

**CSU ASTEX Surface Data Sets from
Porto Santo (June 1-28, 1992)**

by
S. Cox, S. Gillies, A. Heidinger, and C. Keith

FIRE Series No. 9

Department of Atmospheric Science
Colorado State University
Fort Collins, Colorado

Funding Agencies:
Office of Naval Research
National Aeronautics & Space Administration
Department of Energy
National Science Foundation

**Colorado
State
University**

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Paper No. 530

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1. Introduction

During the ASTEX-FIRE II field phase, June 1 - 27, 1992, Colorado State University and NOAA/WPL scientists operated an extensive ensemble of in situ and remote sensing instrumentation on the island of Porto Santo, Madeiras. Figure 1 shows map of the island of Porto Santo and the relative location of the ASTEX site near the north end of the airport runway. Summaries of the site characteristics and instrumentation were presented by Cox et al., (1993). In addition, a document by Schubert, et al., (1992) presented data in graphical format from three-hourly rawinsonde releases from the Porto Santo site. The intent of the Schubert document was to provide the scientific community with a "quick look" visual depiction of a large data set; we have the same intention with the presentations which follow. While the graphical data presentations do not lend themselves to detailed scientific study, they do provide the reader with a nearly continuous summary of surface conditions on the island of Porto Santo during the ASTEX field experiment. From these summaries one can select times of special interest and then access higher time resolution data in digital format for quantitative analyses.

Tables 1-5 summarize the entire set of measurements conducted from the island of Porto Santo during the ASTEX field expedition. More detailed summaries of these instruments and the respective data collection procedures may be found in Cox, et al., (1993).

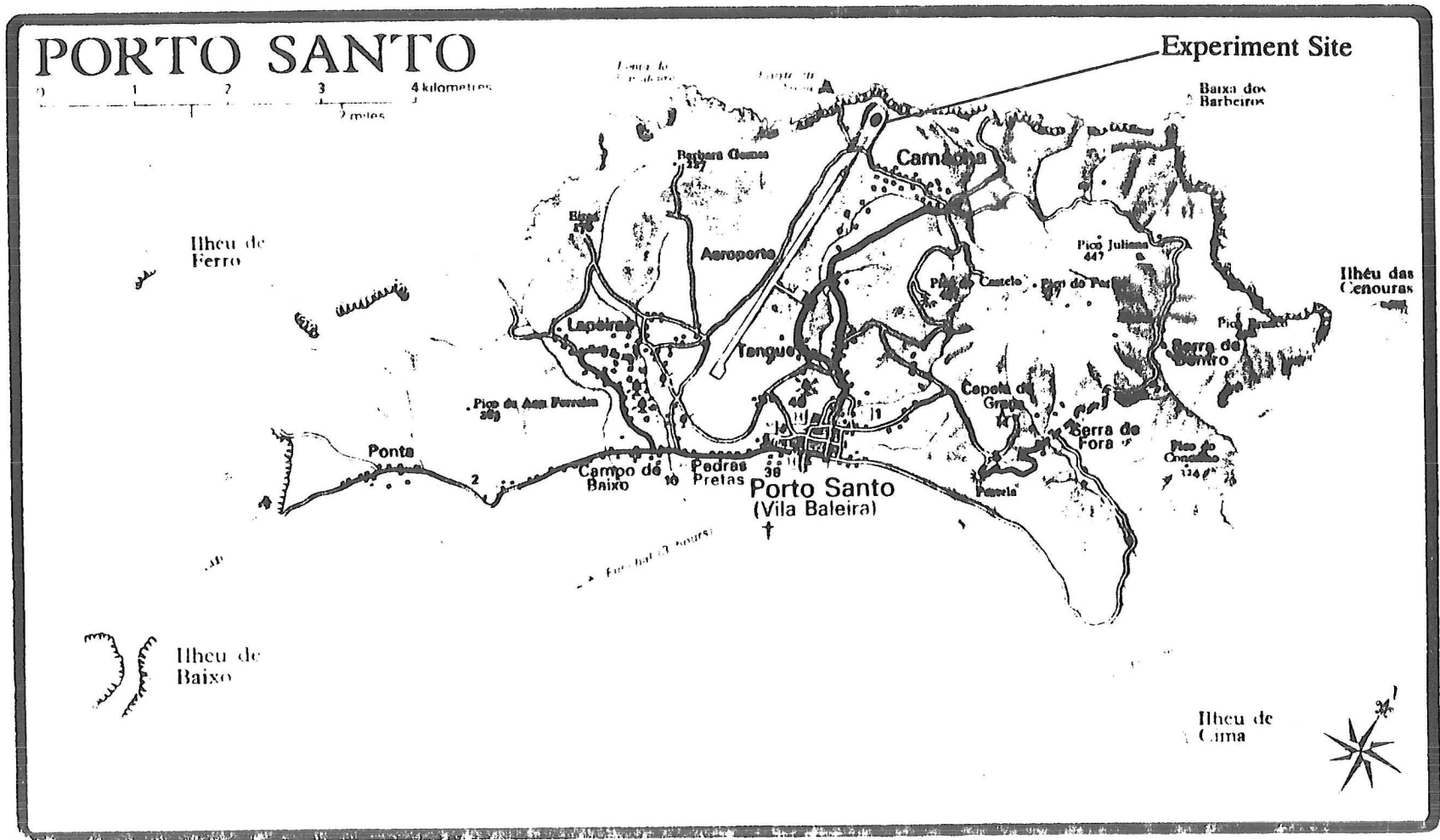


Figure 1: Map of the island of Porto Santo

ASTEX - PORTO SANTO
JUNE 1 - 28, 1992

Table 1. Surface Meteorology Observations

INSTRUMENTATION	VARIABLES MEASURED	DERIVEABLE PARAMETERS	SAMPLING	AGENCY/INSTITUTION
Campbell 21X System	Temperature Relative Humidity Wind Speed Wind Direction	Same as measured variables	Continuous, 2 min. interval	CSU

Table 2. Infrared Radiation Observations

INSTRUMENTATION	VARIABLES MEASURED	DERIVEABLE PARAMETERS	SAMPLING	AGENCY/INSTITUTION
Pyrgeometer	3-50 μ m irradiance	Cloud emittance, effective radiating temperature, cloud base temperature	Continuous, 2 min. interval	CSU & WPL
PRT - 6, PRT - 5	10-11 μ m; 8-10 μ m radiance 2 degree FOV, vertical	Cloud base temperature, Cloud emittance, effective radiating temperature	Continuous, 10 sec. interval	CSU, WPL respectively
Infrared interferometer	5-15 μ m; 1 cm ⁻¹ spectral radiance, 40mr FOV, vertical and angle scan	Temperature(z), atmospheric spectral emittance, equivalent emitting temperature,	On demand	CSU

ASTEX - PORTO SANTO
JUNE 1 - 28, 1992

Table 3. Solar Radiation Observations

INSTRUMENTATION	VARIABLES MEASURED	DERIVEABLE PARAMETERS	SAMPLING	AGENCY/ INSTITUTION
Pyranometer	.3-2.8 μ m irradiance .695-2.8 μ m irradiance	Global radiation, Diffuse component w/ Pyrheliometer	Continuous 2 min. interval	CSU & WPL CSU
Pyrheliometer	.3-2.8 μ m direct solar .53-2.8 μ m direct solar .695-2.8 μ m direct solar 1.0-2.8 μ m direct solar All 5 degree FOV (1/2 angle)	Direct component, aerosol extinction coefficient, cloud optical depth	Continuous 2 min. interval	CSU
Sun Photometer	0.50, 2 μ m	Aerosol extinction coefficient	On demand	CSU/ WPL
Multiple Field of View Radiometer	2°,5°,10°,20° and 30° fields of view, Spectral band pass .4 to 1.1 μ m	Cloud optical depth, droplet/crystal size	Continuous 2 min. interval	CSU

ASTEX - PORTO SANTO
JUNE 1 - 28, 1992

Table 4. Cloud Observations

INSTRUMENTATION	VARIABLES MEASURED	DERIVEABLE PARAMETERS	SAMPLING	AGENCY/ INSTITUTION
Scanning 6.8 mm Radar	radar cross section as a function of height, doppler shifted frequency	liquid/ice water content; radial component of velocity; particle fall velocity; cloud base/top height	Continuous	WPL
Scanning 10.7 μm Doppler Lidar	back scatter coefficient as a function of height, doppler shifted frequency	radial component of velocity; cloud base/top height; aerosol backscatter	On demand	WPL
.9 μm Laser Ceilometer	back scatter efficiency as a function of height	Cloud base height	Continuous 1 min repetition	CSU
Video all sky camera	cloud imagery	cloud cover, cloud type	Continuous	CSU

ASTEX - PORTO SANTO
JUNE 1 - 28, 1992

Table 5. Upper Air Observations¹

INSTRUMENTATION	VARIABLES MEASURED	DERIVEABLE PARAMETERS	SAMPLING	AGENCY/ INSTITUTION
Rawinsonde	Temperature (z) Relative Humidity (z) Horizontal wind components (z)	Thickness, precipitable water, stability, dry/moist static energy	one per 3 hours	CSU
404 Mhz Wind Profiler	Backscatter signal strength (z), doppler shifted frequency (z)	Horizontal wind velocity, vertical wind velocity	Continuous 1 wind set/10 min.	CSU
Radio acoustic sounding system [RASS]	velocity of sound(z)	Temperature (z)	one sounding per hour	CSU

¹ The NOAA/WPL radar and lidar also produce air motion information.

The experiment site was maintained twenty-four hours a day during the entire IFO (6/1/92 - 6/28/92). Some remote sensing, surface radiation systems and surface meteorology systems operated continuously. Other systems operated "on demand" and data were collected only during periods of high interest. Rawinsondes were released every three hours from June 8 to June 27. From June 1 to June 8 a shortage of helium and hydrogen compressed gas dictated scaling down the rawinsonde schedule to six launches per day. Liquid nitrogen was not available on Porto Santo until June 4; therefore CSU's infrared interferometer and NOAA's doppler lidar systems operated only for the period June 4-June 27. Table 6 presents a summary of data acquired from the CSU systems during this period.

**Table 6. Summary of CSU ASTEX Data
May 30 - June 29 1992
Colorado State University
Porto Santo Site**

Data Set	May		June																													
	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
Station 1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Station 3			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Wind Profiler /RASS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ceilometer		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sky Camera			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rawinsonde	1	1	7	6	6	6	6	6	5	6	7	7	8	8	8	8	6	8	8	8	10	8	8	8	8	8	8	8	8	8	8	8
Other:																																
Interferometer						6	12					12	6	15	15			6	18	60	15	12	78	78	99	24	42	41	99			
PRT-6			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

The following sections present three basic data sets from the Porto Santo site. Section 2 presents brief descriptions of data storage and accessibility. Section 3 presents a time series for each experiment day of the following variables: air temperature, relative humidity, wind speed, and wind direction. Section 4 presents similar time series of broadband solar irradiance, downwelling broadband infrared irradiance, $11\mu\text{m}$ sky brightness temperature and ceiling (height of the lowest cloud layer below 5 Km). These data were nominally collected continuously throughout the experiment. More detailed explanations of the instrumentation used to collect the above data are given in Cox, S. K. et al., (1993). Section 5 contains considerably lower temporal resolution depictions of surface pressure, temperature, relative humidity, wind speed and wind direction. These data were manually recorded at the time of each rawinsonde launch; therefore the nominal temporal resolution is one data point every three hours.

A number of preliminary analyses were conducted as a means of evaluating data quality. These analyses produced summaries of the data products which are in themselves useful and interesting in gaining an overall understanding of the meteorological conditions encountered during the experiment.

Section 6 presents hourly depictions of the following variables for each day of the experiment: downward infrared and solar irradiances; solar transmittance; cloud cover deduced from ceilometer data; and 11 micron equivalent radiative brightness temperature. Frequency distributions of cloud cover and 11 micron brightness temperatures for each day are also presented.

Section 7 presents basic statistical data for the experimental period as a whole. Frequency distributions of temperature, relative humidity, wind speed, wind direction, ceiling, infrared radiance, solar irradiance and 11 micron brightness temperature are provided. Also included is a graphical depiction of daily extrema in temperature and relative humidity.

Appendix I is a reproduction of surface weather comments recorded by rawinsonde teams during the experiment.

2. Data Storage and Accessibility

A. Station 1 Data

The station 1 data files contain all measurements shown in this report except for the PRT-6, the ceilometer data and the manually recorded surface data prior to each rawinsonde release. The data files can be found in the /data/astexdata/campbell/station1 directory on the machine trueno.atmos.colostate.edu (129.82.107.109). The files are named station1.nnn where nnn is the julian day. Data fields are separated by a single whitespace character and can be read in using the FORTRAN free format specifier (*). Missing or erroneous data were assigned the value -99.00.

The data were collected every two minutes and the order of the data fields on each line is shown below with an estimate of the precision of each measurement given in the units of the measurement.

	Variable	Estimated Precision
1.	Fractional Julian Day	0.0001157
2.	Wind Speed (m/s)	0.5
3.	Wind Direction (degrees)	5.0
4.	Temperature (Celsius)	0.2
5.	Relative Humidity (%)	5.0
6.	Solar Total Irradiance (W/m ²)	5.0
7.	Near Infrared Irradiance (W/m ²)	5.0
8.	Infrared Irradiance (W/m ²)	5.0

9.	Dome Temperature (Celsius)	0.2
10.	Sink Temperature (Celsius)	0.2
11.	Direct Solar - Yellow Filter (W/m ²) [0 sec]	5.0
12.	Direct Solar - Red Filter (W/m ²) [30 sec]	5.0
13.	Direct Solar - Dark Red Filter (W/m ²) [60 sec]	5.0
14.	Direct Solar - No Filter (W/m ²) [90 sec]	5.0
15.	Direct Solar - No Filter (W/m ²) [0 sec]	5.0
16.	Direct Solar - No Filter (W/m ²) [30 sec]	5.0
17.	Direct Solar - No Filter (W/m ²) [60 sec]	5.0
18.	Direct Solar - No Filter (W/m ²) [90 sec]	5.0
19.	Hour-Minute (hhmm UTC)	0.1667

B. Ceilometer Data

Ceilometer data is stored in the /data/astexdata/ceilometer directory on TRUENO.

The naming convention on the files is such that the data for June 12, 1992 is located in the file called 920612.prn. Data were collected every minute and each data line consists of 5 fields separated by commas. The first three fields are the month, the day of the month, and the year respectively. The fifth field is the measured ceiling in meters with negative values meaning no ceiling was detected. An example section of a data file is shown below.

6,12,1992,1214,-1

6,12,1992,1215, 853.4400

6,12,1992,1216, 876.3000

C. 11 Micron Brightness Temperature

The 11 micron brightness temperature data are stored in the file /data/astexdata on TRUENO. Data were recorded every ten seconds. Each line consists of the fractional julian day and the 11 micron equivalent brightness temperature in degrees Absolute. The FORTRAN format statement used to produce the files was (F11.7,2x,F8.3). The file naming convention for these files is such that the data for June 12 , 1992 is in the file called prt0612.ebt. Missing values were assigned the value -99.00.

An example of the data is shown below.

164.5090332 285.693

164.5091553 285.864

164.5092621 285.475

D. Rawinsonde Surface Data

During the launching of each rawinsonde, a set of surface observations was taken. These observations included the surface pressure measured from an aneroid barometer, the temperature and relative humidity measured using an aspirated psychrometer and the wind speed and direction measured from the position of a wind sock. The wind speed was estimated to the nearest knot and the wind direction to the nearest ten degrees. These data were recorded from May 30 to June 28 and are stored in the sfc.obs file in the data/astexdata/sfcobs directory on TRUENO. The wind speed recorded in the sfc.obs file has been converted from knots to meters/second. The value of -99.0 was given to any missing data points.

A section of the sfc.obs file is shown below.

Time Julian Day	Pressure (mb)	Temperature (C)	RH (%)	Wind Speed (m/s)	Wind Direction
149.33130	1004.09998	18.60000	87.00000	2.57220	350.00000
150.95419	1006.09998	16.80000	74.00000	3.60108	350.00000
151.07291	1005.79999	16.80000	74.00000	1.54332	350.00000

E. Data Accessibility

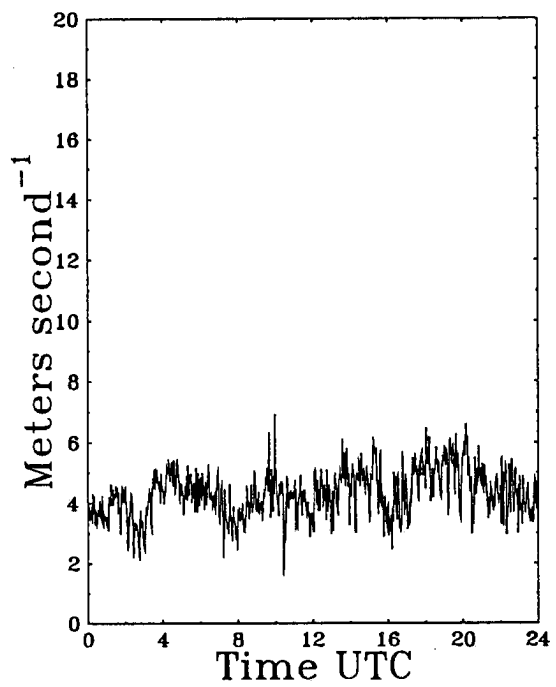
All of the above data is available through anonymous ftp on [trueno.atmos.colostate.edu](ftp://trueno.atmos.colostate.edu) (12982.107.109). More details on this process can be obtained from Paul Hein. His computer address is hein@trueno.atmos.colostate.edu or he can be reached at the following phone number : 303-491-8714 .

3. Surface Meteorology Time Series

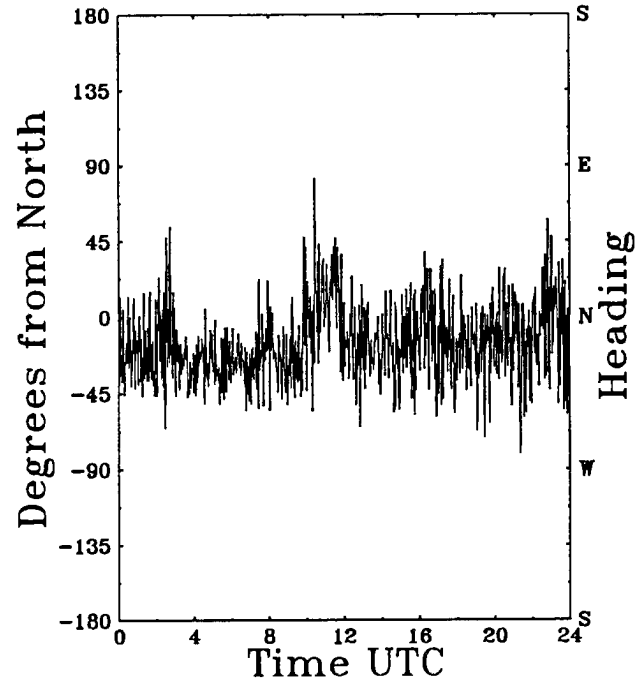
Air Temperature, relative humidity, wind speed and wind direction were monitored on the Porto Santo experiment site continuously from June 2 to June 28, 1992. The four parameters were sampled once every two minutes. The data were recorded using a Campbell 21X data system and downloaded once each day to a floppy disk. Pages 15 - 41 present these data at full temporal resolution.

Julian Day 154 (2 June, 1992)

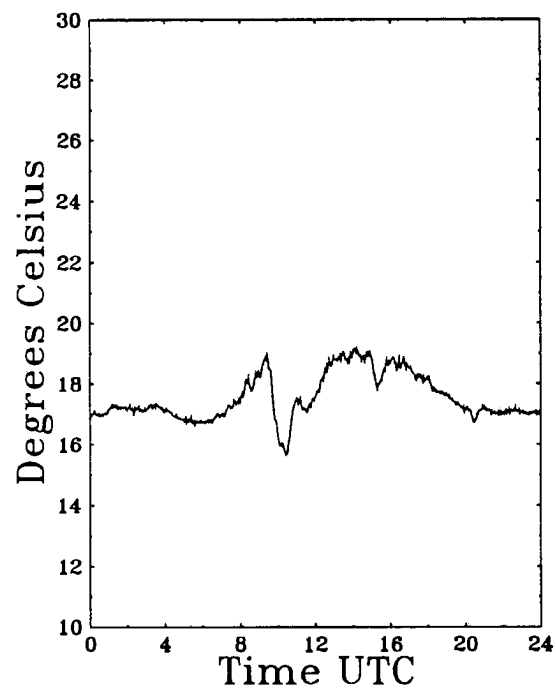
Wind Speed



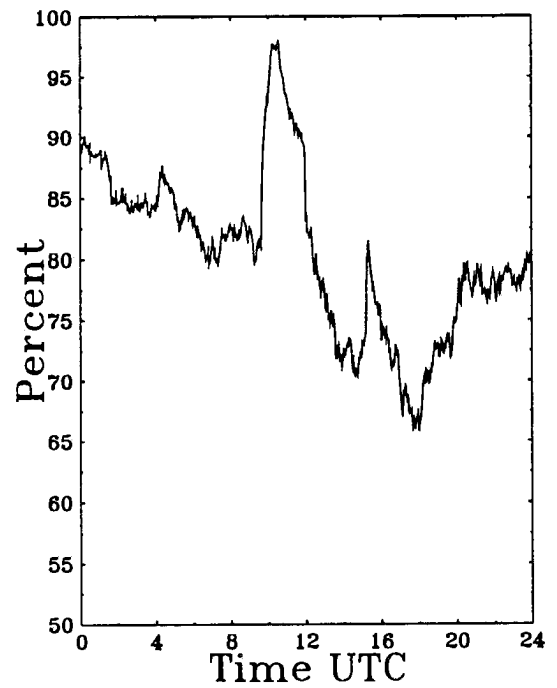
Wind Direction



Surface Temperature

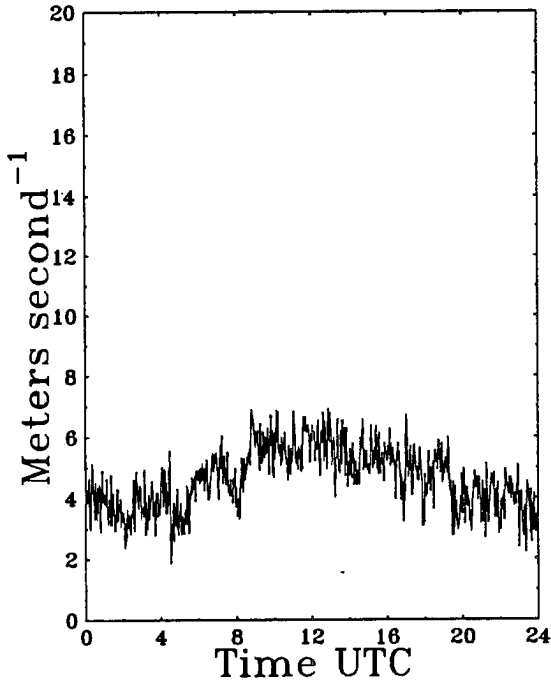


Relative Humidity

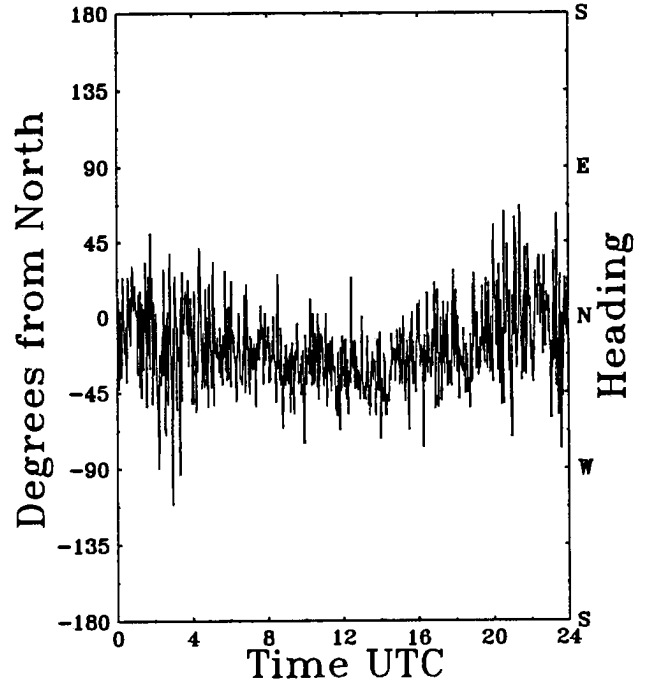


Julian Day 155 (3 June, 1992)

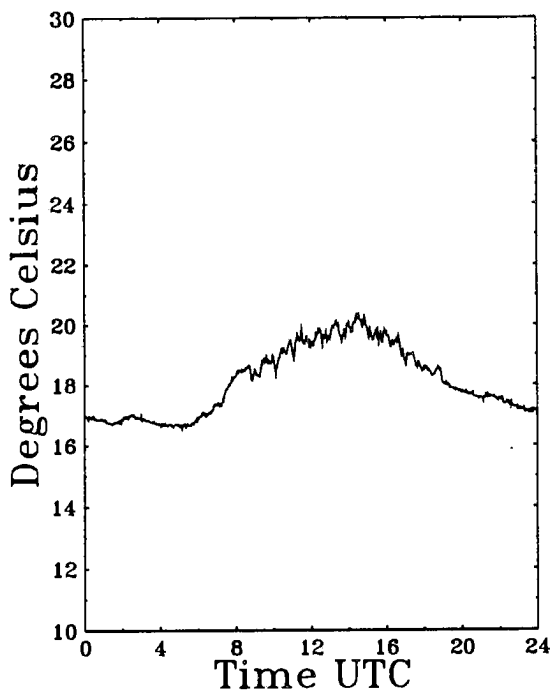
Wind Speed



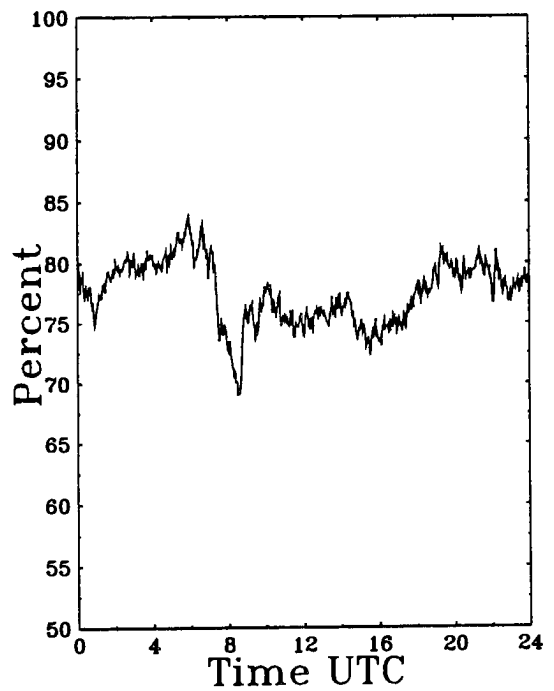
Wind Direction



Surface Temperature

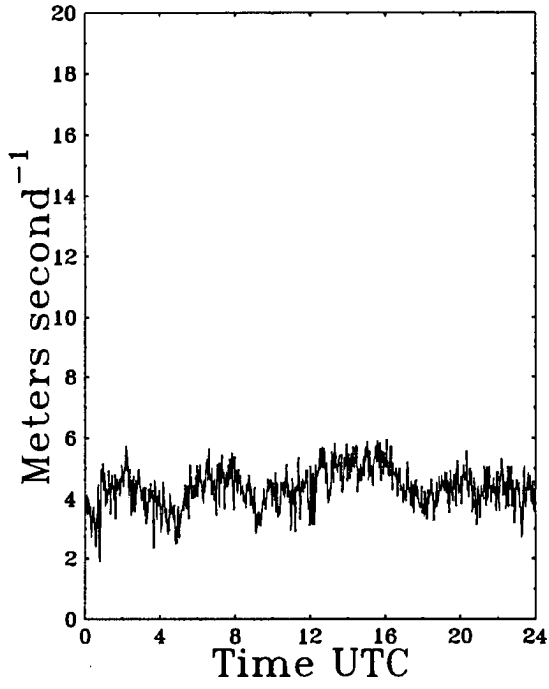


Relative Humidity

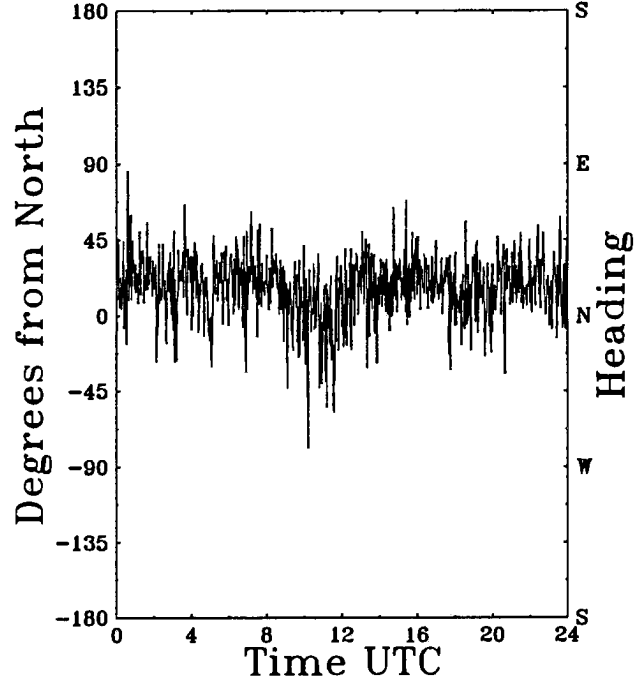


Julian Day 156 (4 June, 1992)

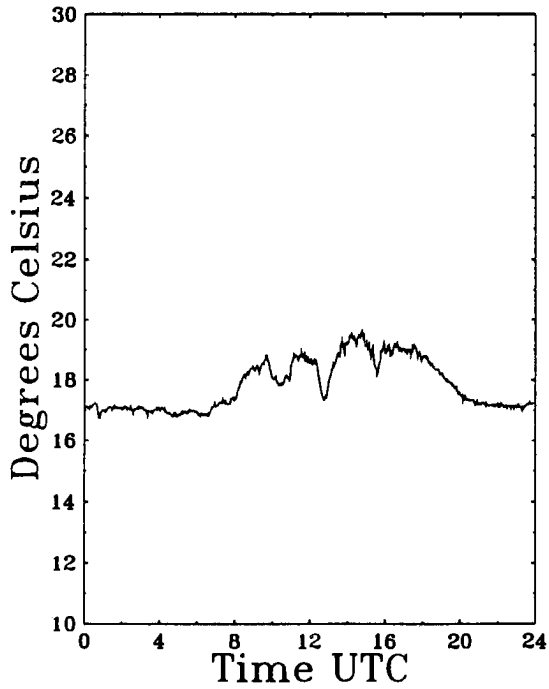
Wind Speed



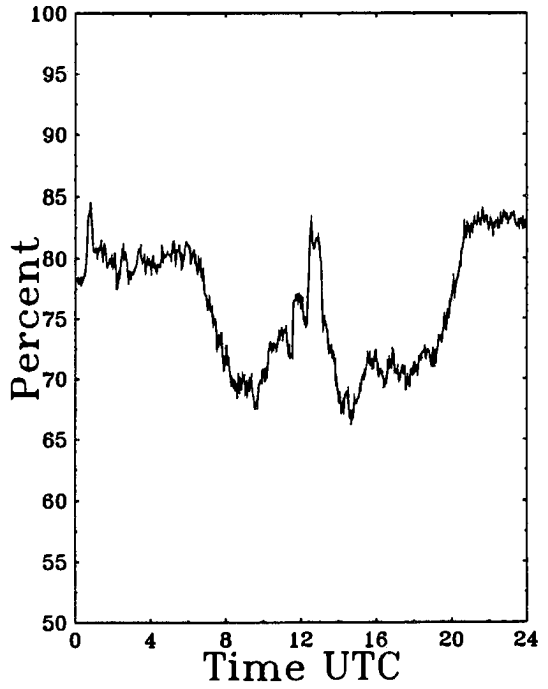
Wind Direction



Surface Temperature

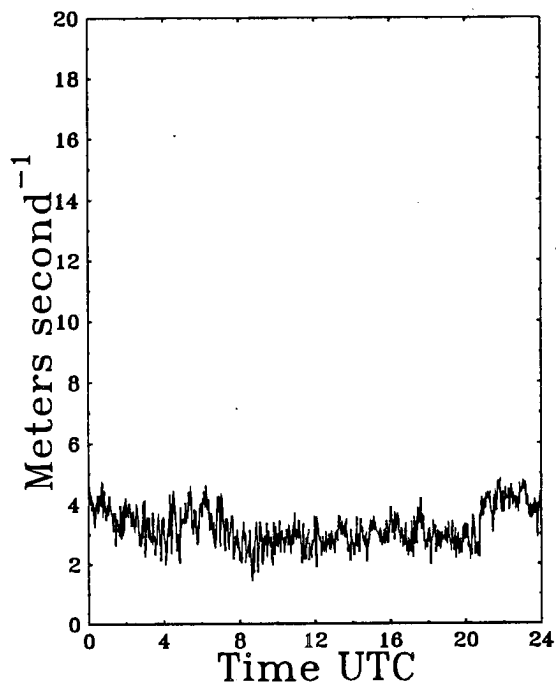


Relative Humidity

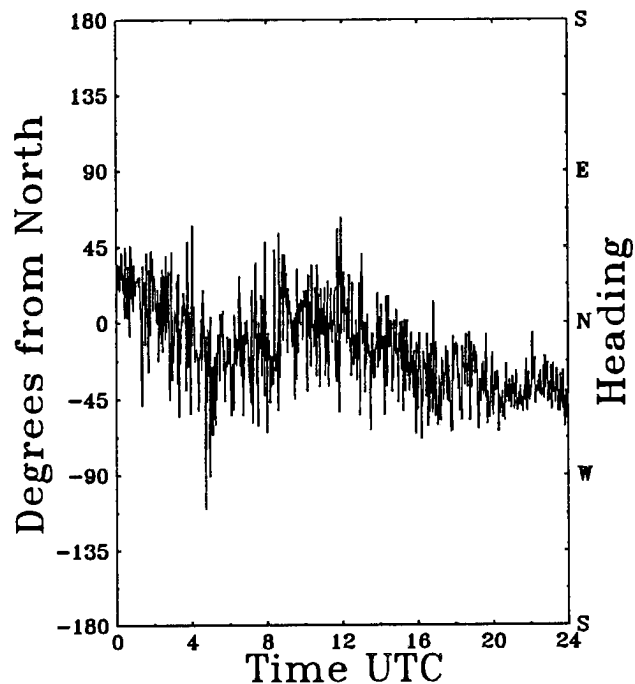


Julian Day 157 (4 June, 1992)

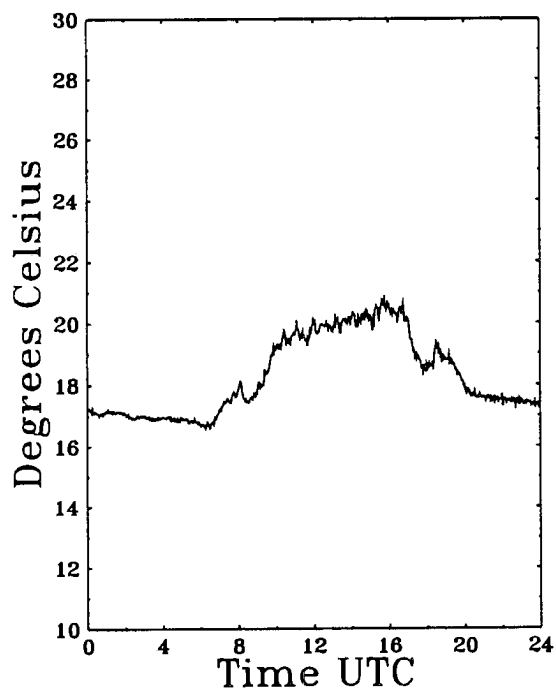
Wind Speed



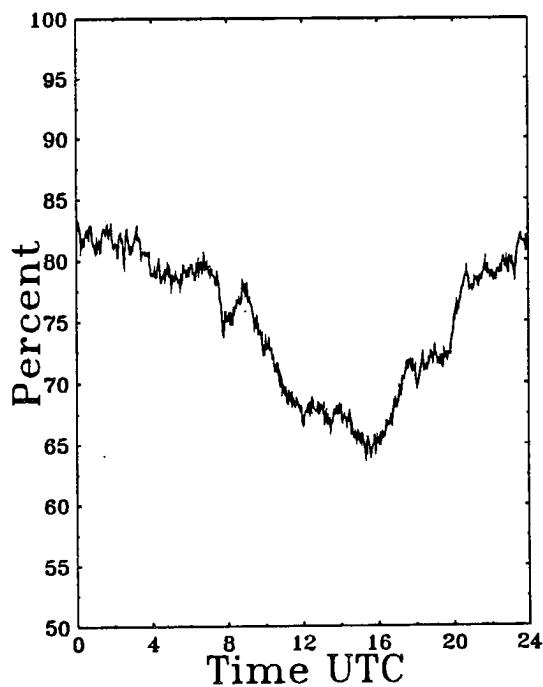
Wind Direction



Surface Temperature

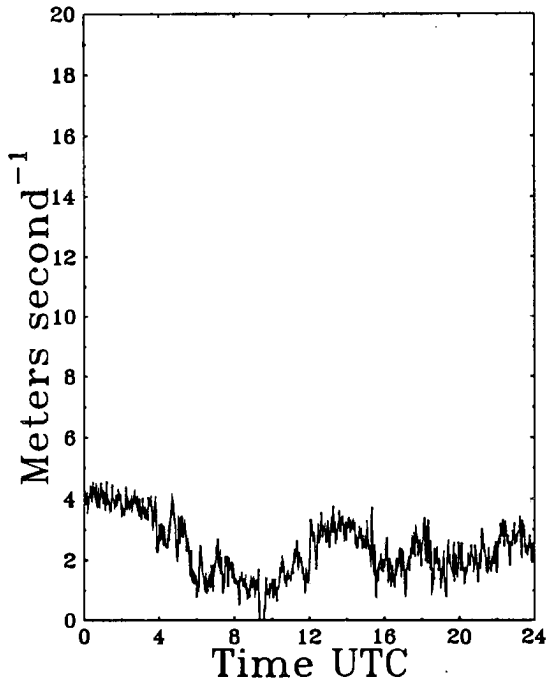


Relative Humidity

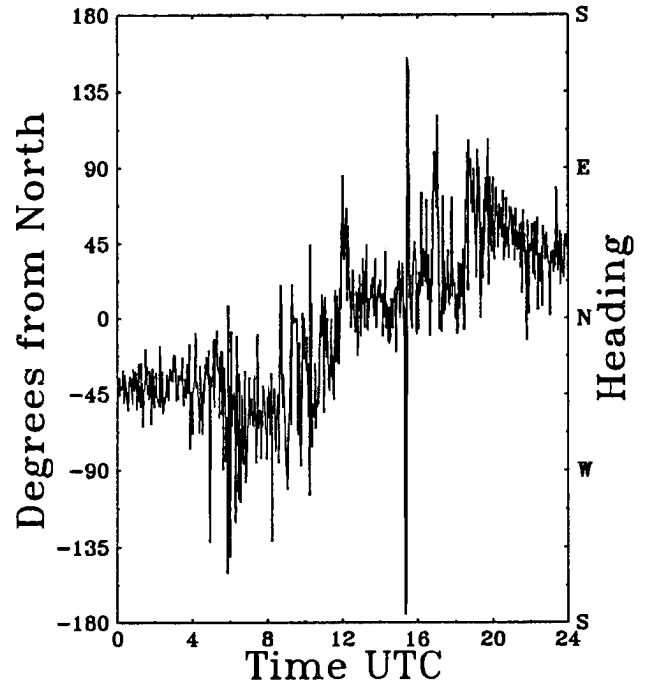


Julian Day 158 (6 June, 1992)

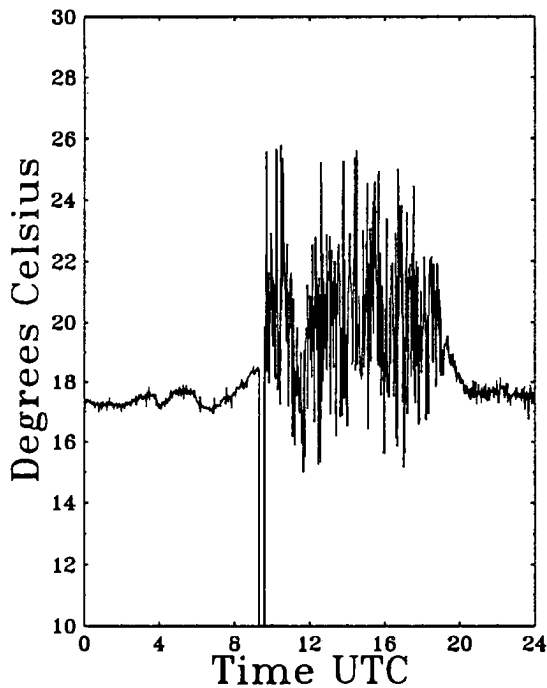
Wind Speed



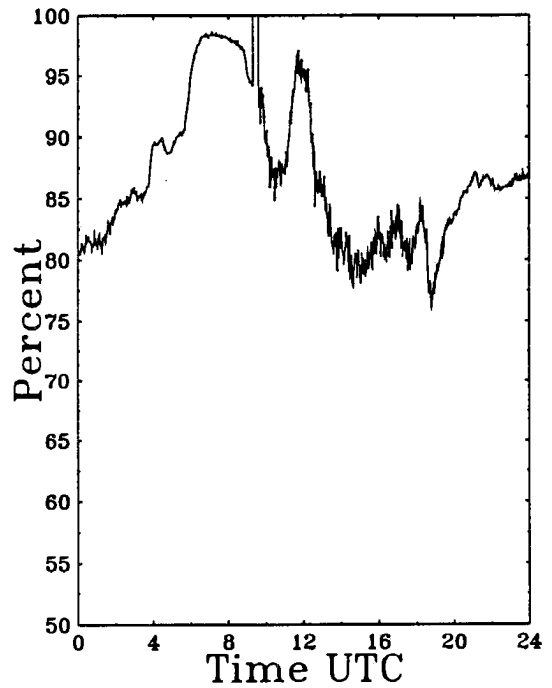
Wind Direction



Surface Temperature

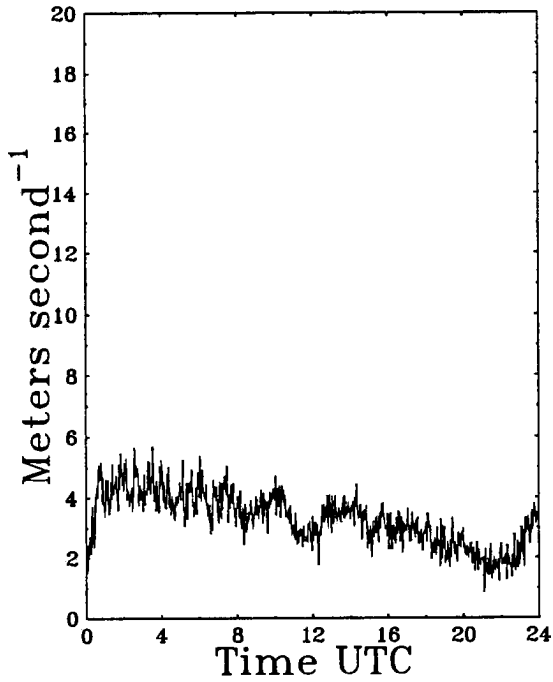


Relative Humidity

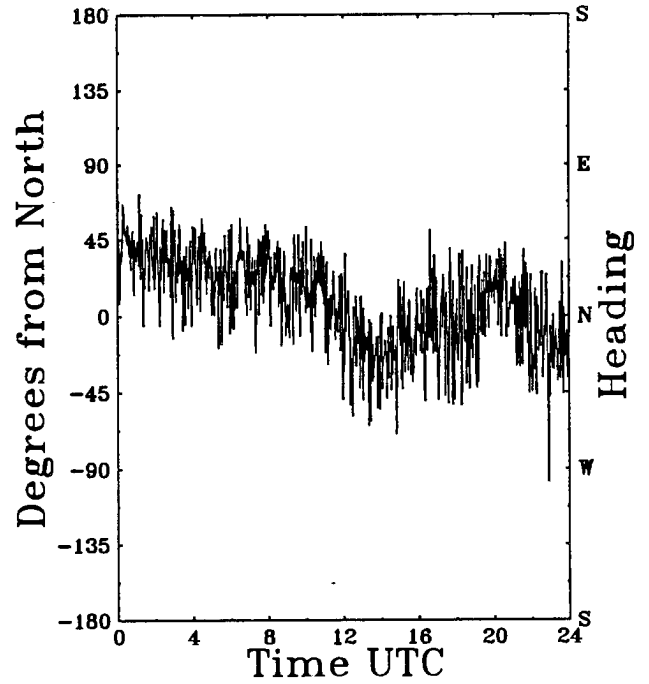


Julian Day 159 (7 June, 1992)

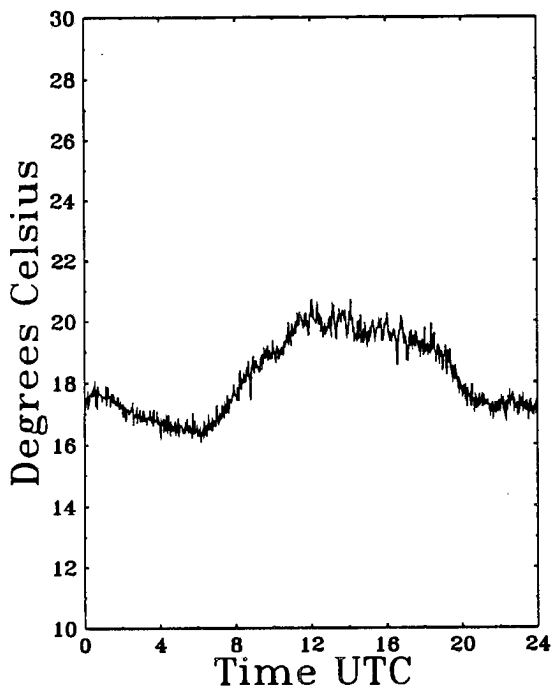
Wind Speed



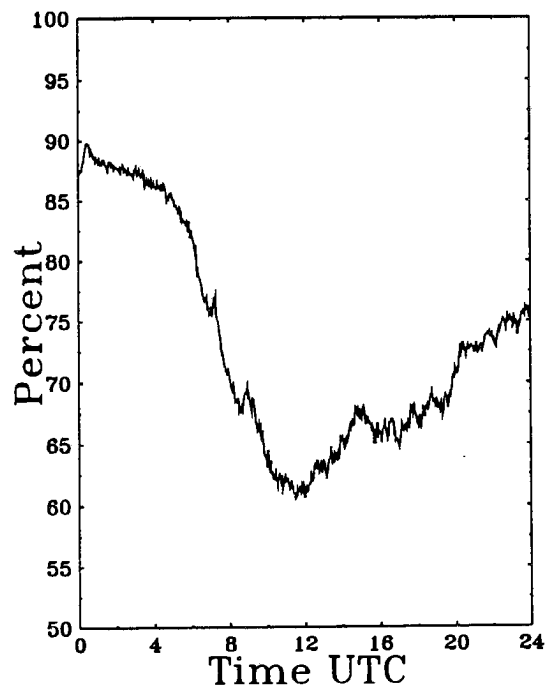
Wind Direction



Surface Temperature

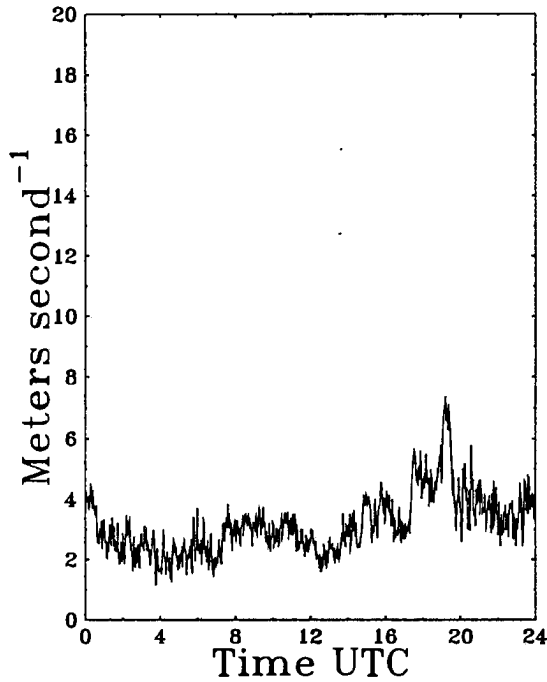


Relative Humidity

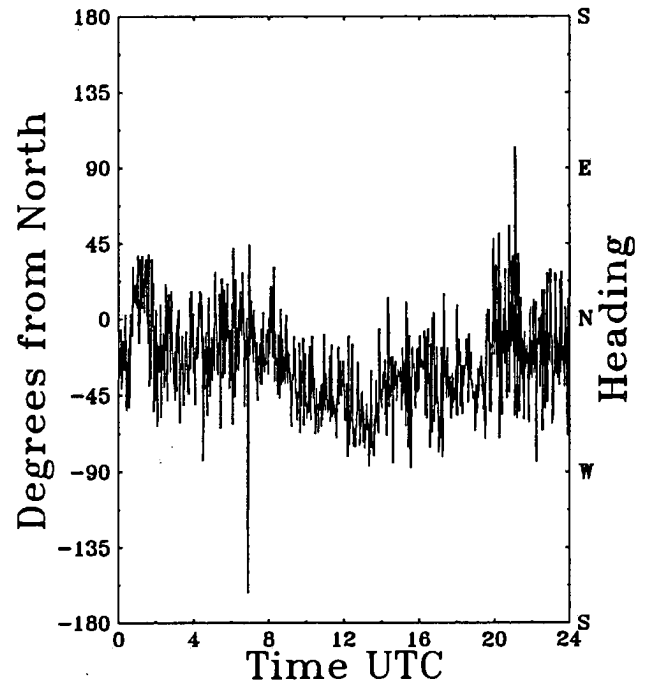


Julian Day 160 (8 June, 1992)

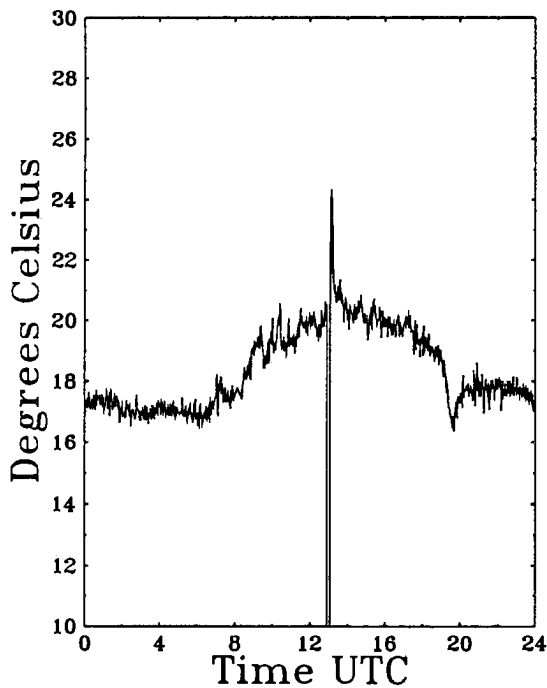
Wind Speed



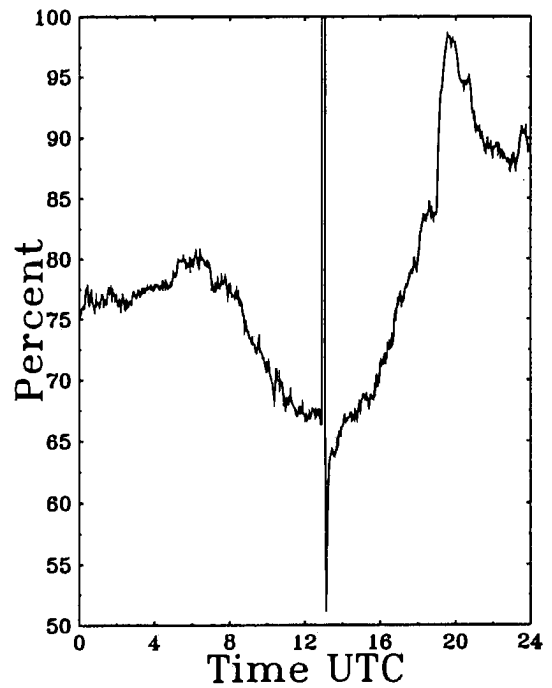
Wind Direction



Surface Temperature

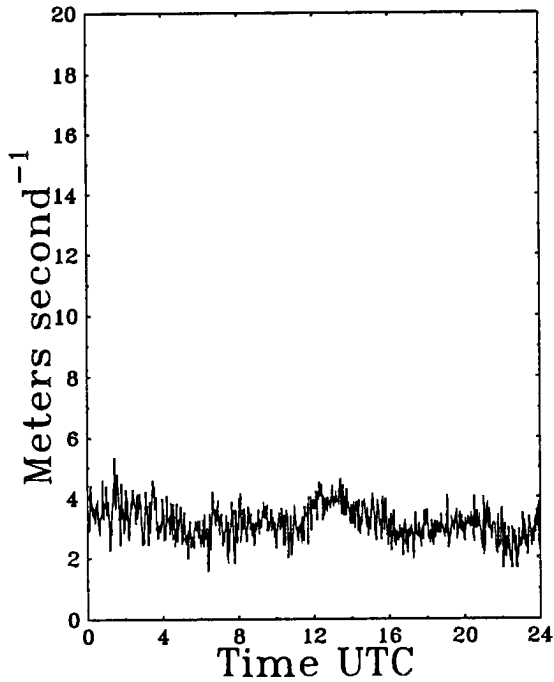


Relative Humidity

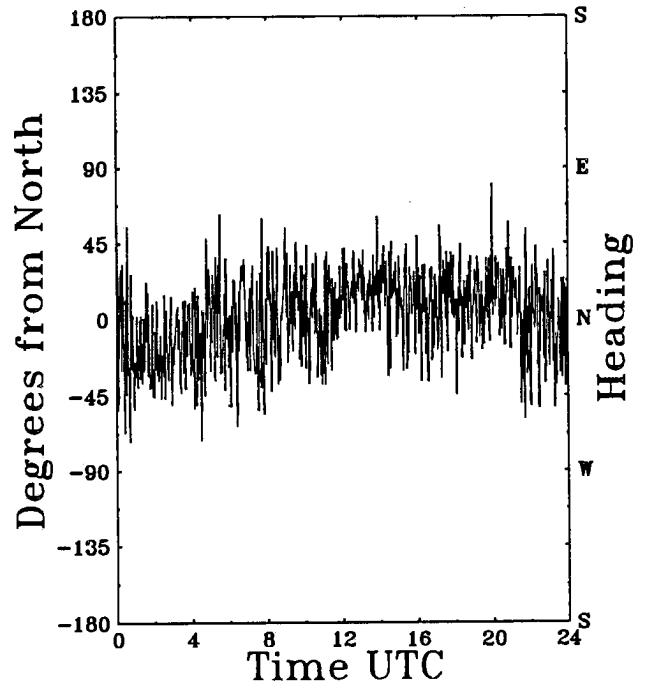


Julian Day 161 (9 June, 1992)

