64.74	14.1	34.78	1.48	.83	1.15	59.64	16.92	33.70
229	Aug. 16	59.05	12.1	35.94	1.35	.69	1.13	57.44	16.80	33.44
230	Aug. 17	68.01	17.2	34.37	1.53	.93	1.13	61.07	15.11	32.81
231	Aug. 18	58.29	9.7	27.94	1.12	.57	.84	59.67	14.14	32.96
232	Aug. 19	42.90	8.2	20.69	.92	.42	.64	59.08	13.45	32.24
233	Aug. 20	32.83	9.5	17.10	.74	.45	.55	57.14	13.57	31.02
234	Aug. 21	32.50	8.1	17.34	.66	.43	.54	50.35	12.19	29.42
235	Aug. 22	37.16	8.1	20.16	.78	.23	.54	50.12	9.04	26.94
236	Aug. 23	27.20	8.0	15.47	.42	.22	.30	51.30	5.74	23.70
237	Aug. 24	29.65	10.0	17.36	.44	.23	.34	50.65	5.28	27.79
238	Aug. 25	27.40	8.9	15.41	.55	.21	.35	48.07	6.01	24.28
239	Aug. 26	21.37	4.3	10.52	.25	.16	.20	48.59	4.88	22.88
240	Aug. 27	19.92	3.3	8.45	.20	.12	.17	49.86	3.16	23.09
241	Aug. 28	22.25	7.5	14.02	.61	.19	.37	47.80	5.11	24.76
242	Aug. 29	30.61	11.1	20.92	.68	.48	.60	49.30	13.71	26.92
243	Aug. 30	43.93	7.7	28.17	.86	.30	.61	45.00	9.39	23.71
244	Aug. 31	44.92	18.2	31.39	.75	.51	.62	46.45	6.46	22.96
245	Sept. 1	53.31	20.0	35.92	.84	.68	.76	47.30	8.48	23.10
246	Sept. 2	56.66	15.0	32.94	.83	.53	.70	40.96	10.59	22.82
247	Sept. 3	38.40	16.2	24.53	.65	.45	.57	39.04	9.32	21.60
248	Sept. 4	56.34	22.4	37.37	.89	.59	.74	38.24	8.75	20.91
249	Sept. 5	50.95	10.0	27.26	.64	.33	.50	43.82	5.49	21.85
250	Sept. 6	25.38	3.6	15.92	.49	.13	.36	44.42	8.99	23.04
251	Sept. 7	34.68	11.3	21.25	.48	.35	.42	46.88	4.42	22.09
252	Sept. 8	31.16	8.1	18.01	.48	.32	.40	45.90	6.43	22.89
253	Sept. 9	27.68	10.5	19.22	.60	.34	.45	49.88	6.49	24.14
254	Sept. 10	32.83	10.3	18.22	.59	.38	.47	49.52	7.45	25.05
255	Sept. 11	26.29	10.7	18.87	.59	.41	.48	38.75	10.03	23.33
256	Sept. 12	31.90	3.5	17.33	.60	.14	.41	44.44	9.29	23.50
257	Sept. 13	36.00	8.6	19.86	.50	.29	.39	45.97	4.95	21.81
258	Sept. 14	28.35	4.7	16.38	.45	.20	.31	41.83	4.04	20.38
259	Sept. 15	33.86	10.6	22.42	.74	.41	.51	42.03	5.91	21.83
260	Sept. 16	49.84	18.0	31.10	.91	.61	.74	45.18	9.48	23.62
261	Sept. 17	46.39	11.5	27.09	.90	.79	.60	45.53	7.43	22.69
262	Sept. 18	94.39	47.1	73.04	1.44	1.03	1.25	33.16	9.76	18.16
263	Sept. 19	95.05	23.2	59.40	1.13	.75	.99	40.82	6.74	20.27
264	Sept. 20	83.92	17.4	43.00	1.00	.60	.78	44.14	6.56	21.94
265	Sept. 21	58.91	13.7	33.24	.79	.56	.68	46.39	7.41	23.07

Table 3. Summary of soil heat flux and plant-canopy temperature values, Railroad Valley, Nev., 1992