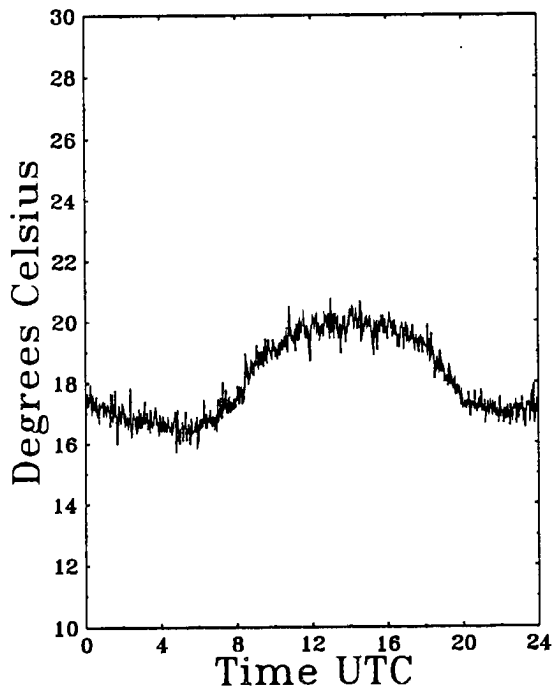
Wind Speed



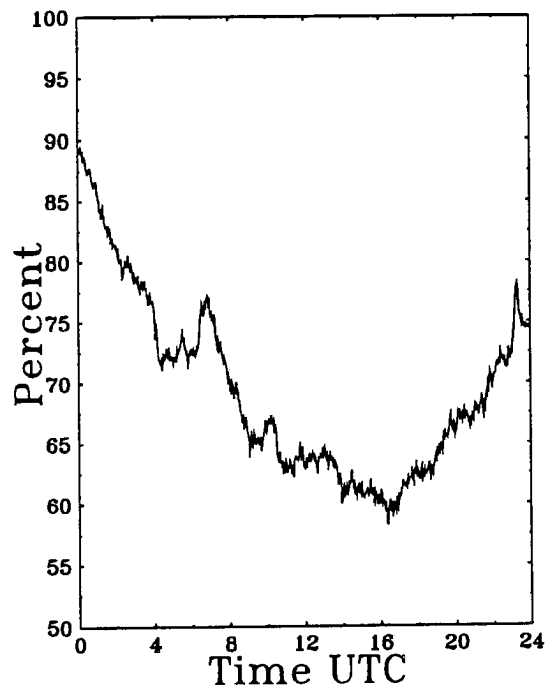
Wind Direction



Surface Temperature

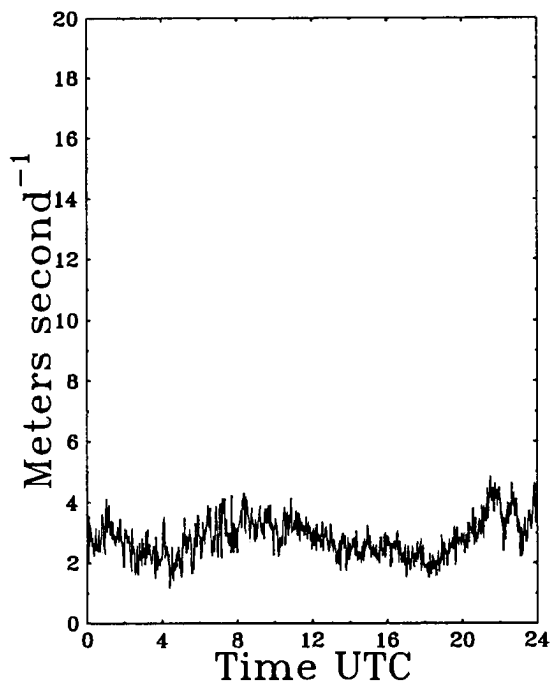


Relative Humidity

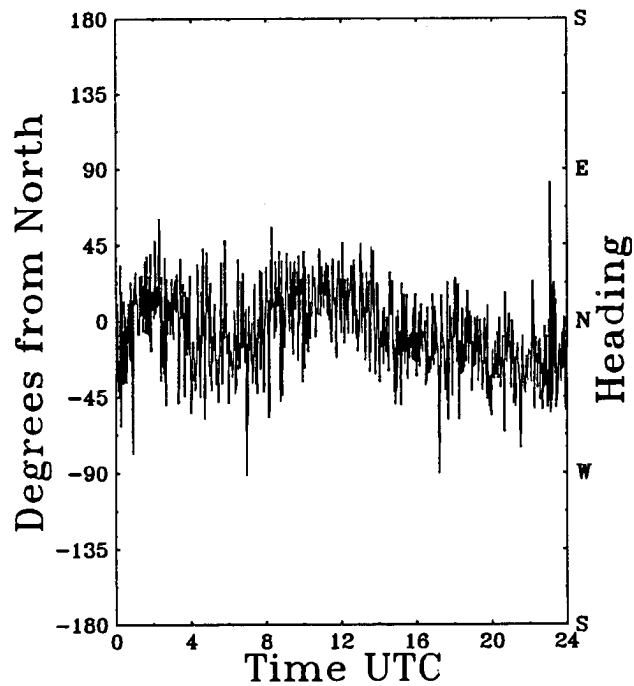


Julian Day 162 (10 June, 1992)

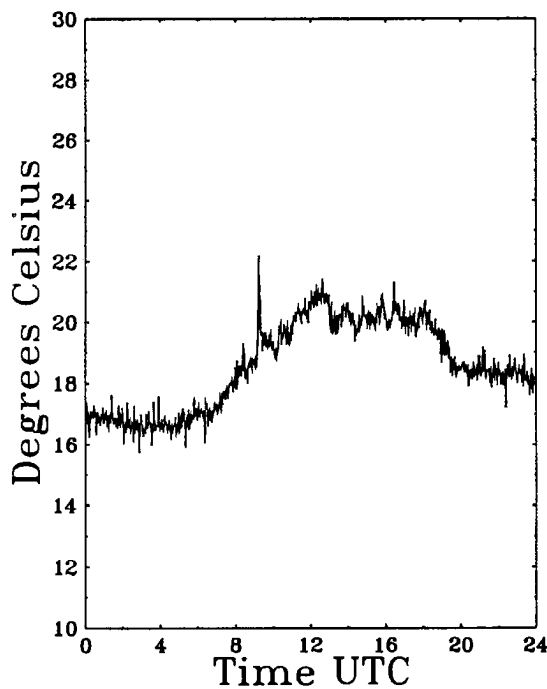
Wind Speed



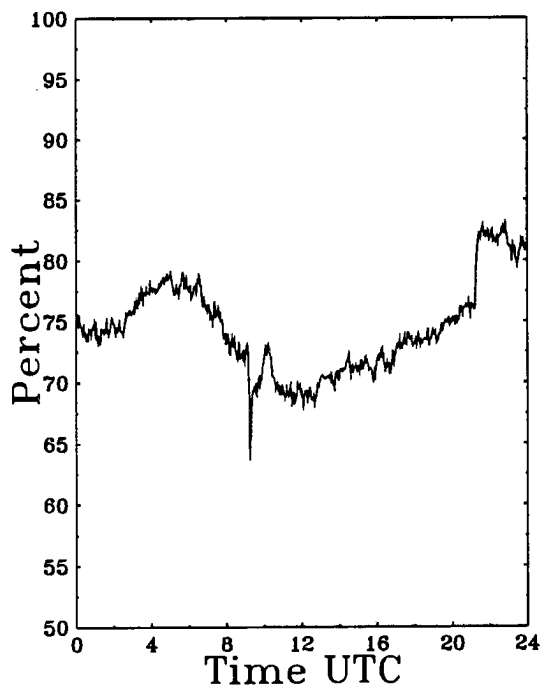
Wind Direction



Surface Temperature

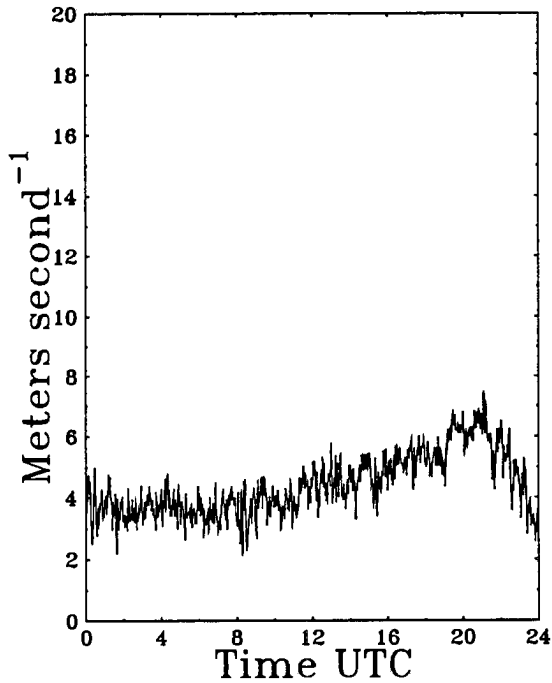


Relative Humidity

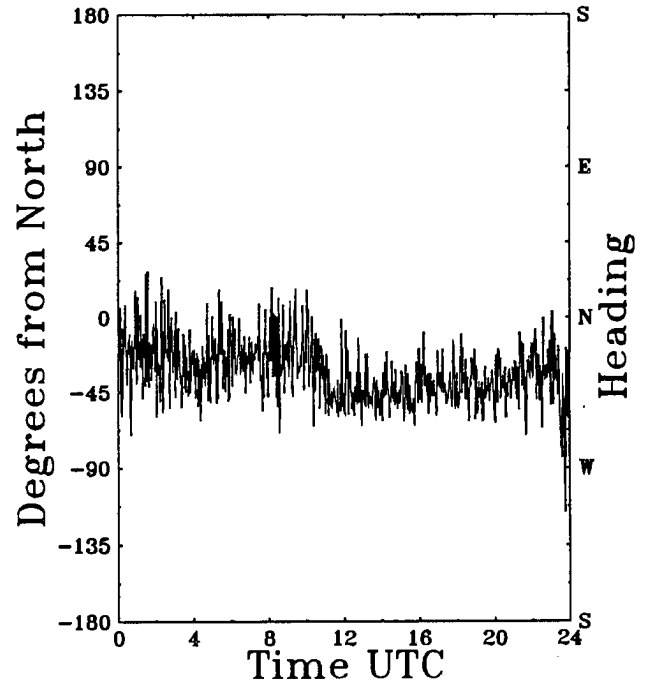


Julian Day 163 (11 June, 1992)

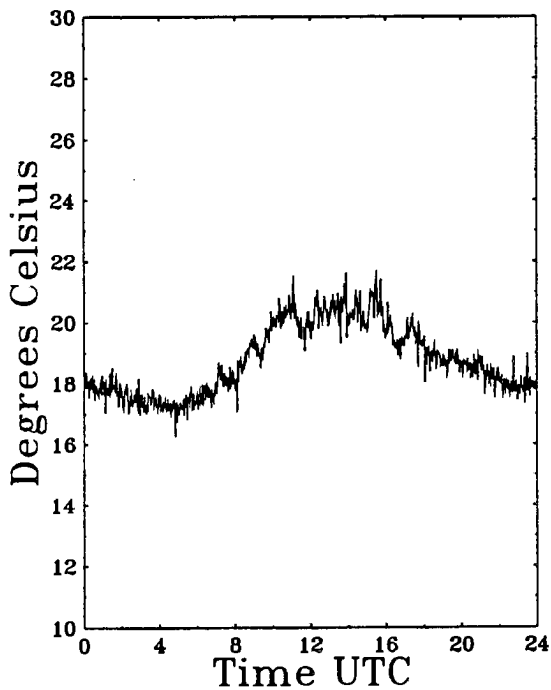
Wind Speed



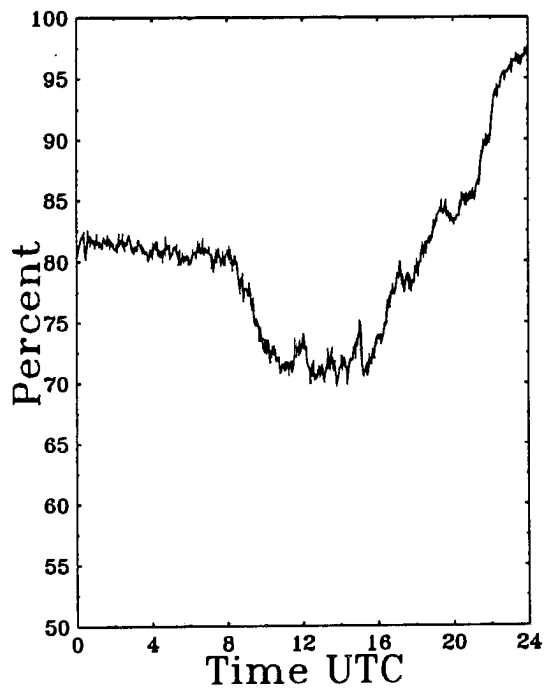
Wind Direction



Surface Temperature

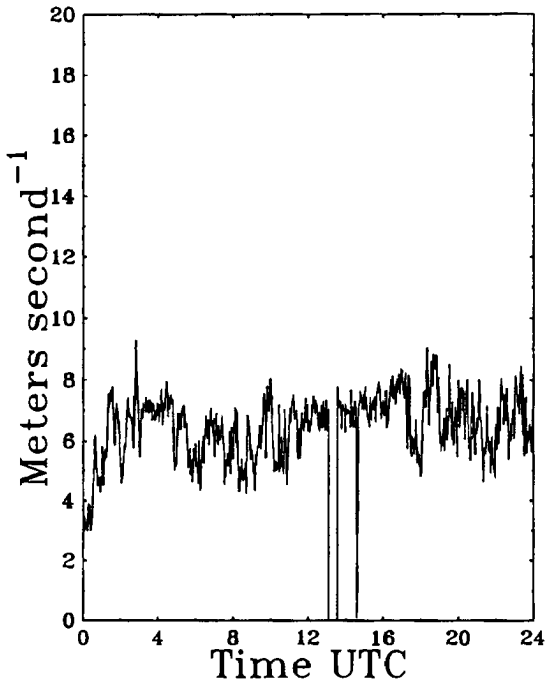


Relative Humidity

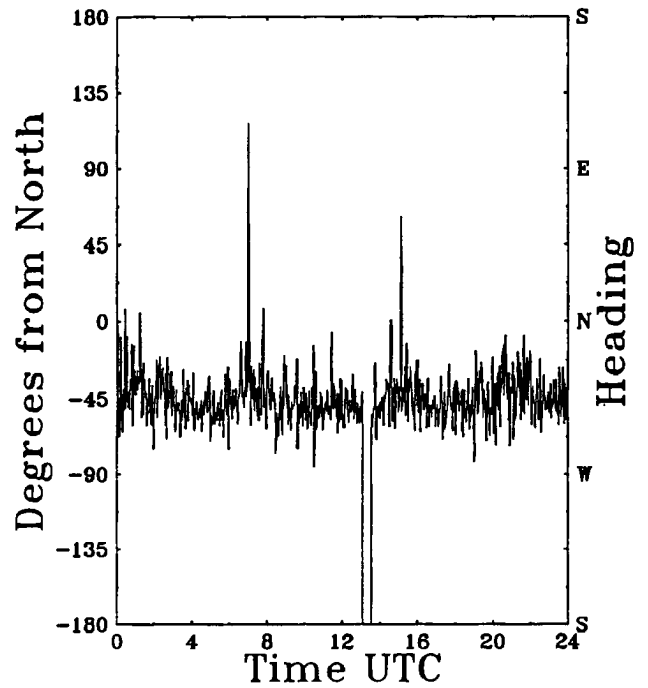


Julian Day 164 (12 June, 1992)

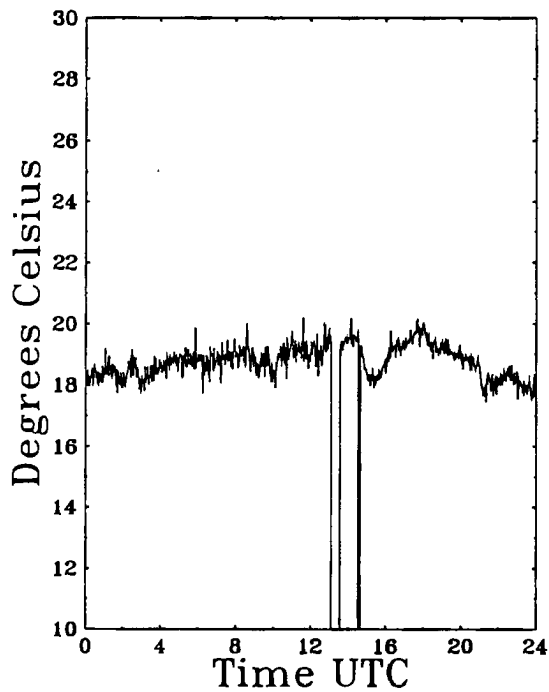
Wind Speed



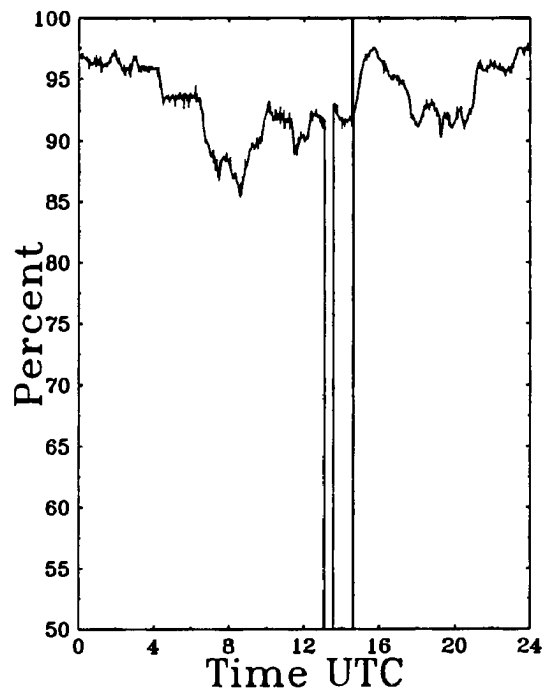
Wind Direction



Surface Temperature

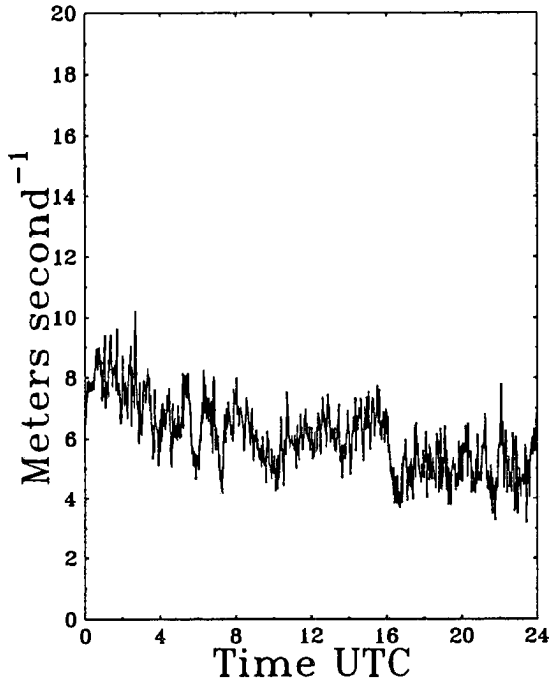


Relative Humidity

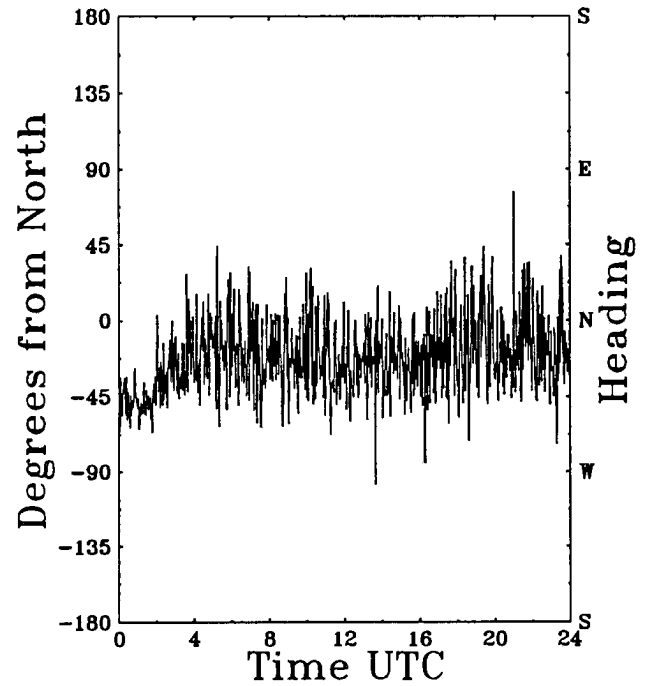


Julian Day 165 (13 June, 1992)

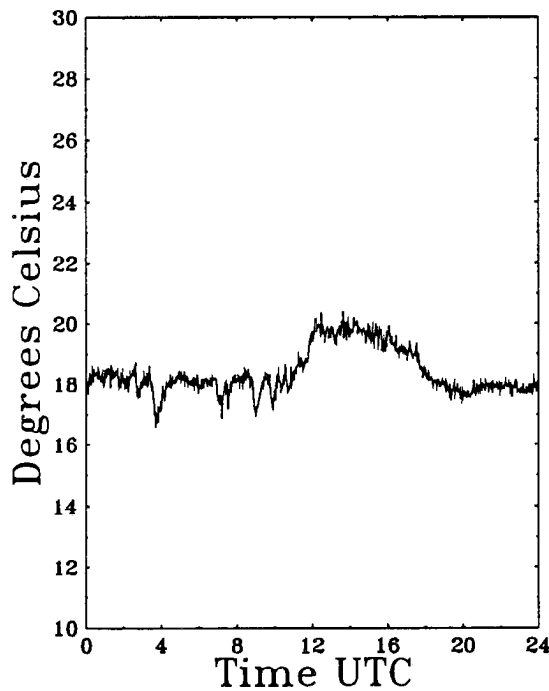
Wind Speed



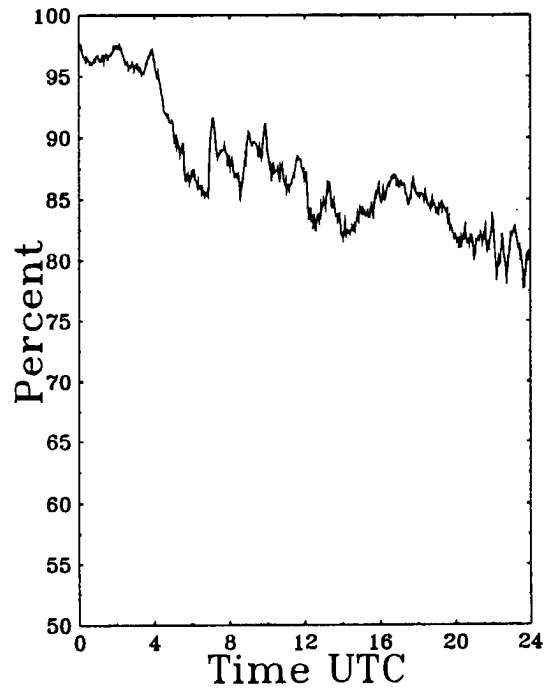
Wind Direction



Surface Temperature

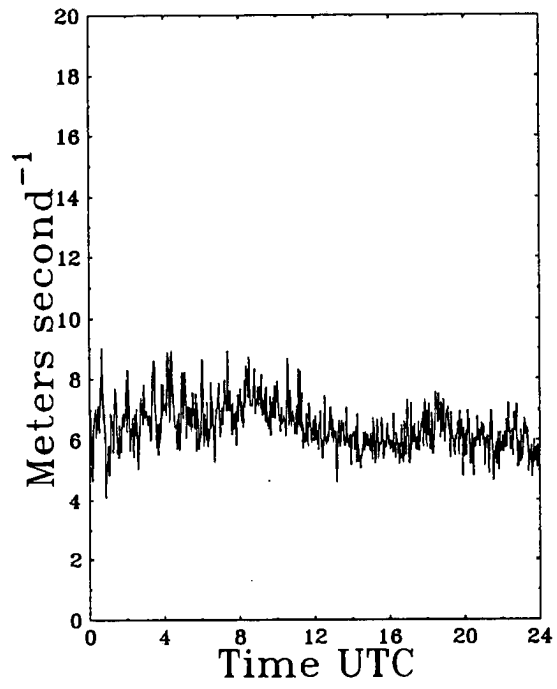


Relative Humidity

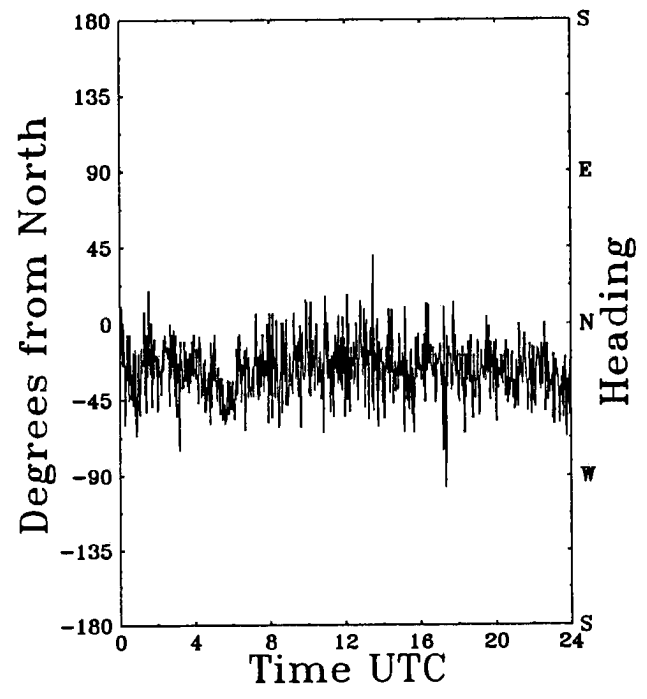


Julian Day 166 (14 June, 1992)

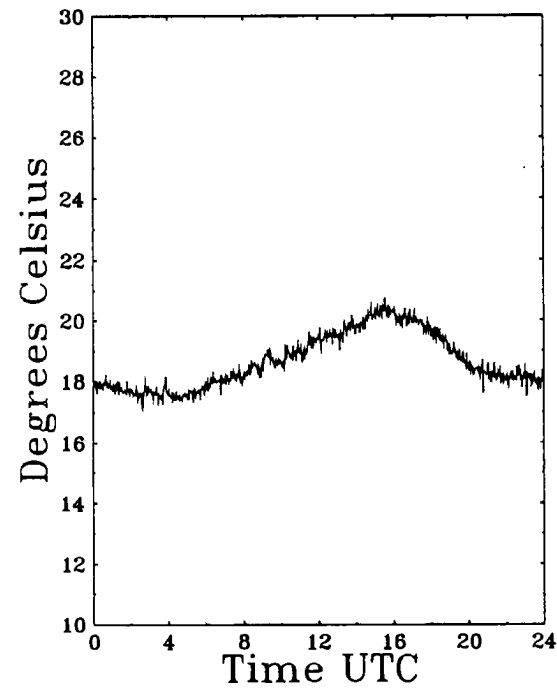
Wind Speed



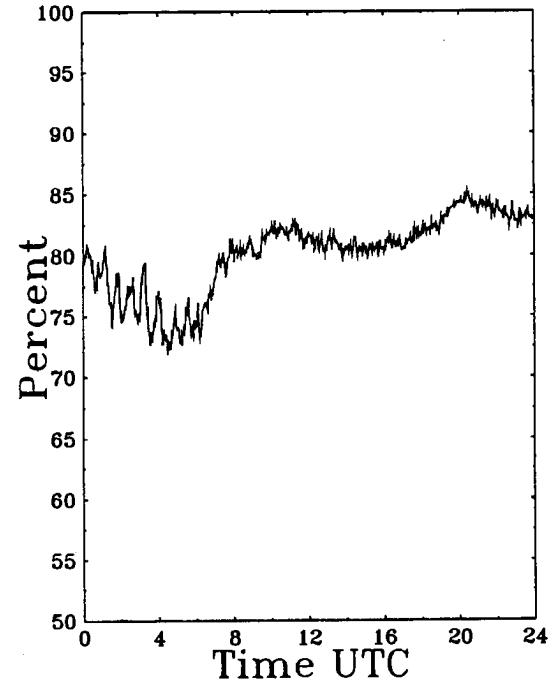
Wind Direction



Surface Temperature

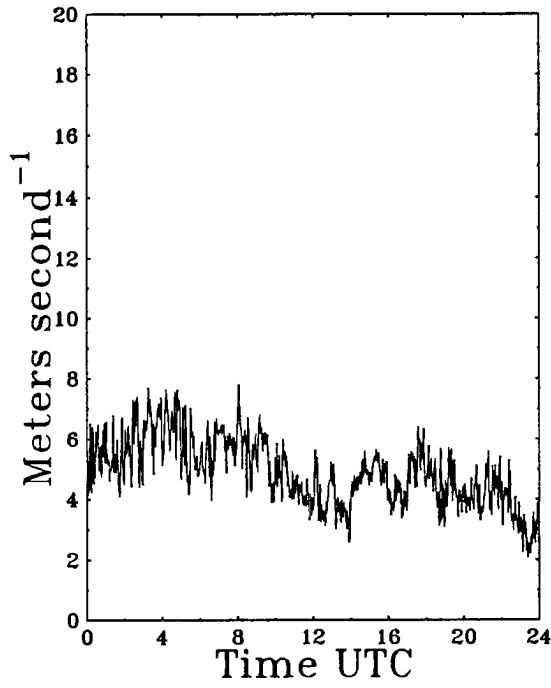


Relative Humidity

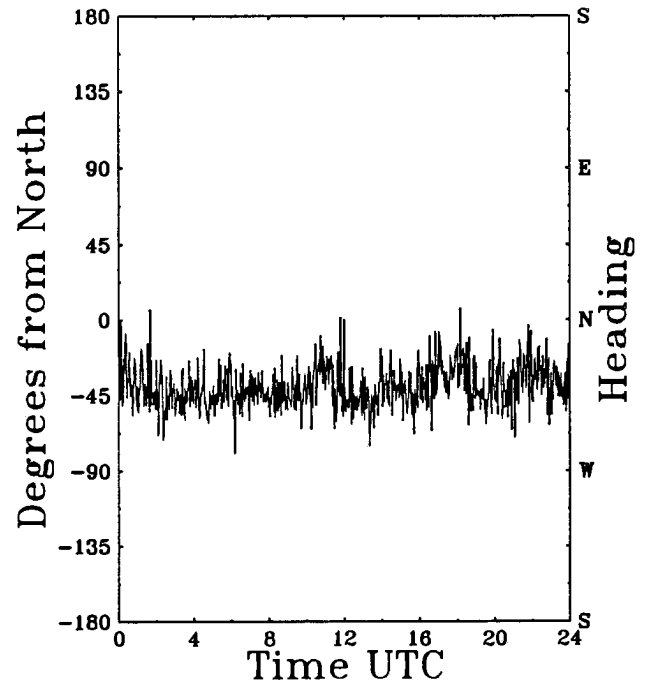


Julian Day 167 (15 June, 1992)

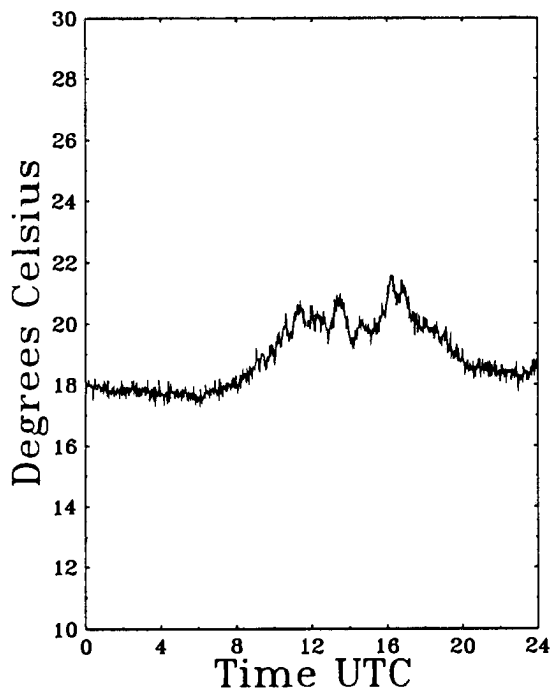
Wind Speed



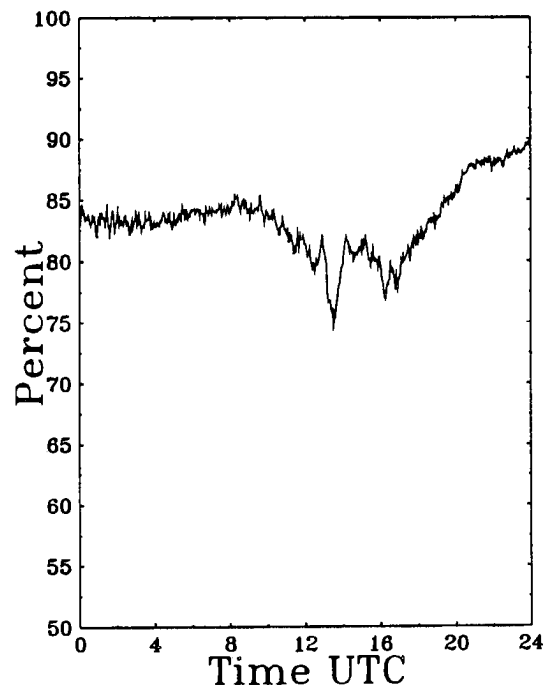
Wind Direction



Surface Temperature

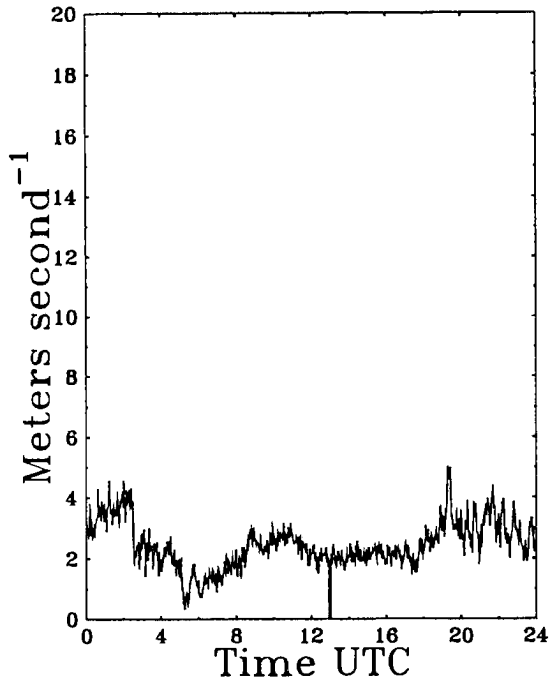


Relative Humidity

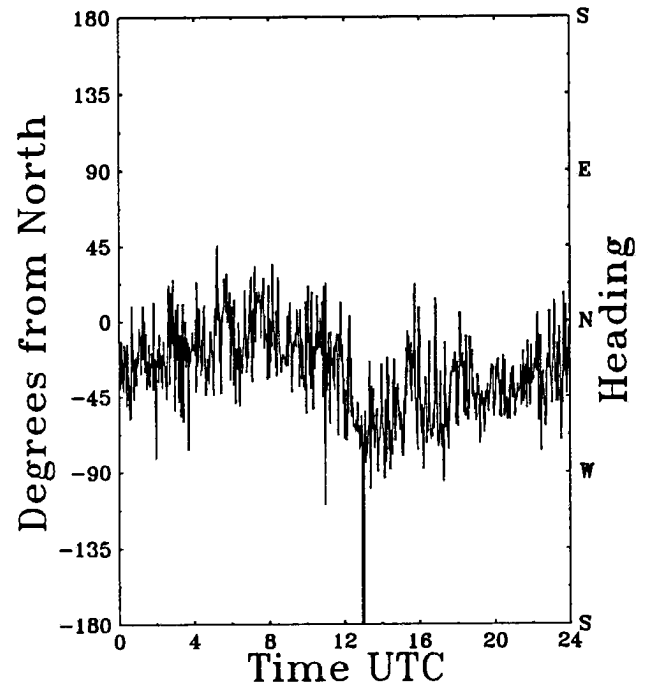


Julian Day 168 (16 June, 1992)

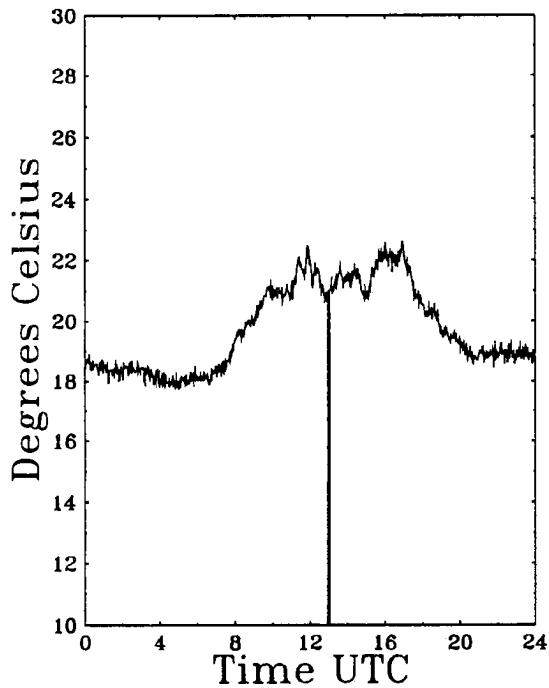
Wind Speed



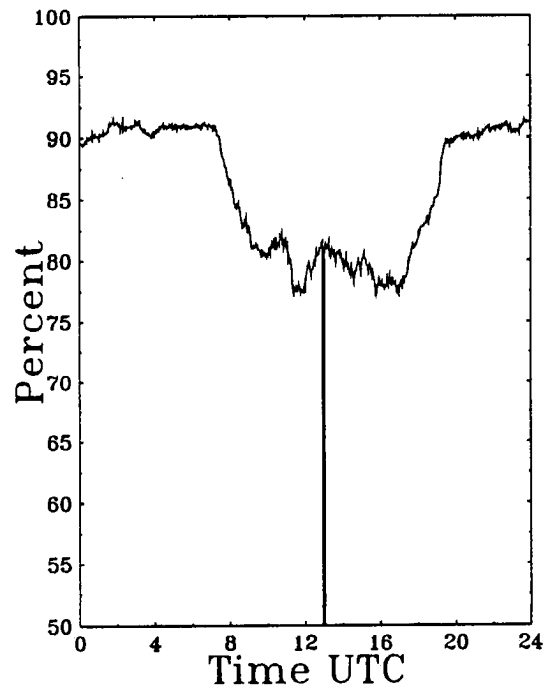
Wind Direction



Surface Temperature

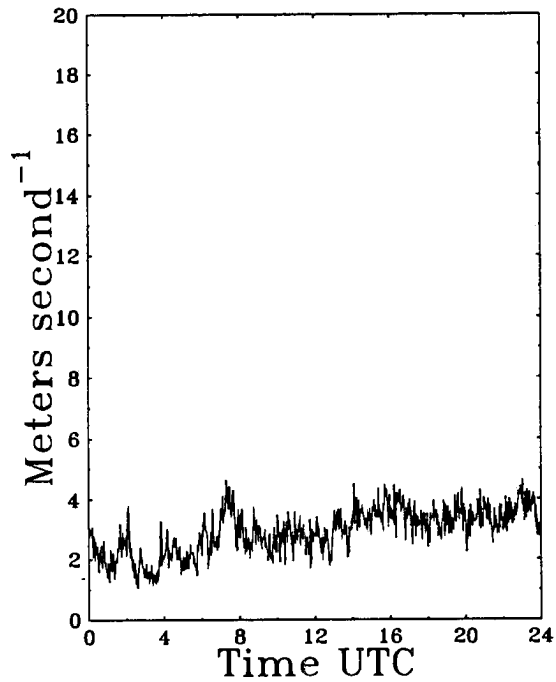


Relative Humidity

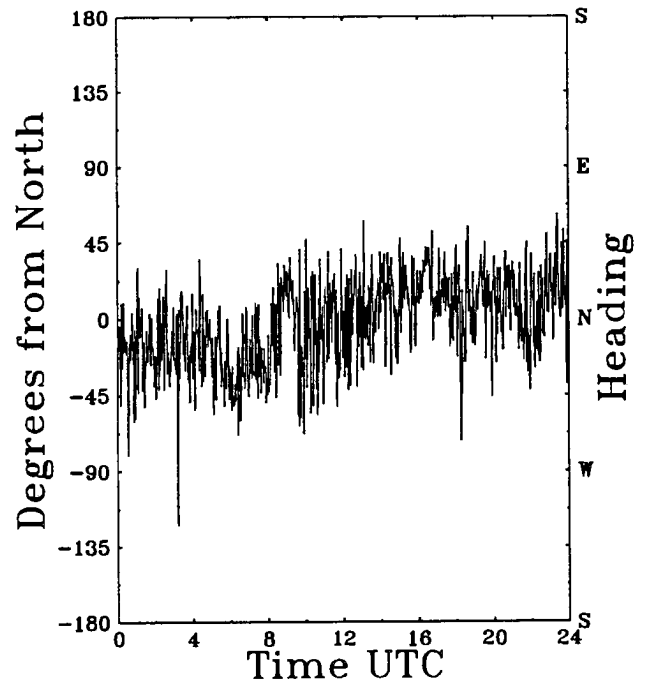


Julian Day 169 (17 June, 1992)

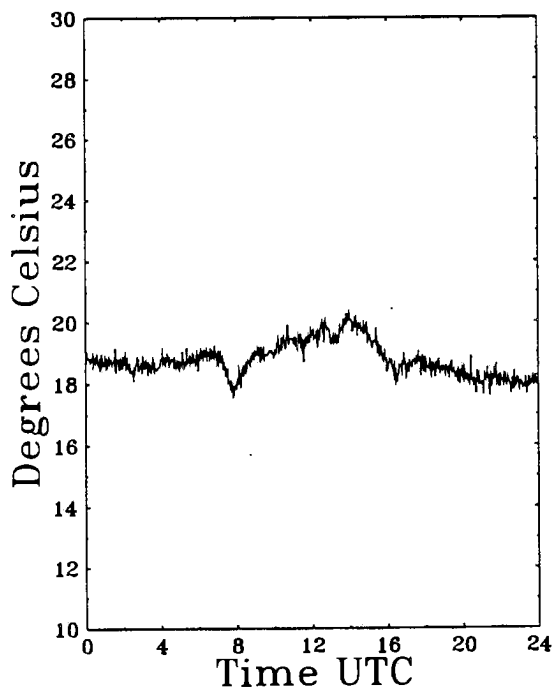
Wind Speed



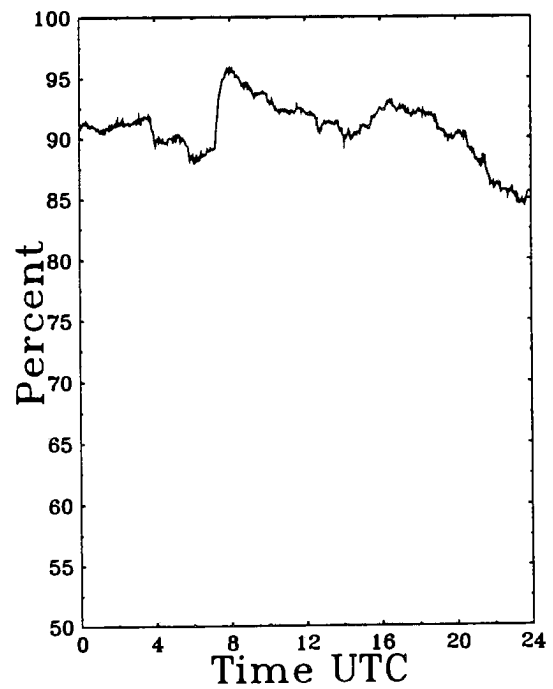
Wind Direction



Surface Temperature

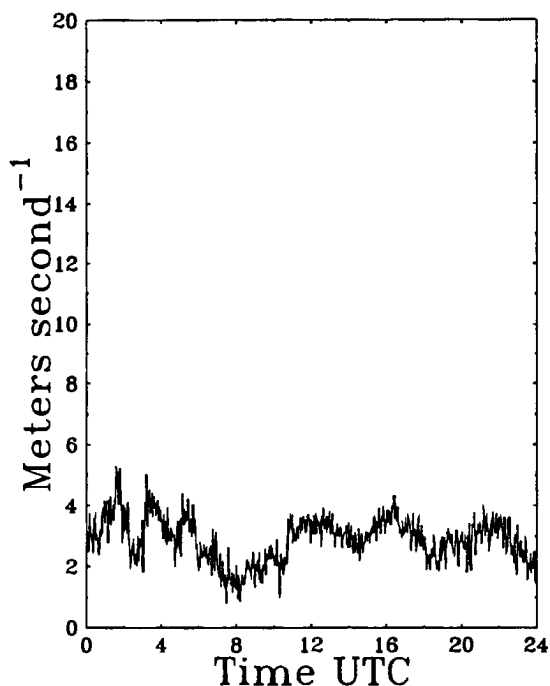


Relative Humidity

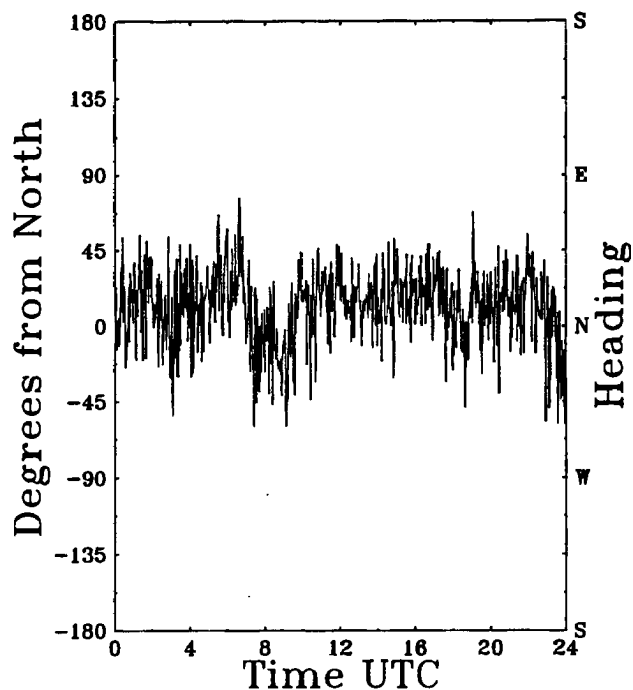


Julian Day 170 (18 June, 1992)

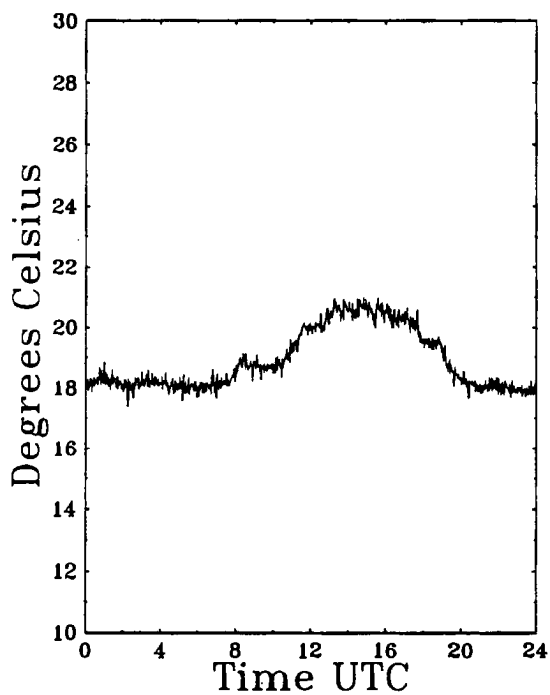
Wind Speed



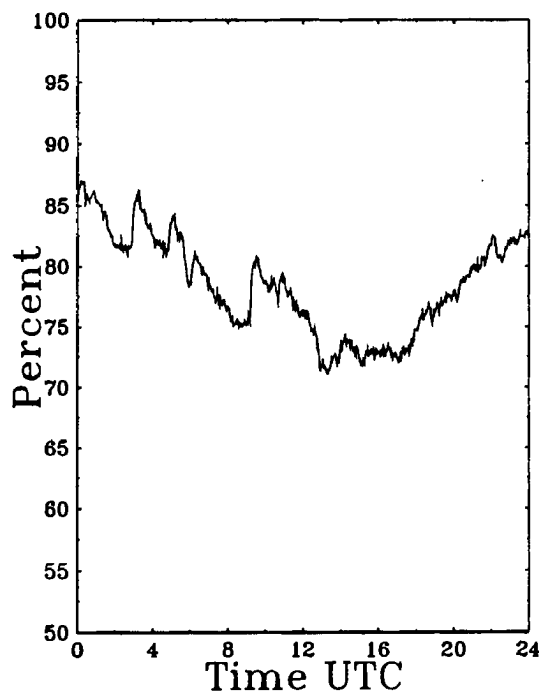
Wind Direction



Surface Temperature

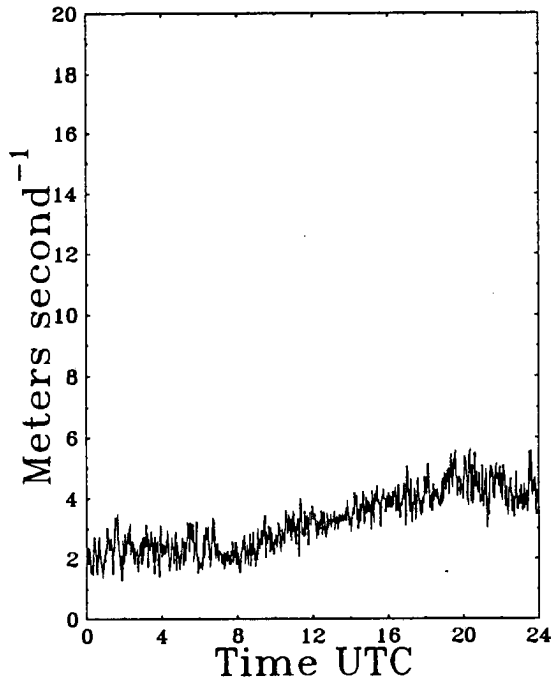


Relative Humidity

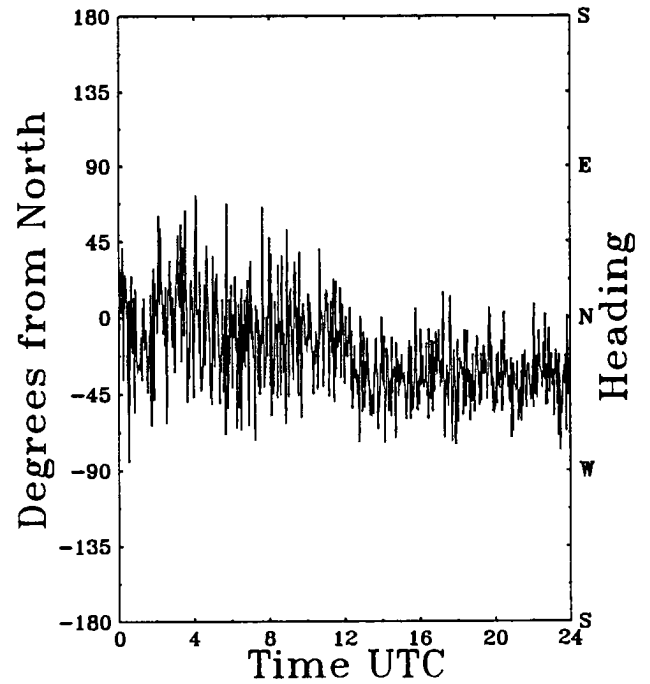


Julian Day 171 (19 June, 1992)

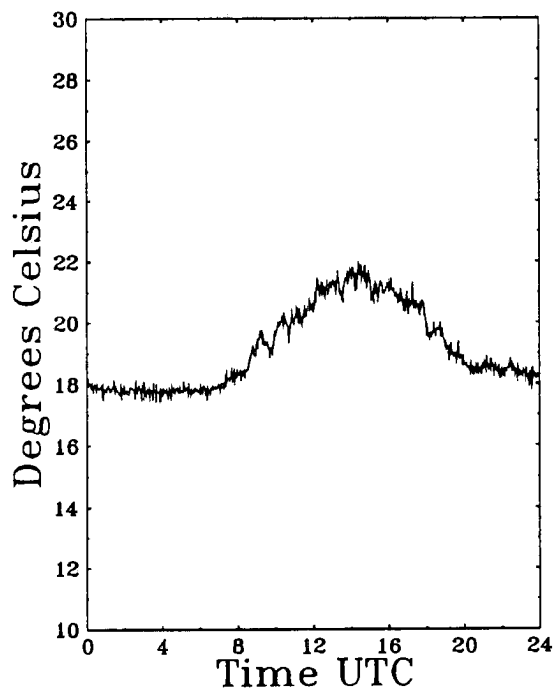
Wind Speed



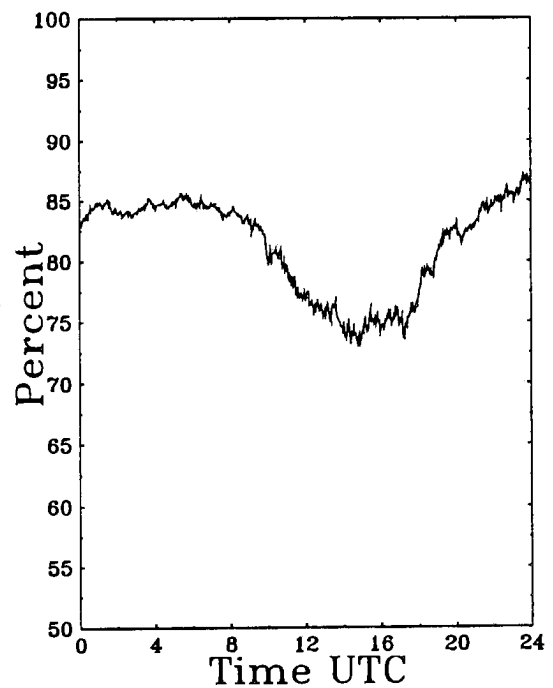
Wind Direction



Surface Temperature

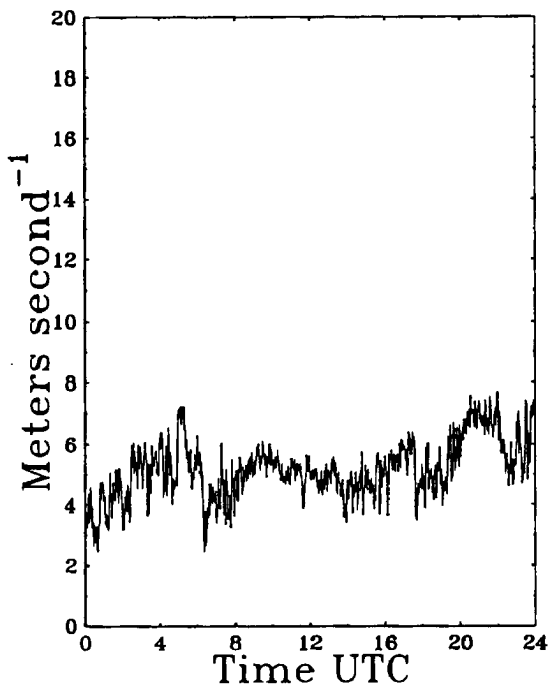


Relative Humidity

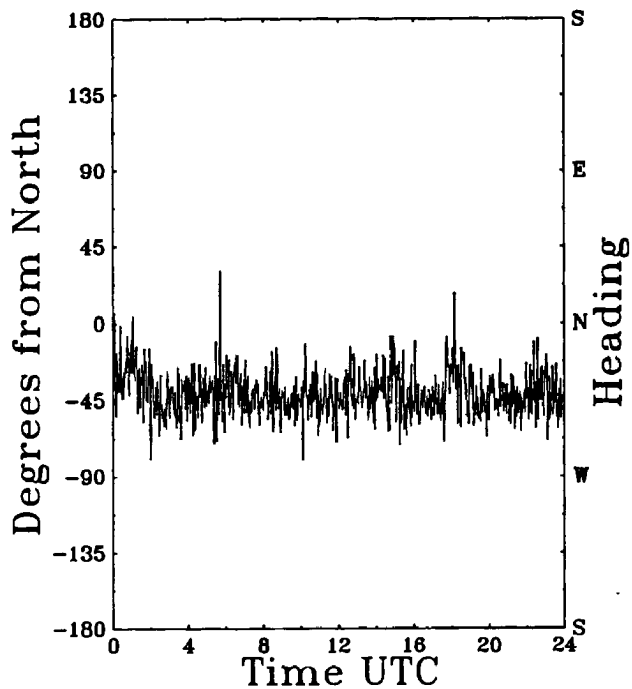


Julian Day 172 (20 June, 1992)

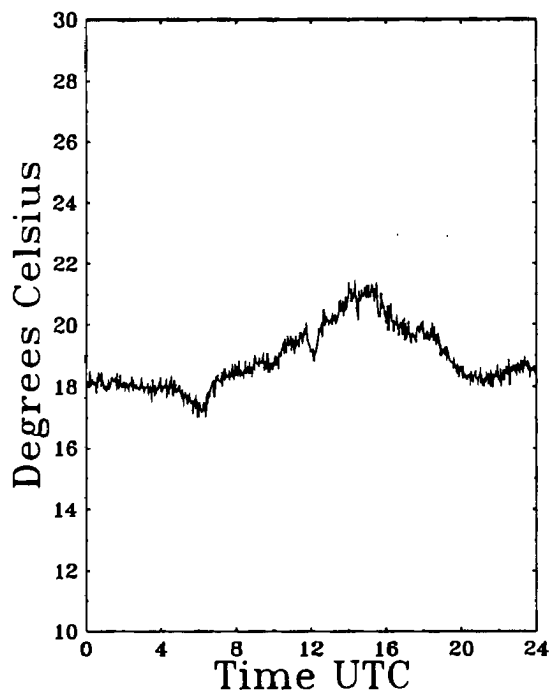
Wind Speed



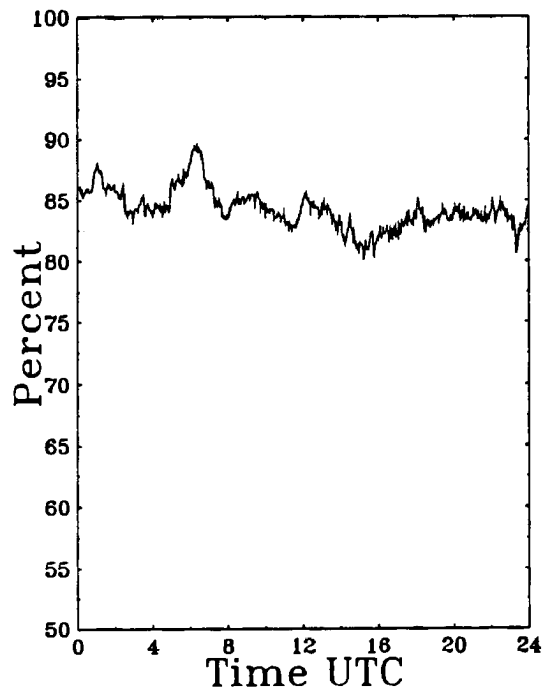
Wind Direction



Surface Temperature

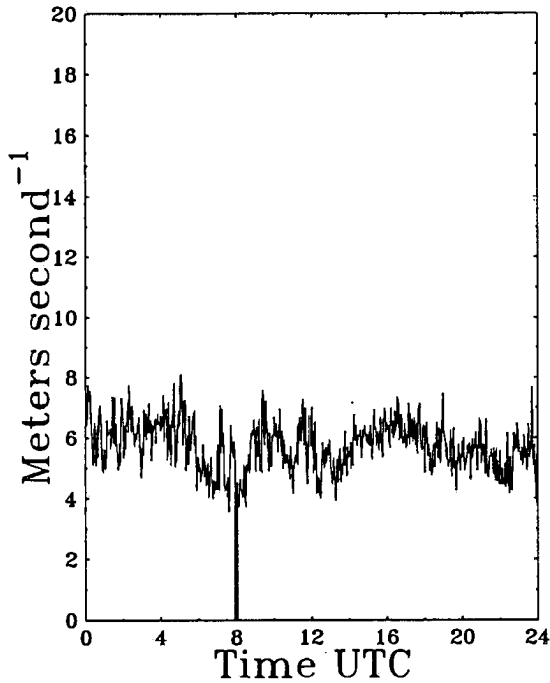


Relative Humidity

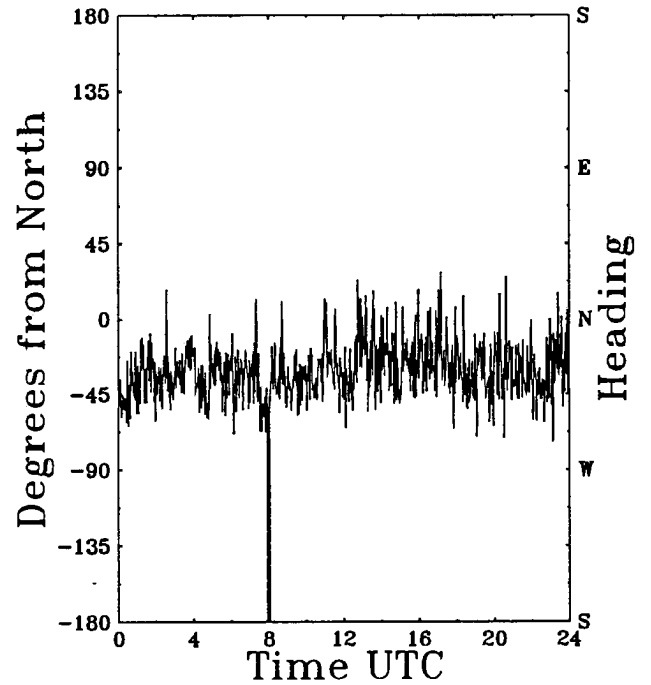


Julian Day 173 (21 June, 1992)

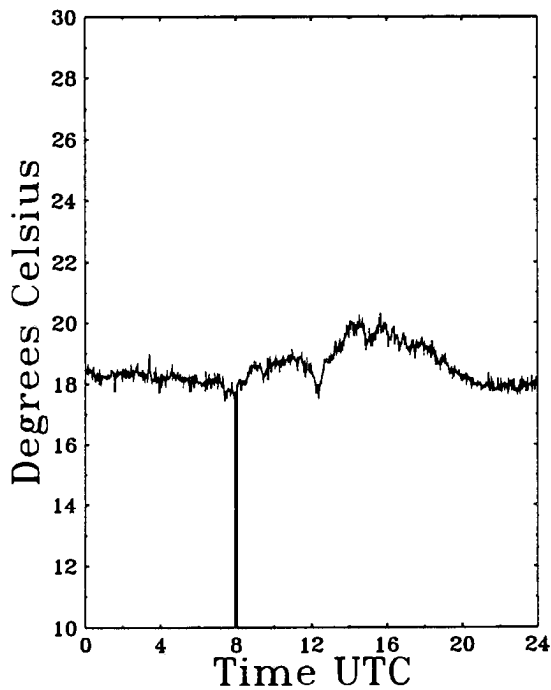
Wind Speed



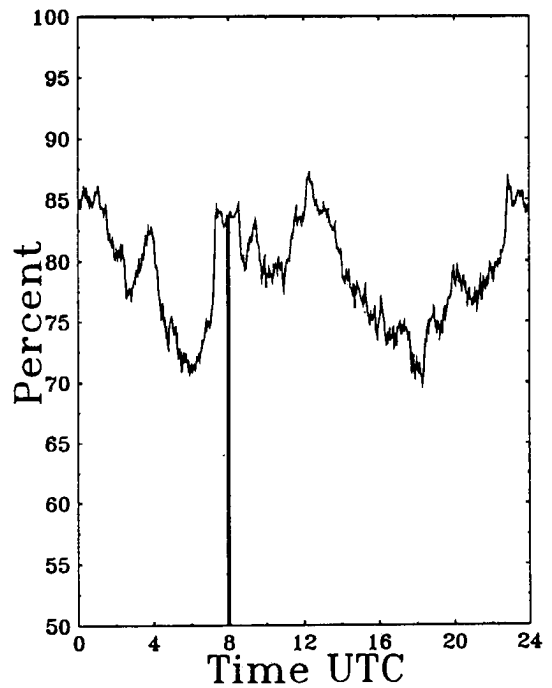
Wind Direction



Surface Temperature

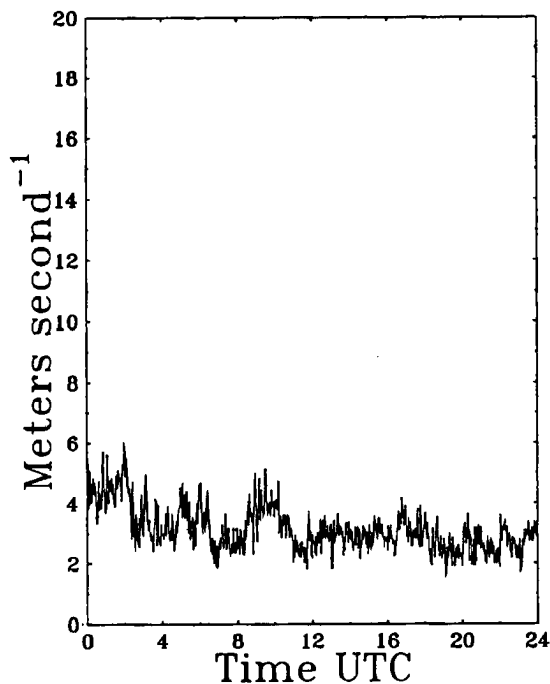


Relative Humidity

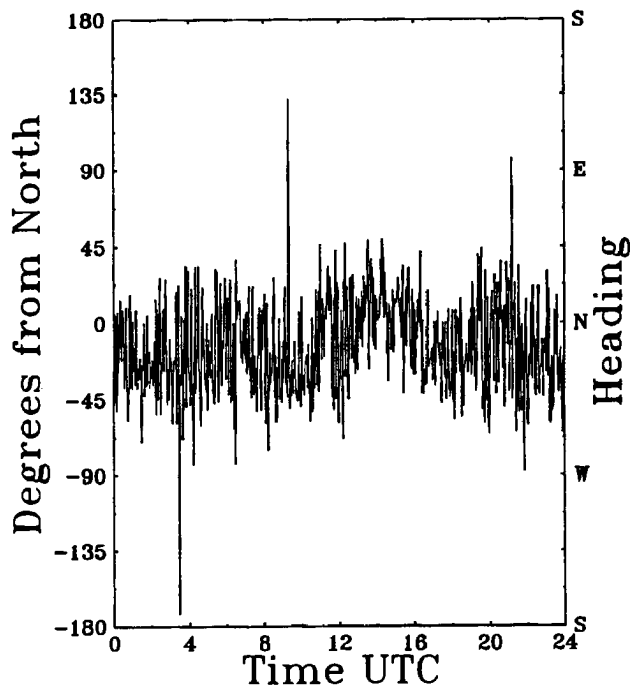


Julian Day 174 (22 June, 1992)

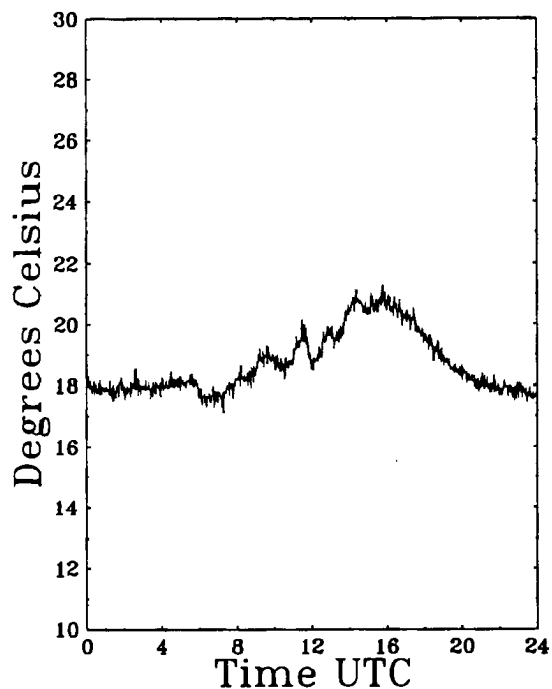
Wind Speed



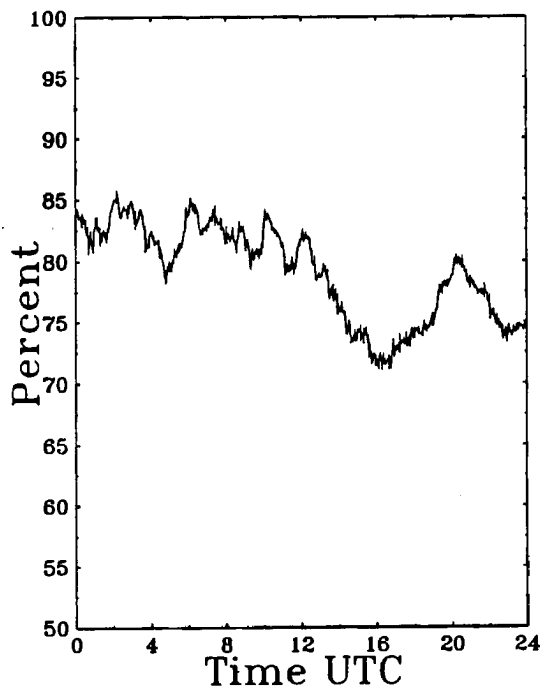
Wind Direction



Surface Temperature

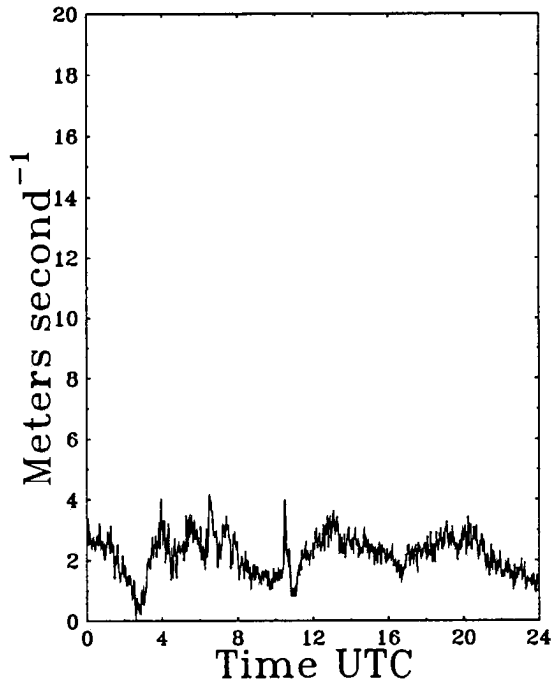


Relative Humidity

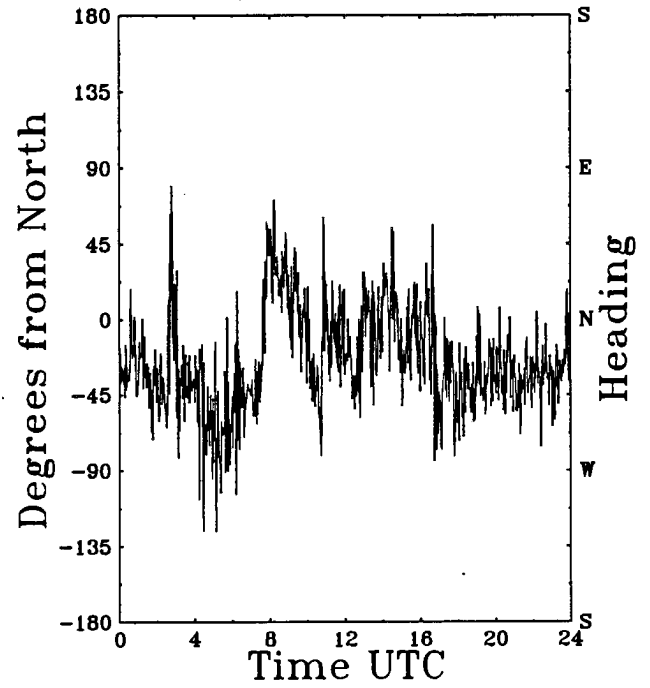


Julian Day 175 (23 June, 1992)

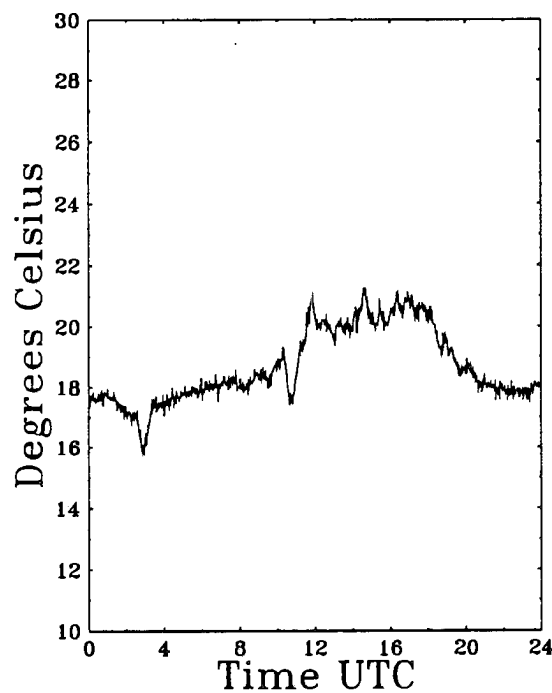
Wind Speed



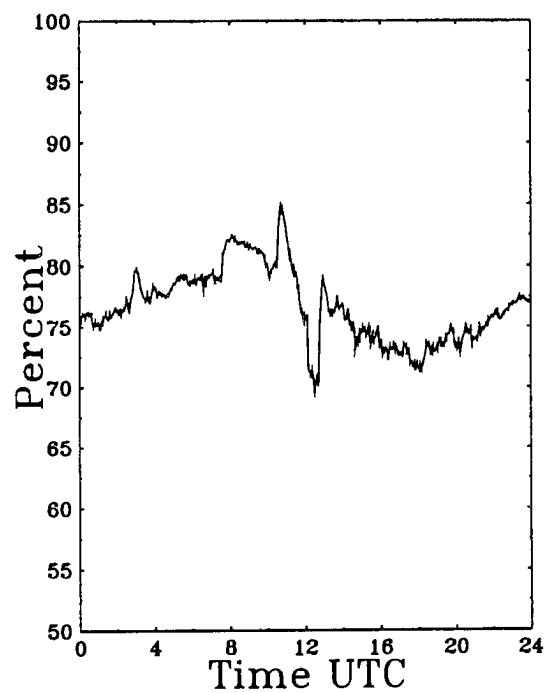
Wind Direction



Surface Temperature

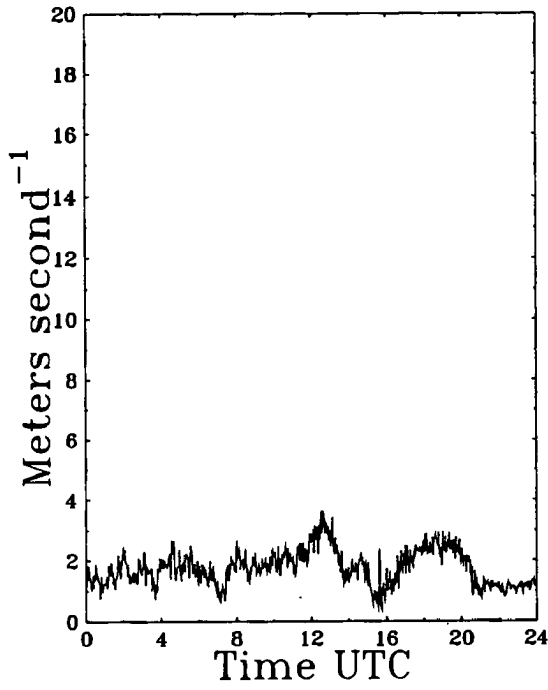


Relative Humidity

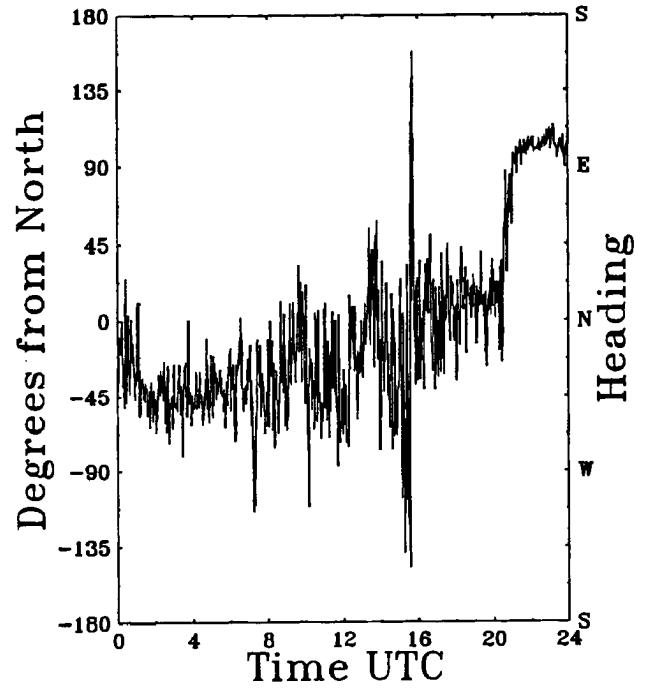


Julian Day 176 (24 June, 1992)

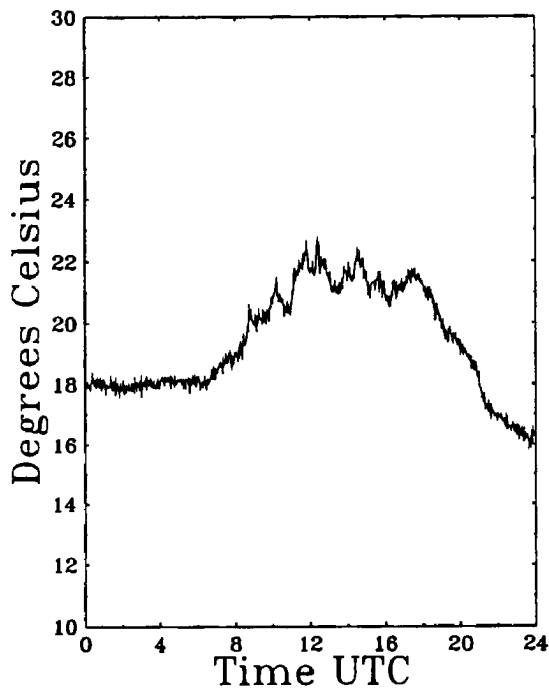
Wind Speed



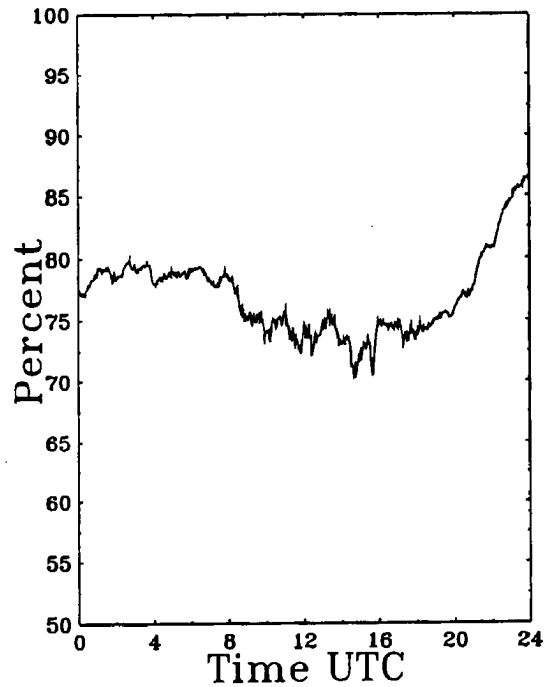
Wind Direction



Surface Temperature

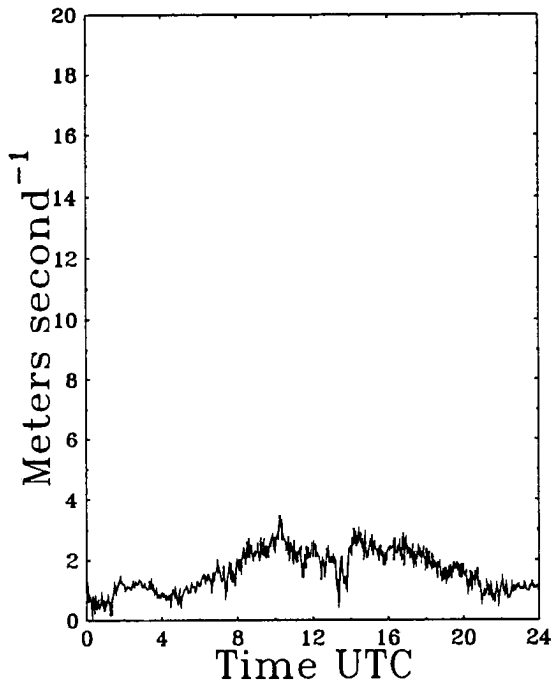


Relative Humidity

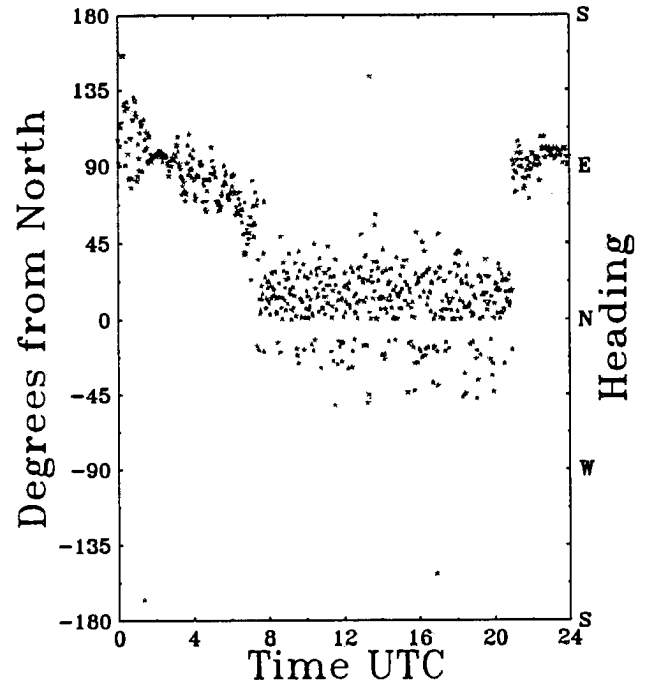


Julian Day 177 (25 June, 1992)

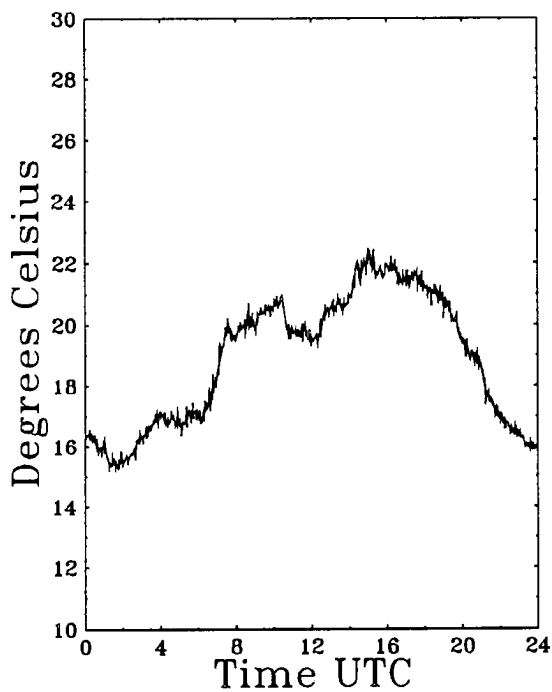
Wind Speed



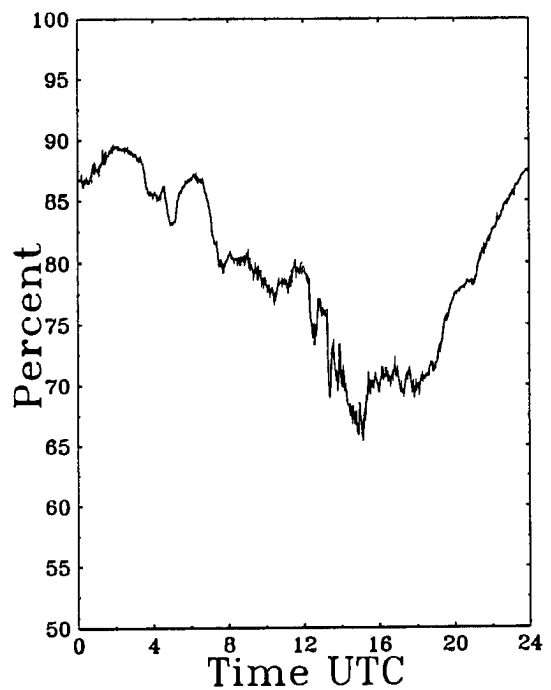
Wind Direction



Surface Temperature

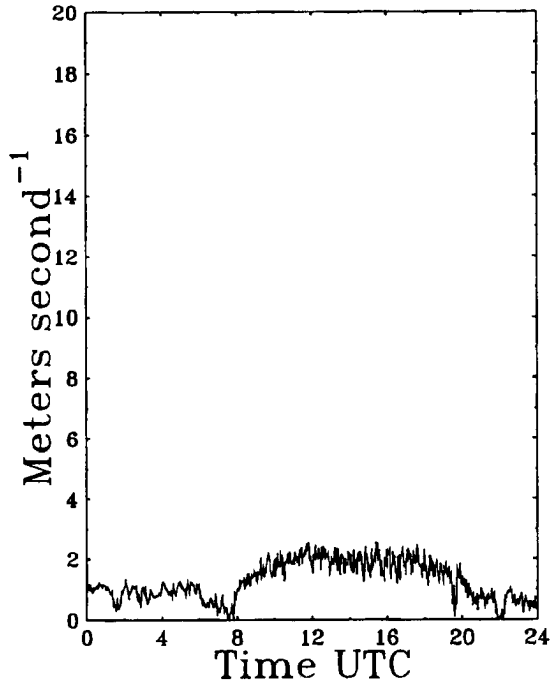


Relative Humidity

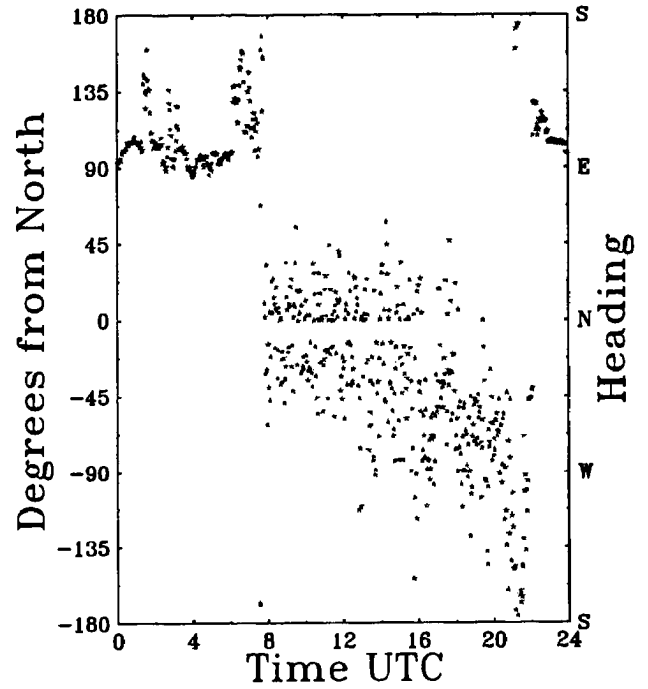


Julian Day 178 (26 June, 1992)

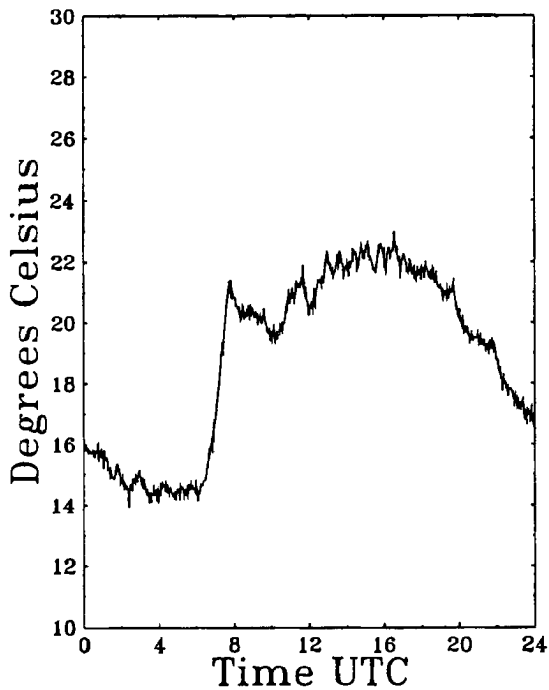
Wind Speed



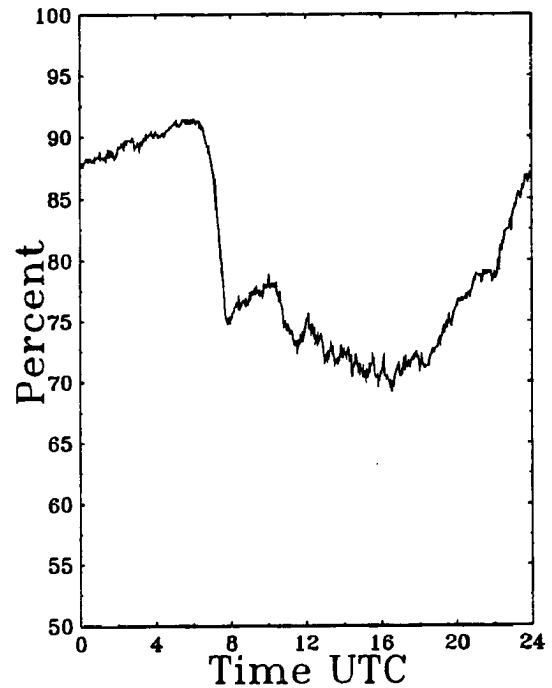
Wind Direction



Surface Temperature

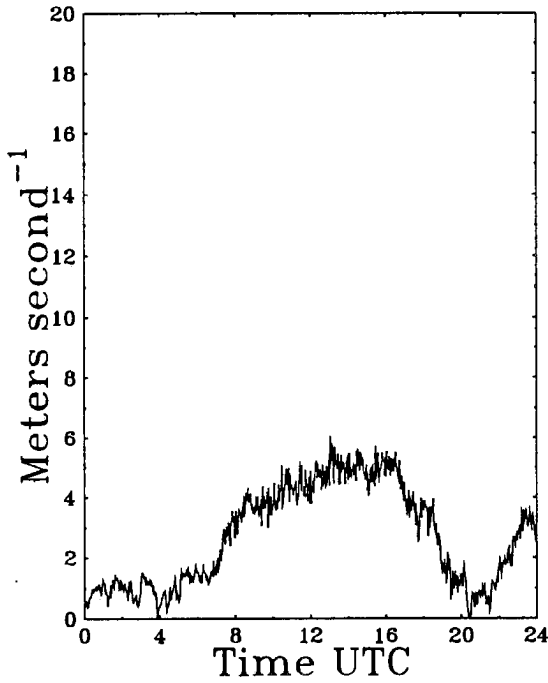


Relative Humidity

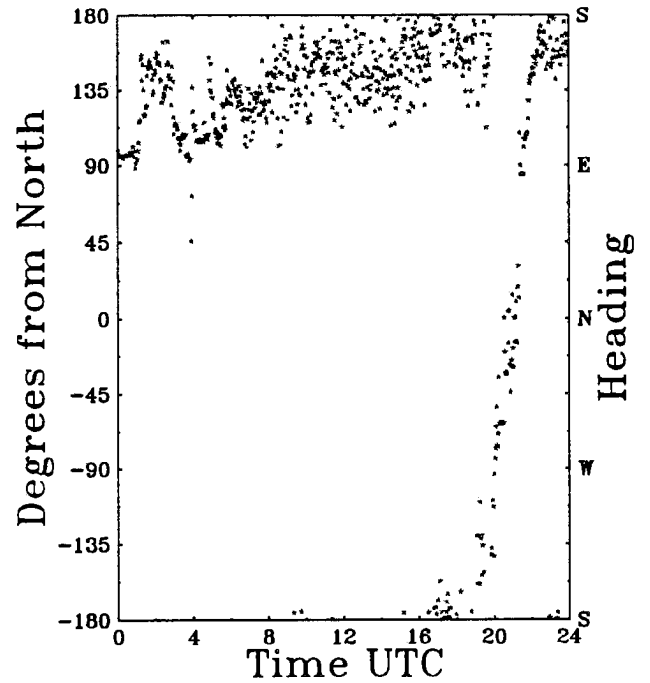


Julian Day 179 (27 June, 1992)

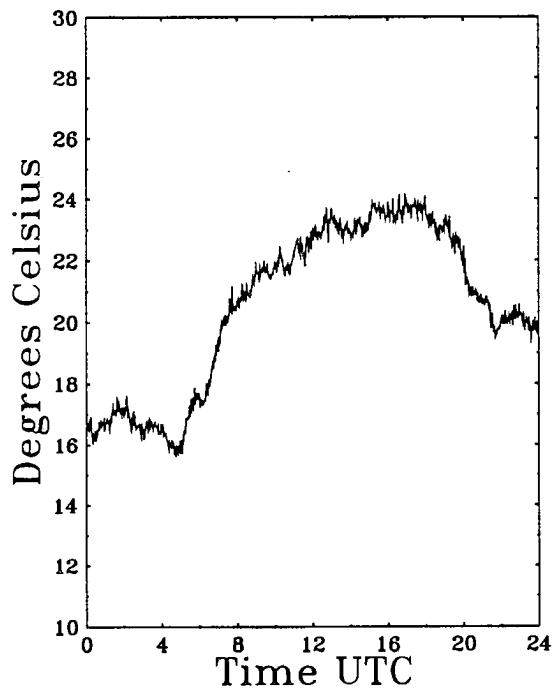
Wind Speed



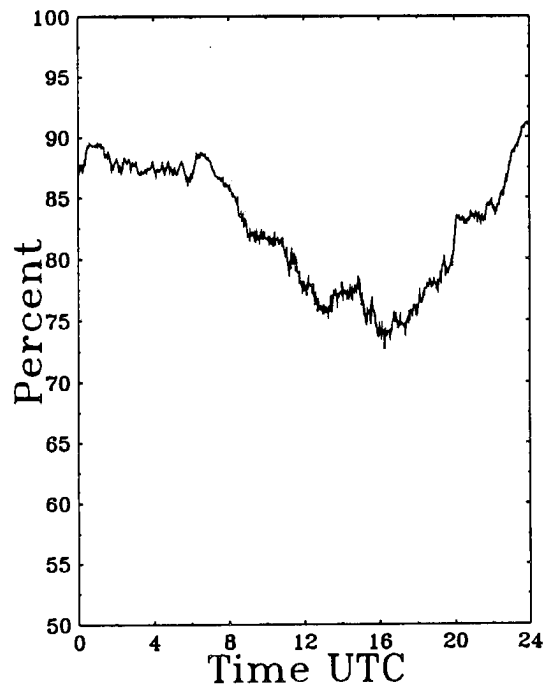
Wind Direction



Surface Temperature

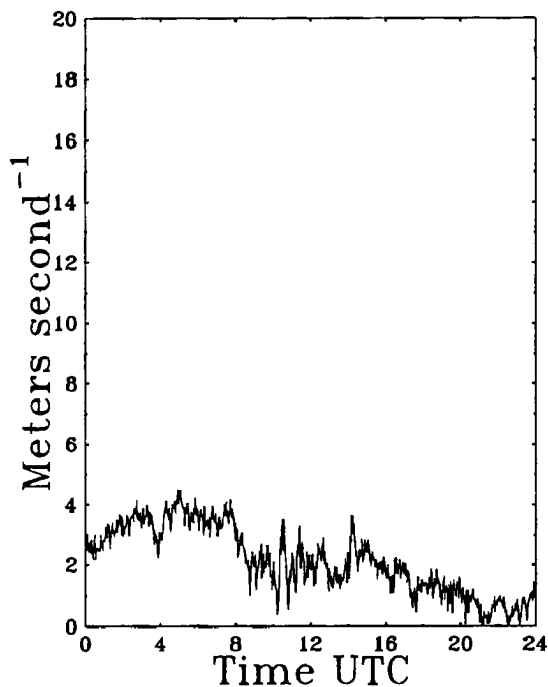


Relative Humidity

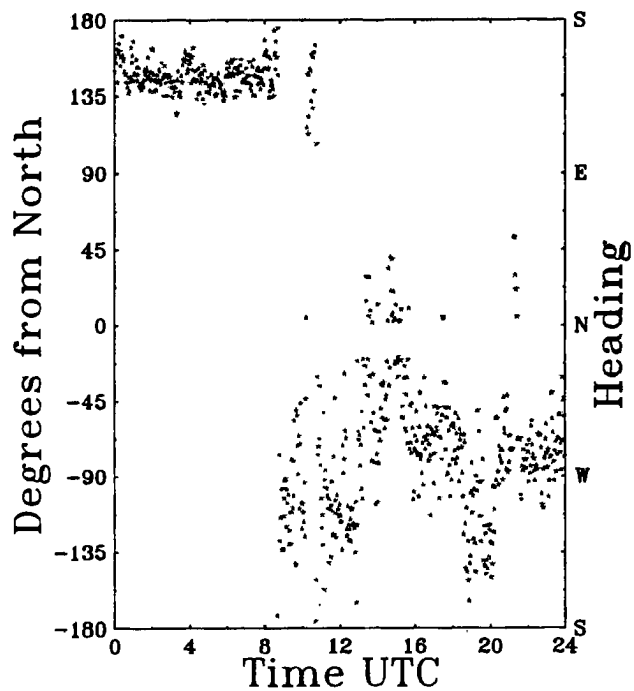


Julian Day 180 (28 June, 1992)

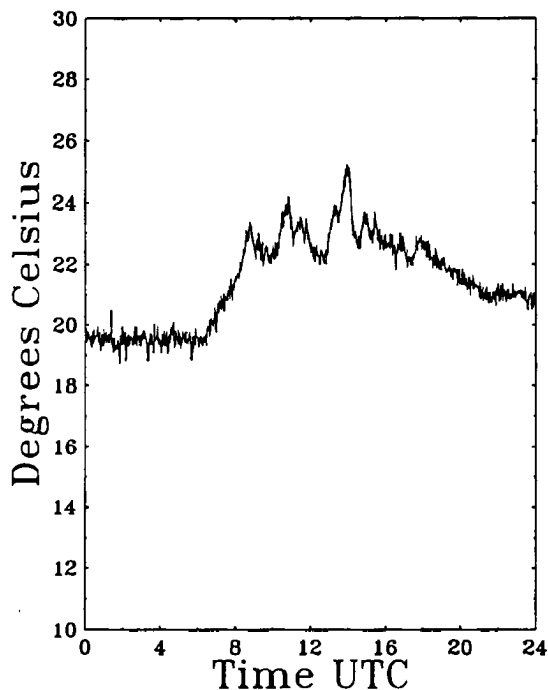
Wind Speed



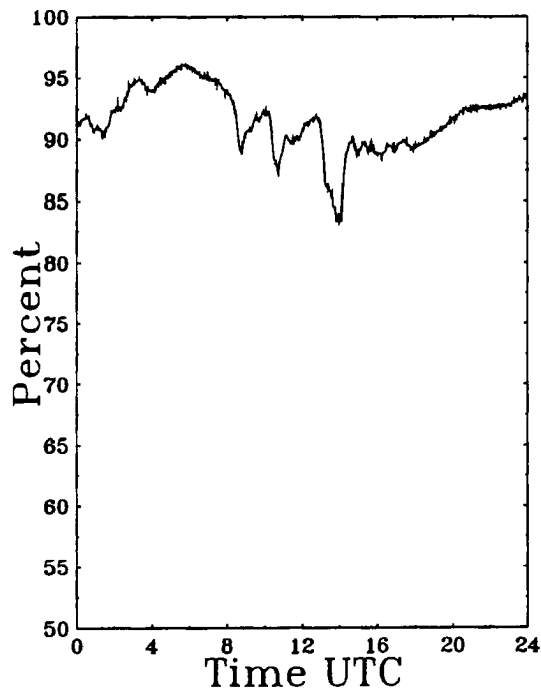
Wind Direction



Surface Temperature



Relative Humidity

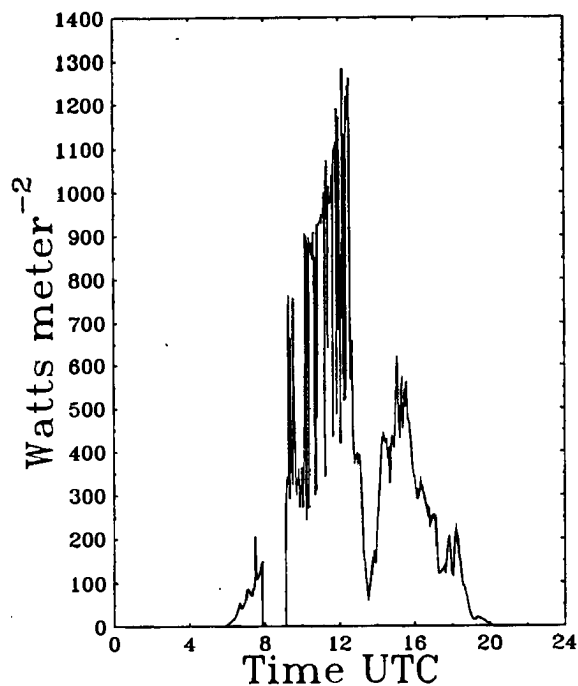


4. Radiation and Ceiling Time Series

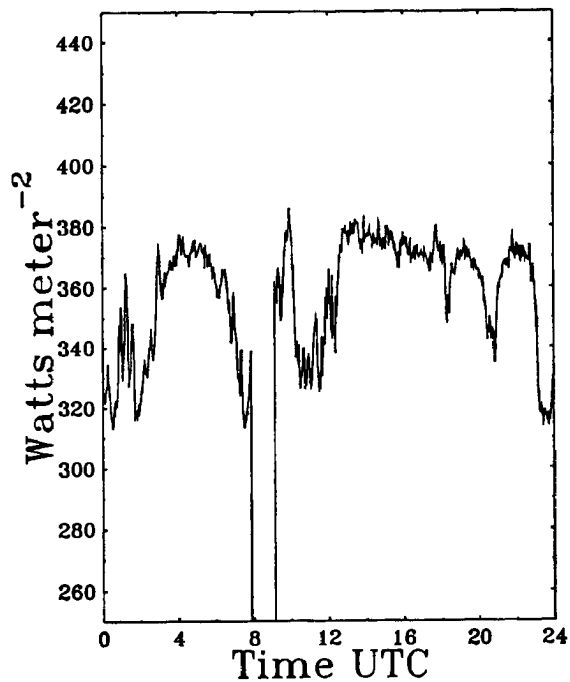
The downwelling infrared and solar radiation irradiances, the 11 micron brightness temperature of the sky at zenith and the ceiling were monitored at the experiment site continuously from June 1 to June 28, 1992. The irradiances were sampled once every two minutes, the 11 micron brightness temperature sampling frequency was once per 10 sec and the ceiling was sampled once per minute. The irradiance data were recorded on the same system as the surface meteorology data while the 11 micron brightness temperature data were recorded on a separate Campbell 21X system. The ceilometer data were recorded via a RS-232 connection on a 386 class PC. These data are presented at full temporal resolution on the following pages 43 - 71.