[Data are from Lockes East site from June 21 through August 2, Lockes Center from August 3 through August 9, and Lockes West for August 10 through September 21; values are from 20-minute averages]

Julian day	Calendar date	Soil heat flux, in watts per square meter			Plant-canopy temperature, in degrees Celsius		
		Maximum	Minimum	Mean	Maximum	Minimum	Mean
173	June 21	61.34	-30.03	5.91	35.85	10.80	24.05
174	June 22	65.40	-28.62	10.17	37.16	9.83	25.96
175	June 23	63.46	-21.19	5.79	36.23	15.70	25.36
176	June 24	54.93	-21.98	5.76	33.23	14.37	24.63
177	June 25	49.59	-24.43	.76	30.59	12.75	21.22
178	June 26	56.03	-22.92	5.69	31.74	12.90	22.18
179	June 27	61.80	-22.80	9.20	37.14	13.76	26.22
180	June 28	46.71	-25.72	6.40	36.48	13.21	27.36
181	June 29	35.71	-15.92	3.18	29.82	18.87	24.90
182	June 30	56.13	-23.74	6.34	30.28	15.53	22.53
183	July 1	51.25	-28.93	-1.06	24.01	9.66	16.66
184	July 2	65.44	-29.72	5.58	29.31	7.63	20.06
185	July 3	55.40	-30.26	3.18	34.57	10.10	24.21
186	July 4	40.64	-25.44	1.54	36.43	14.91	26.64
187	July 5	40.50	-27.49	.71	36.49	13.18	25.98
188	July 6	55.08	-23.08	6.55	38.47	15.23	27.75
189	July 7	58.59	-18.49	9.13	37.40	18.66	27.45
190	July 8	40.36	-17.94	3.46	32.73	17.75	25.18
191	July 9	59.43	-21.03	8.92	35.84	15.32	26.64
192	July 10	60.47	-20.28	7.44	34.86	16.95	27.05
193	July 11	10.17	-19.60	-10.01	24.33	15.21	19.24
194	July 12	52.59	-22.07	-3.19	25.37	14.80	19.03
195	July 13	61.56	-32.88	2.07	29.97	7.23	20.86
196	July 14	80.90	-32.15	9.95	32.75	13.84	24.82
197	July 15	88.10	-35.36	1.58	32.78	14.96	24.12
198	July 16	91.70	-36.95	7.25	35.28	12.97	24.95
199	July 17	88.40	-35.74	-4.14	35.90	15.16	25.12
200	July 18	80.70	-30.99	5.45	36.35	14.86	25.98
201	July 19	73.20	-31.53	3.95	36.77	15.34	26.83
202	July 20	67.99	-33.04	1.98	37.80	13.75	26.64
203	July 21	70.80	-33.29	4.32	35.41	11.50	25.66
204	July 22	50.81	-30.44	1.40	34.78	14.22	24.81
205	July 23	64.74	-30.67	2.53	34.81	12.62	24.26
206	July 24	68.15	-30.65	5.23	34.85	10.96	24.27
207	July 25	67.93	-28.70	6.10	34.85	12.70	25.05
208	July 26	68.07	-28.07	7.87	36.16	15.53	26.14
209	July 27	70.30	-27.13	7.53	37.54	15.20	26.95
210	July 28	66.37	-26.58	7.76	38.17	14.13	27.88
211	July 29	67.68	-28.93	7.42	38.59	14.30	27.25
212	July 30	68.03	-29.71	7.66	38.73	13.05	28.77
213	July 31	65.92	-23.51	6.93	38.55	16.91	27.30
214	Aug. 1	74.30	-33.53	9.93	37.50	16.04	27.62
215	Aug. 2	73.70	-31.13	9.03	39.59	17.93	29.71
216	Aug. 3	68.94	-33.12	9.56	39.80	16.18	30.02
217	Aug. 4	62.71	-31.19	4.88	37.56	17.37	27.05

Table 3. Summary of soil heat flux and plant-canopy temperature values, Railroad Valley, Nev., 1992—Continued