Julian Day 153 (1 June, 1992)

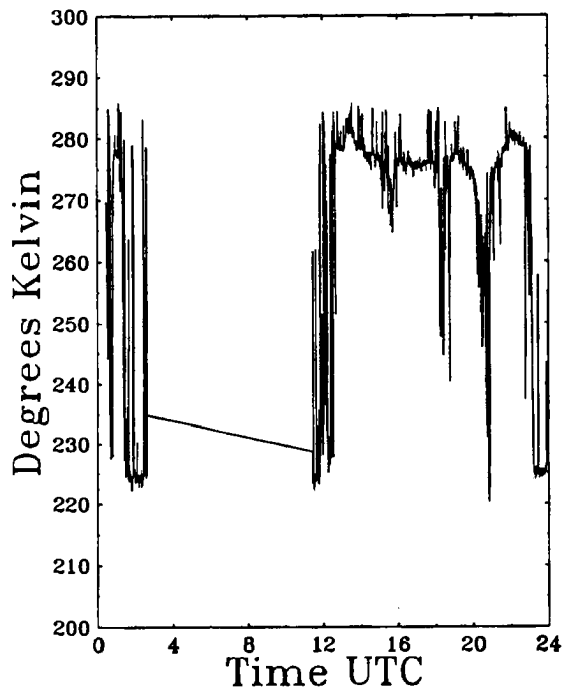
Solar Irradiance



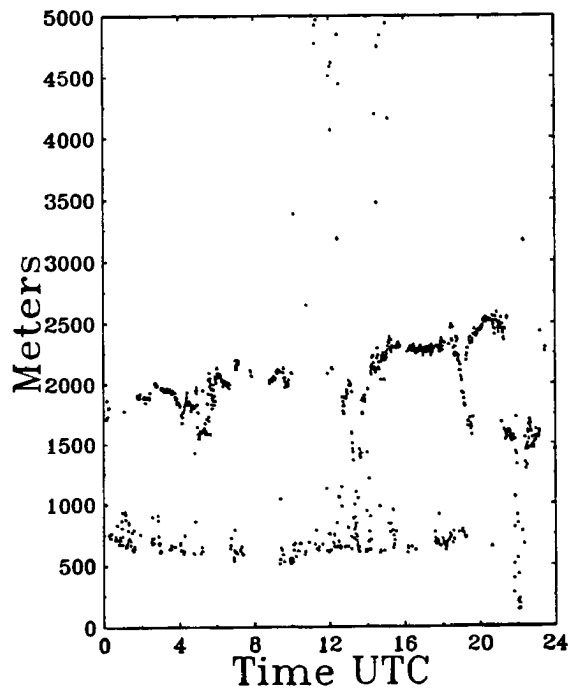
IR Irradiance



11 μm Brightness Temp

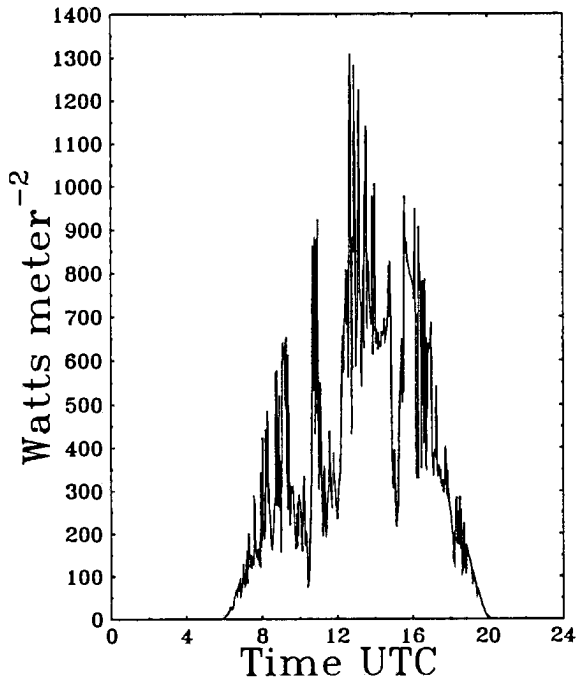


Ceiling

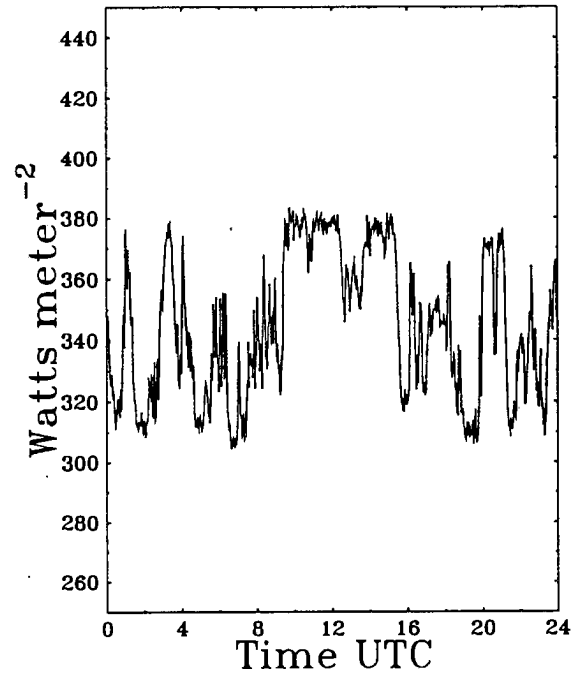


Julian Day 154 (2 June, 1992)

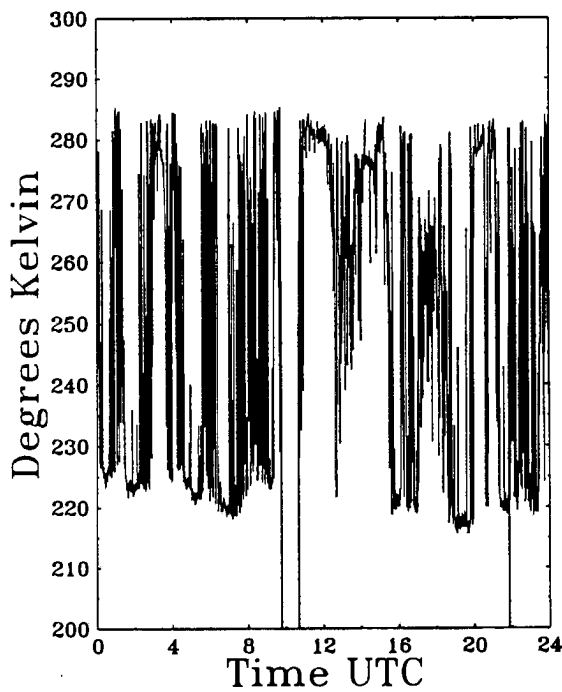
Solar Irradiance



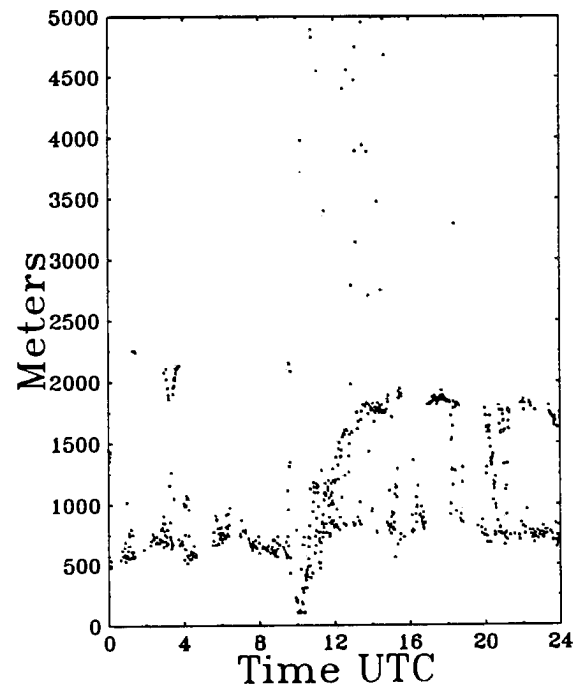
IR Irradiance



11 μm Brightness Temp

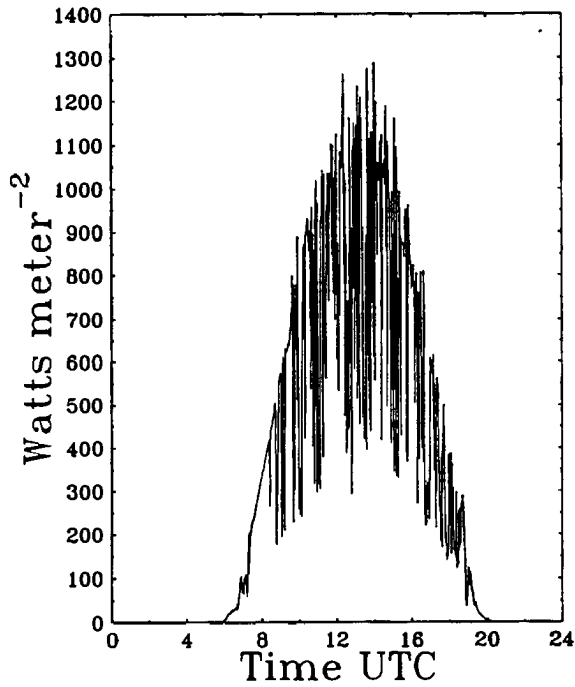


Ceiling

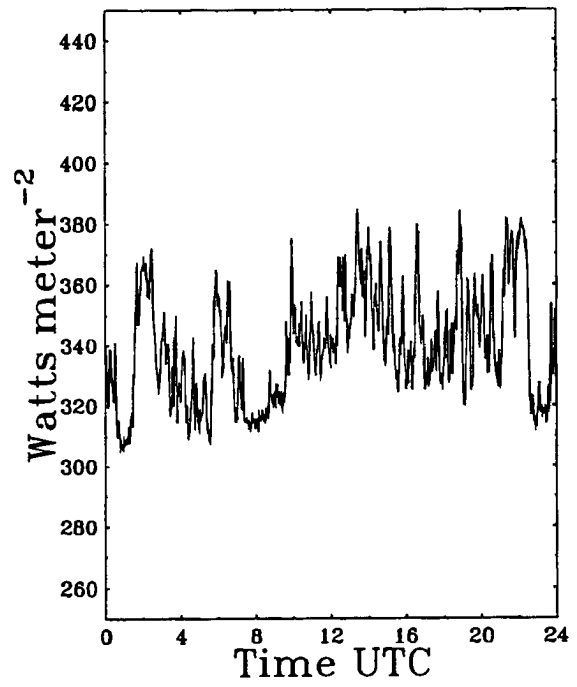


Julian Day 155 (3 June, 1992)

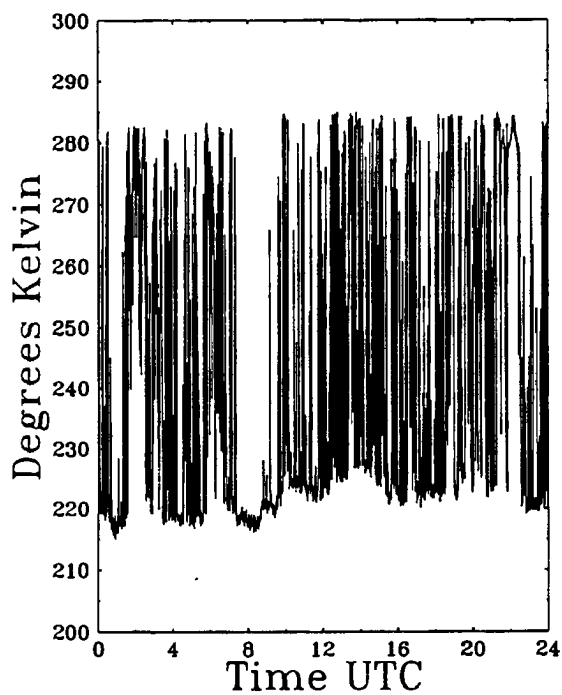
Solar Irradiance



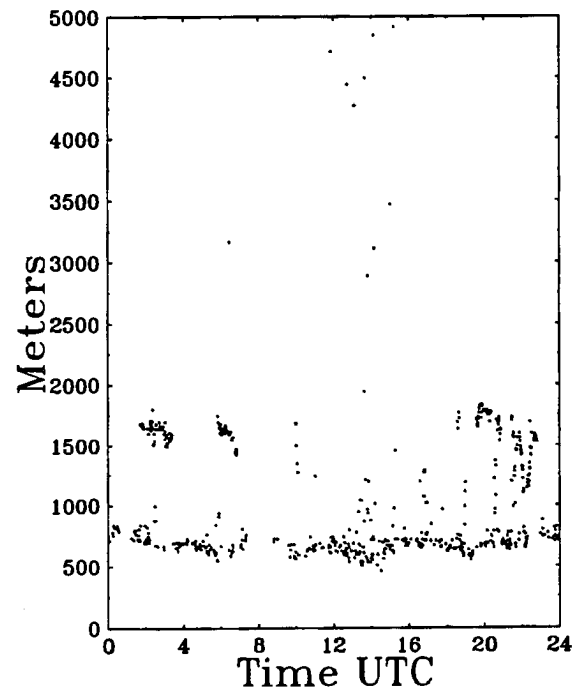
IR Irradiance



11 μ m Brightness Temp

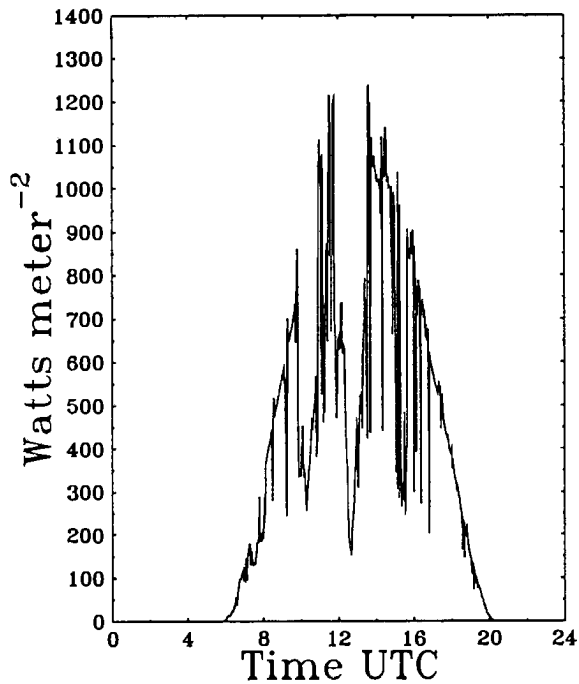


Ceiling

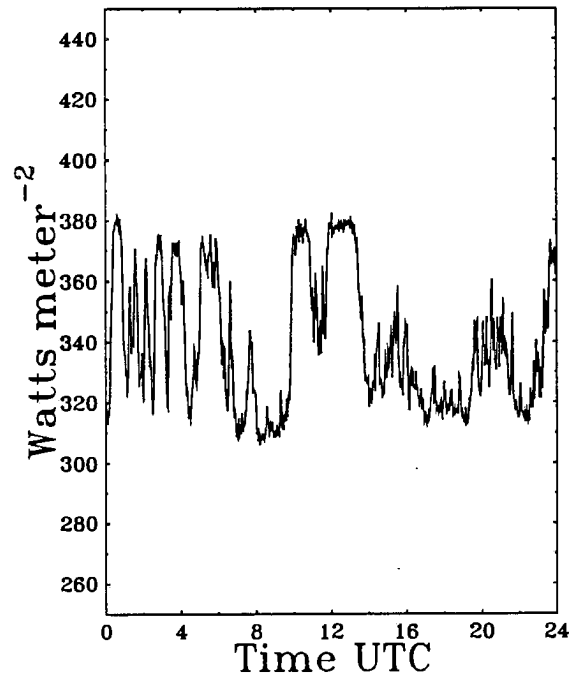


Julian Day 156 (4 June, 1992)

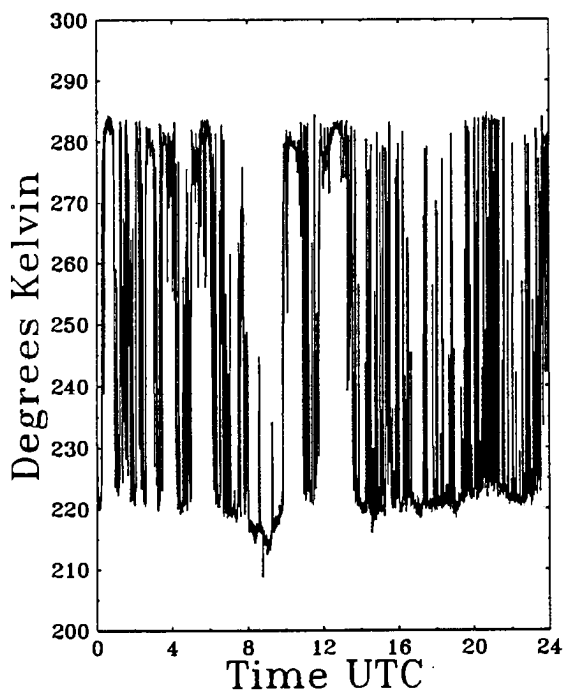
Solar Irradiance



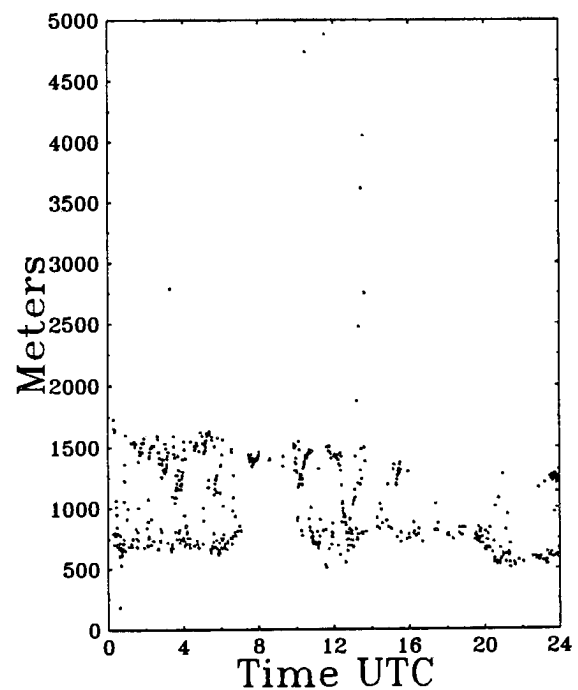
IR Irradiance



11 μm Brightness Temp

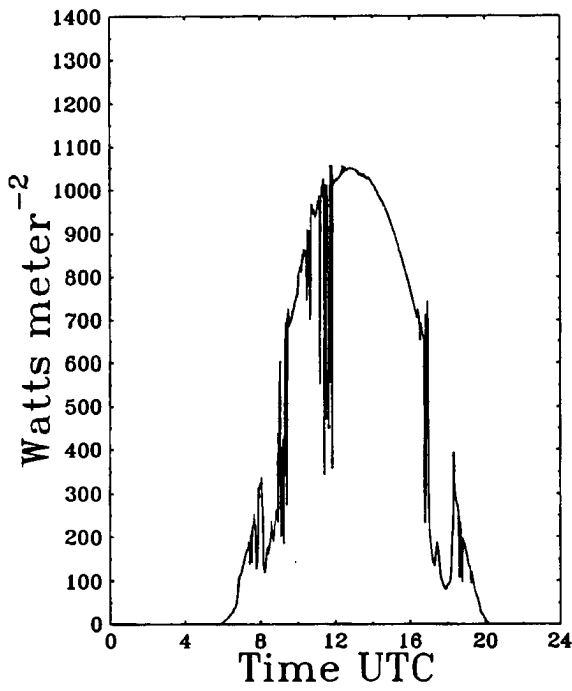


Ceiling

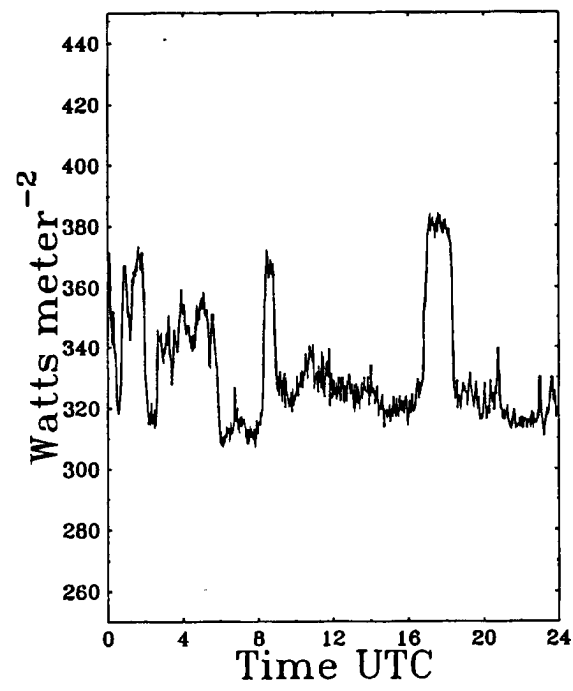


Julian Day 157 (5 June, 1992)

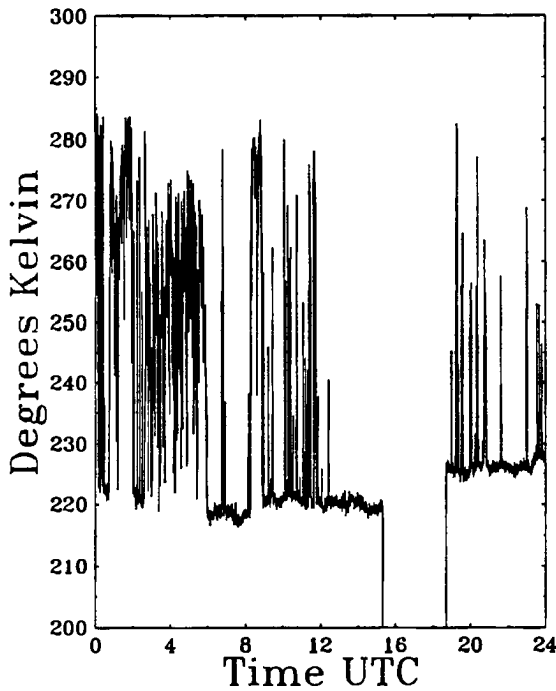
Solar Irradiance



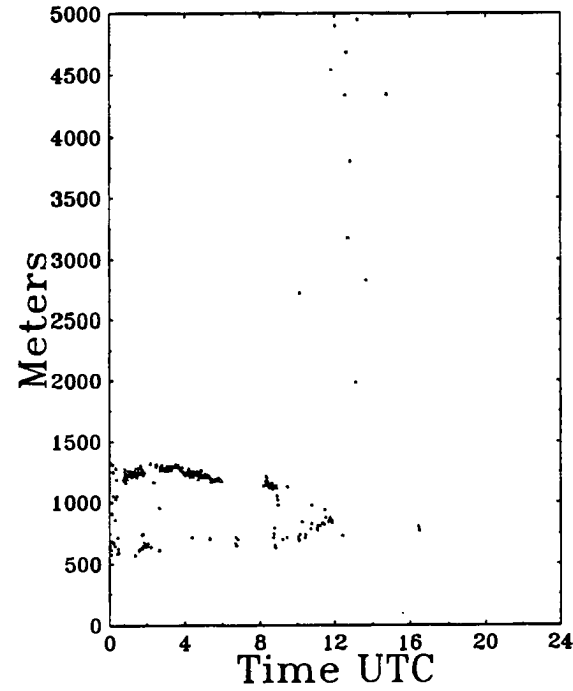
IR Irradiance



11 μm Brightness Temp

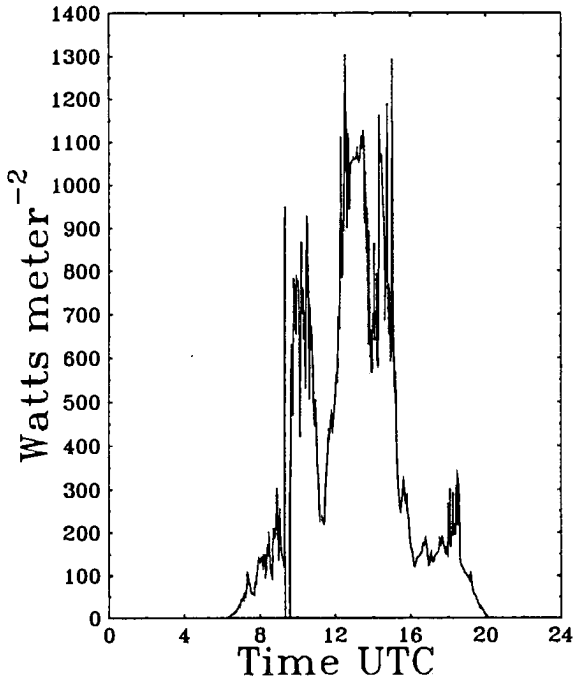


Ceiling

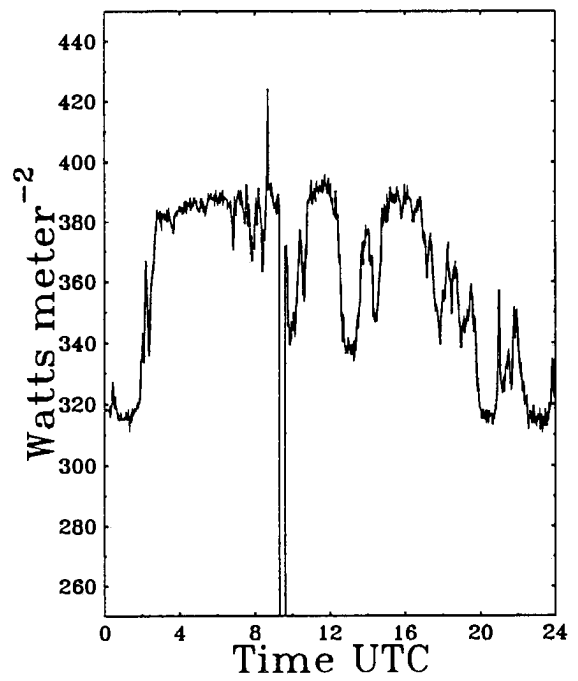


Julian Day 158 (6 June, 1992)

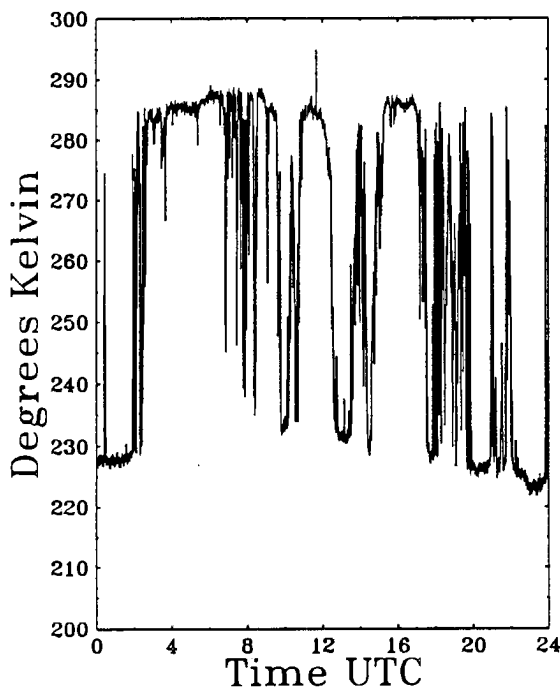
Solar Irradiance



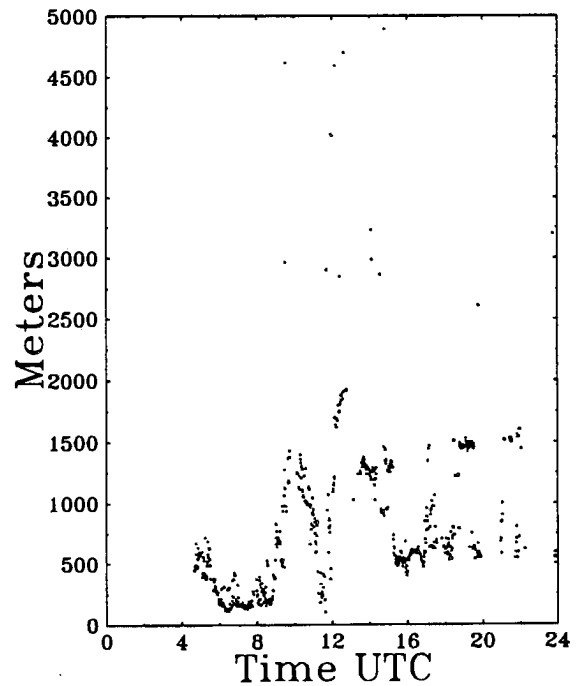
IR Irradiance



11 μ m Brightness Temp

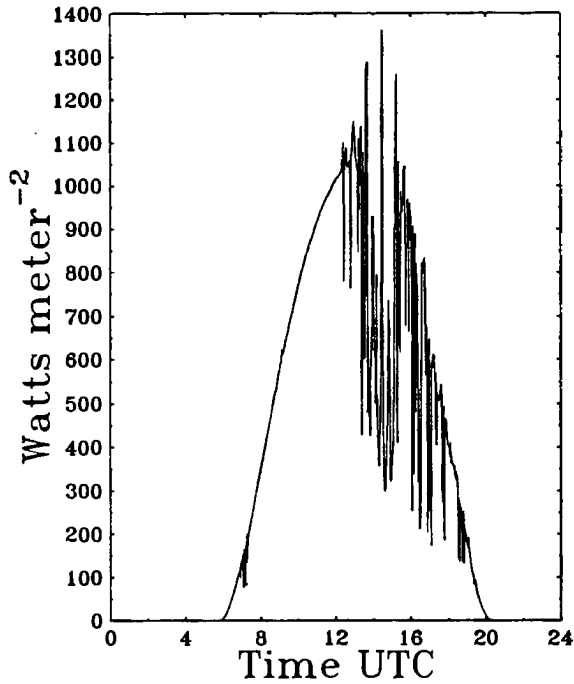


Ceiling

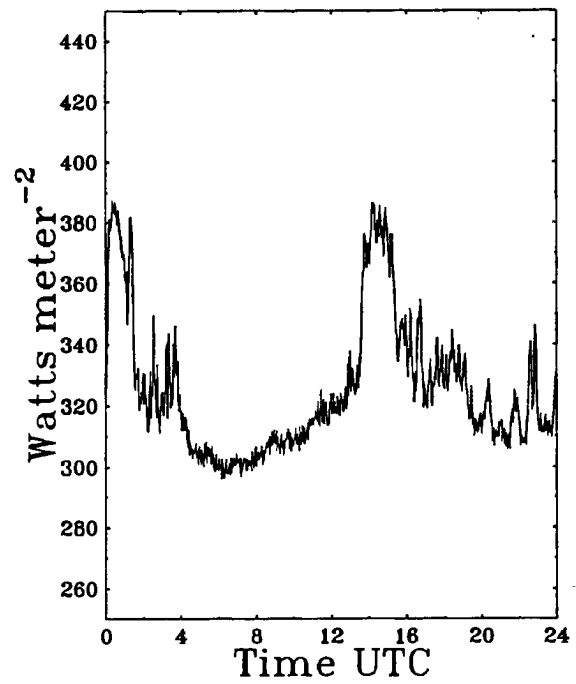


Julian Day 159 (7 June, 1992)

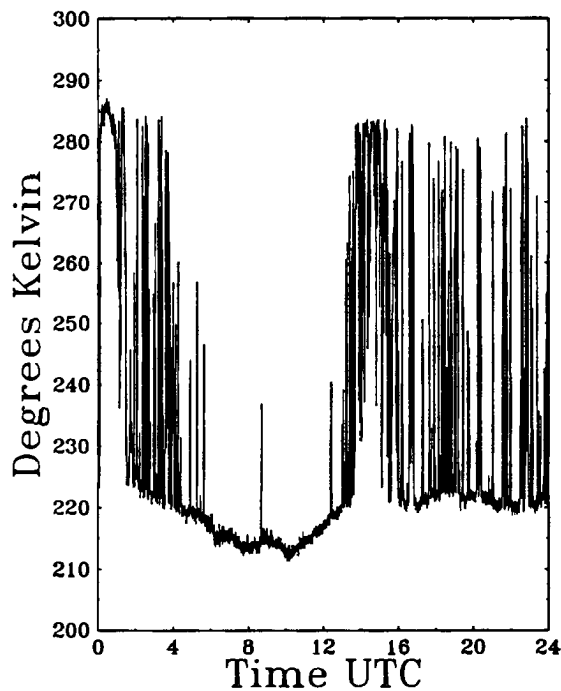
Solar Irradiance



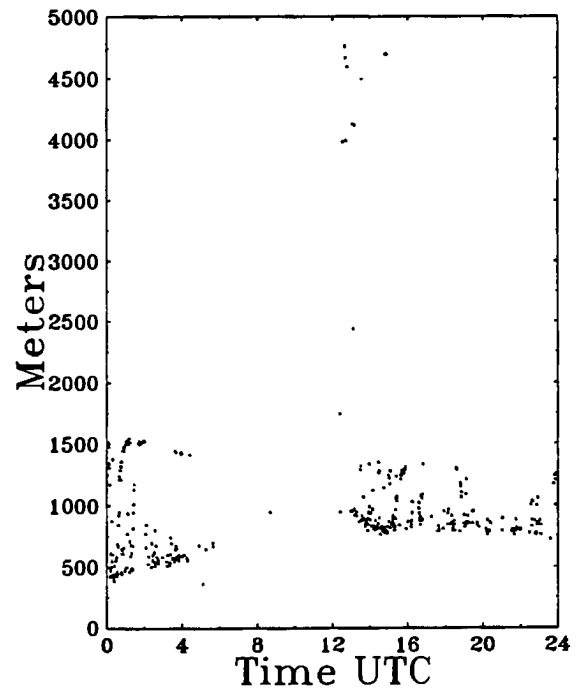
IR Irradiance



11 μm Brightness Temp

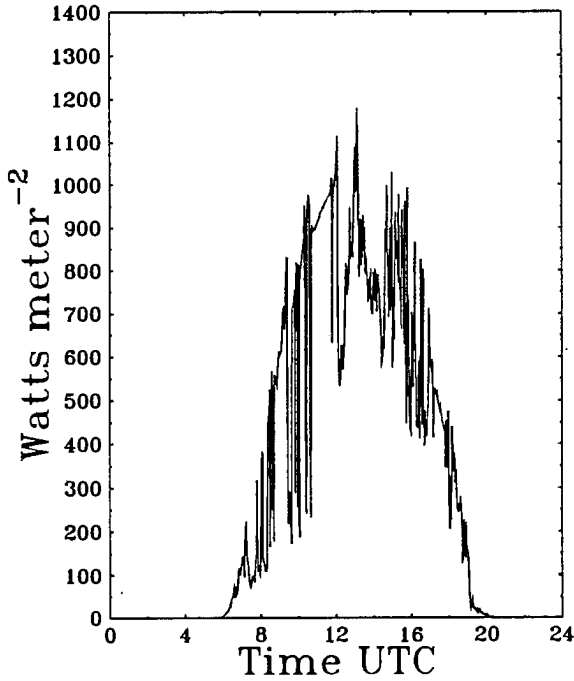


Ceiling

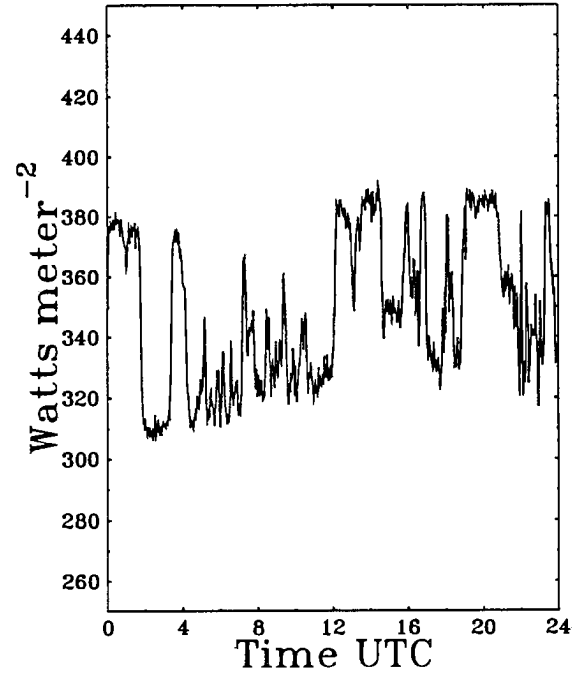


Julian Day 160 (8 June, 1992)

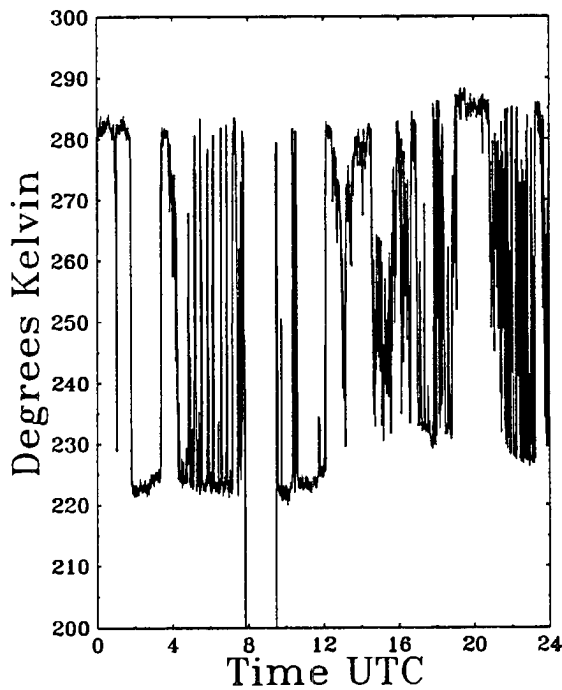
Solar Irradiance



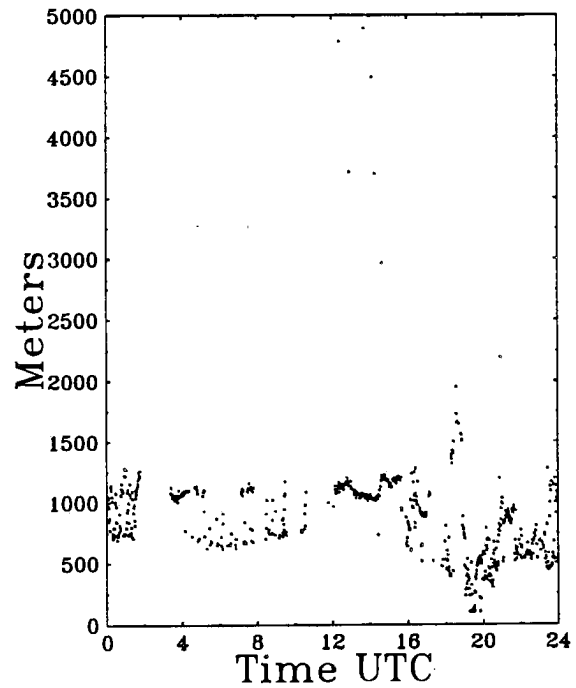
IR Irradiance



11 μm Brightness Temp

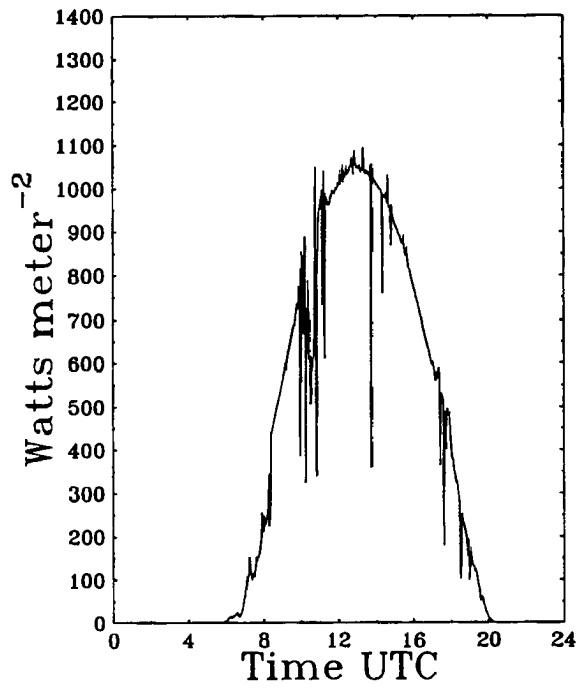


Ceiling

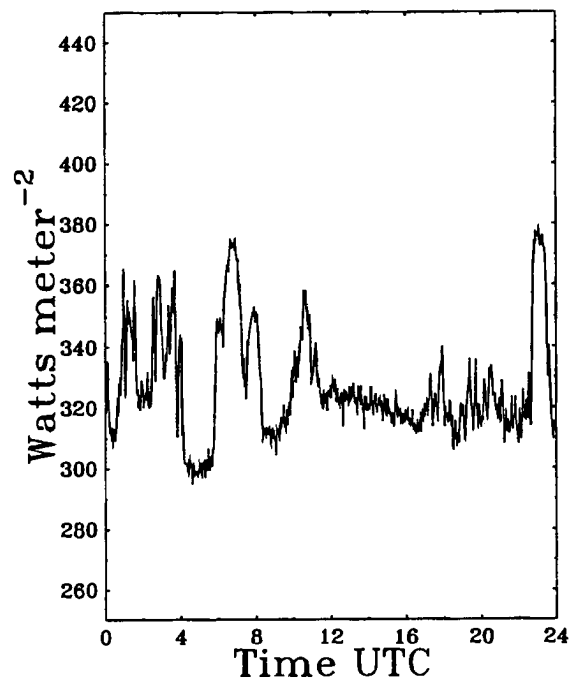


Julian Day 161 (9 June, 1992)

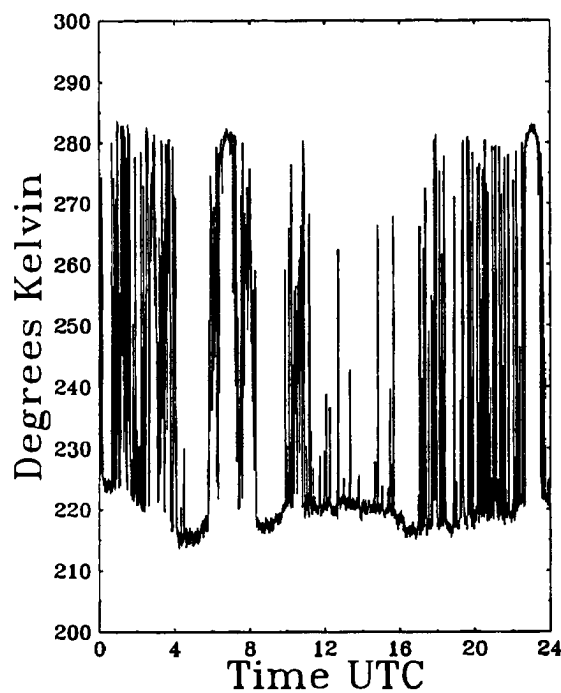
Solar Irradiance



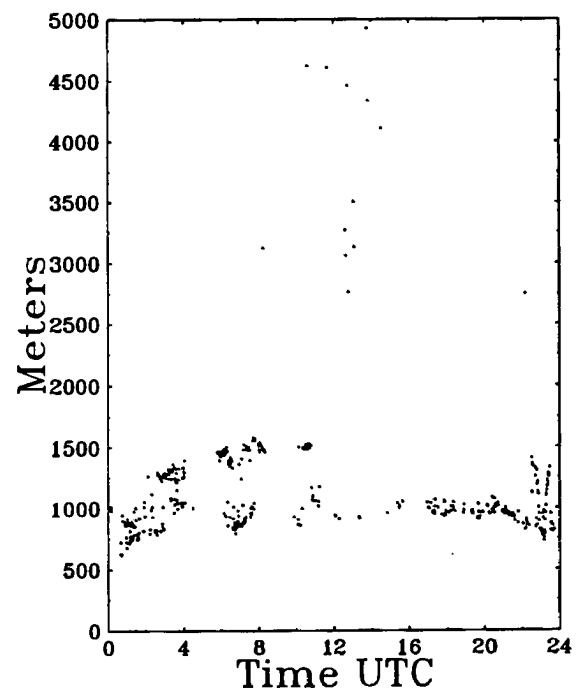
IR Irradiance



11 μ m Brightness Temp

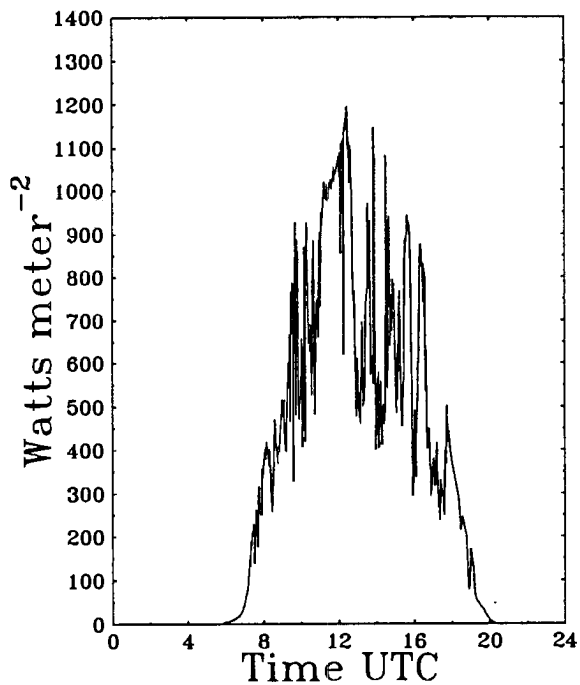


Ceiling

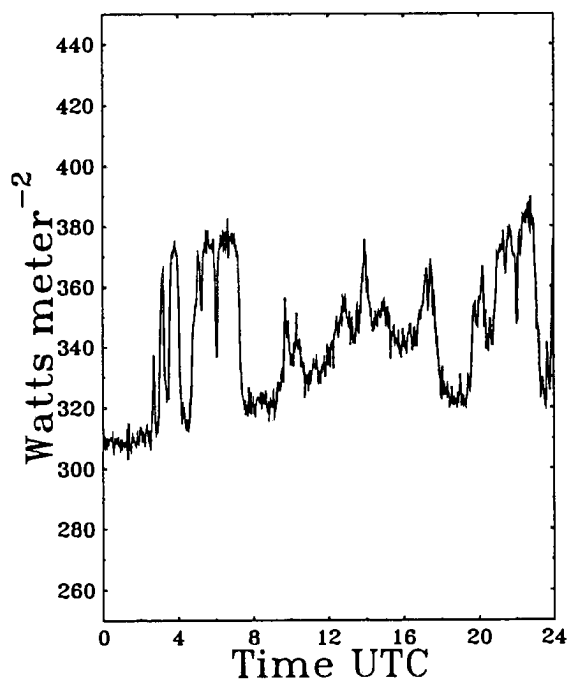


Julian Day 162 (10 June, 1992)

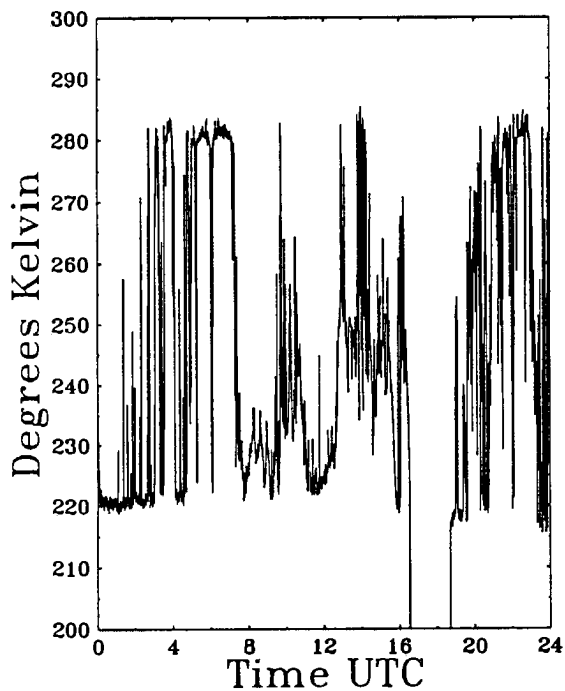
Solar Irradiance



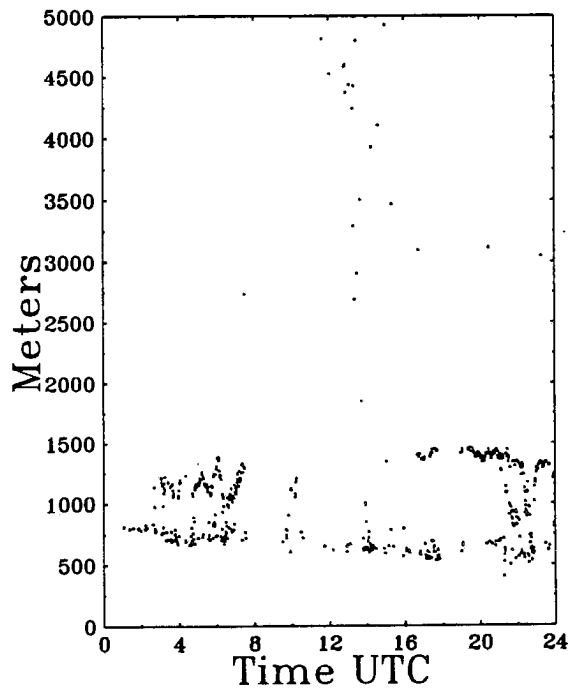
IR Irradiance



11 μm Brightness Temp

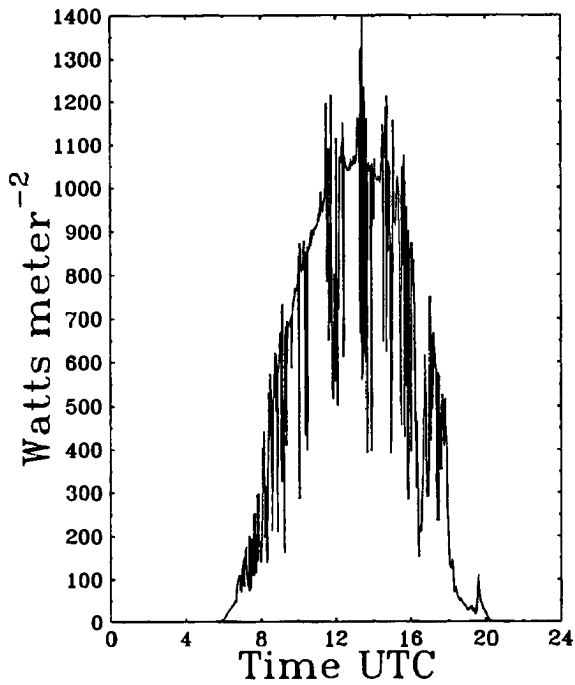


Ceiling

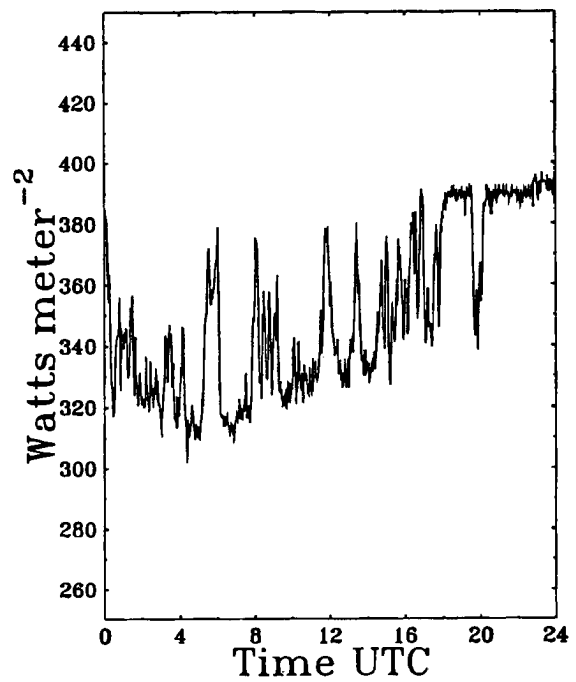


Julian Day 163 (11 June, 1992)

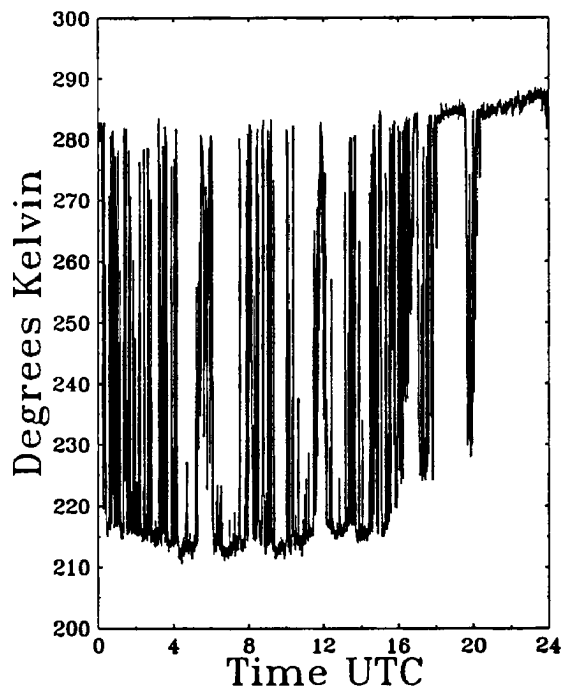
Solar Irradiance



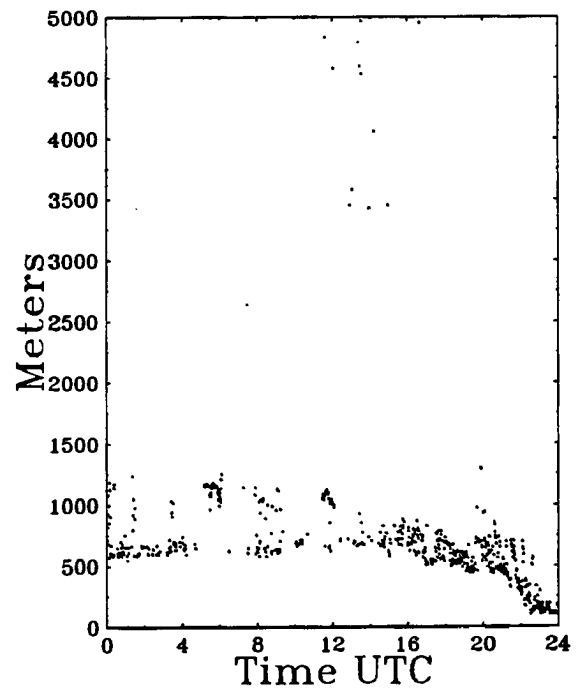
IR Irradiance



11 μm Brightness Temp

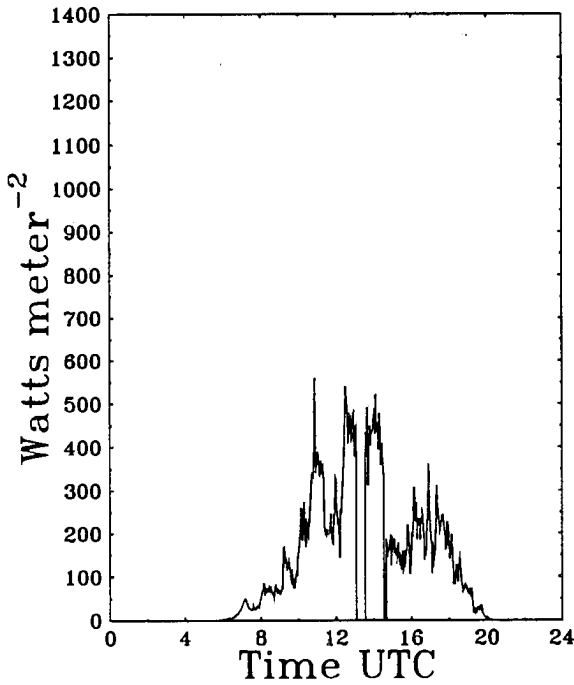


Ceiling

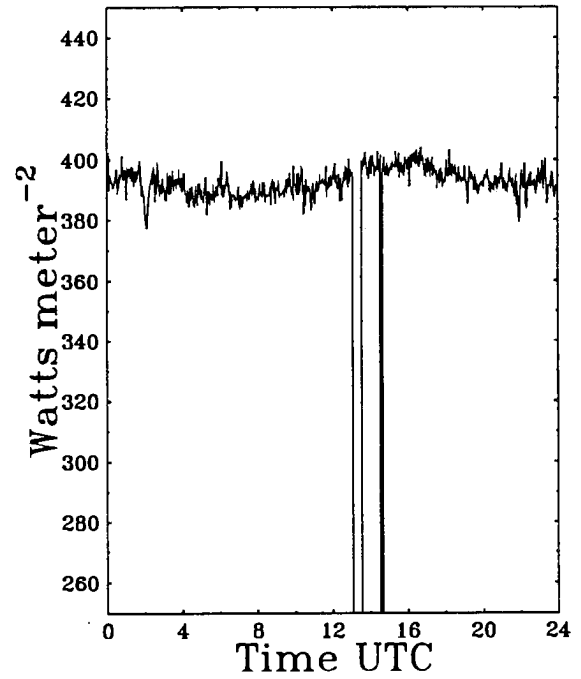


Julian Day 164 (12 June, 1992)

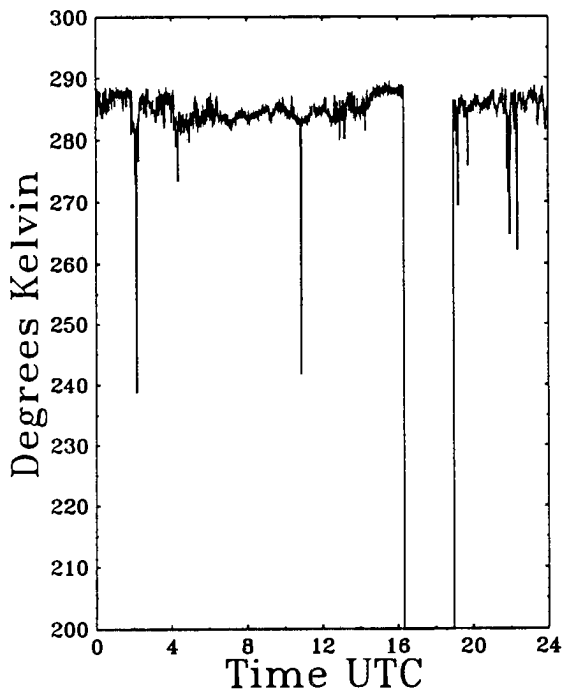
Solar Irradiance



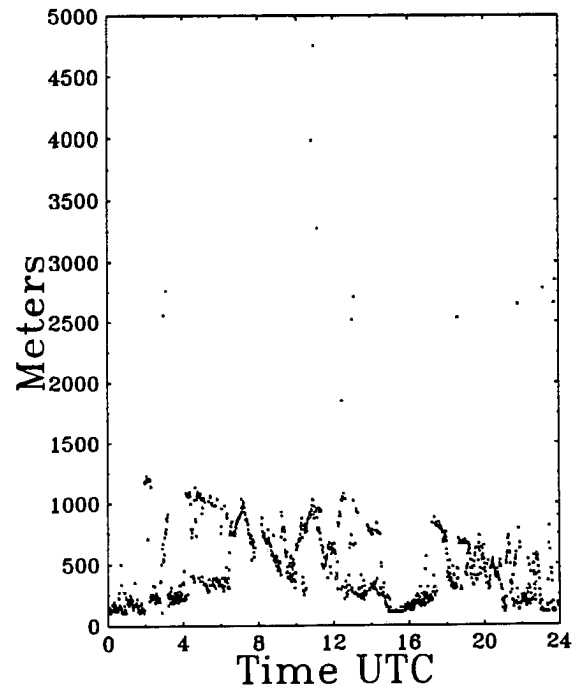
IR Irradiance



11 μm Brightness Temp

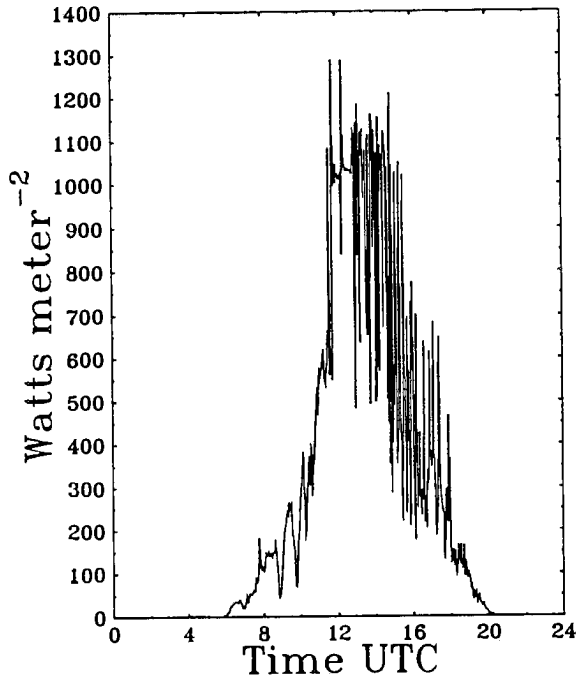


Ceiling

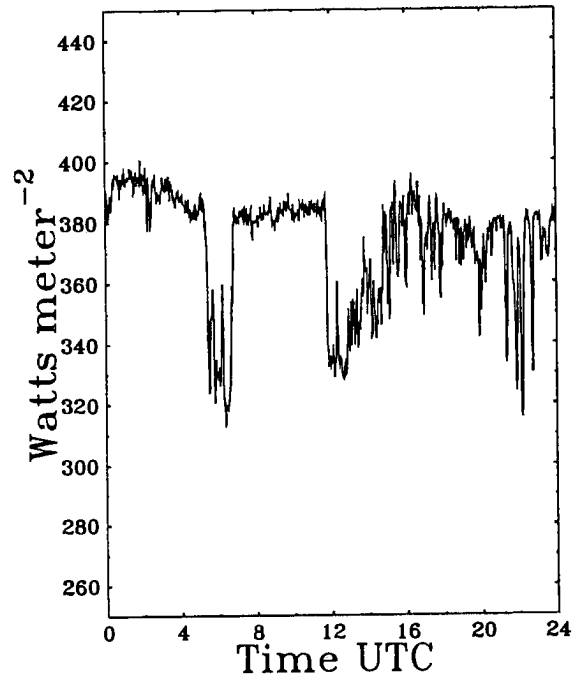


Julian Day 165 (13 June, 1992)

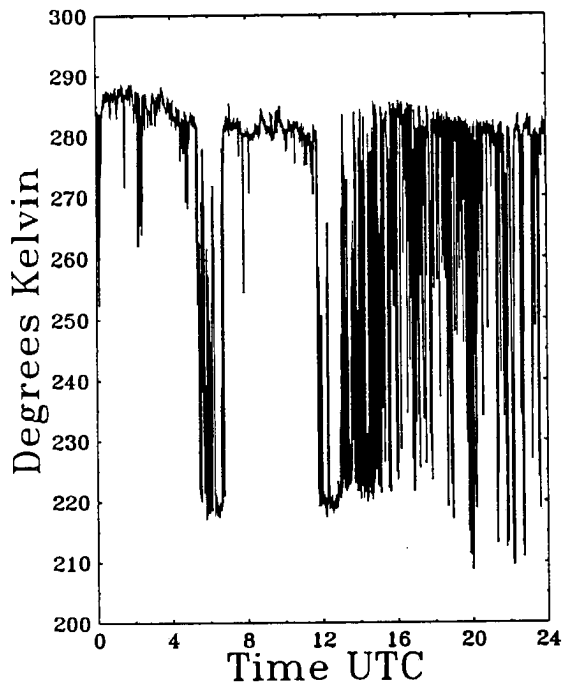
Solar Irradiance



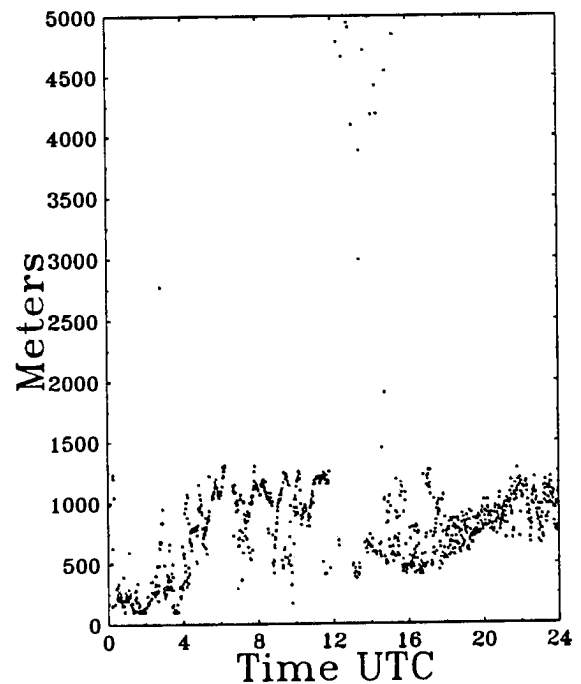
IR Irradiance



11 μm Brightness Temp

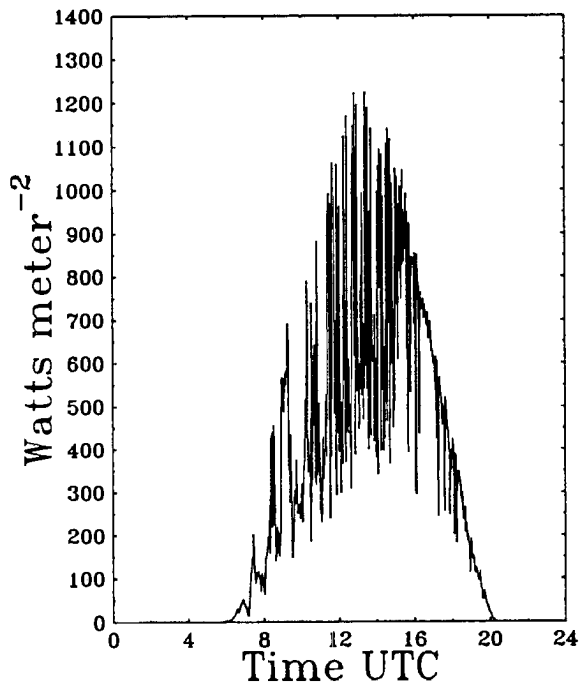


Ceiling

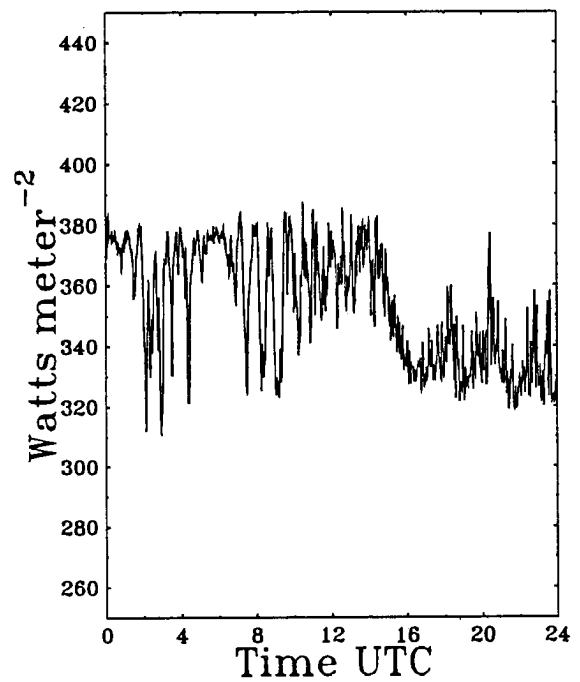


Julian Day 166 (14 June, 1992)

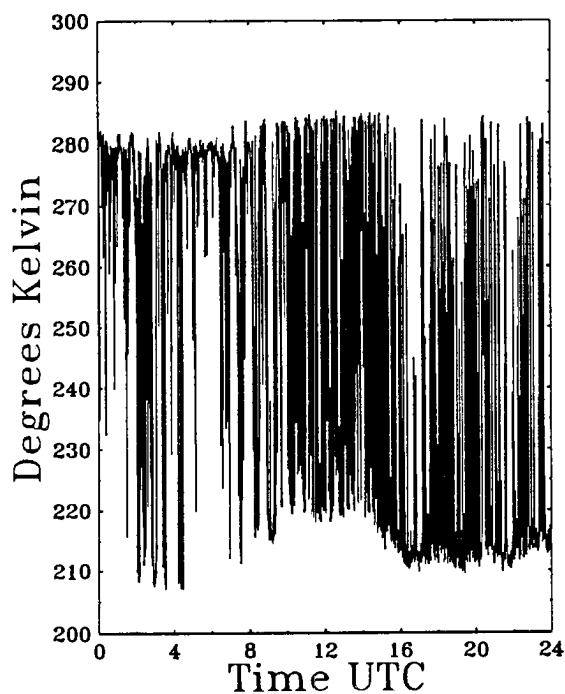
Solar Irradiance



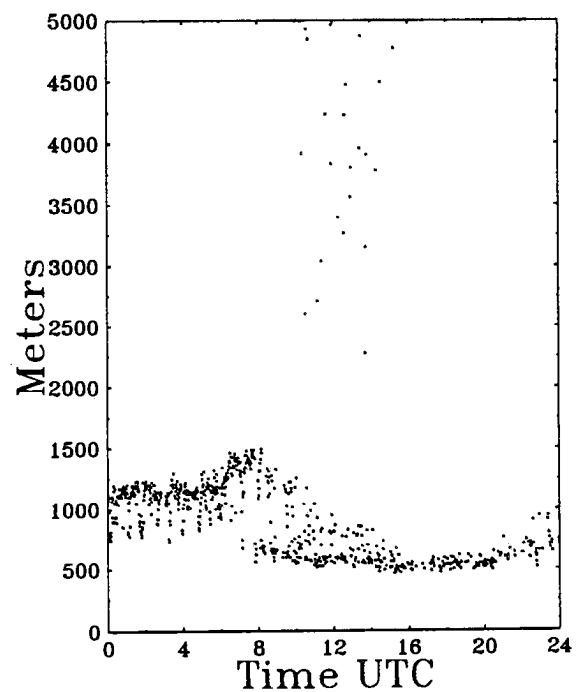
IR Irradiance



11 μm Brightness Temp

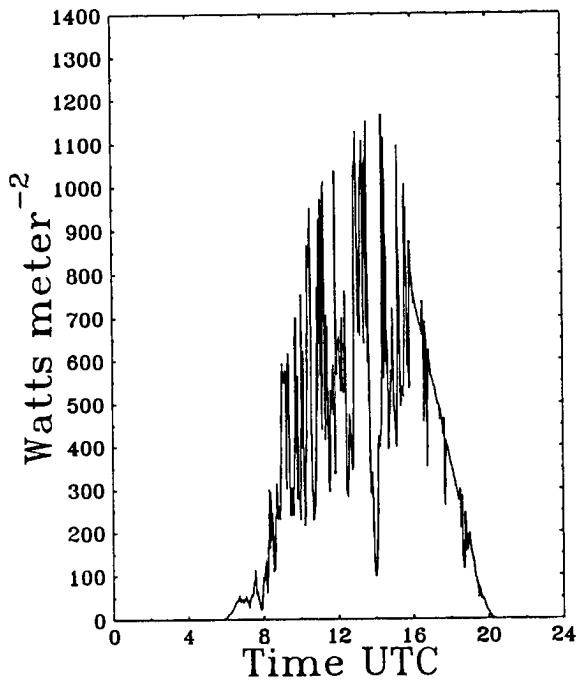


Ceiling

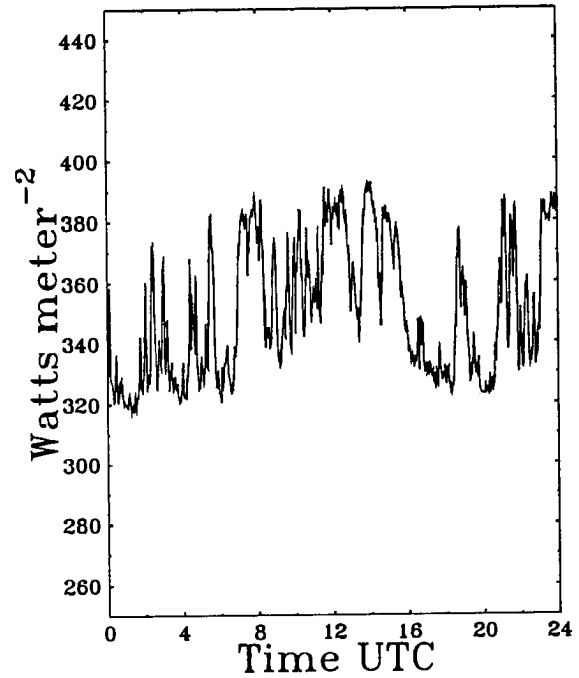


Julian Day 167 (15 June, 1992)

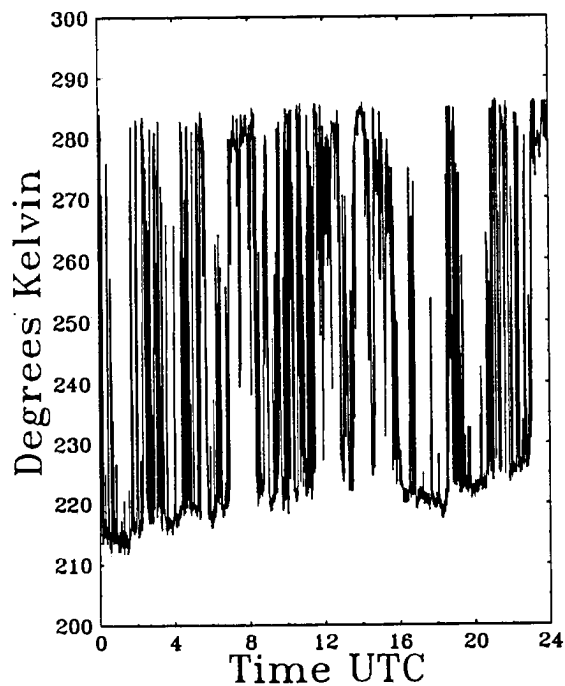
Solar Irradiance



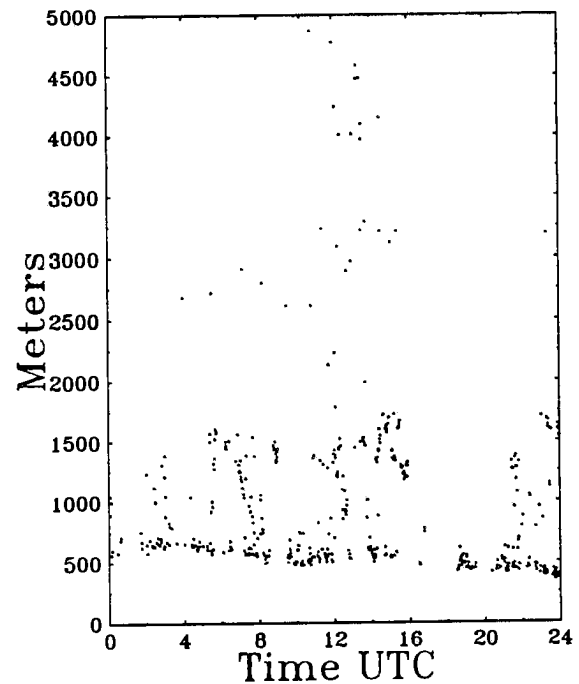
IR Irradiance



11 μm Brightness Temp

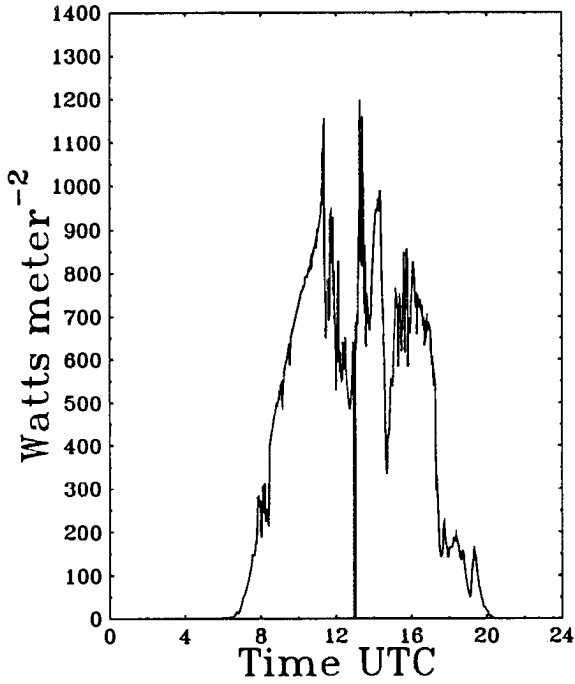


Ceiling

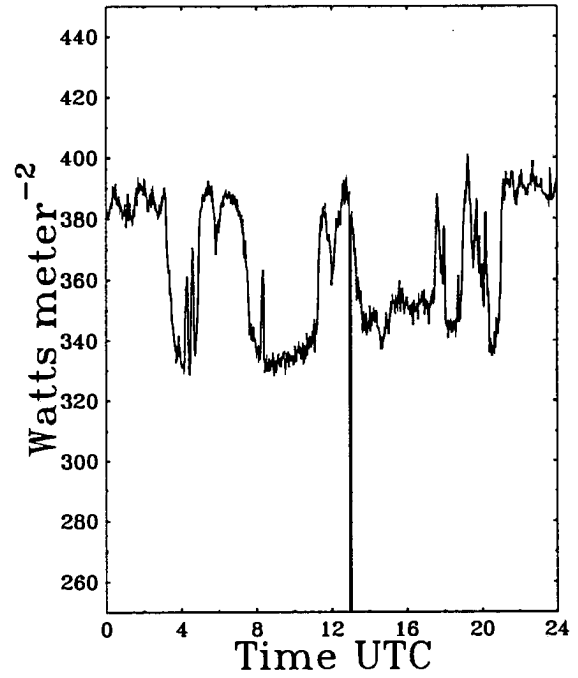


Julian Day 168 (16 June, 1992)

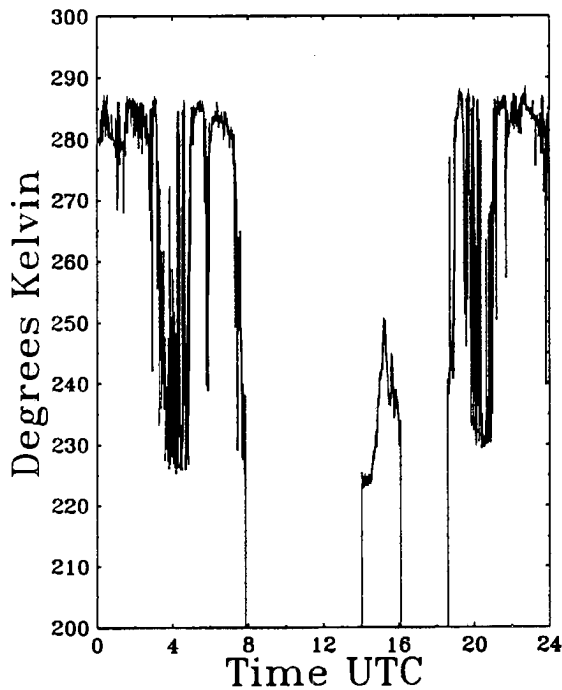
Solar Irradiance



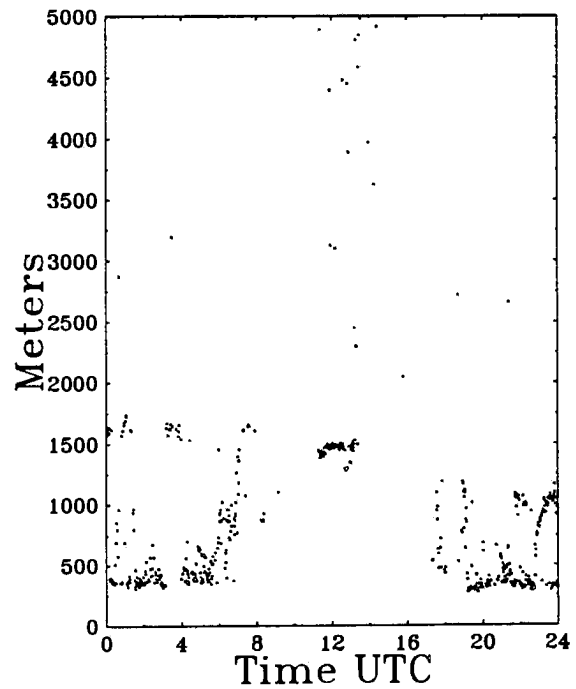
IR Irradiance



11 μm Brightness Temp

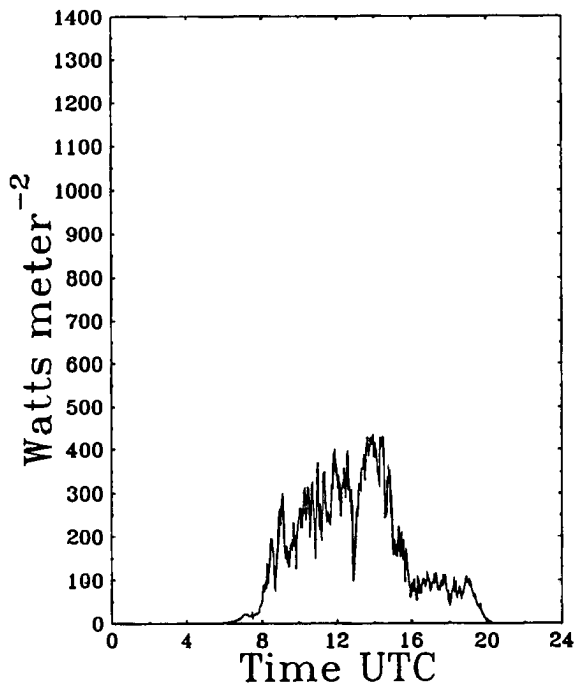


Ceiling

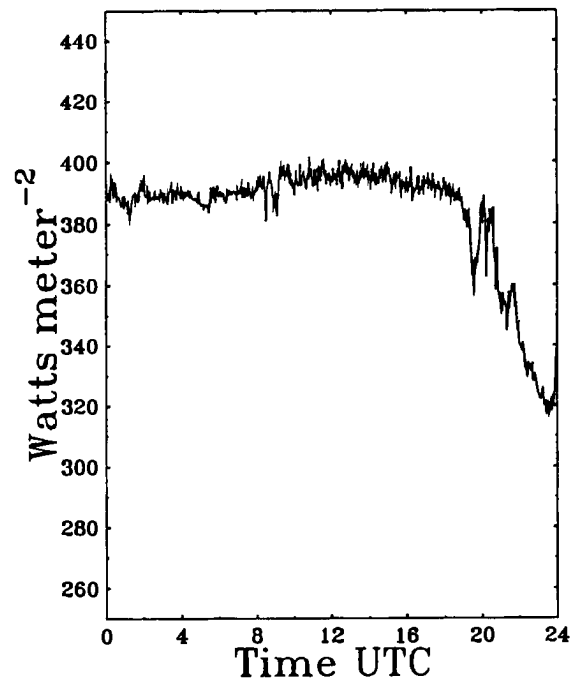


Julian Day 169 (17 June, 1992)

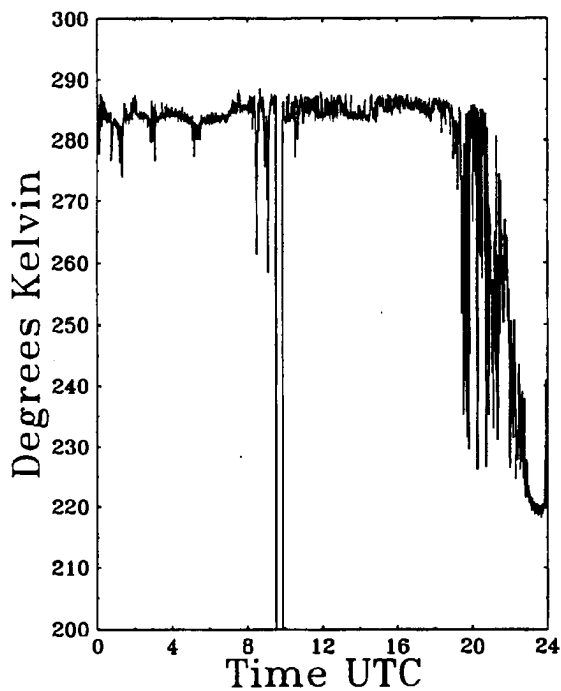
Solar Irradiance



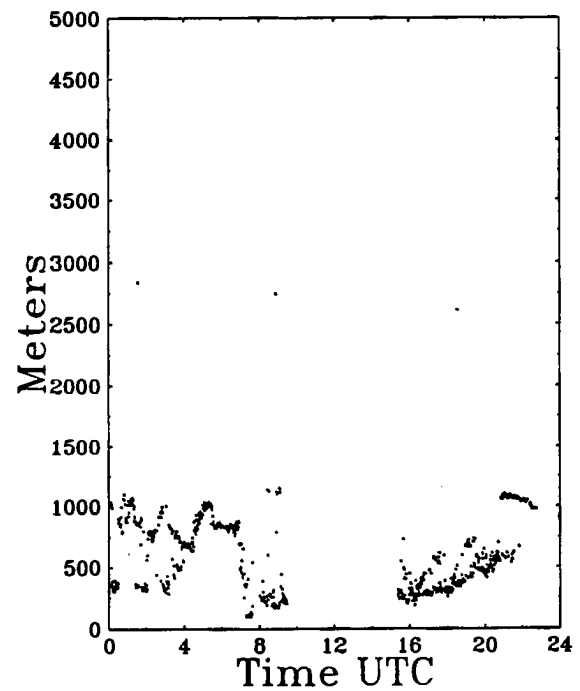
IR Irradiance



11 μm Brightness Temp

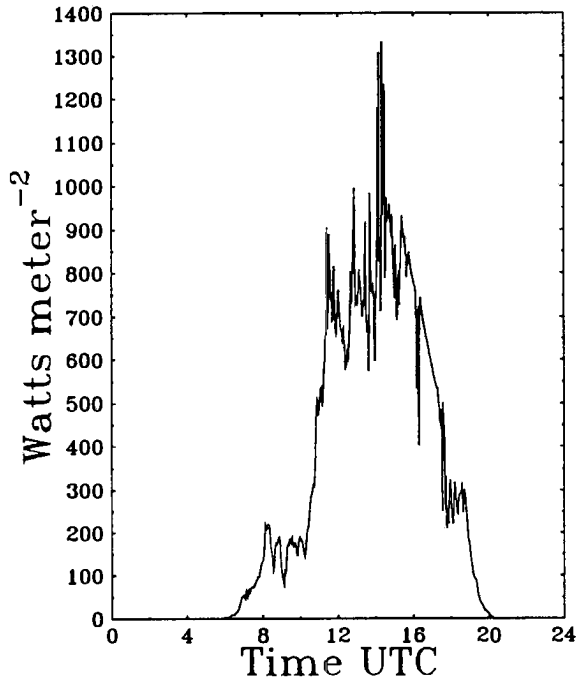


Ceiling

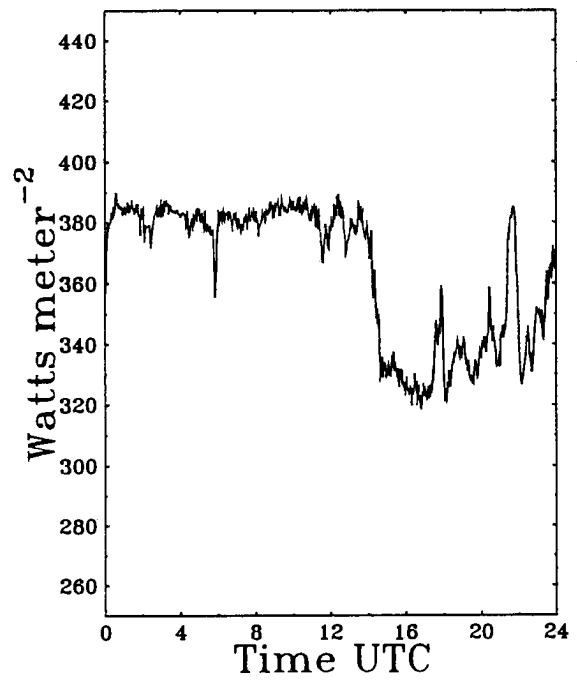


Julian Day 170 (18 June, 1992)

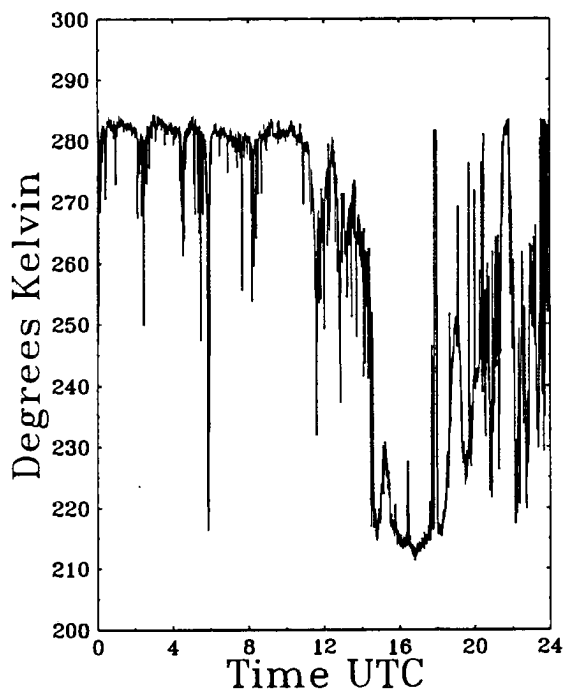
Solar Irradiance



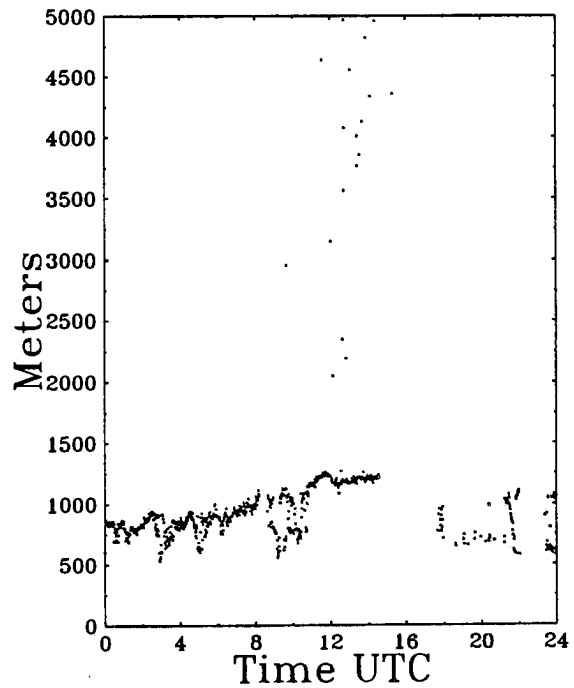
IR Irradiance



11 μ m Brightness Temp

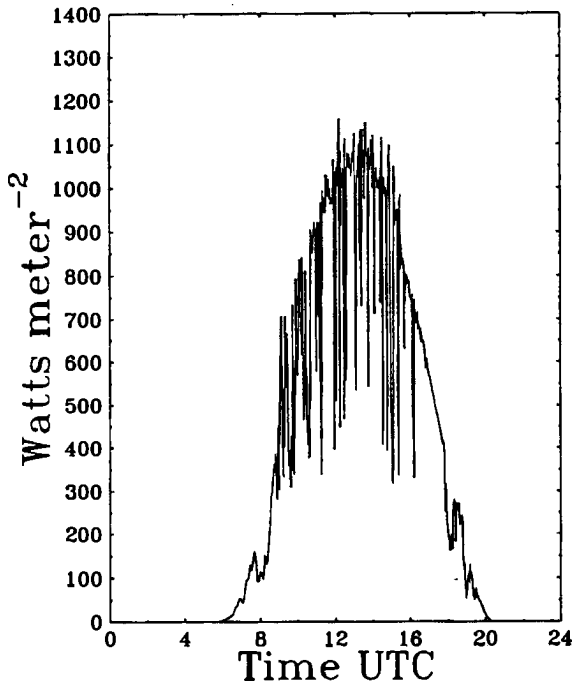


Ceiling

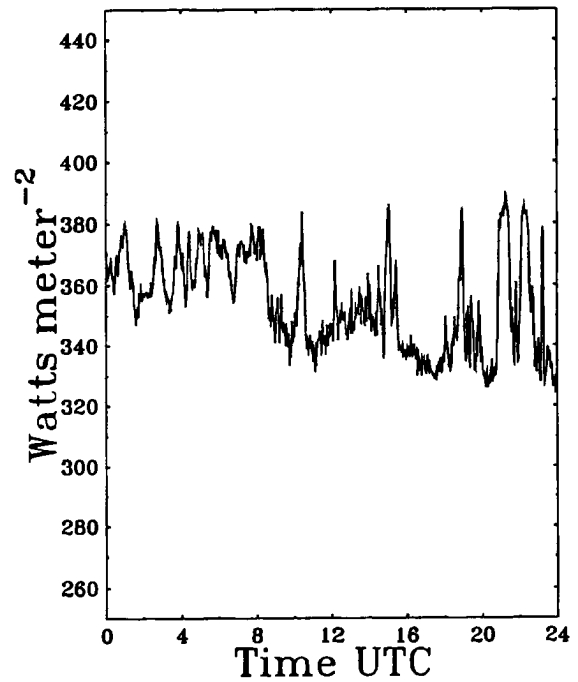


Julian Day 171 (19 June, 1992)

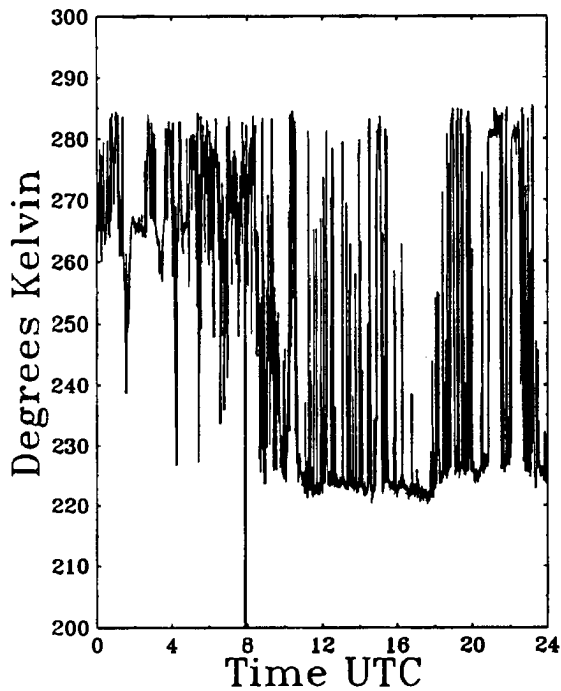
Solar Irradiance



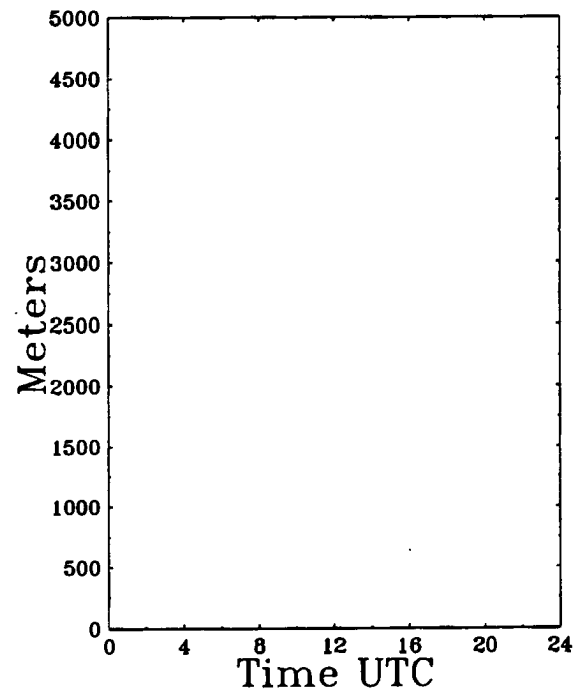
IR Irradiance



11 μm Brightness Temp

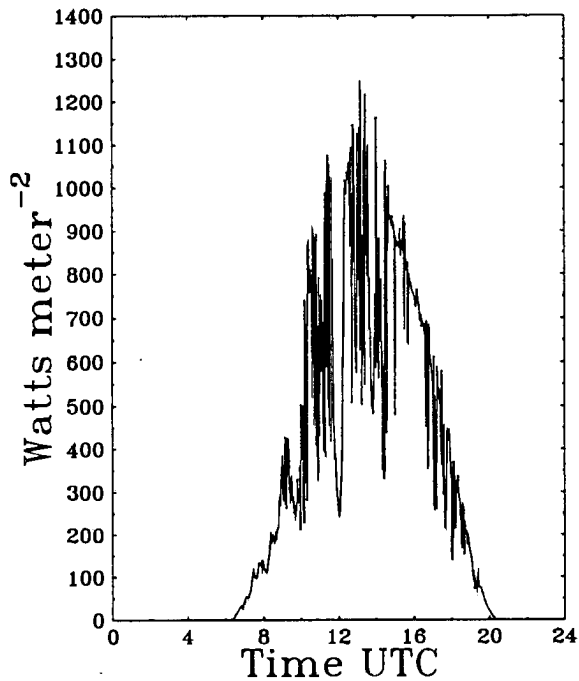


Ceiling

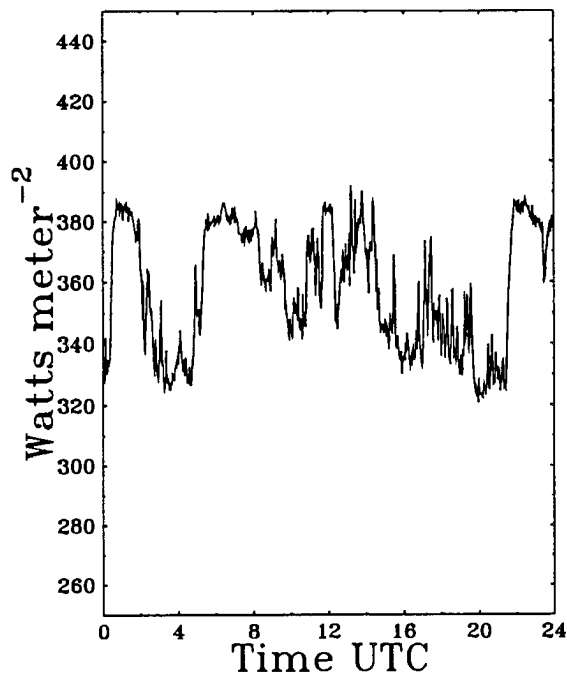


Julian Day 172 (20 June, 1992)

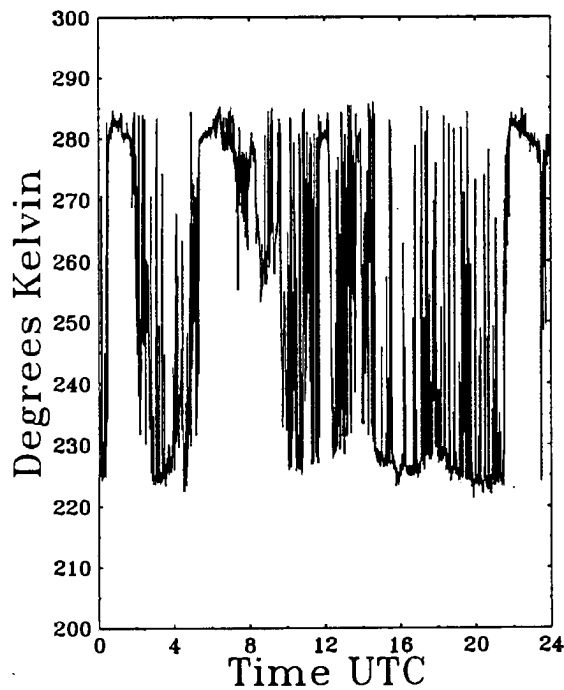
Solar Irradiance



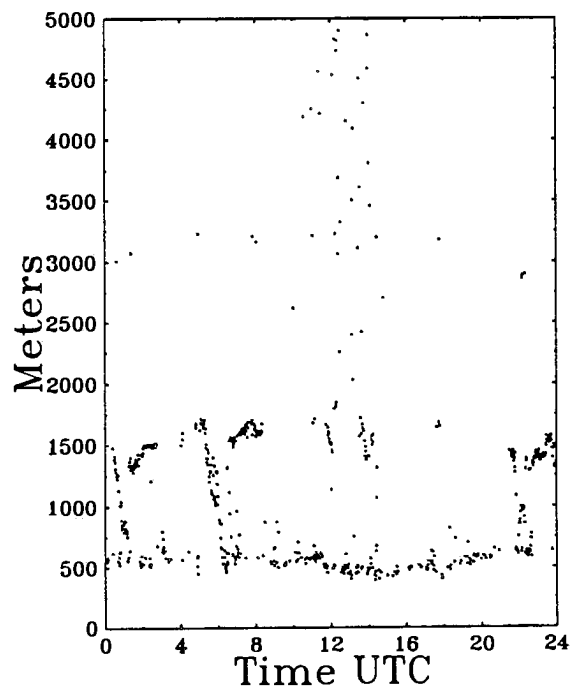
IR Irradiance



11 μm Brightness Temp

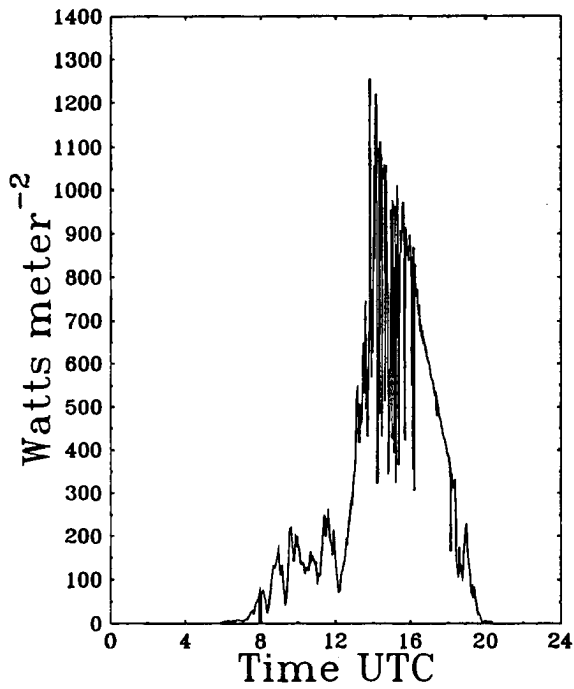


Ceiling

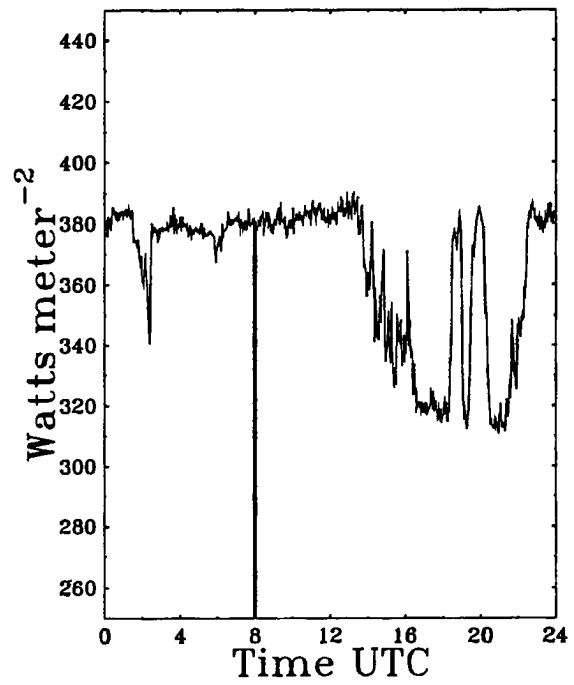


Julian Day 173 (21 June, 1992)

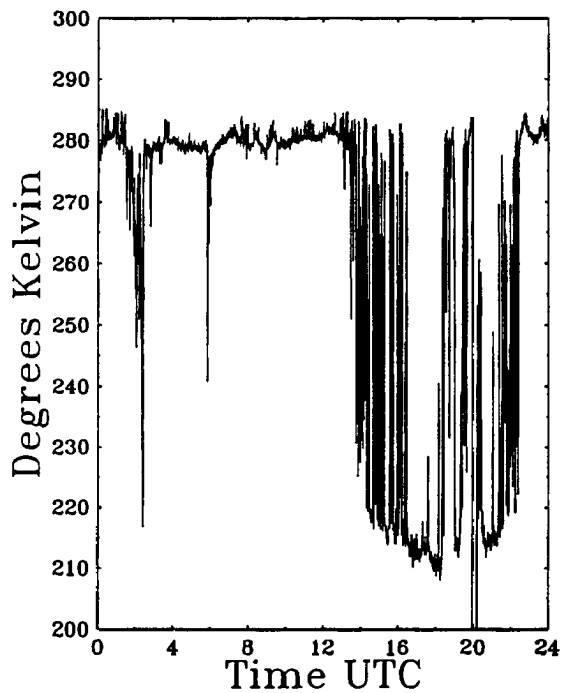
Solar Irradiance



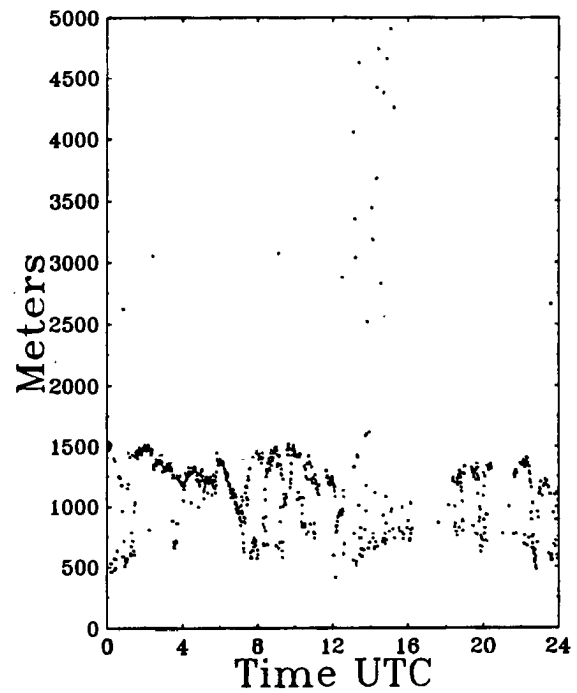
IR Irradiance



11 μm Brightness Temp

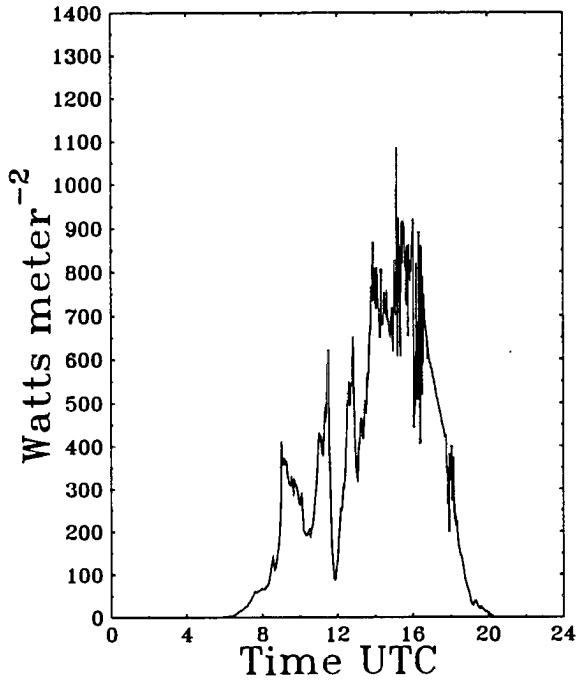


Ceiling

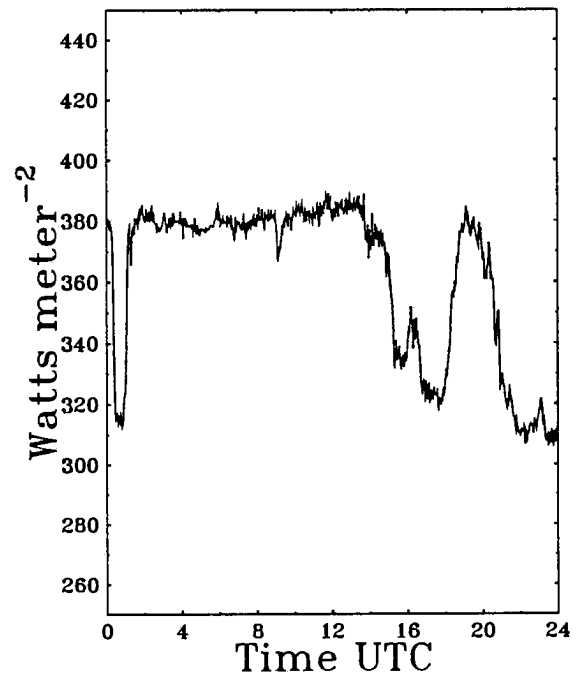


Julian Day 174 (22 June, 1992)

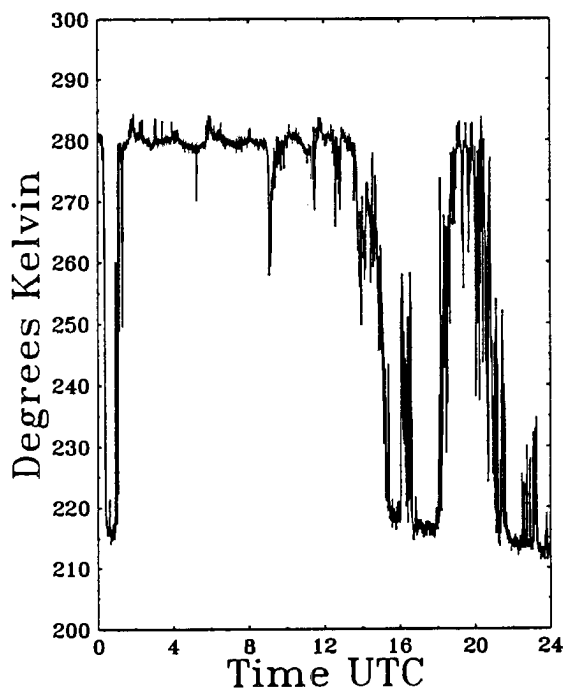
Solar Irradiance



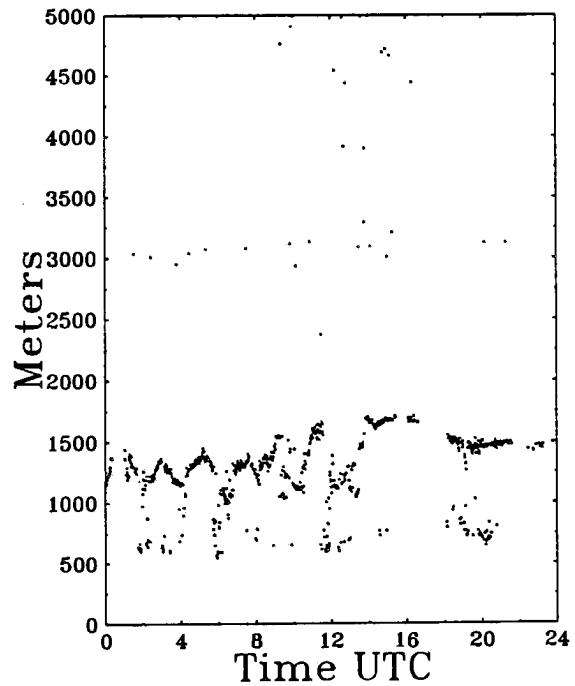
IR Irradiance



11 μm Brightness Temp

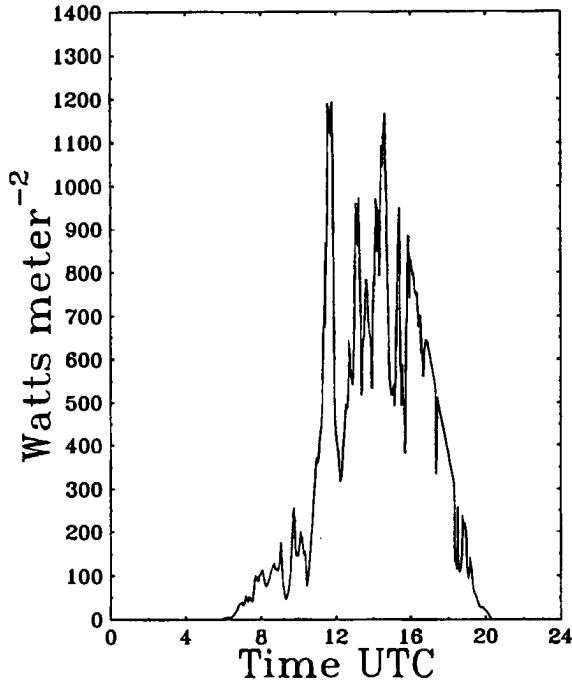


Ceiling

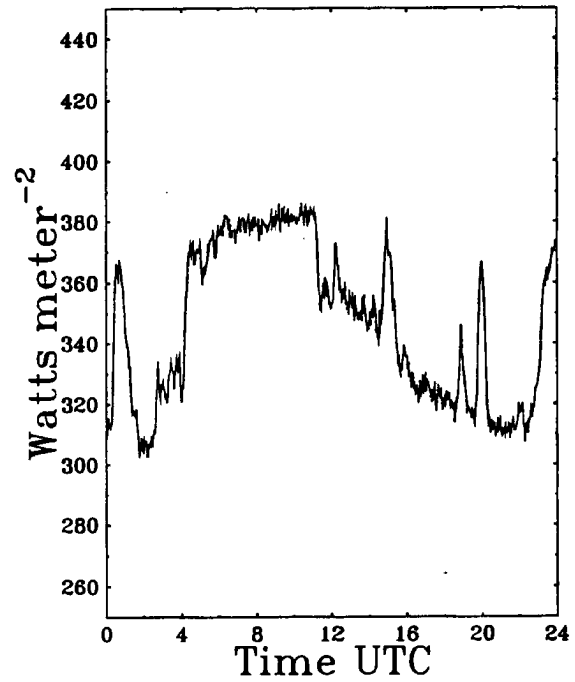


Julian Day 175 (23 June, 1992)