Julian day	Calendar date	Soil heat flux, in watts per square meter			Plant-canopy temperature, in degrees Celsius		
		Maximum	Minimum	Mean	Maximum	Minimum	Mean
218	Aug. 5	65.55	-36.71	-3.16	36.24	17.09	24.03
219	Aug. 6	76.70	-35.88	4.00	33.05	16.09	25.04
220	Aug. 7	62.97	-38.04	.79	35.01	15.89	26.49
221	Aug. 8	66.17	-39.32	2.41	35.51	14.55	26.15
222	Aug. 9	79.90	-39.72	6.44	35.94	13.38	26.39
223	Aug. 10	49.84	-34.81	.60	36.16	13.71	26.08
224	Aug. 11	84.30	-30.30	14.25	38.53	15.78	29.68
225	Aug. 12	79.70	-19.94	15.34	39.65	19.48	30.56
226	Aug. 13	75.10	-29.05	9.53	37.51	18.35	27.98
227	Aug. 14	68.46	-29.00	10.17	37.13	18.12	28.61
228	Aug. 15	71.70	-28.75	9.70	37.87	17.35	28.39
229	Aug. 16	68.60	-30.25	7.20	37.63	18.24	27.99
230	Aug. 17	74.10	-27.09	8.00	37.72	16.36	27.66
231	Aug. 18	72.40	-34.11	7.90	38.38	14.69	27.62
232	Aug. 19	73.00	-35.45	6.31	38.88	14.63	28.13
233	Aug. 20	67.50	-34.05	4.90	37.92	15.31	27.23
234	Aug. 21	50.76	-35.51	.20	35.74	13.07	27.51
235	Aug. 22	54.27	-32.22	.88	31.19	11.45	23.08
236	Aug. 23	60.96	-41.16	-3.59	28.39	7.57	18.32
237	Aug. 24	64.56	-44.36	-2.61	29.42	6.80	21.57
238	Aug. 25	32.27	-24.20	.53	32.43	9.50	21.95
239	Aug. 26	30.06	-24.11	-.37	31.48	8.70	20.37
240	Aug. 27	31.68	-26.04	-.83	34.49	6.96	21.46
241	Aug. 28	29.89	-23.22	.37	35.05	8.05	23.37
242	Aug. 29	29.00	-9.94	4.30	33.86	17.99	25.81
243	Aug. 30	28.06	-18.30	1.07	32.28	12.58	21.92
244	Aug. 31	27.02	-22.80	-1.03	29.85	10.36	20.12
245	Sept. 1	25.63	-19.48	-.63	30.55	12.46	21.05
246	Sept. 2	19.72	-17.15	-.53	29.49	12.97	21.29
247	Sept. 3	17.52	-16.93	-2.13	29.73	13.17	22.06
248	Sept. 4	19.06	-14.94	-.82	26.55	13.25	19.51
249	Sept. 5	28.67	-21.38	.04	29.99	9.88	20.15
250	Sept. 6	27.66	-11.92	2.20	32.21	13.55	22.67
251	Sept. 7	31.61	-22.50	.75	31.37	8.21	20.27
252	Sept. 8	30.89	-19.85	2.12	34.39	10.11	22.06
253	Sept. 9	34.77	-31.58	-5.40	34.50	10.38	22.35
254	Sept. 10	81.70	-30.42	-2.26	36.34	10.86	24.02
255	Sept. 11	54.76	-38.13	-1.32	33.26	15.37	24.94
256	Sept. 12	67.45	-42.44	.45	34.96	15.05	24.92
257	Sept. 13	74.70	-46.31	-2.20	33.44	9.74	21.78
258	Sept. 14	70.90	-47.81	-3.92	34.36	8.75	21.90
259	Sept. 15	71.40	-40.52	.92	34.44	11.50	23.68
260	Sept. 16	76.90	-34.17	3.94	34.68	15.20	24.48
261	Sept. 17	78.60	-40.41	2.26	33.93	13.83	22.32
262	Sept. 18	44.47	-51.10	-19.44	23.24	12.52	17.07
263	Sept. 19	95.80	-48.68	-.66	28.56	8.28	18.07
264	Sept. 20	98.00	-49.18	1.28	30.74	8.74	19.92
265	Sept. 21	97.80	-46.86	2.30	33.02	10.33	21.30