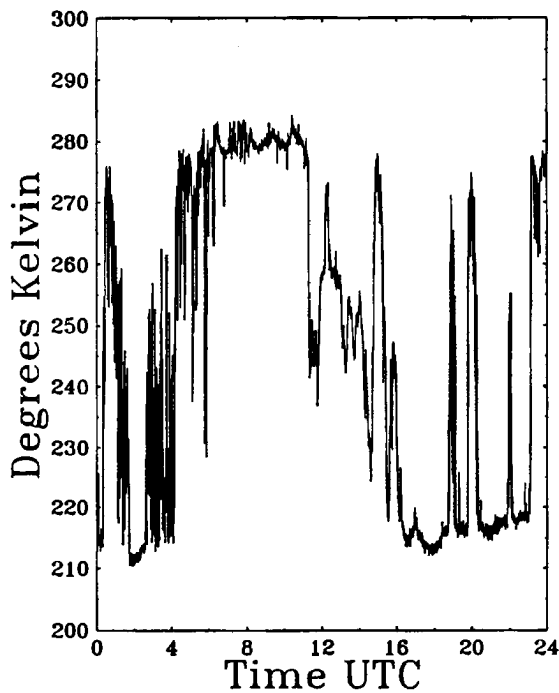
Solar Irradiance



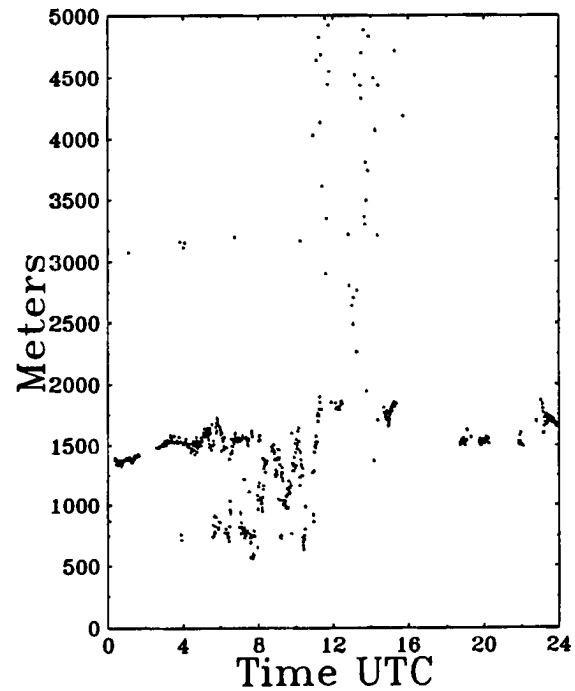
IR Irradiance



11 μm Brightness Temp

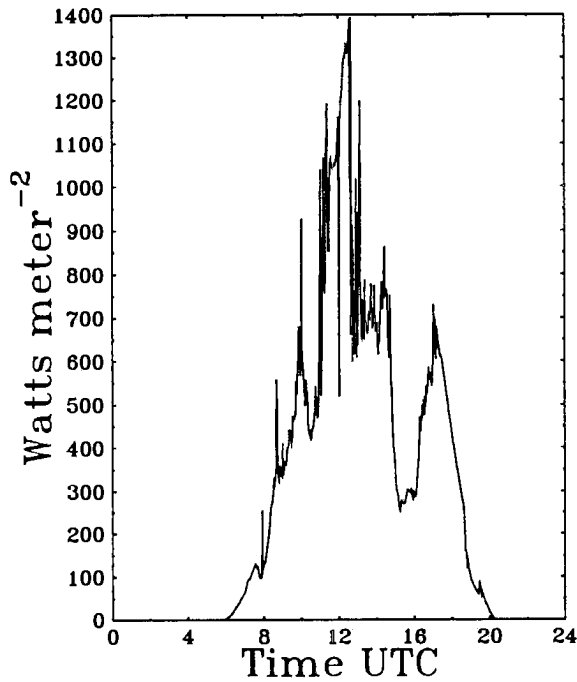


Ceiling

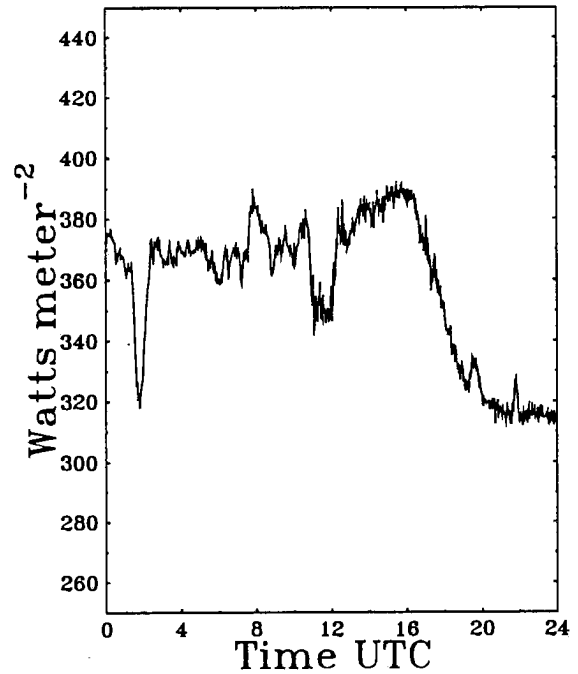


Julian Day 176 (24 June, 1992)

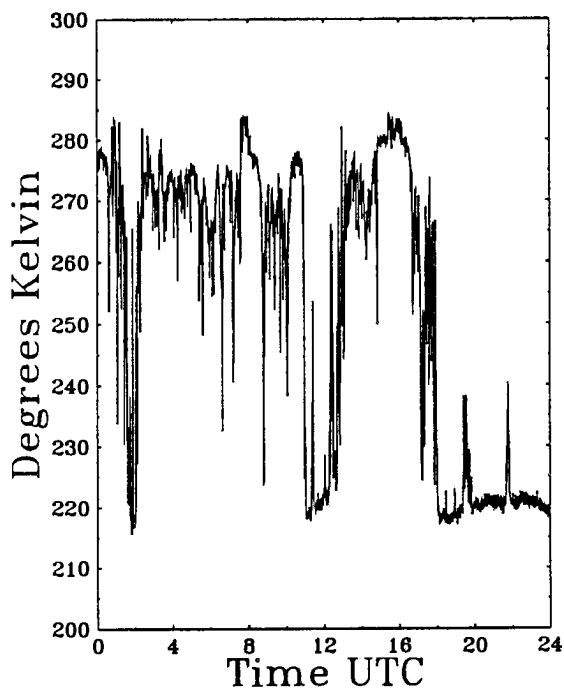
Solar Irradiance



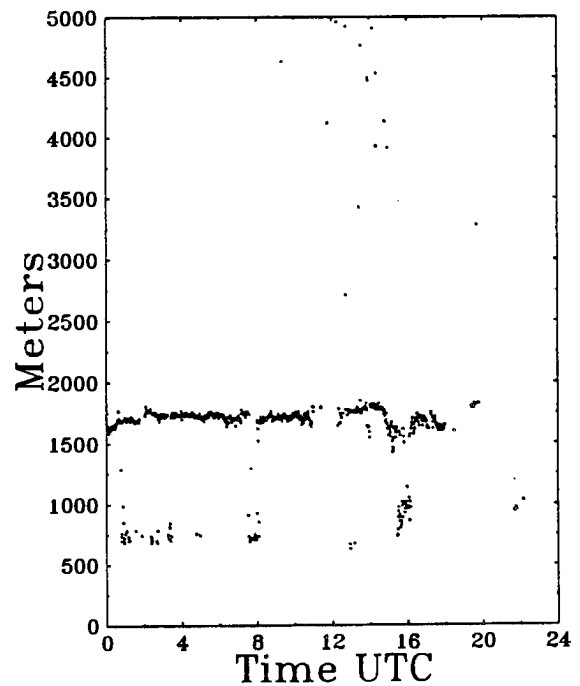
IR Irradiance



11 μm Brightness Temp

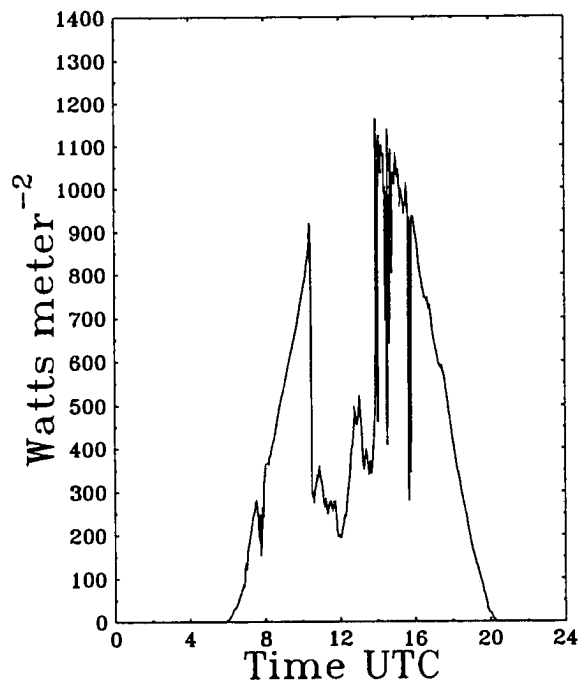


Ceiling

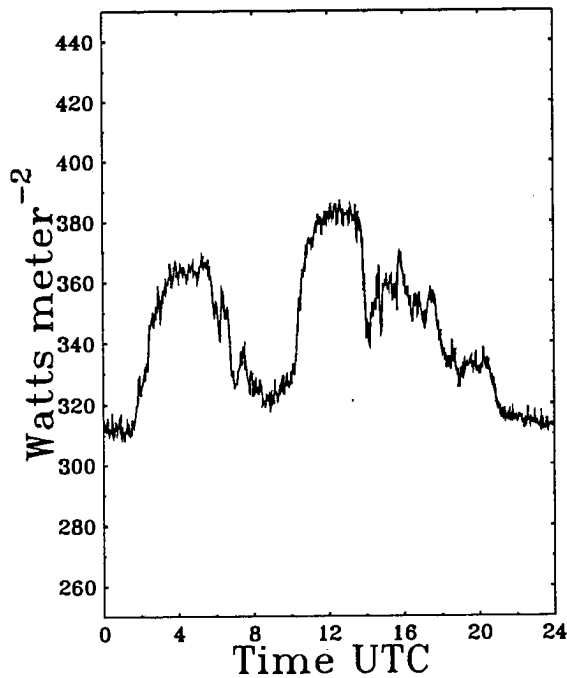


Julian Day 177 (25 June, 1992)

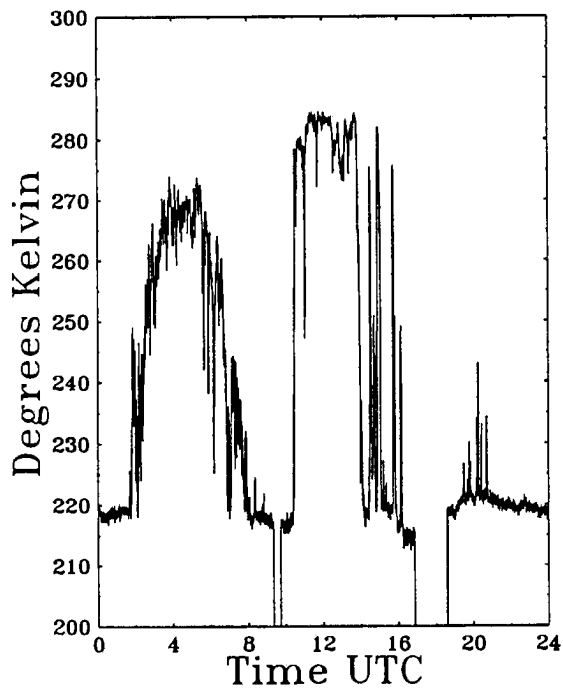
Solar Irradiance



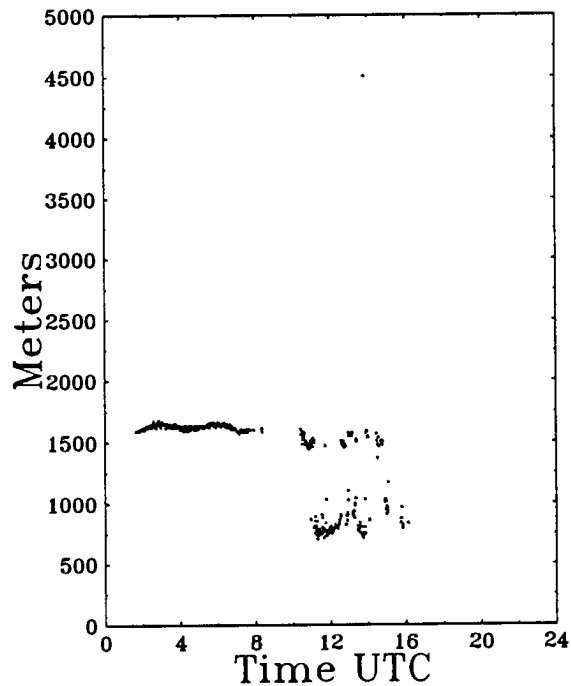
IR Irradiance



11 μm Brightness Temp

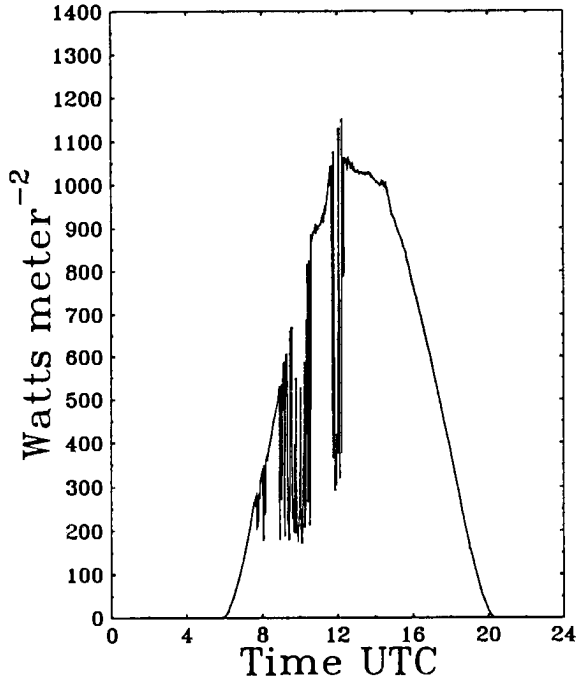


Ceiling

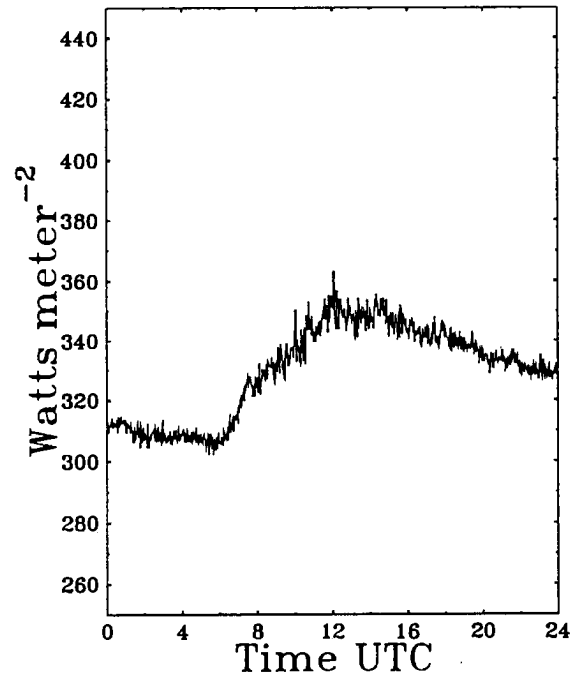


Julian Day 178 (26 June, 1992)

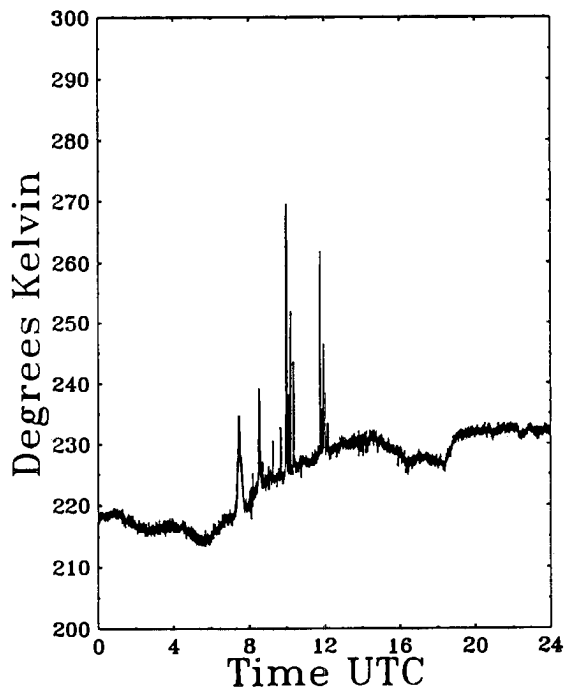
Solar Irradiance



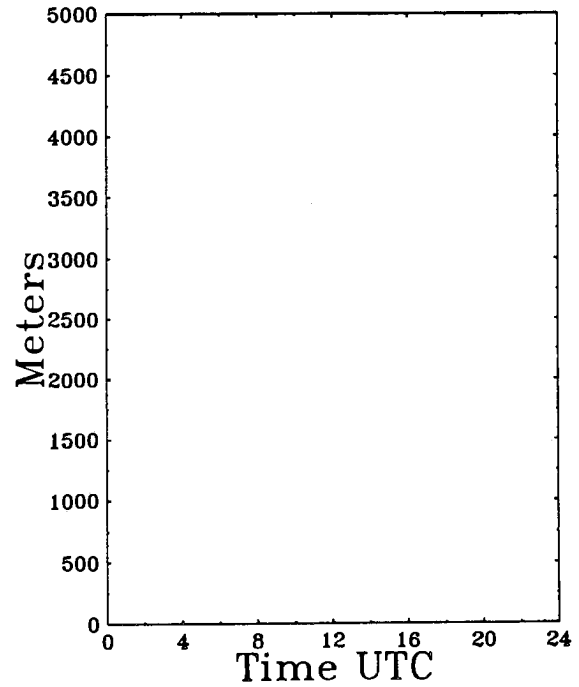
IR Irradiance



11 μm Brightness Temp

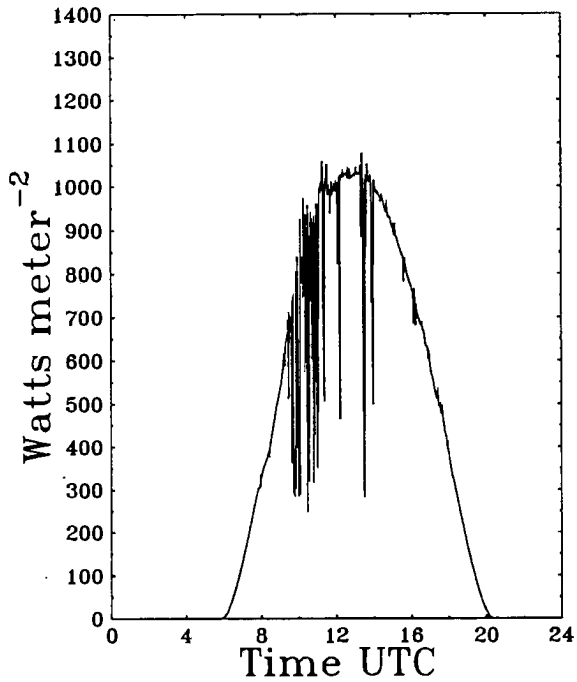


Ceiling

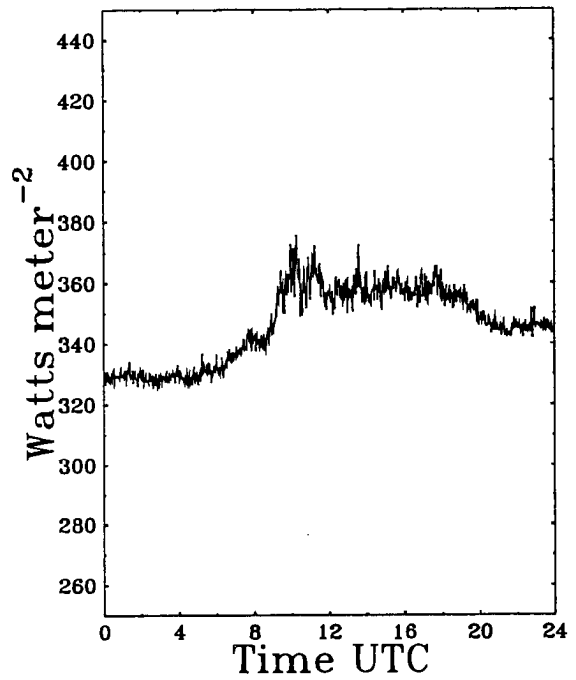


Julian Day 179 (27 June, 1992)

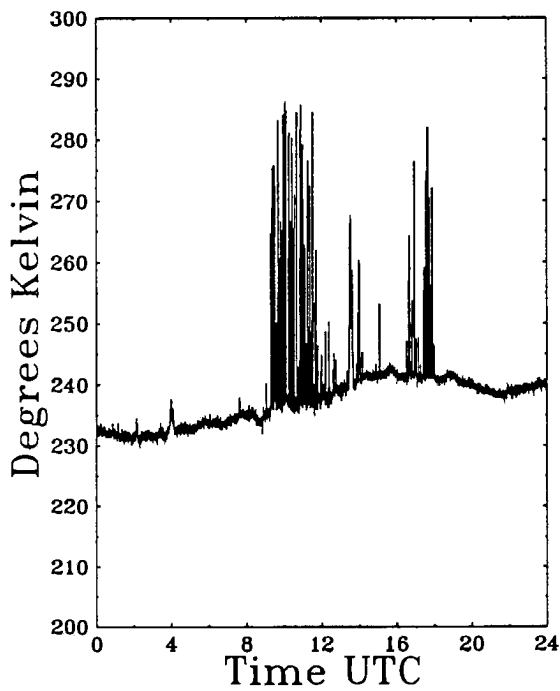
Solar Irradiance



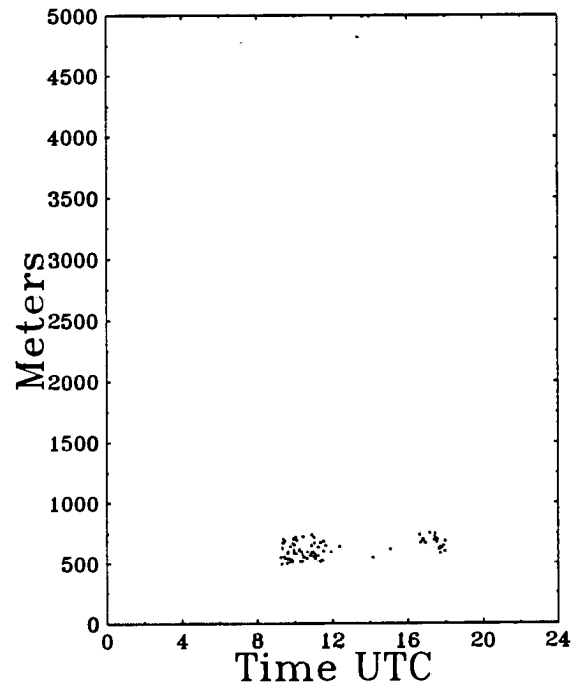
IR Irradiance



11 μm Brightness Temp

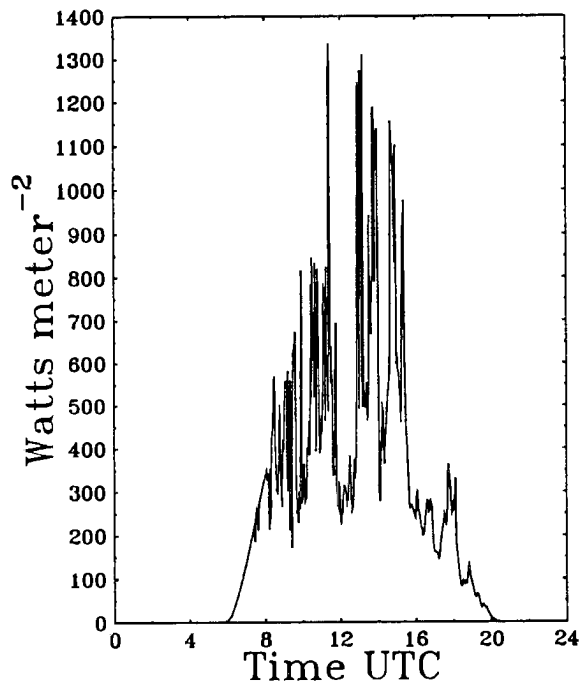


Ceiling

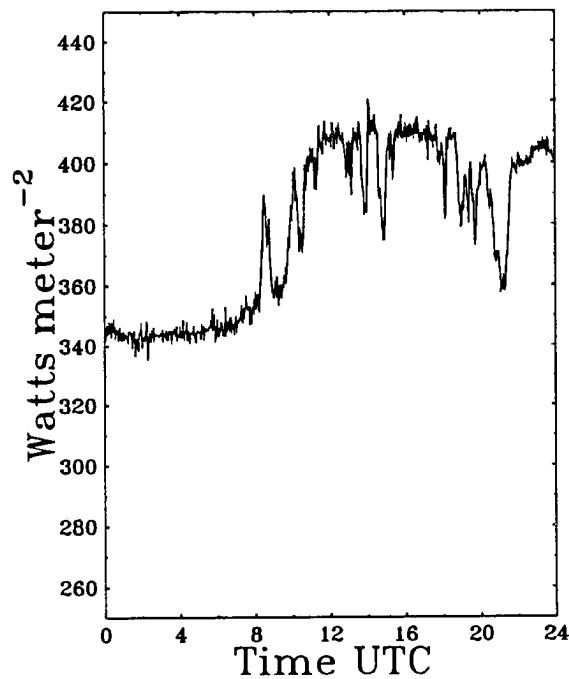


Julian Day 180 (28 June, 1992)

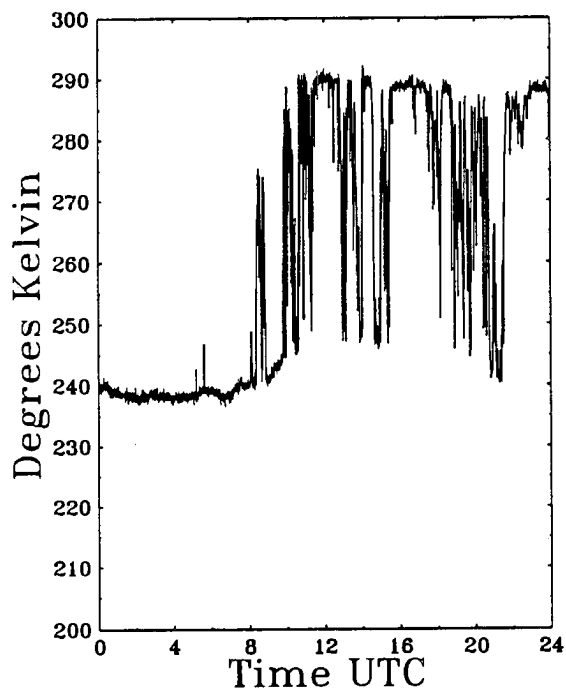
Solar Irradiance



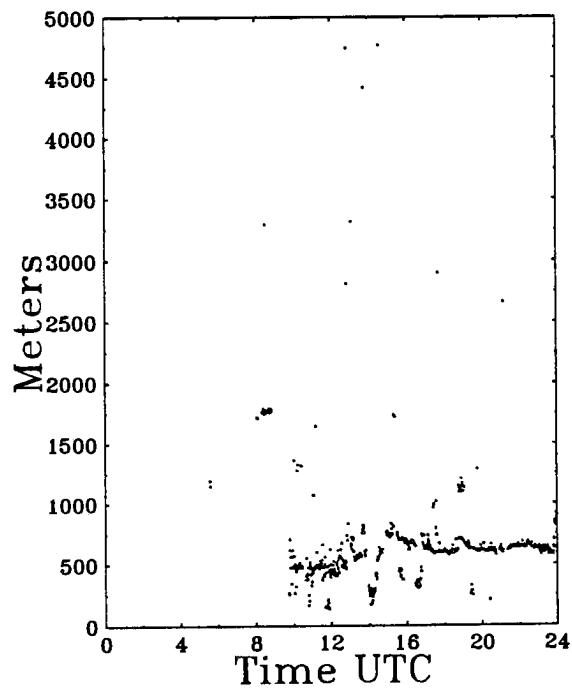
IR Irradiance



11 μm Brightness Temp

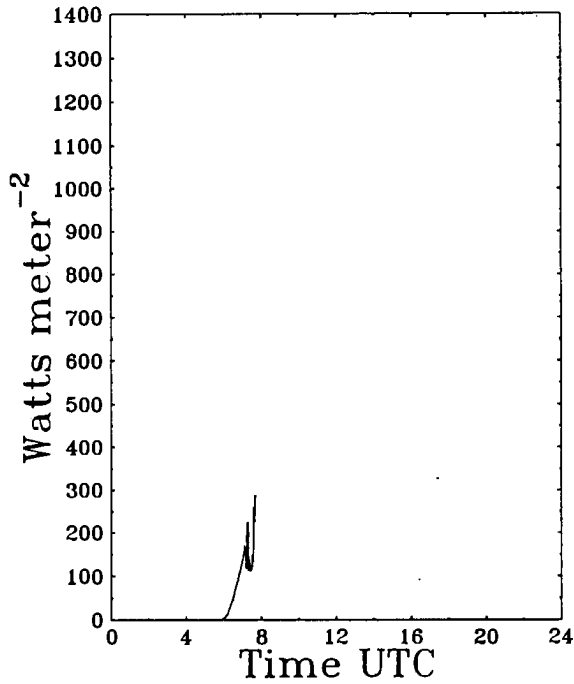


Ceiling

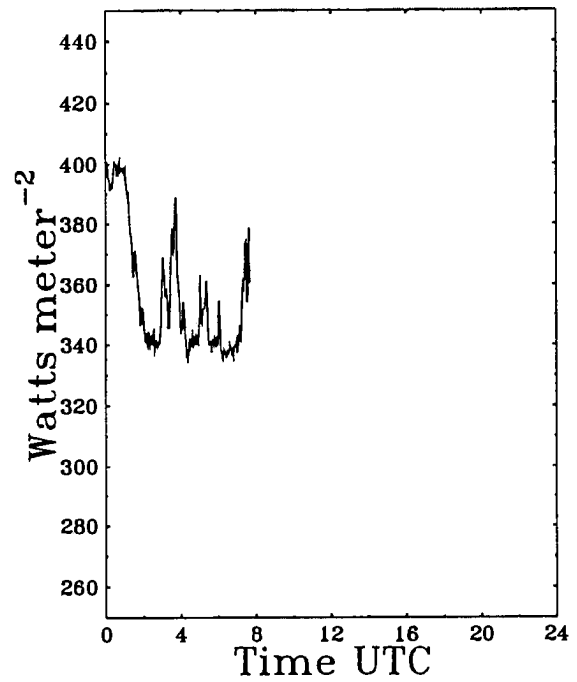


Julian Day 181 (29 June, 1992)

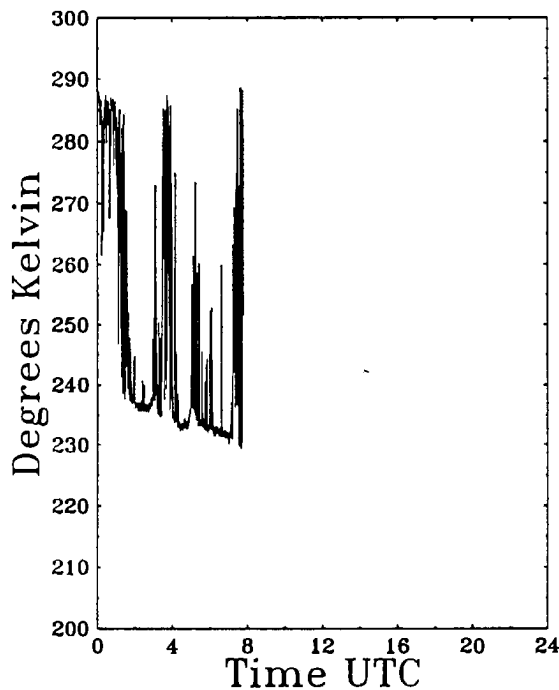
Solar Irradiance



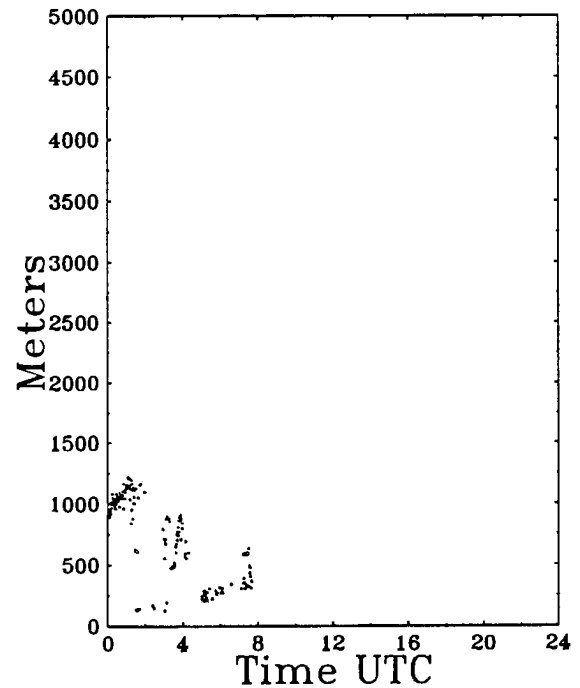
IR Irradiance



11 μm Brightness Temp



Ceiling

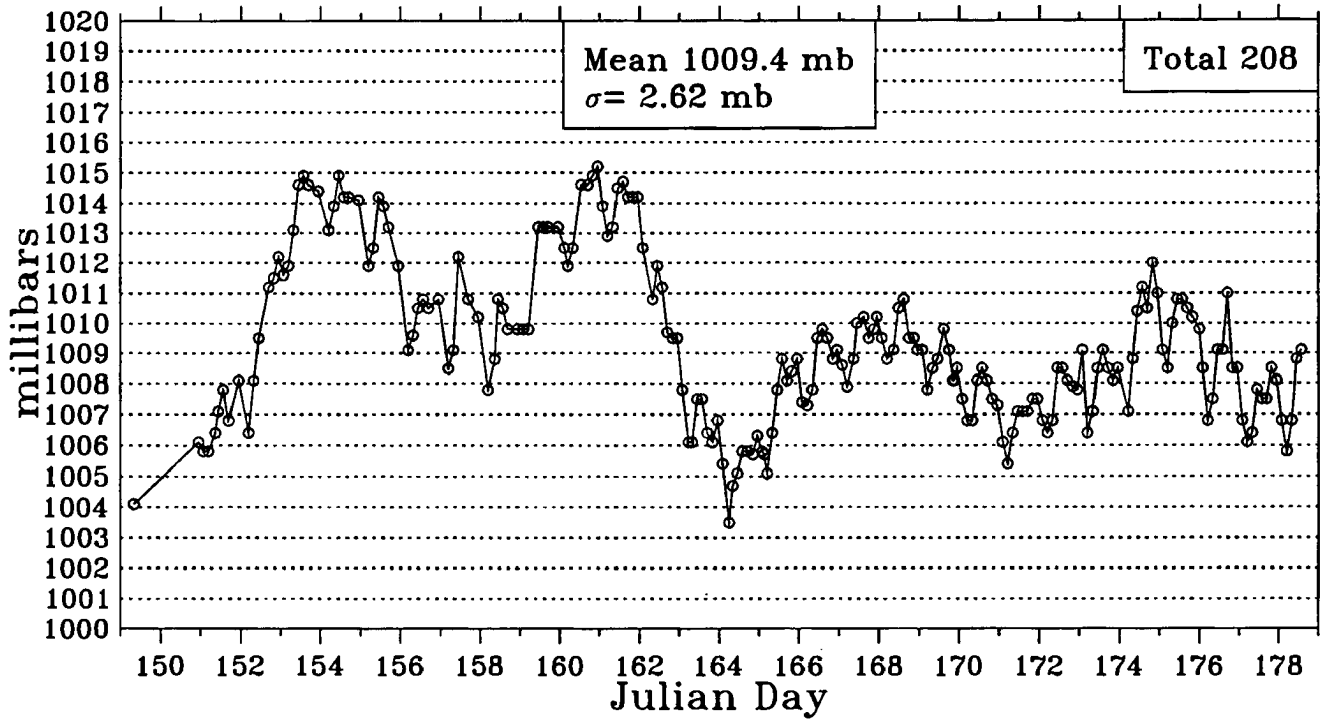


5. Rawinsonde Surface Meteorology Observations

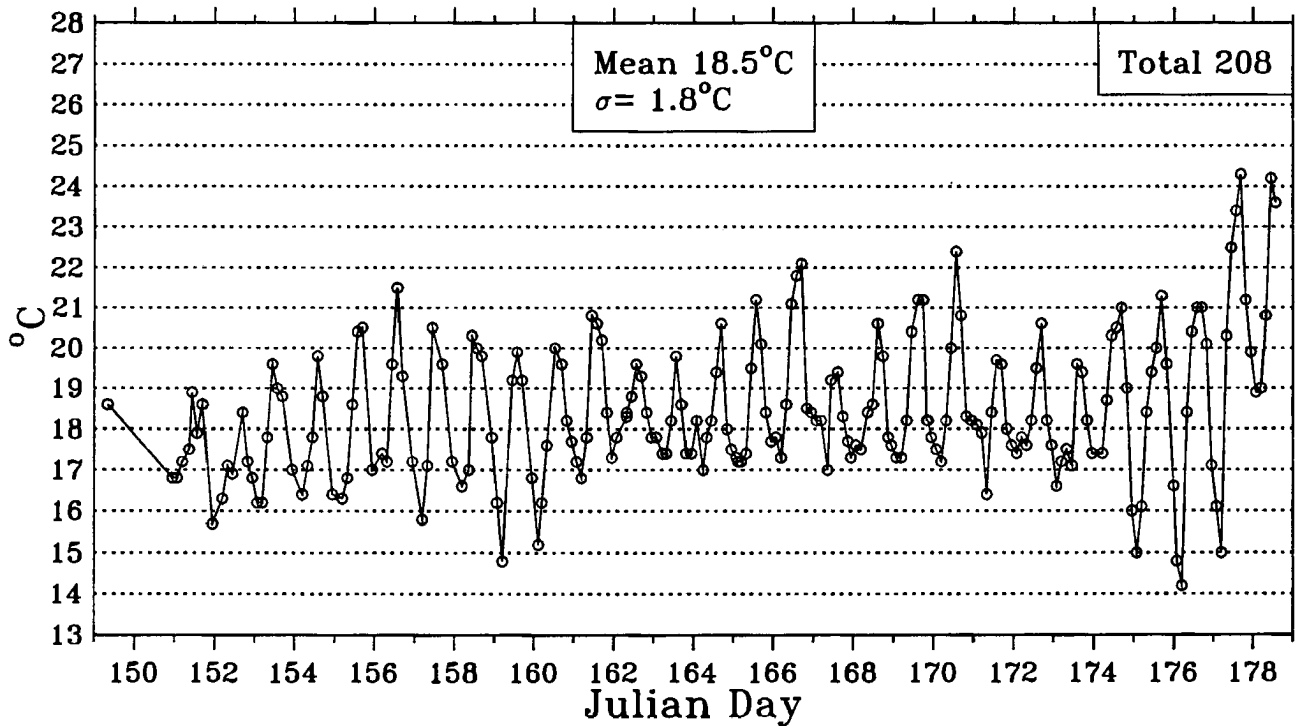
The following figures show lower temporal resolution depictions of surface pressure, temperature, relative humidity, wind speed and wind direction. These data were manually recorded at the time of each rawinsonde launch; therefore the nominal temporal resolution is one data point every three hours. The pressure was measured using a Model PAB-5 Micro Altimeter-Barometer manufactured by American Paulin System, the dry bulb and wet bulb temperatures were measured using an Assman aspirated psychrometer and the wind speed and direction were estimated from a visual inspection of a wind sock approximately 120° K meters south of the rawinsonde launch site. The nominal three-hour resolution data recorded prior to each rawinsonde launch are presented on pages 73-75.

Surface Pressure and Temperature

Surface Pressure

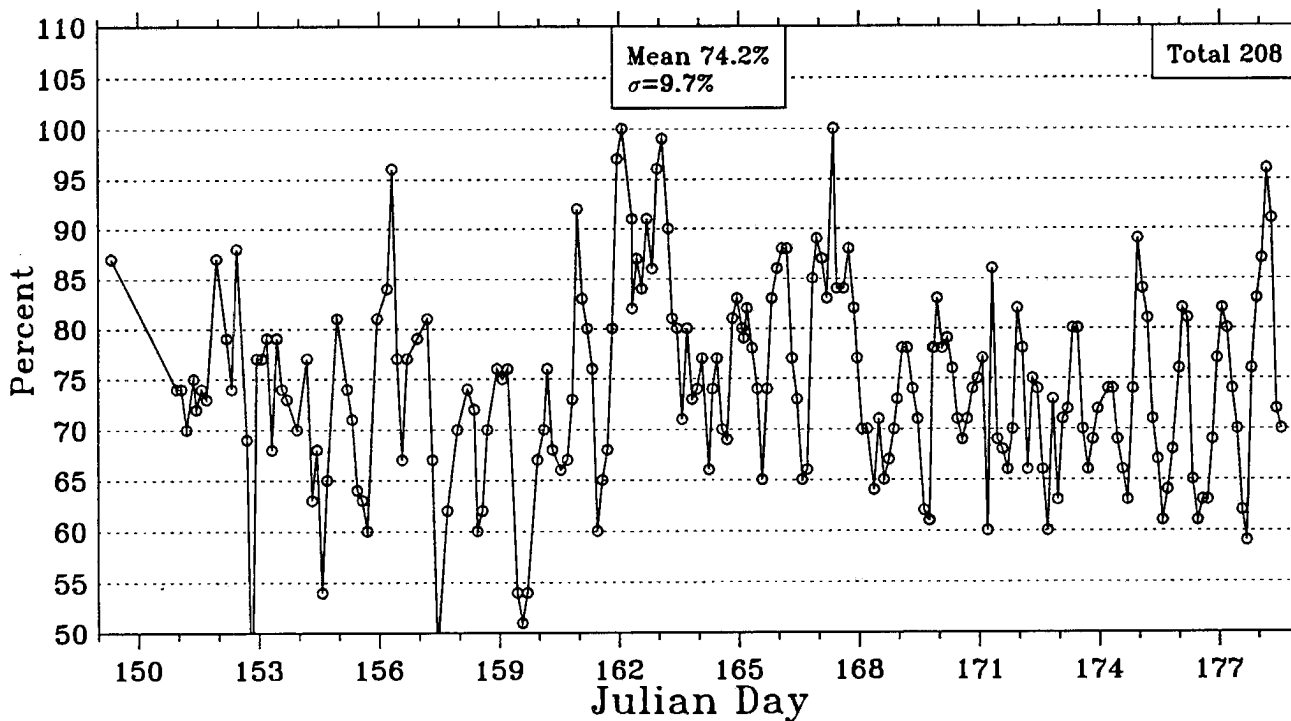


Surface Temperature



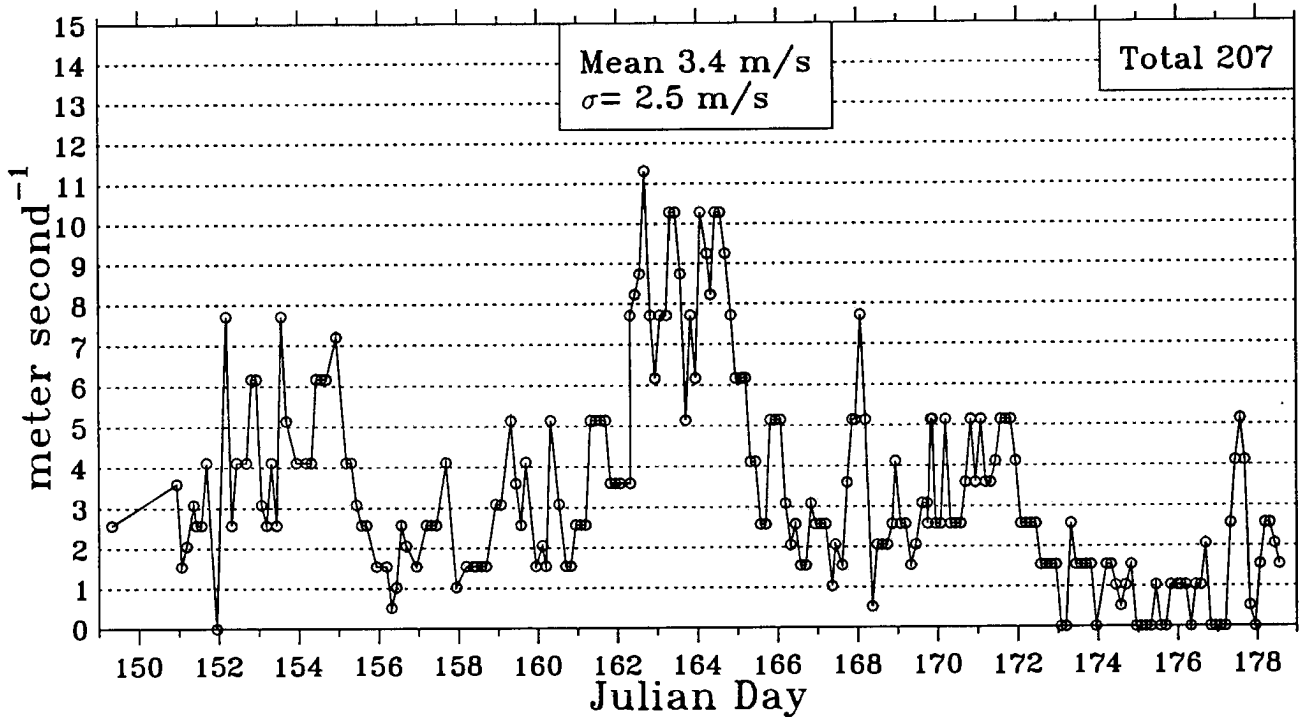
Relative Humidity

Relative Humidity

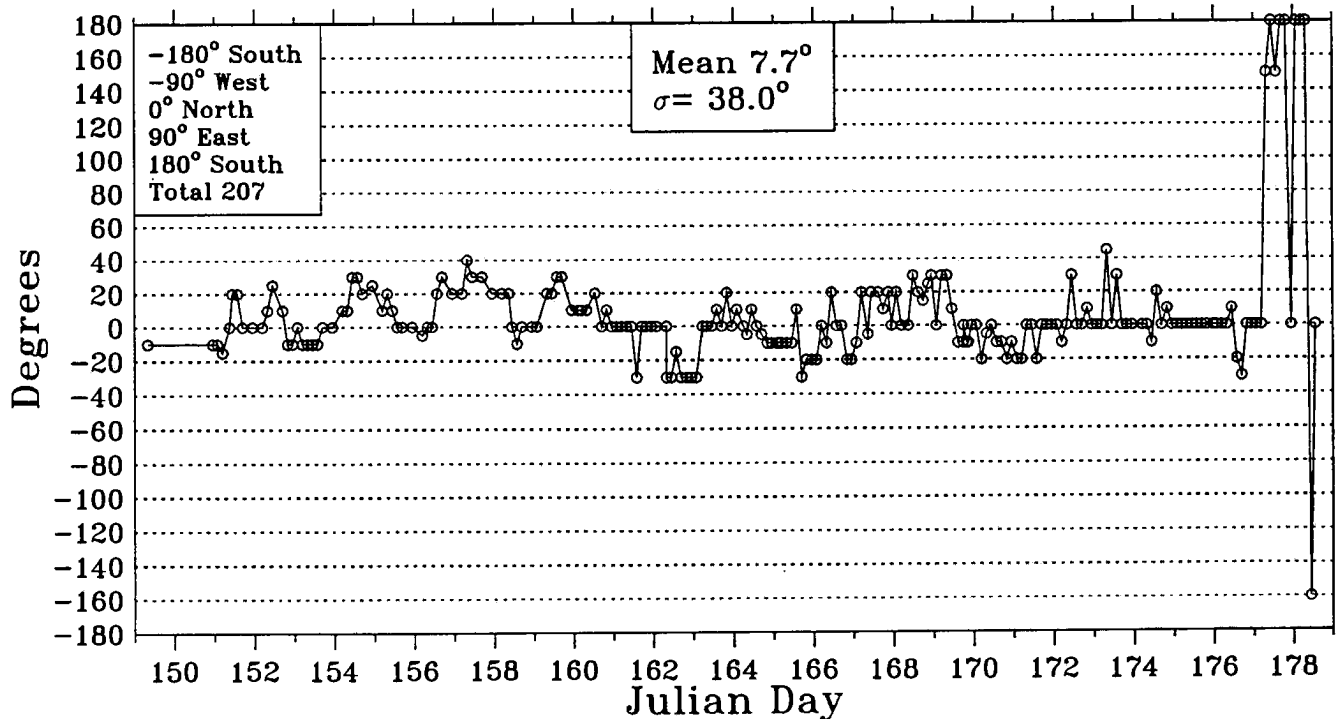


Surface Wind Speed and Direction

Surface Wind Speed



Surface Wind Direction



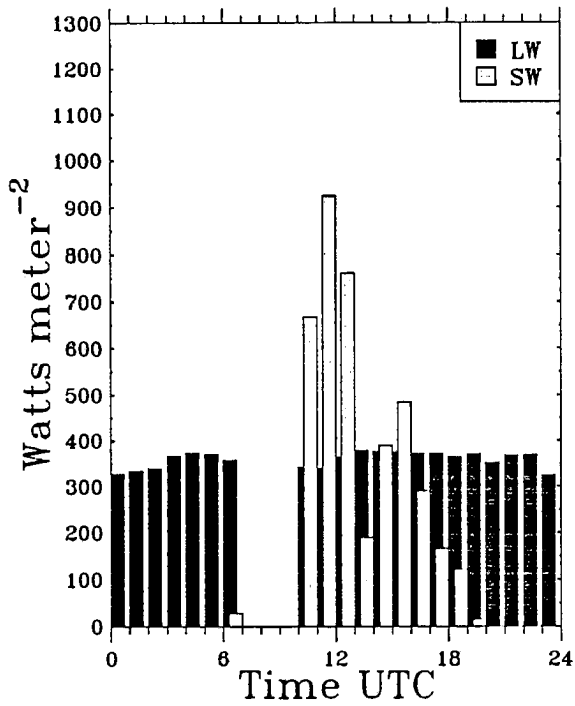
6. Hourly Distributions of Radiation and Cloud Variables

For the period of June 1-29, mean hourly values of downwelling solar and longwave irradiance, transmittance of the direct solar beam, zenith cloud cover, and equivalent brightness temperature of the zenith sky have been computed. The mean downwelling irradiances are derived from the average of 30 sample per hour (30 sa h^{-1}) data. Small gaps in the high resolution data have been bridged by linear interpolation. No hourly mean values are reported for hours in which all data were missing. The reported solar transmittance is the hourly average of 30 sa h^{-1} pyrheliometer data divided by the solar flux density at the top of the atmosphere. The top of the atmosphere irradiance was calculated daily. The reported cloud cover is the number of ceilings measured at zenith (60 sa h^{-1}) divided by sixty. The hourly means of equivalent brightness temperature are the average of the high resolution (360 sa h^{-1}) data. These data are shown in the figures appearing on pages 77 - 105.

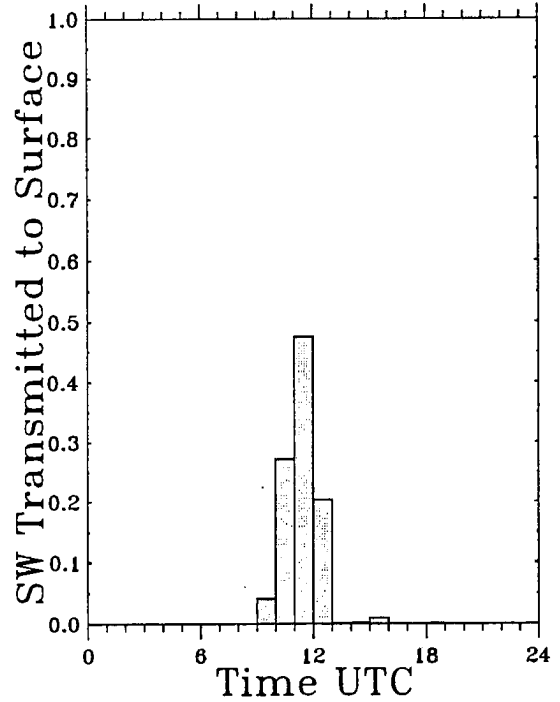
For the period of June 1-29, histograms representing the frequency of occurrence of ceiling and brightness temperature observations have been compiled. Observations of ceilings are distributed into 50 meter bins. The number of clear sky, high ceiling (greater than three kilometer), and all observations are also reported. Observations of equivalent brightness temperature are distributed in 2 degree Kelvin bins and the total number of observations is also reported. The frequency of occurrence analyses of ceiling and 11 micron brightness temperature are displayed in the figures on pages 106 - 133.

1 June (Day 153) Hourly Means

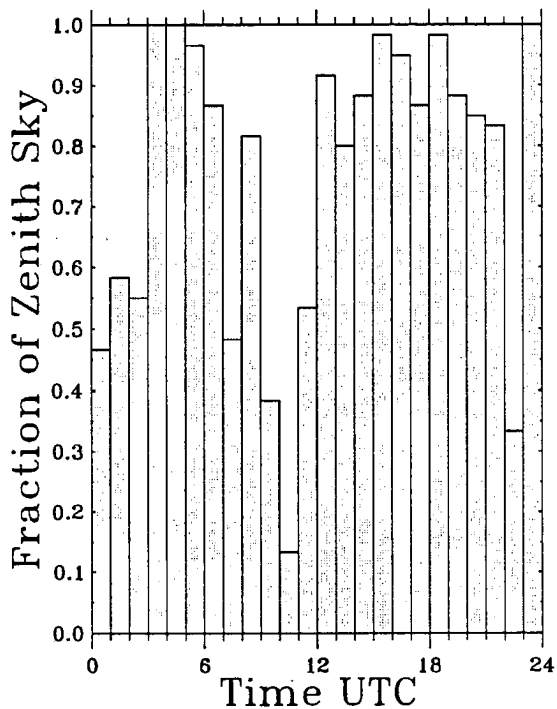
Mean Downwelling Flux



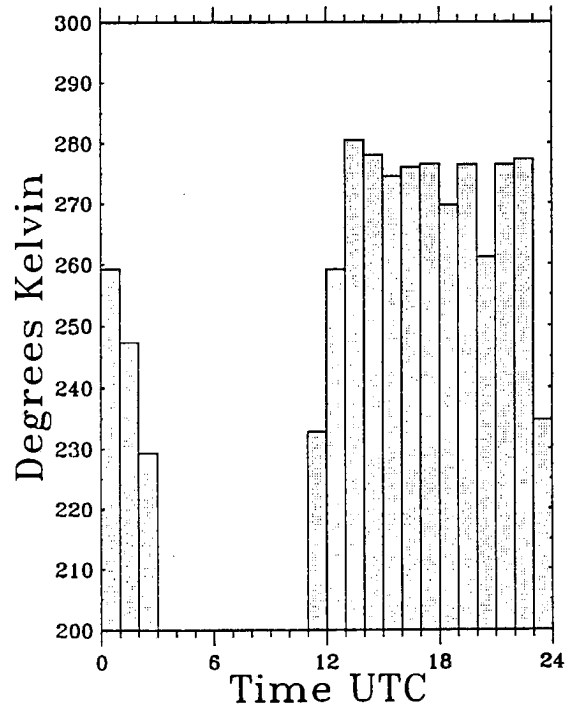
Solar Transmittance



Cloud Cover - Ceilometer

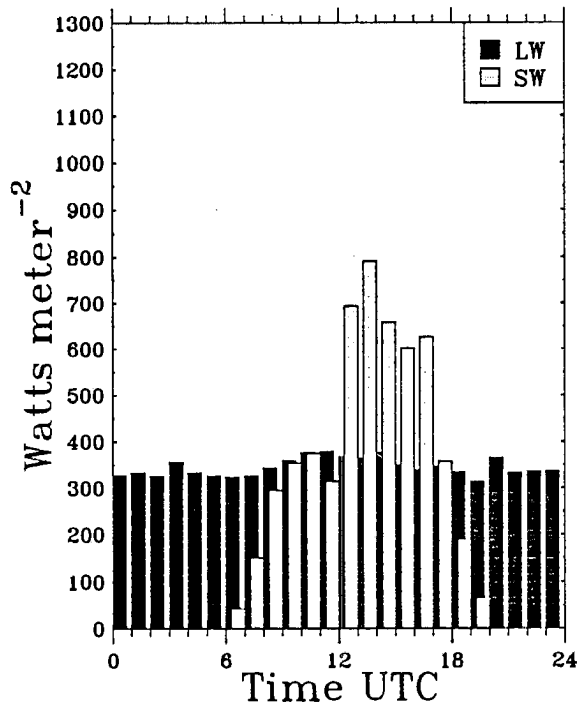


11μm Equivalent Brightness Temp

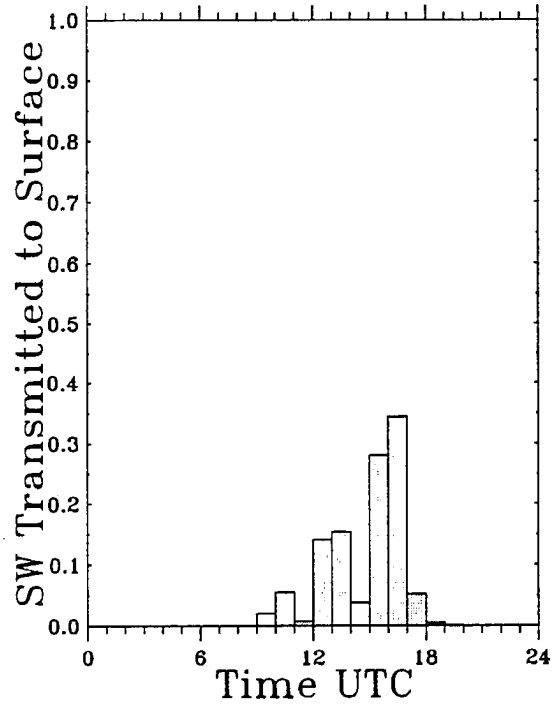


2 June (Day 154) Hourly Means

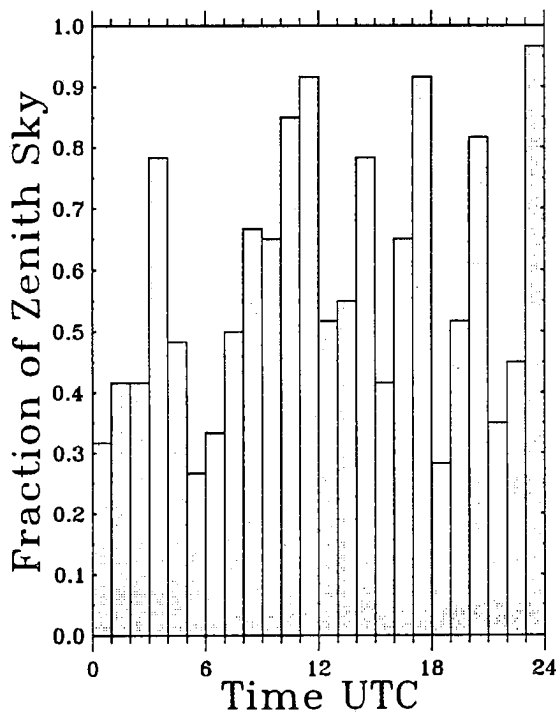
Mean Downwelling Flux



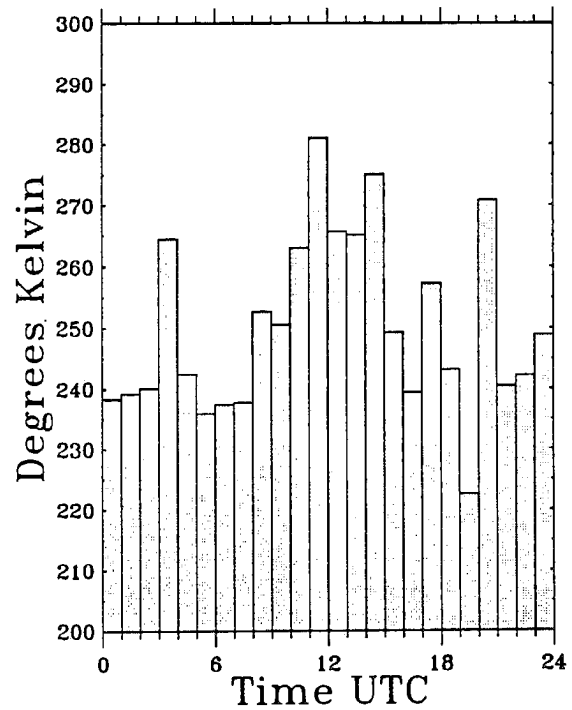
Solar Transmittance



Cloud Cover - Ceilometer

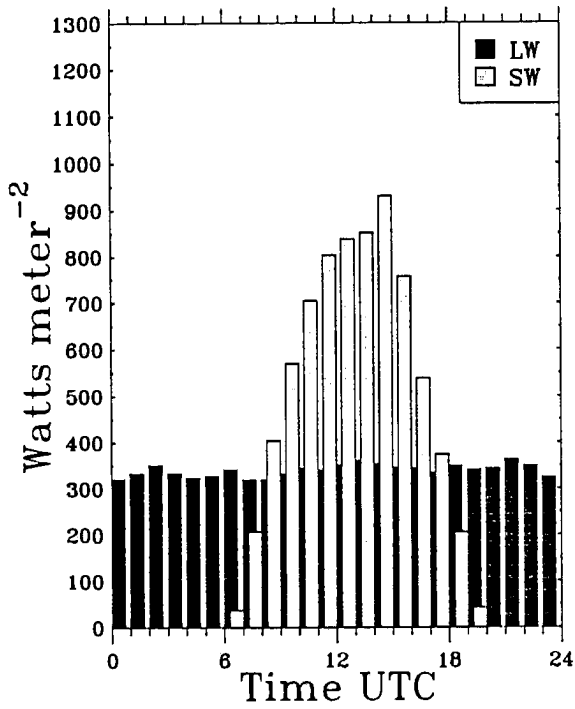


11μm Equivalent Brightness Temp

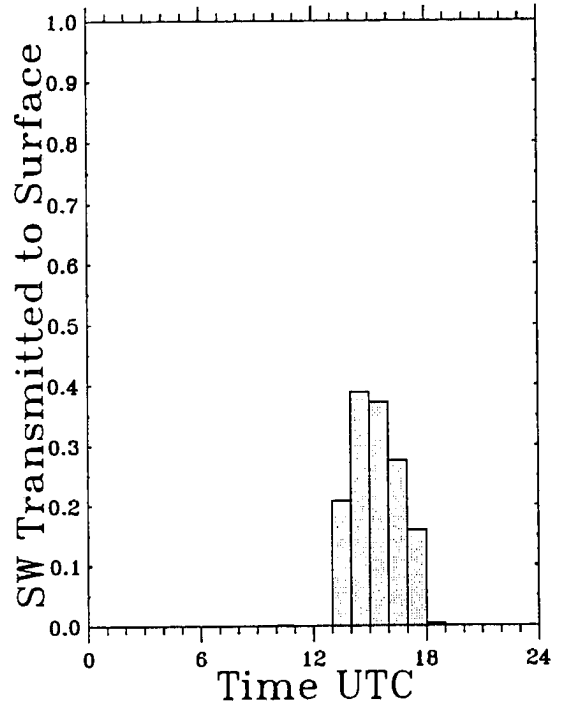


3 June (Day 155) Hourly Means

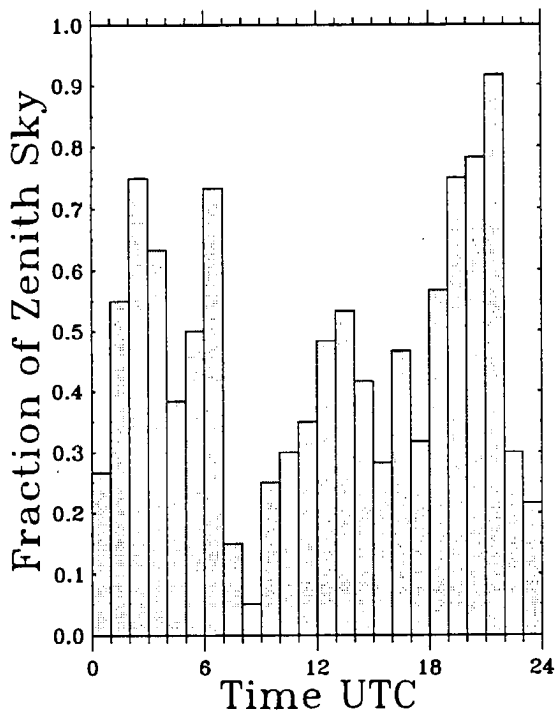
Mean Downwelling Flux



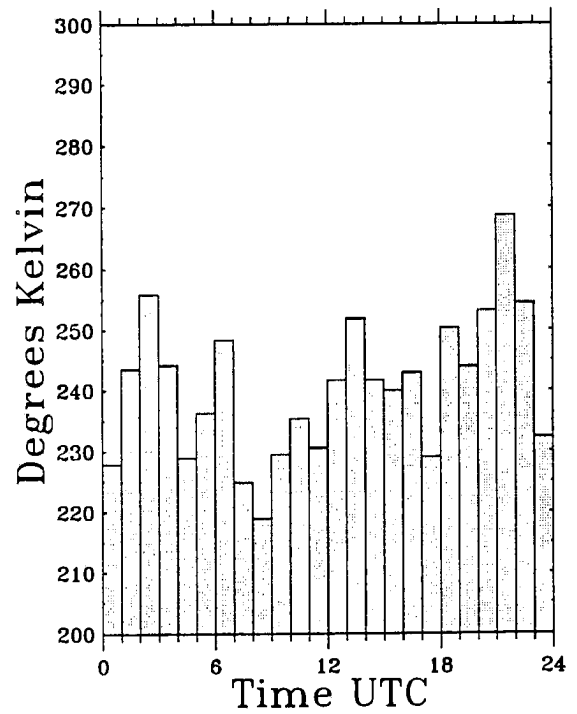
Solar Transmittance



Cloud Cover - Ceilometer

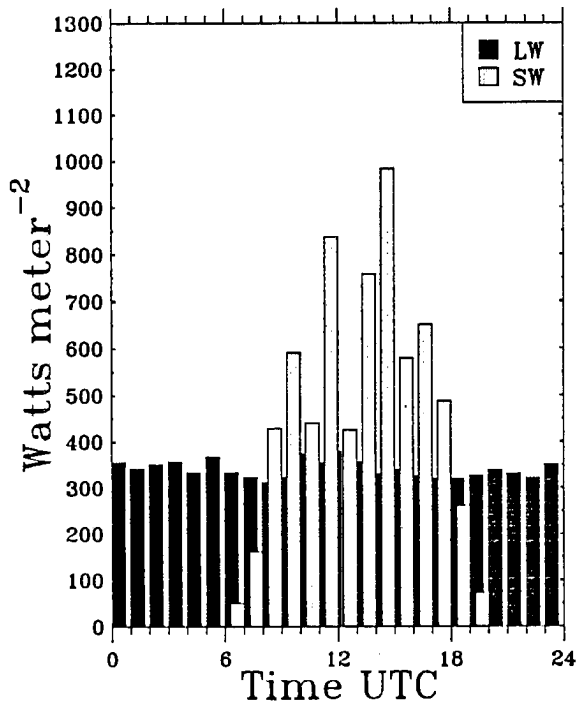


11μm Equivalent Brightness Temp

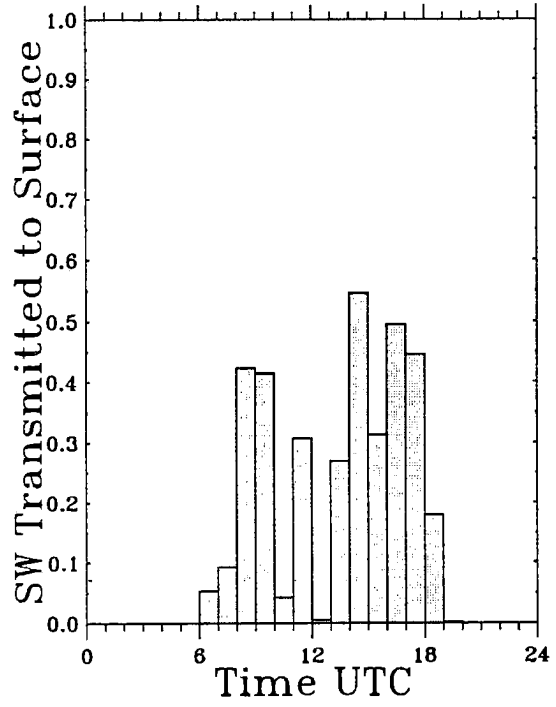


4 June (Day 156) Hourly Means

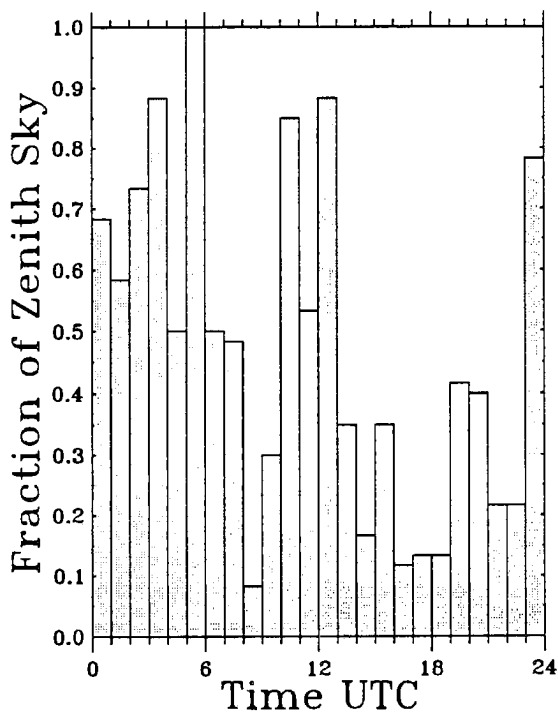
Mean Downwelling Flux



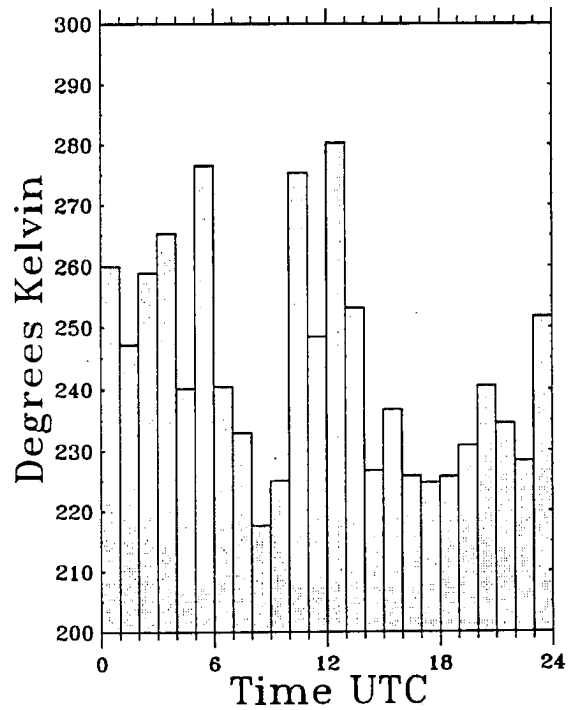
Solar Transmittance



Cloud Cover - Ceilometer

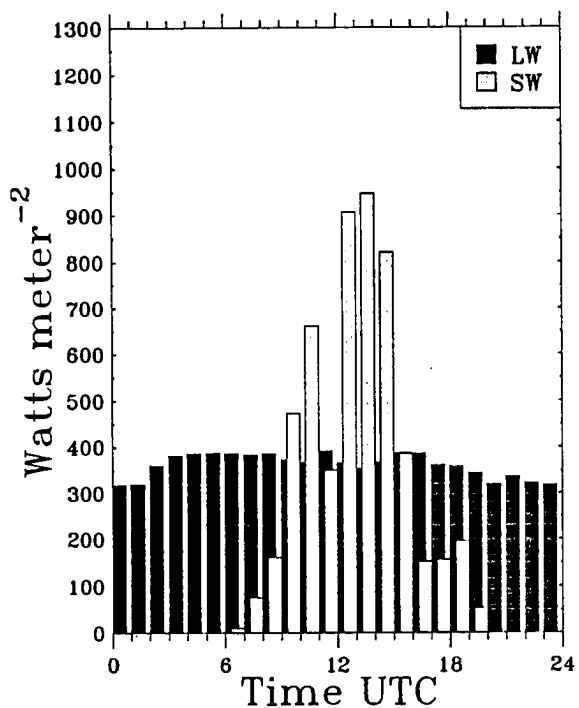


11μm Equivalent Brightness Temp

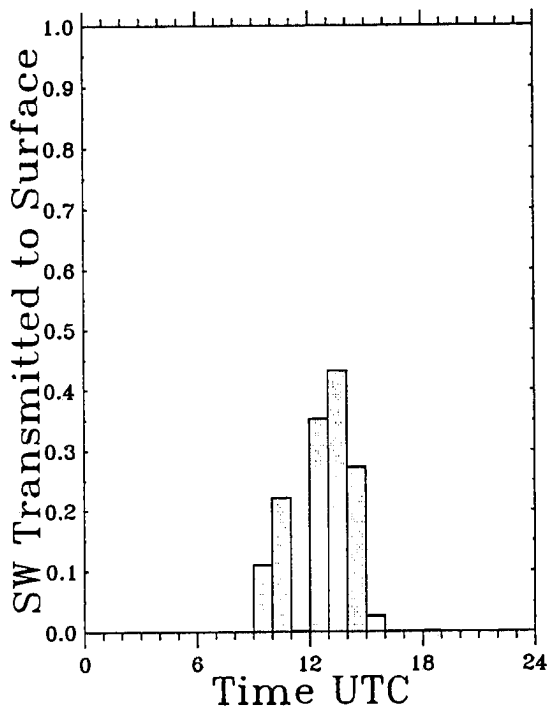


6 June (Day 158) Hourly Means

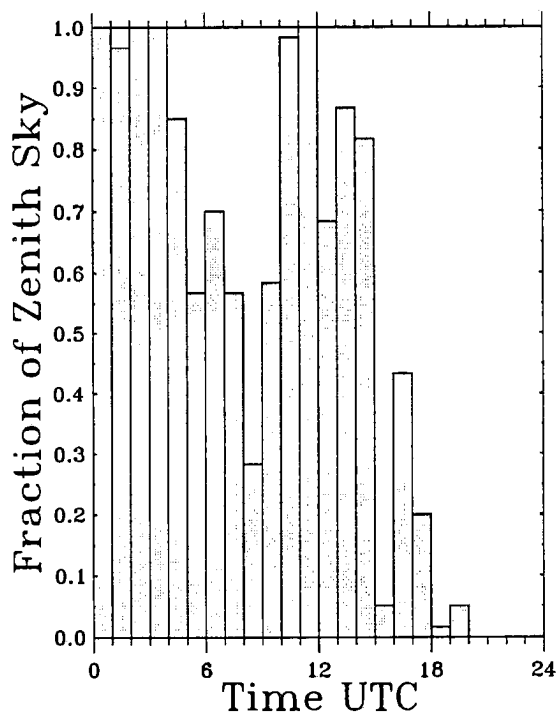
Mean Downwelling Flux



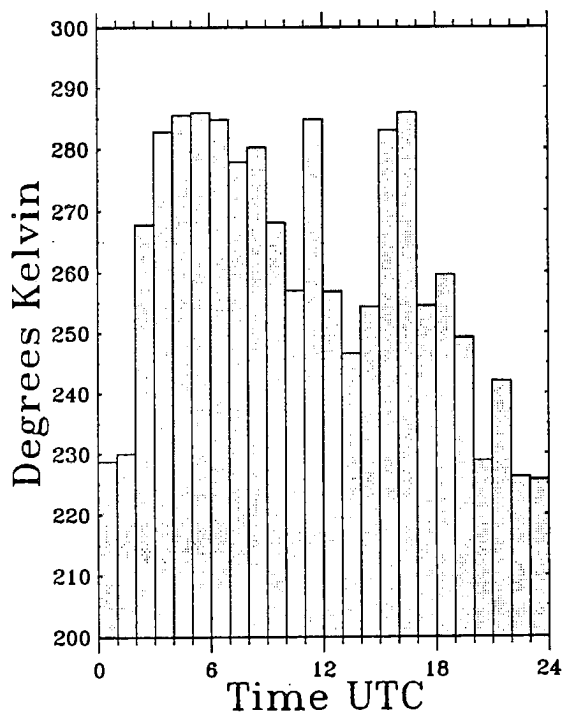
Solar Transmittance



Cloud Cover - Ceilometer

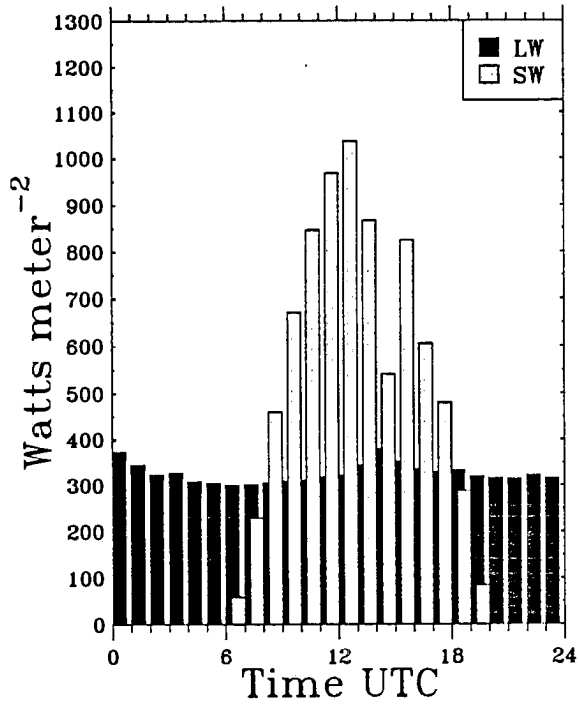


11μm Equivalent Brightness Temp

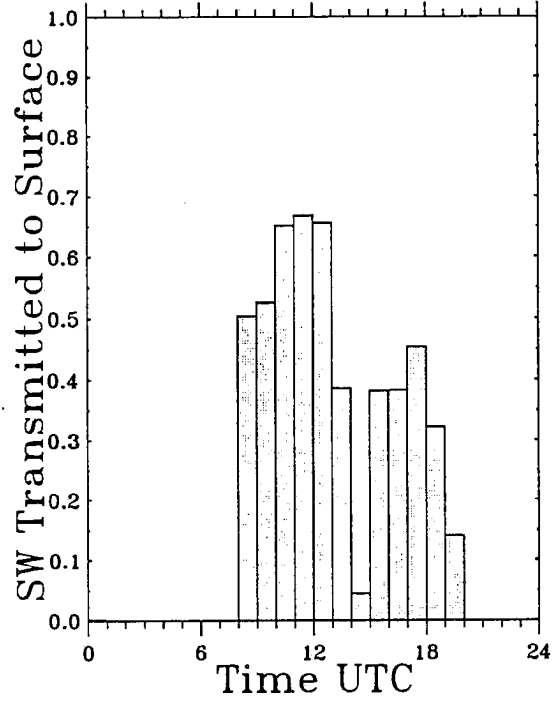


7 June (Day 159) Hourly Means

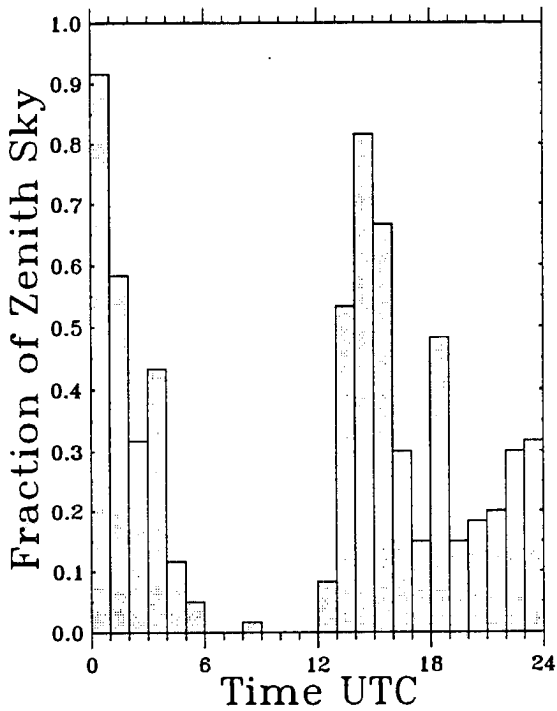
Mean Downwelling Flux



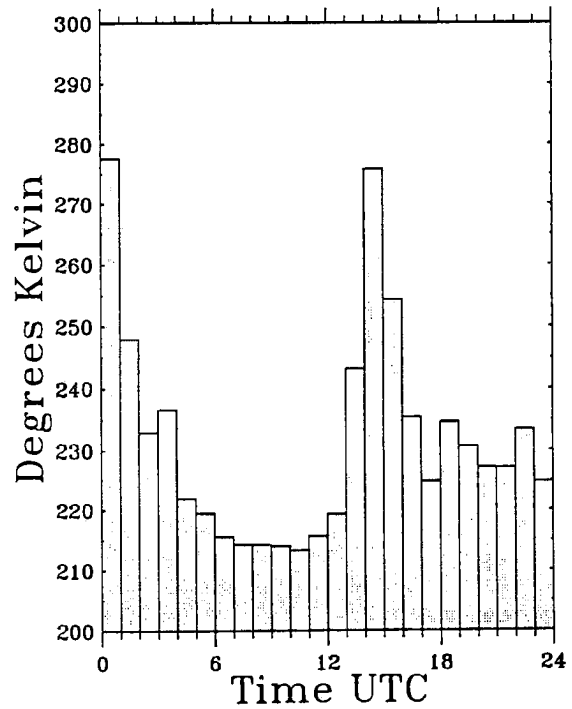
Solar Transmittance



Cloud Cover - Ceilometer

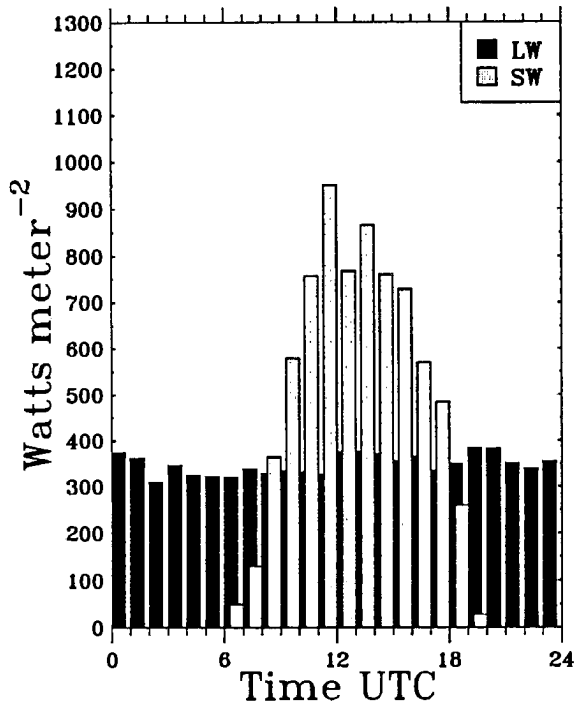


11μm Equivalent Brightness Temp

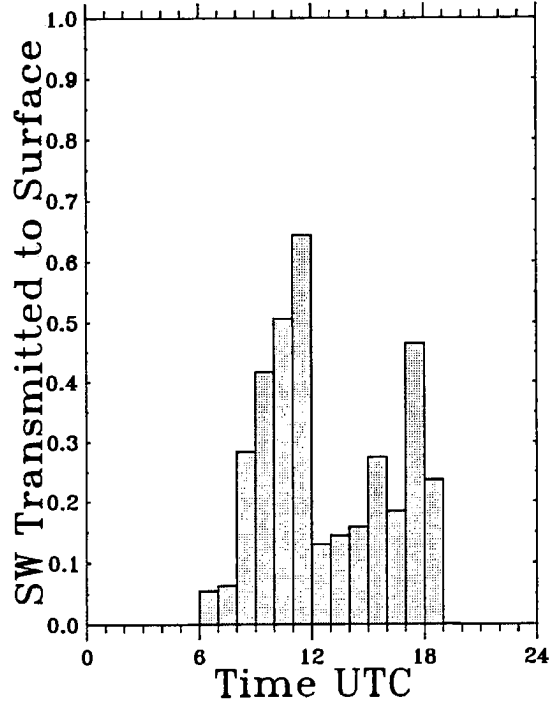


8 June (Day 160) Hourly Means

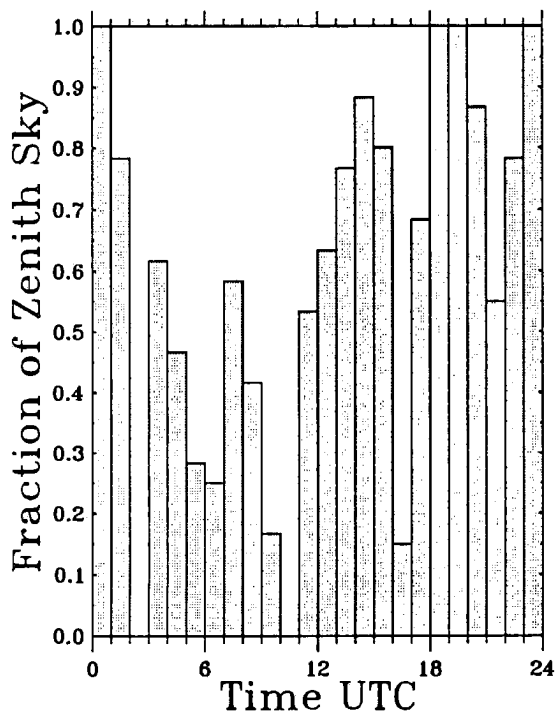
Mean Downwelling Flux



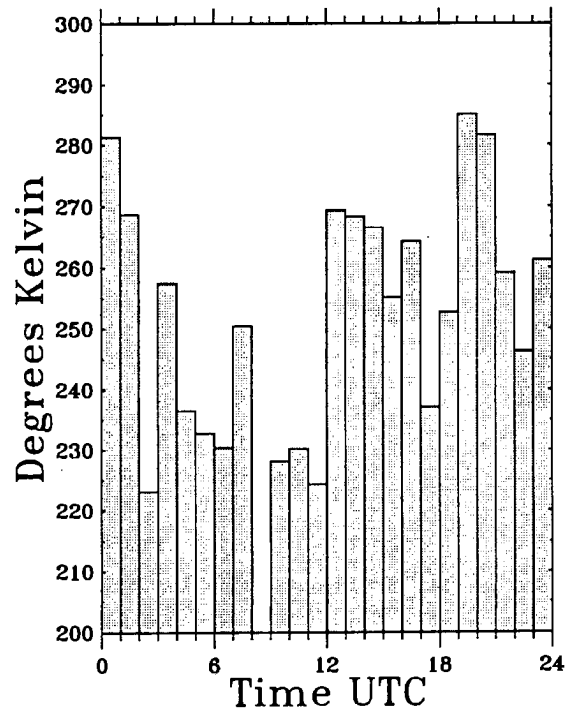
Solar Transmittance



Cloud Cover - Ceilometer

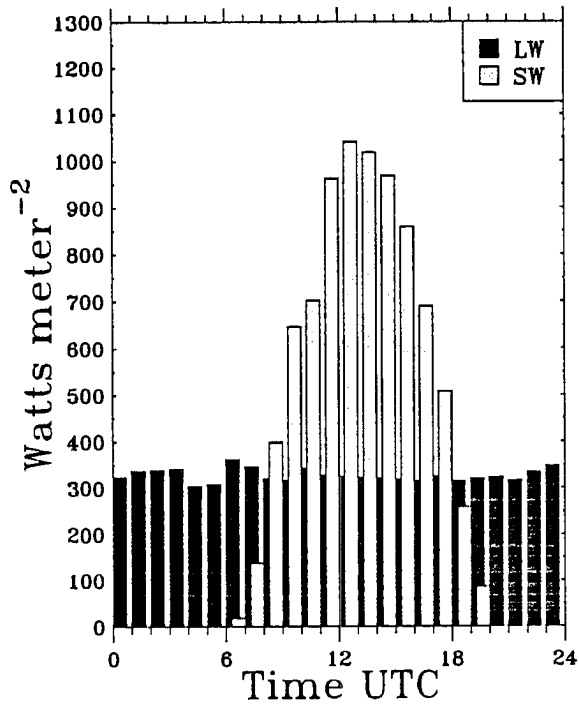


11μm Equivalent Brightness Temp

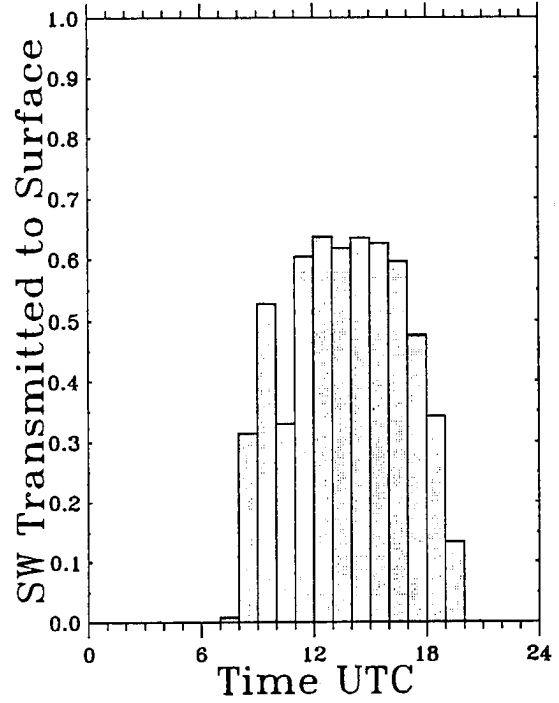


9 June (Day 161) Hourly Means

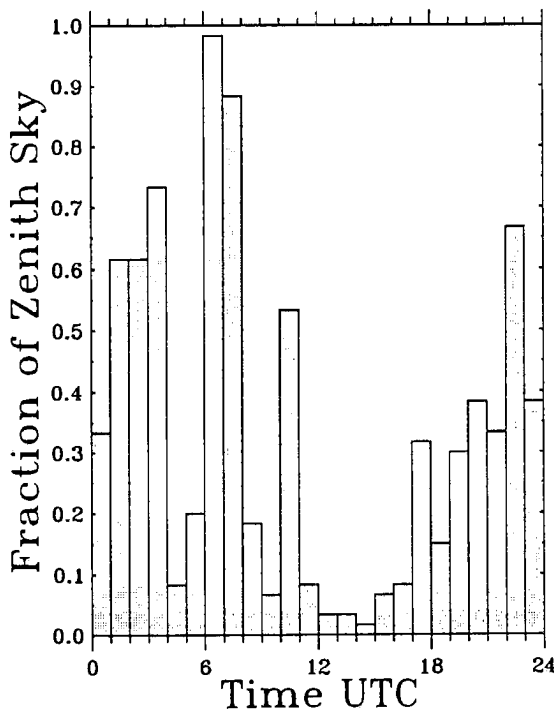
Mean Downwelling Flux



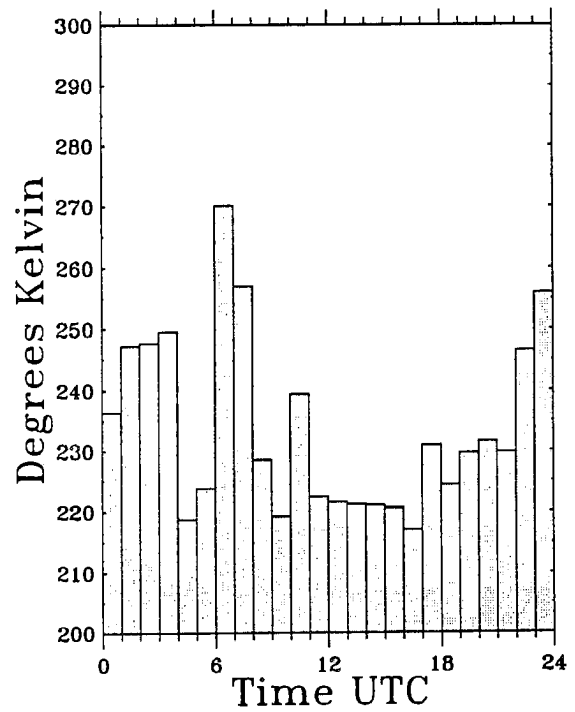
Solar Transmittance



Cloud Cover - Ceilometer

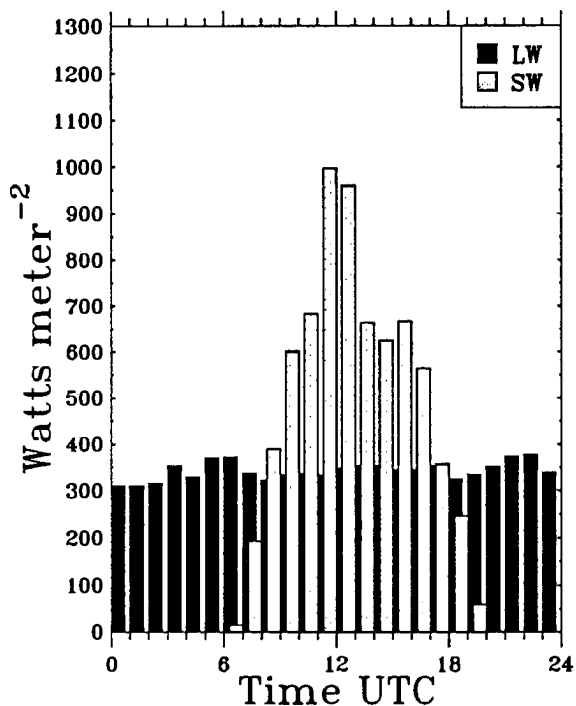


11μm Equivalent Brightness Temp

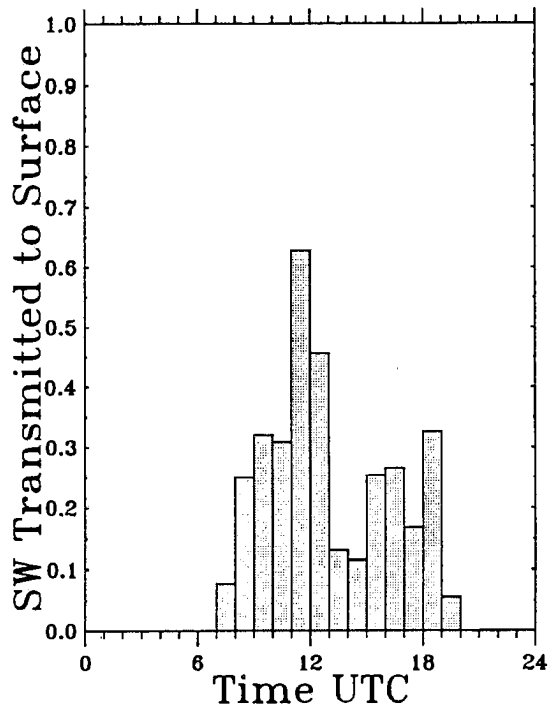


10 June (Day 162) Hourly Means

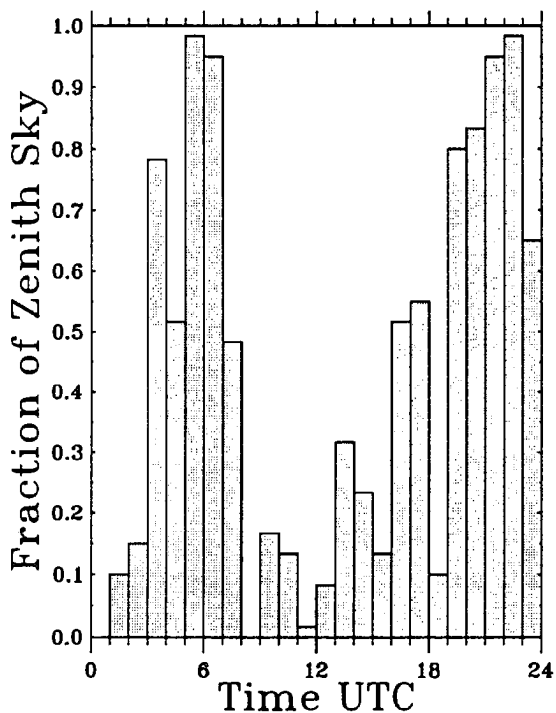
Mean Downwelling Flux



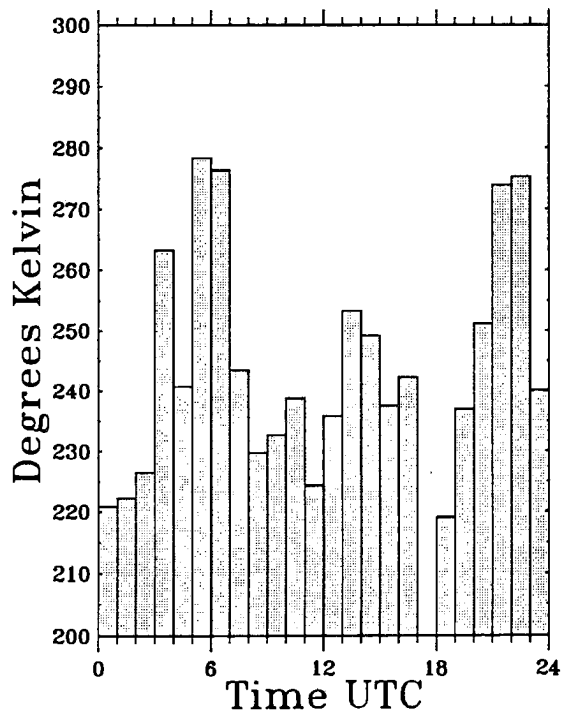
Solar Transmittance



Cloud Cover - Ceilometer

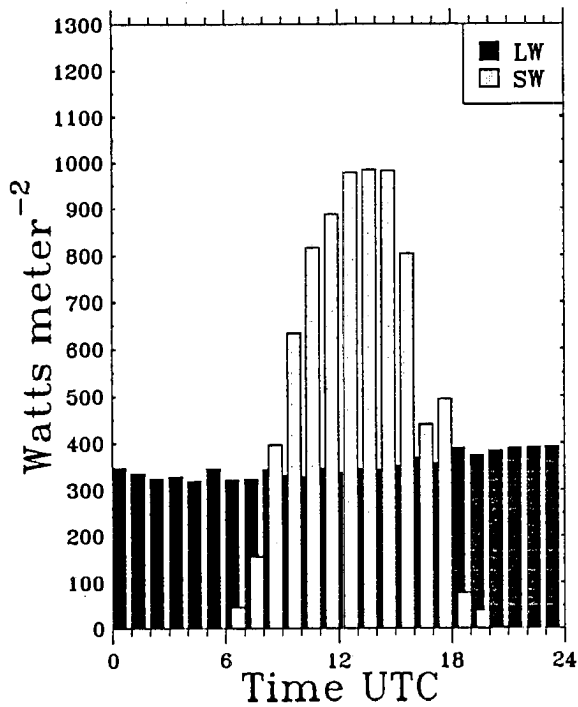


11μm Equivalent Brightness Temp

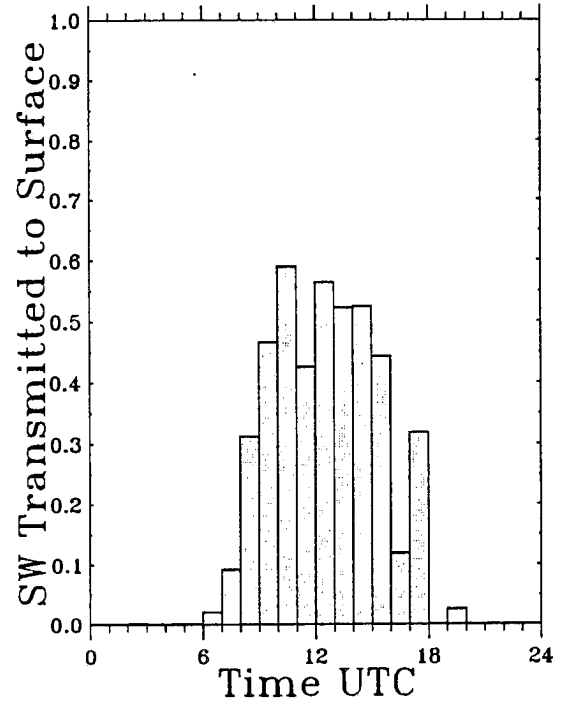


11 June (Day 163) Hourly Means

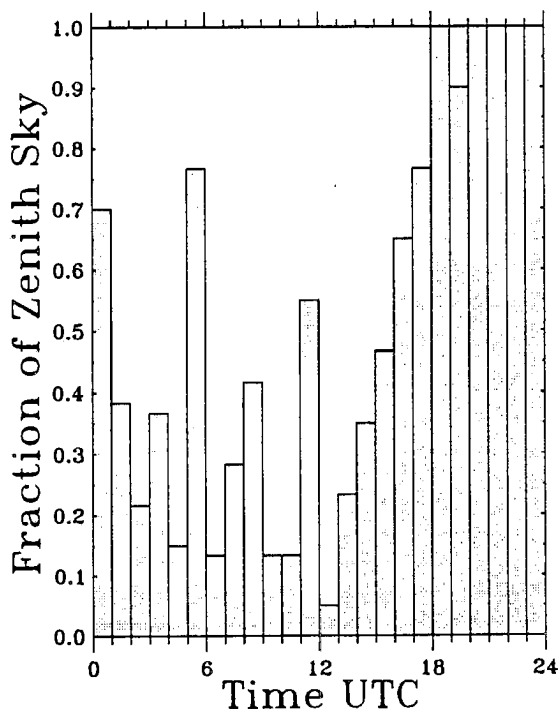
Mean Downwelling Flux



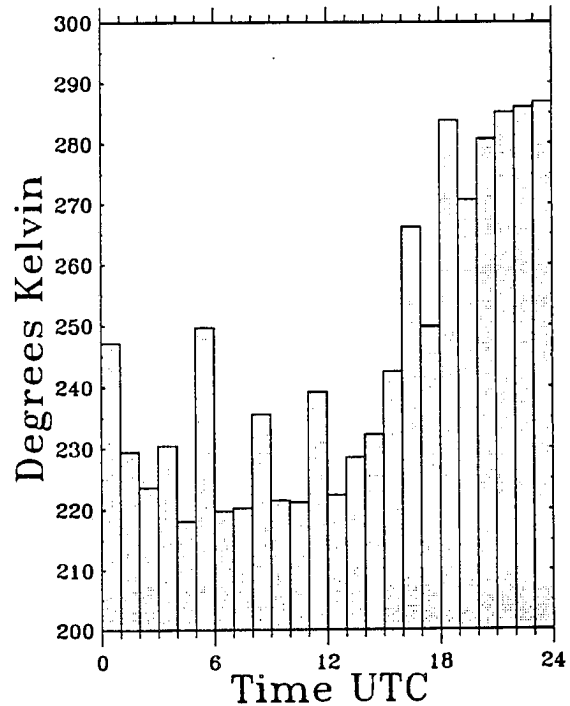
Solar Transmittance



Cloud Cover - Ceilometer

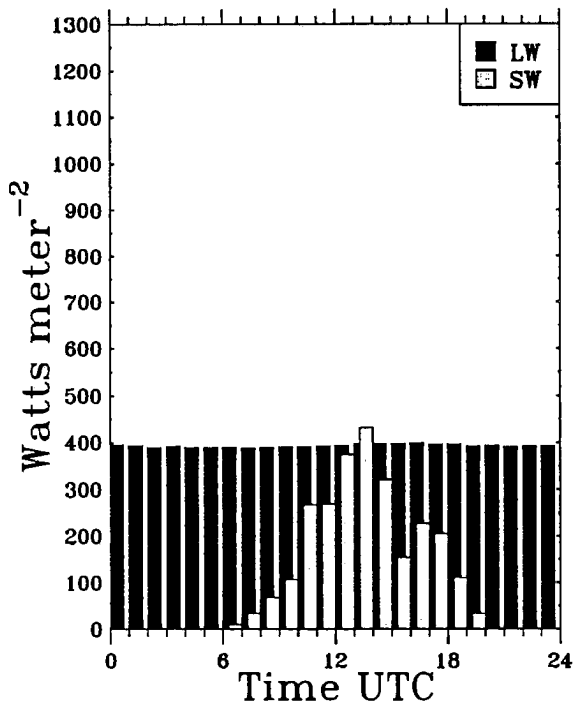


11μm Equivalent Brightness Temp

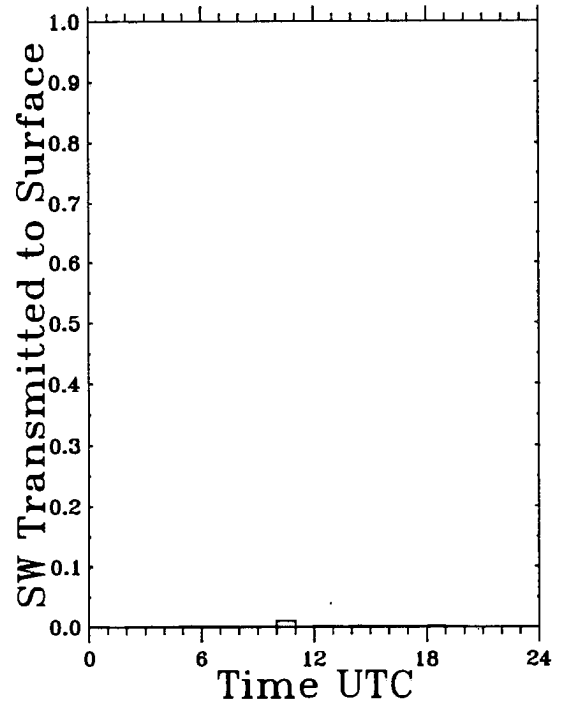


12 June (Day 164) Hourly Means

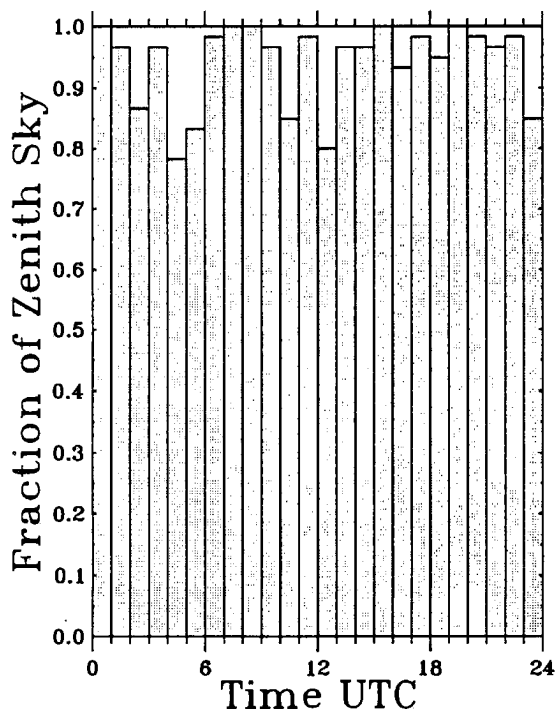
Mean Downwelling Flux



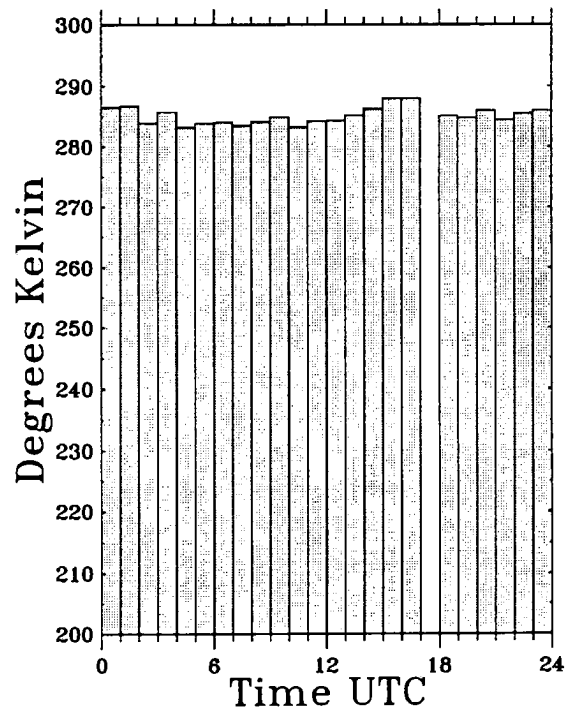
Solar Transmittance



Cloud Cover - Ceilometer

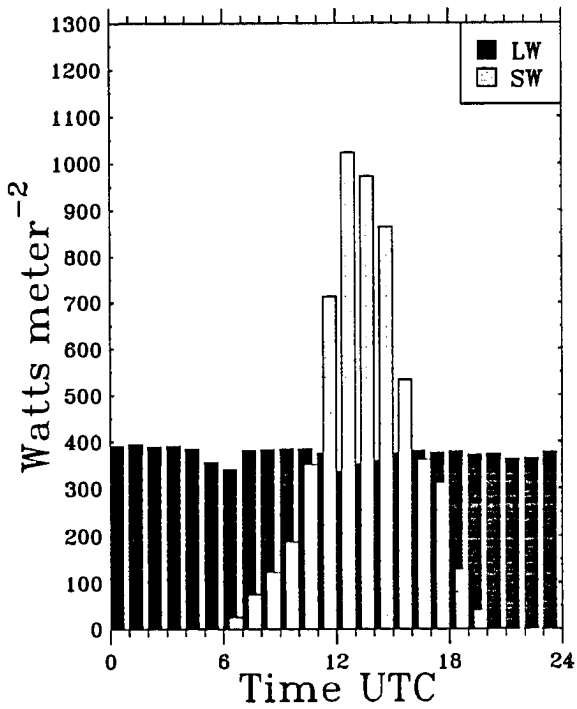


11μm Equivalent Brightness Temp

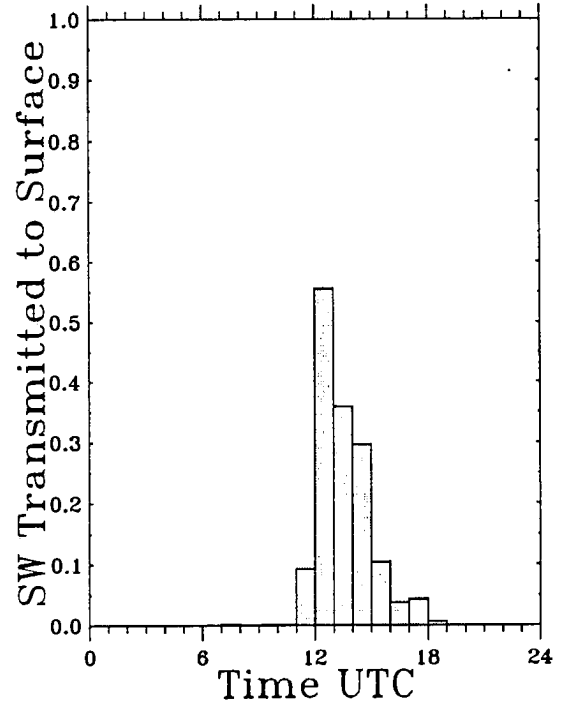


13 June (Day 165) Hourly Means

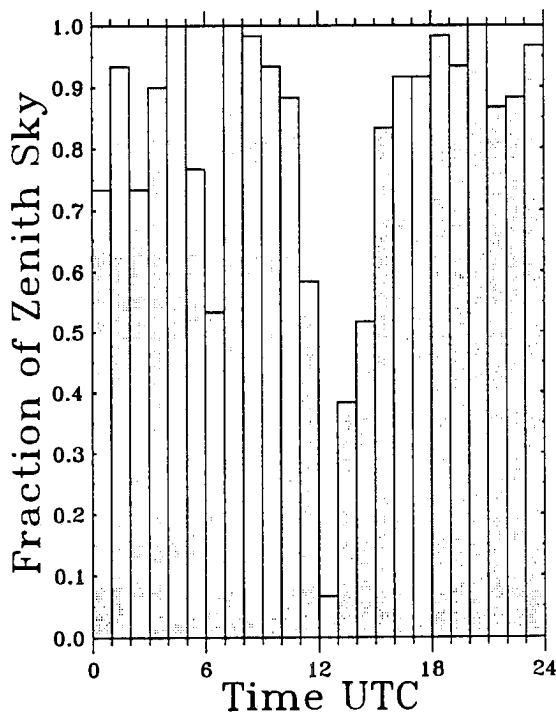
Mean Downwelling Flux



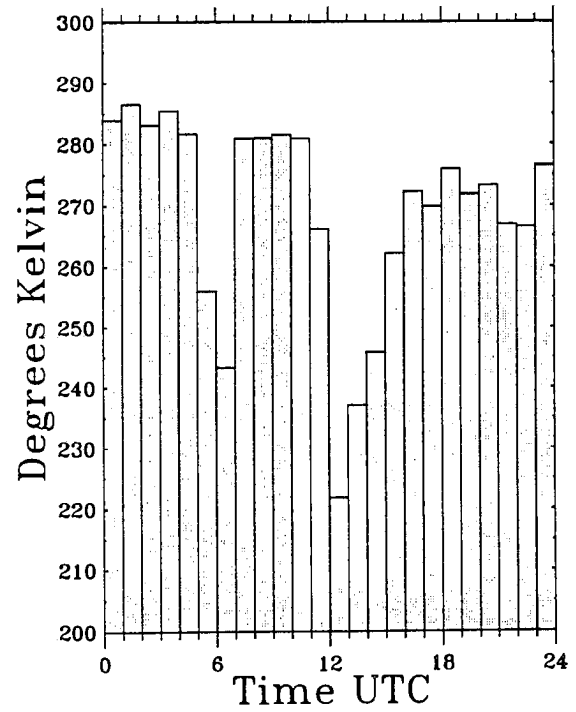
Solar Transmittance



Cloud Cover - Ceilometer

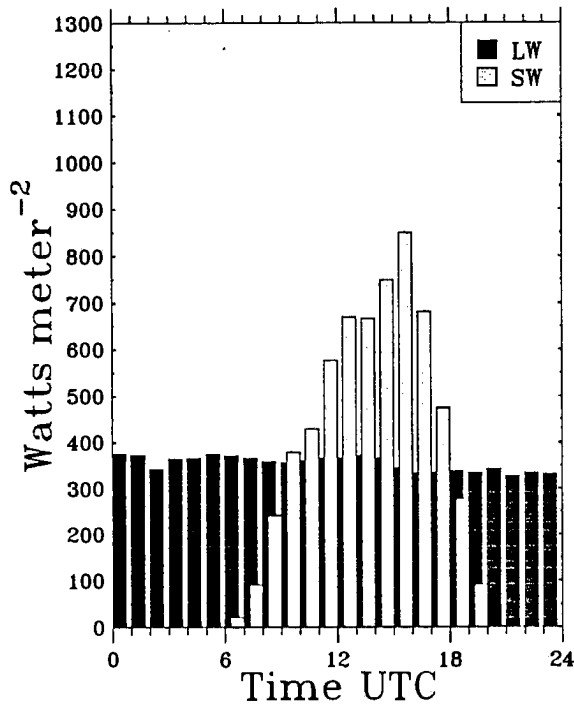


11μm Equivalent Brightness Temp

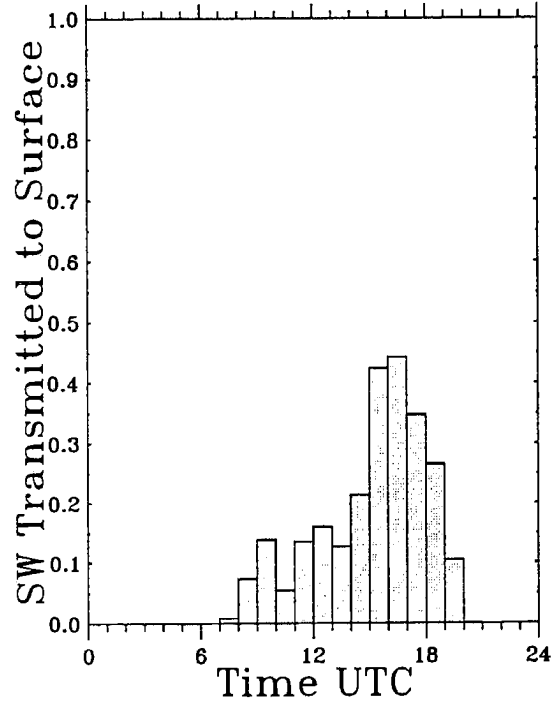


14 June (Day 166) Hourly Means

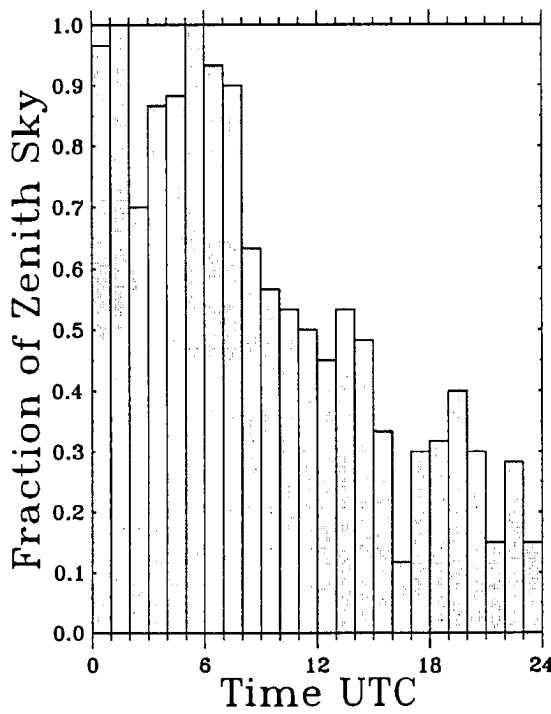
Mean Downwelling Flux



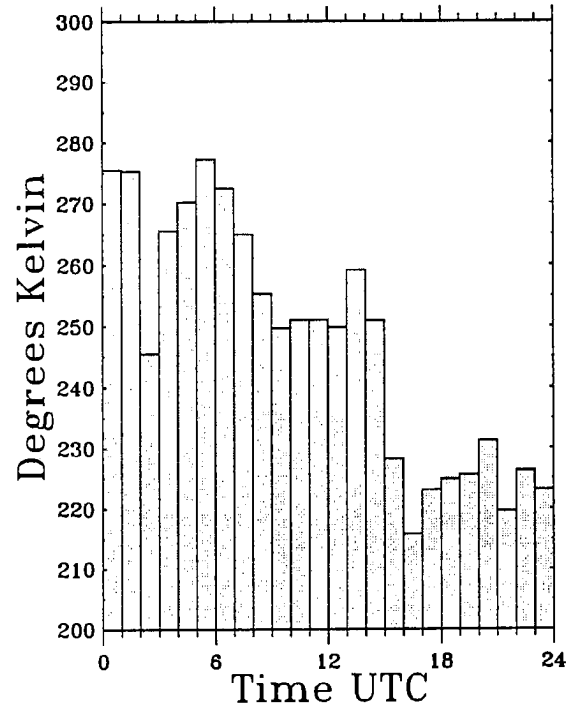
Solar Transmittance



Cloud Cover - Ceilometer

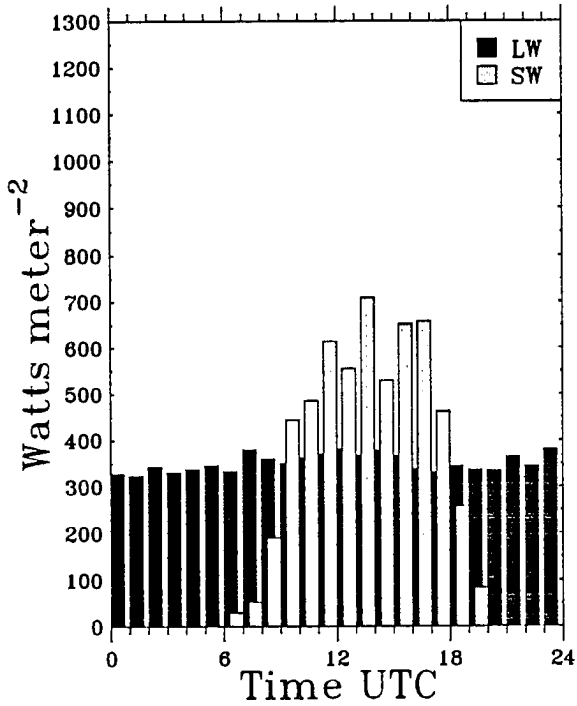


11μm Equivalent Brightness Temp

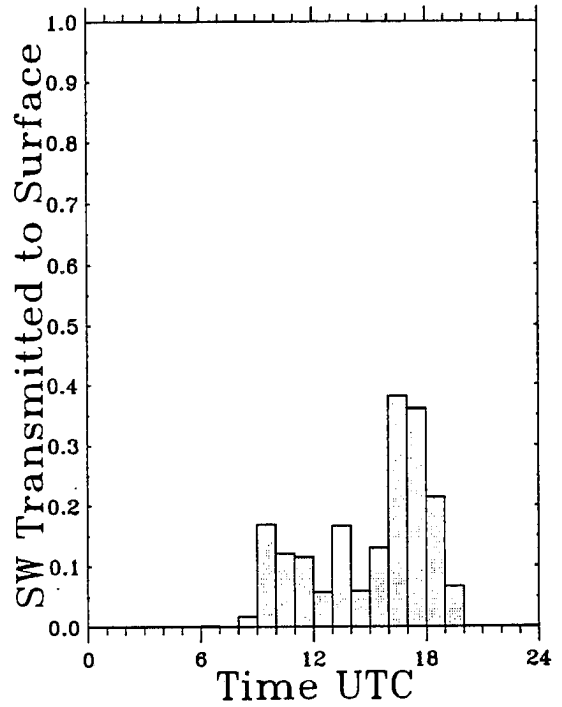


15 June (Day 167) Hourly Means

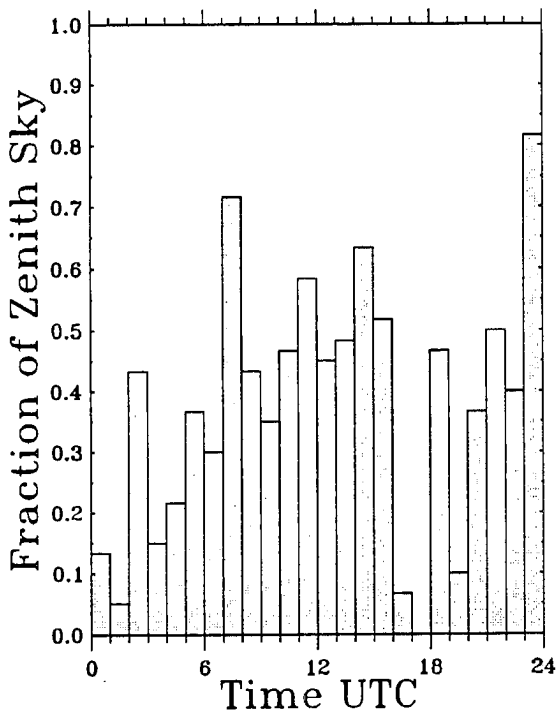
Mean Downwelling Flux



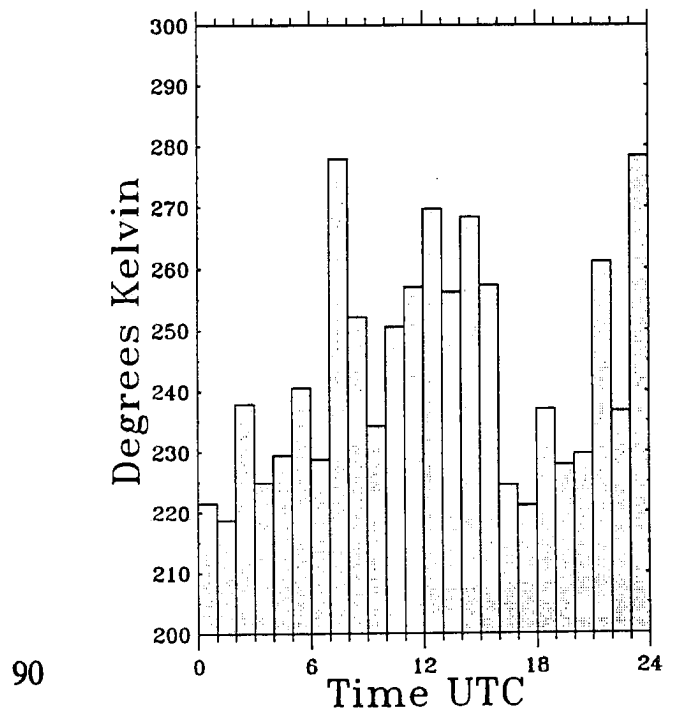
Solar Transmittance



Cloud Cover - Ceilometer

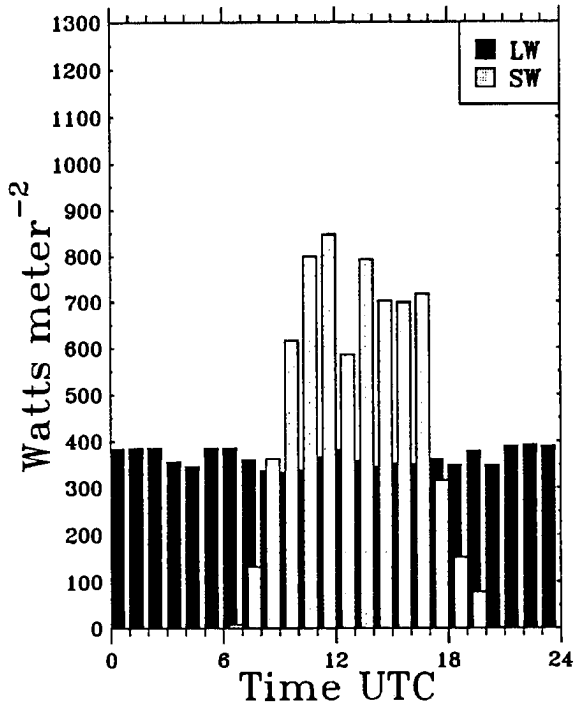


11μm Equivalent Brightness Temp

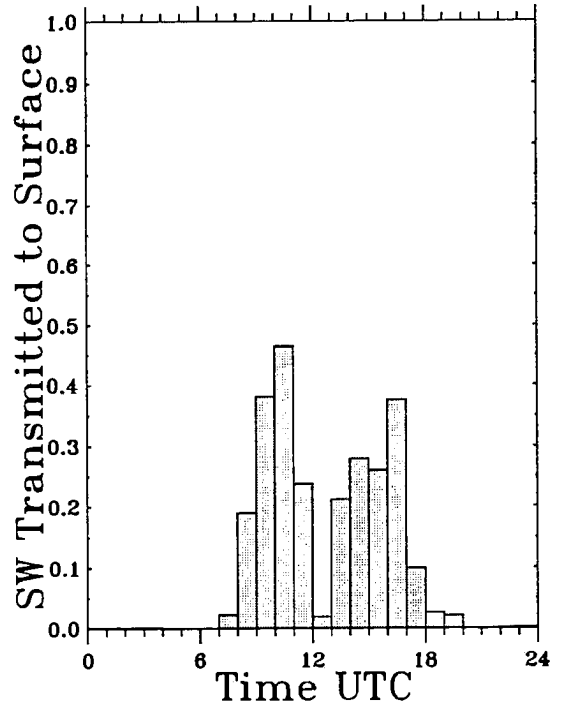


16 June (Day 168) Hourly Means

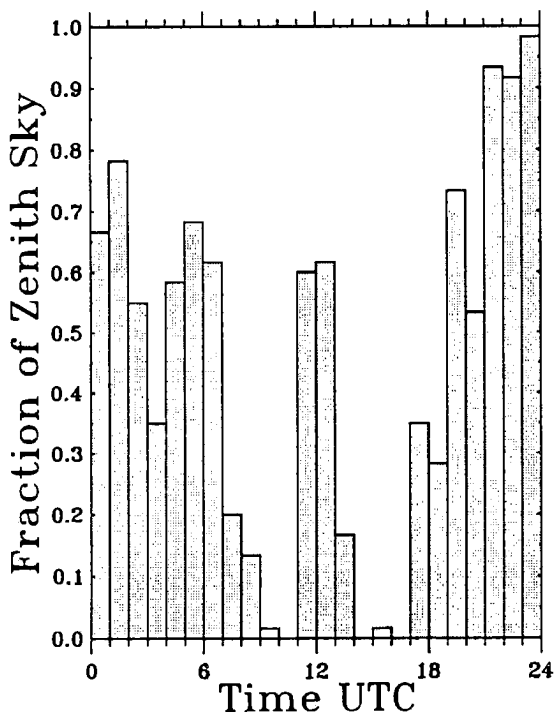
Mean Downwelling Flux



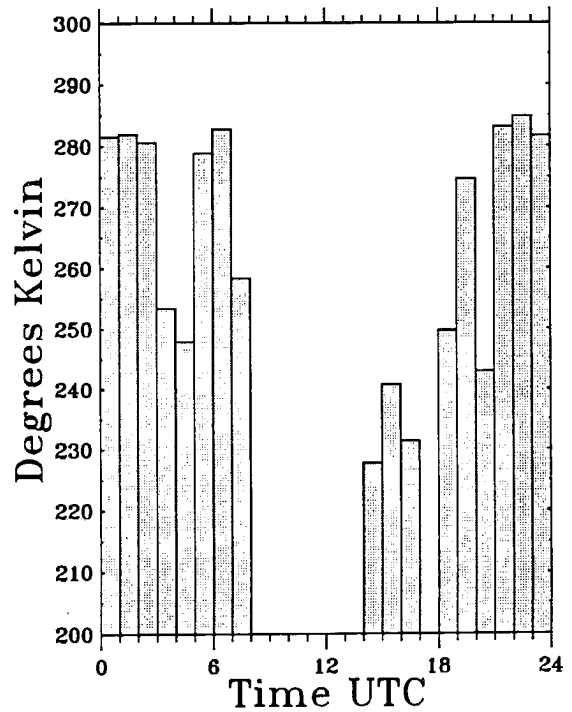
Solar Transmittance



Cloud Cover - Ceilometer

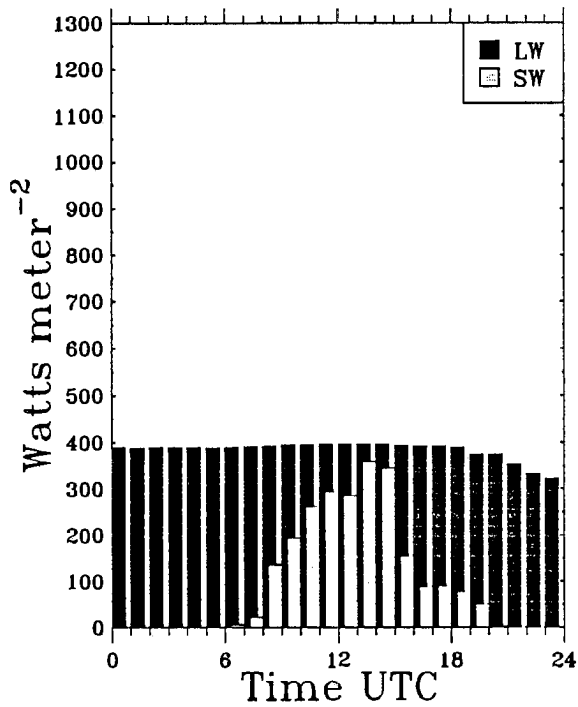


11μm Equivalent Brightness Temp

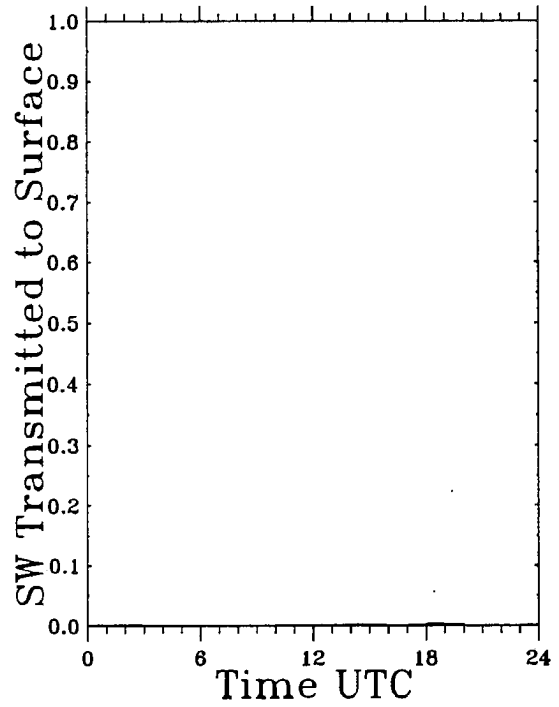


17 June (Day 169) Hourly Means

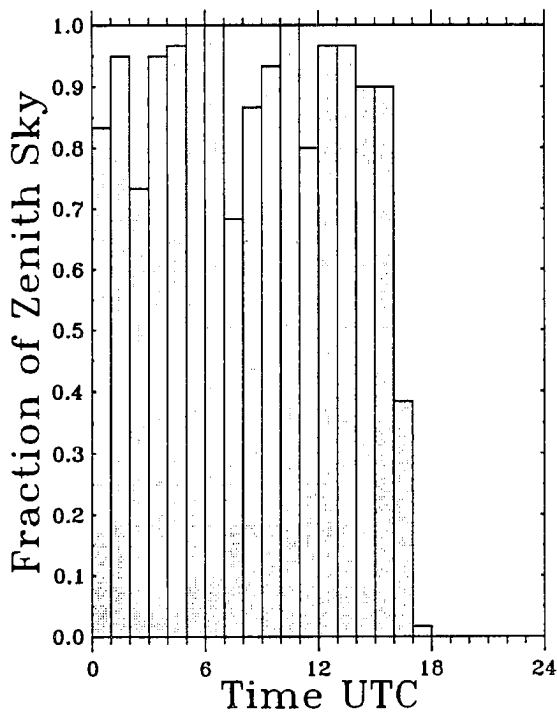
Mean Downwelling Flux



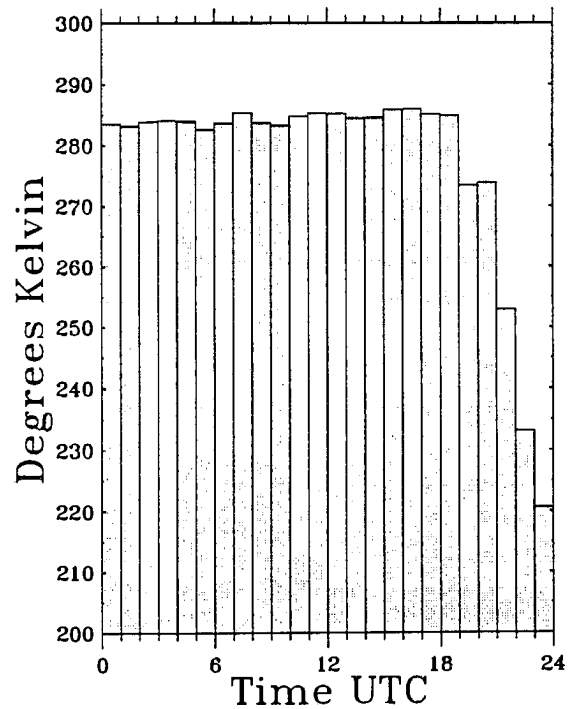
Solar Transmittance



Cloud Cover - Ceilometer

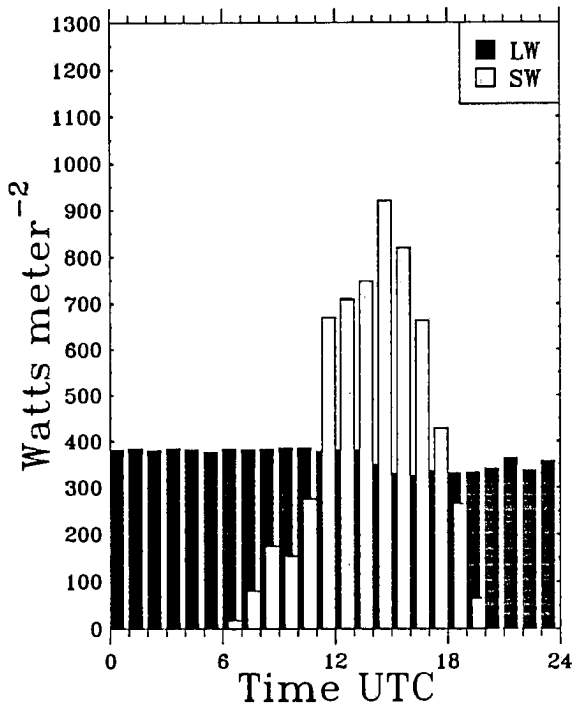


11μm Equivalent Brightness Temp

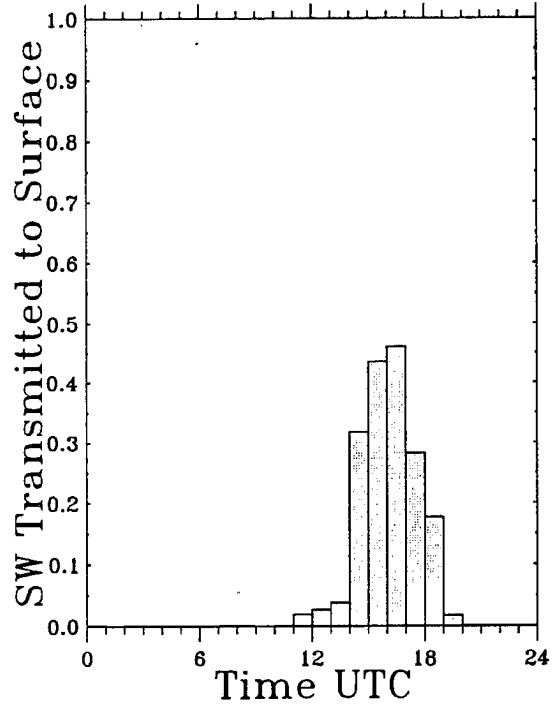


18 June (Day 170) Hourly Means

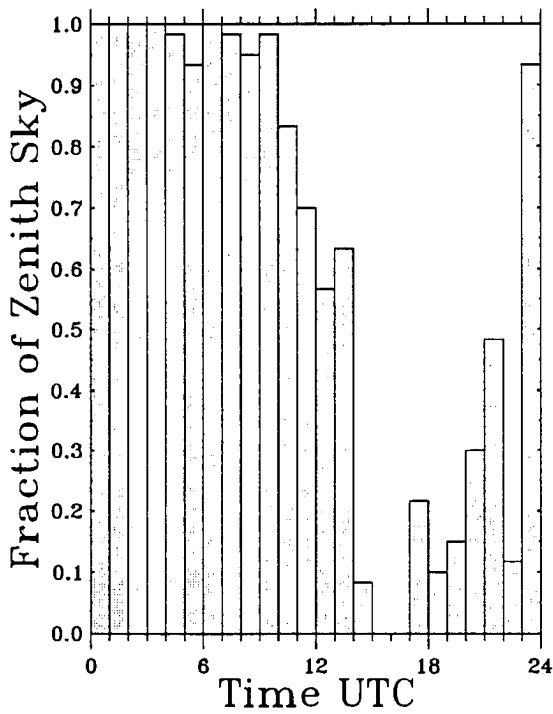
Mean Downwelling Flux



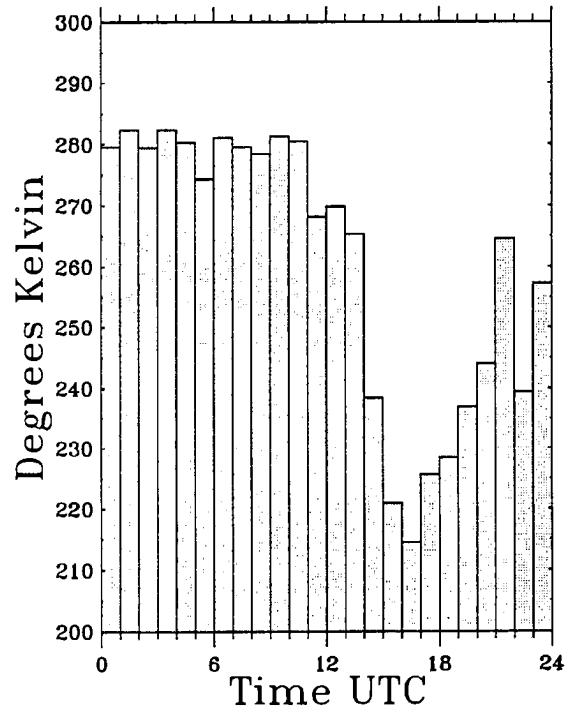
Solar Transmittance



Cloud Cover - Ceilometer

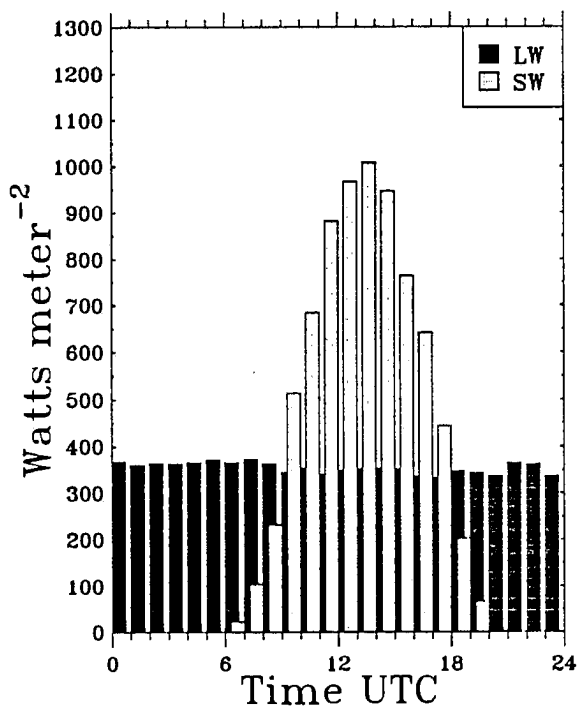


11μm Equivalent Brightness Temp

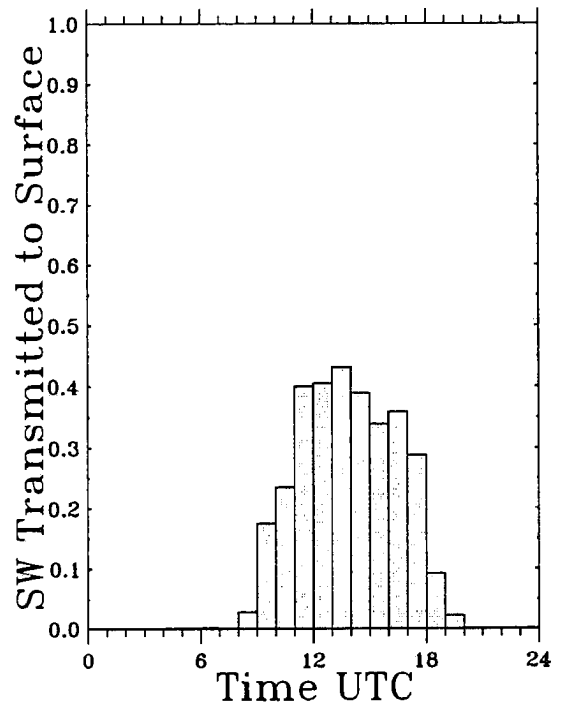


19 June (Day 171) Hourly Means

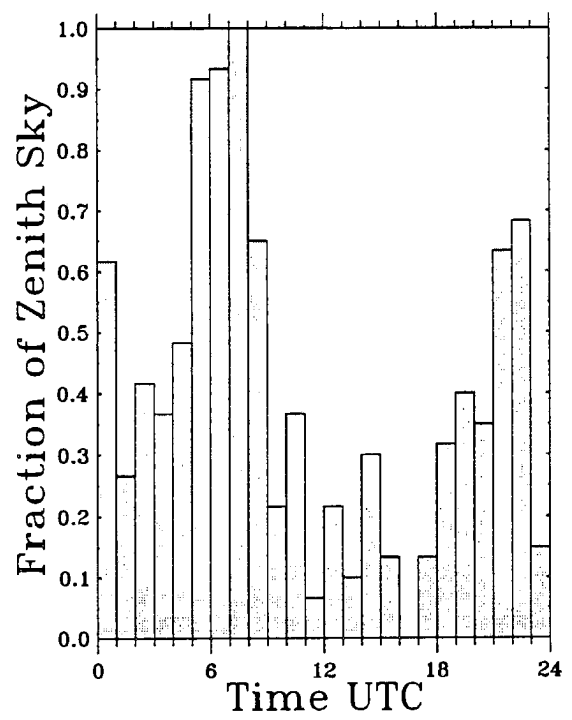
Mean Downwelling Flux



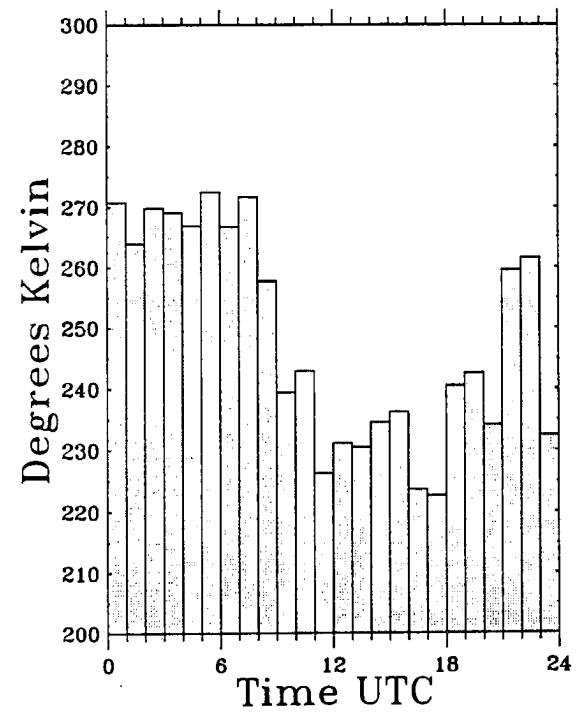
Solar Transmittance



Cloud Cover - Ceilometer

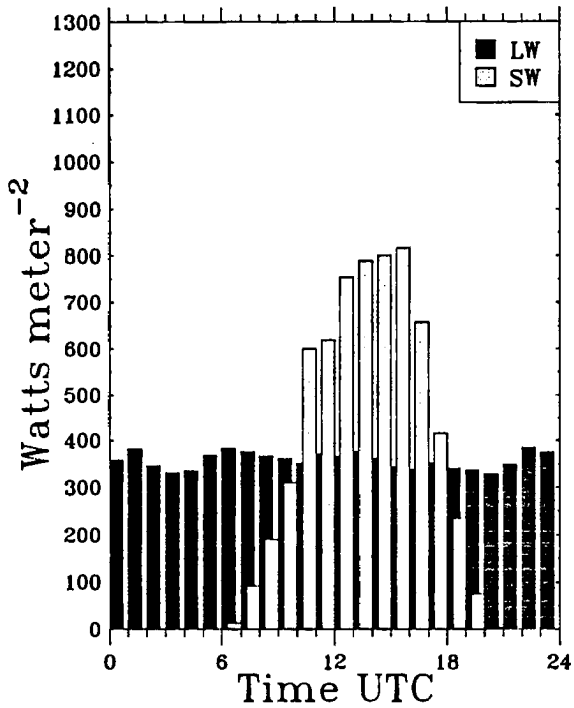


11μm Equivalent Brightness Temp

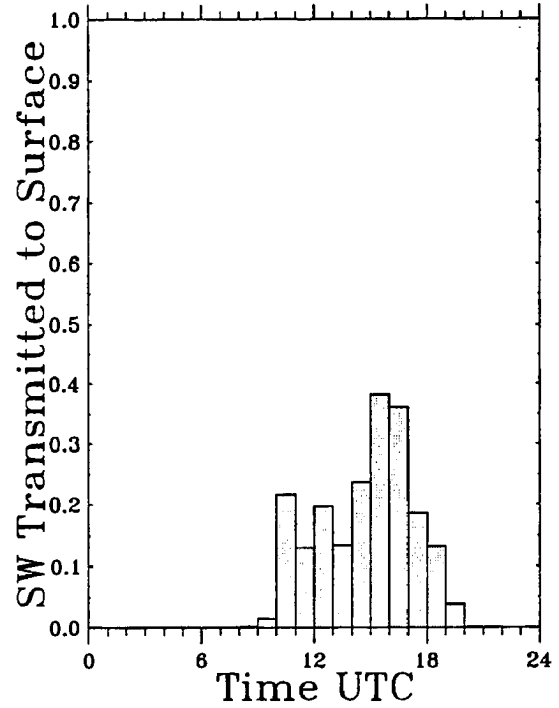


20 June (Day 172) Hourly Means

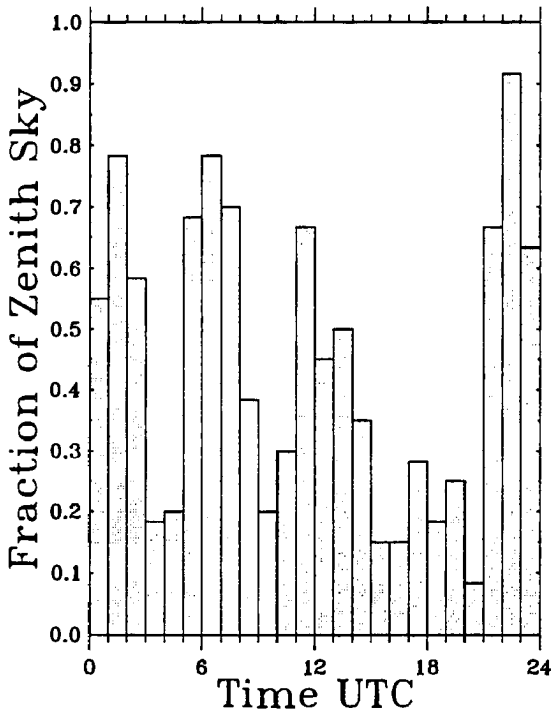
Mean Downwelling Flux



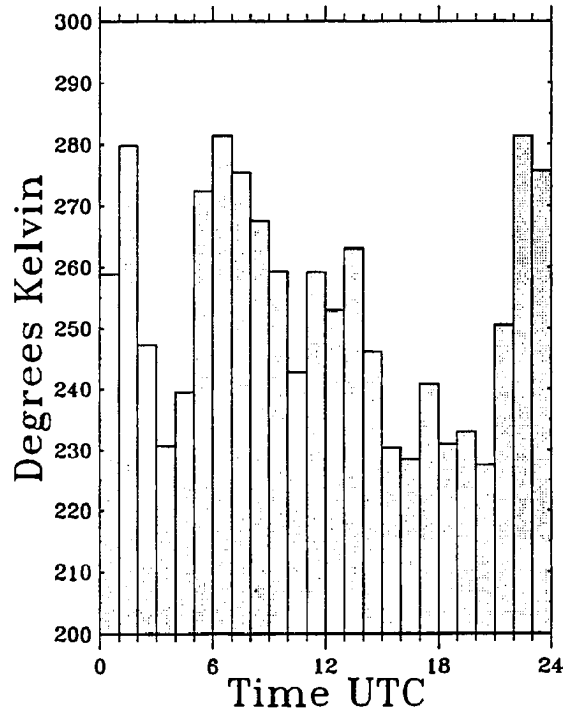
Solar Transmittance



Cloud Cover - Ceilometer

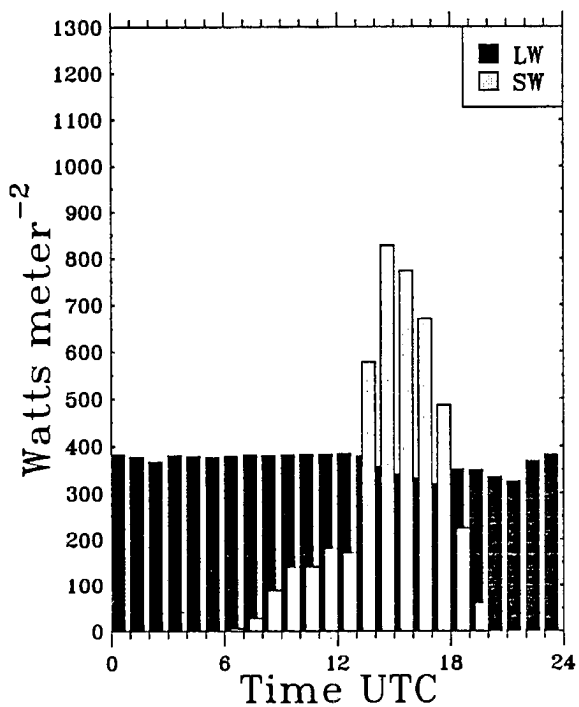


11μm Equivalent Brightness Temp

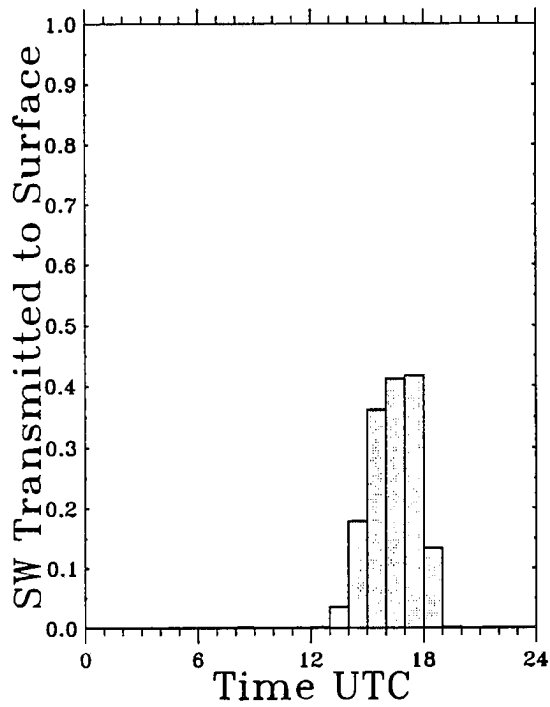


21 June (Day 173) Hourly Means

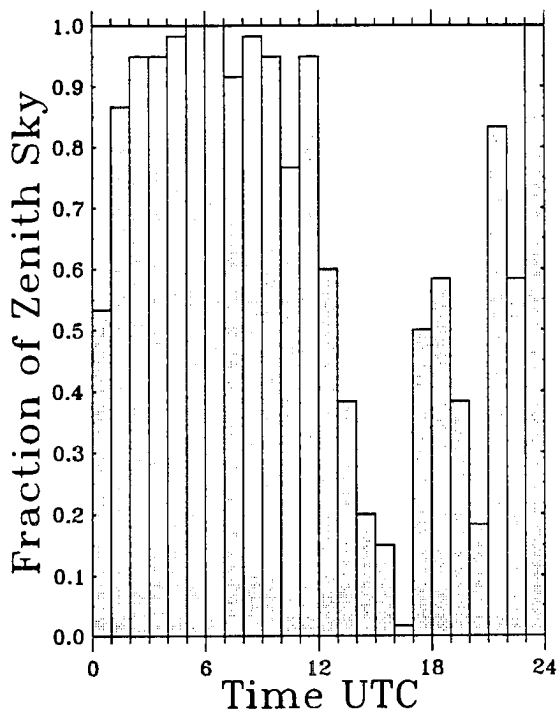
Mean Downwelling Flux



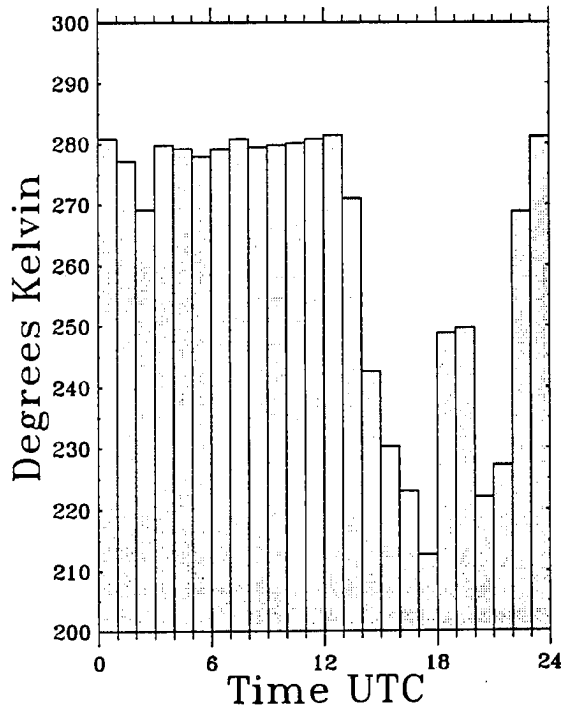
Solar Transmittance



Cloud Cover - Ceilometer

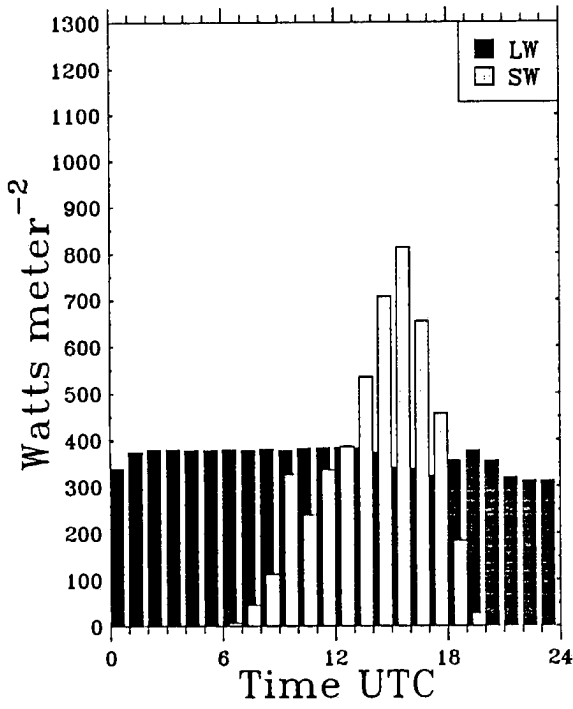


11μm Equivalent Brightness Temp

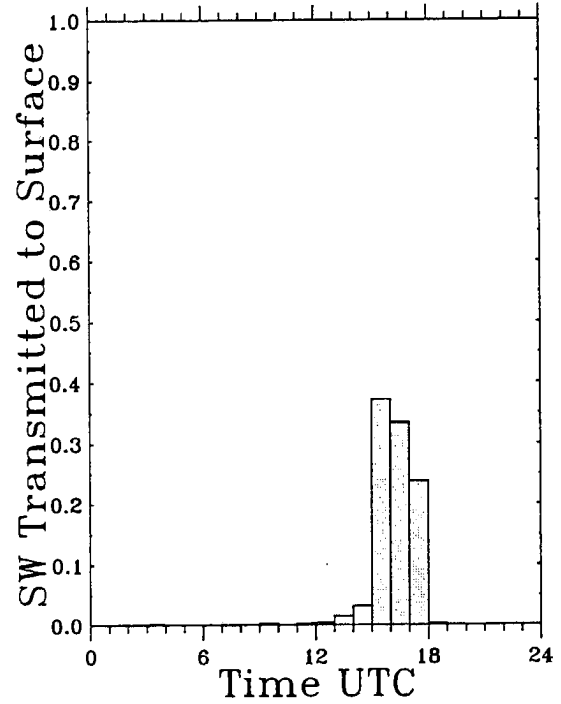


22 June (Day 174) Hourly Means

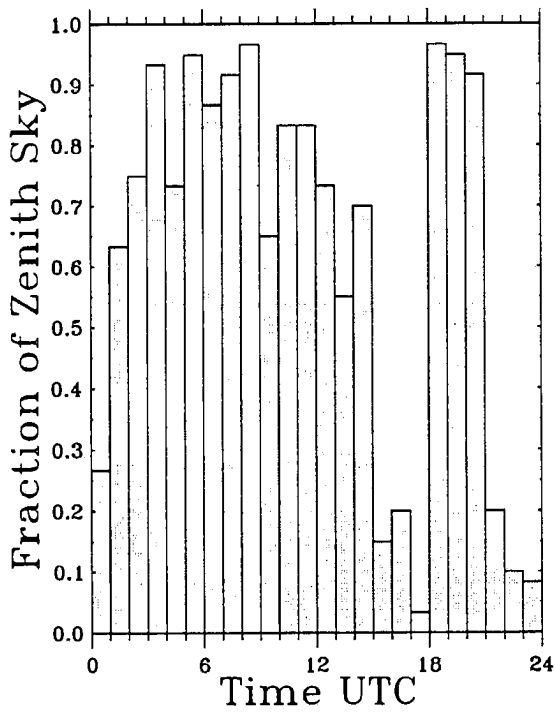
Mean Downwelling Flux



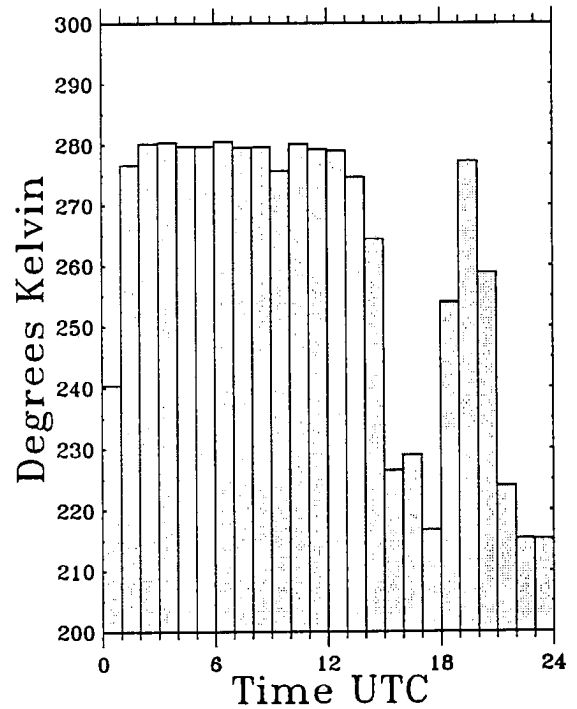
Solar Transmittance



Cloud Cover - Ceilometer

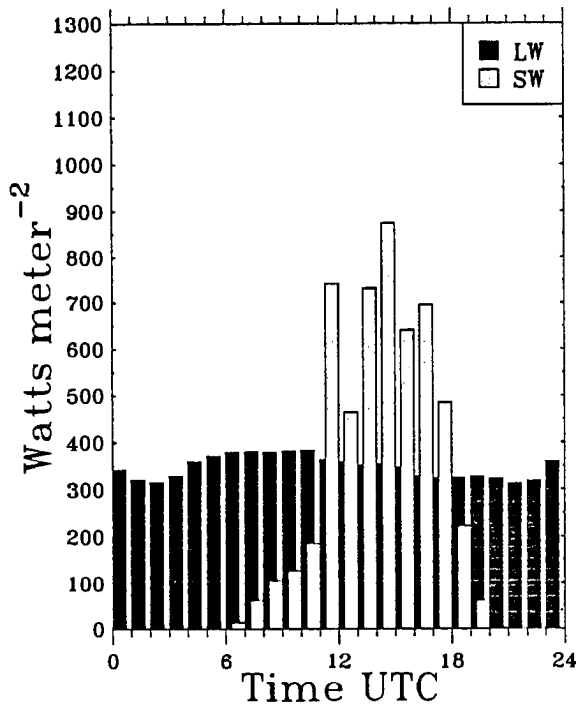


11μm Equivalent Brightness Temp

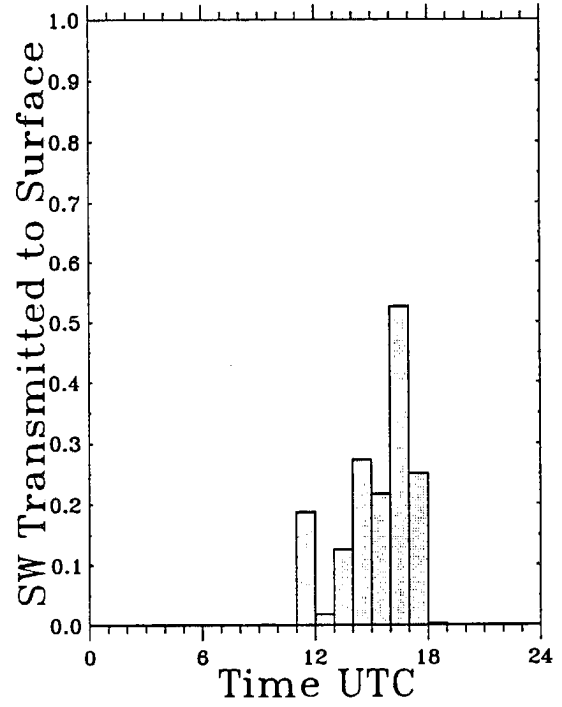


23 June (Day 175) Hourly Means

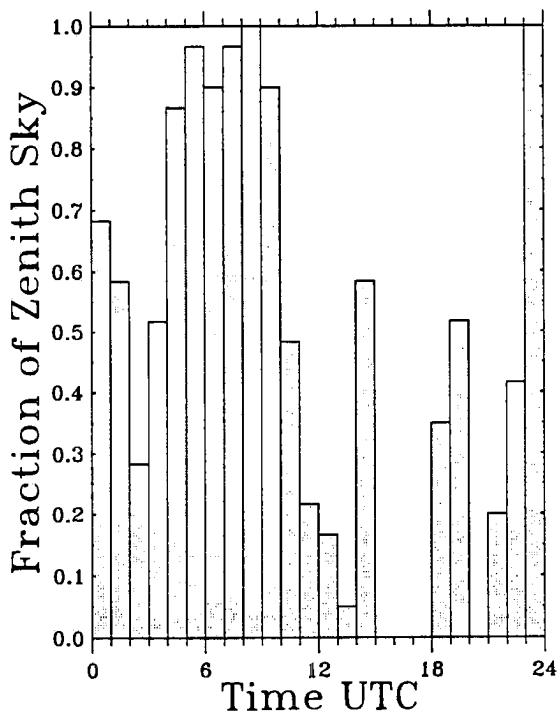
Mean Downwelling Flux



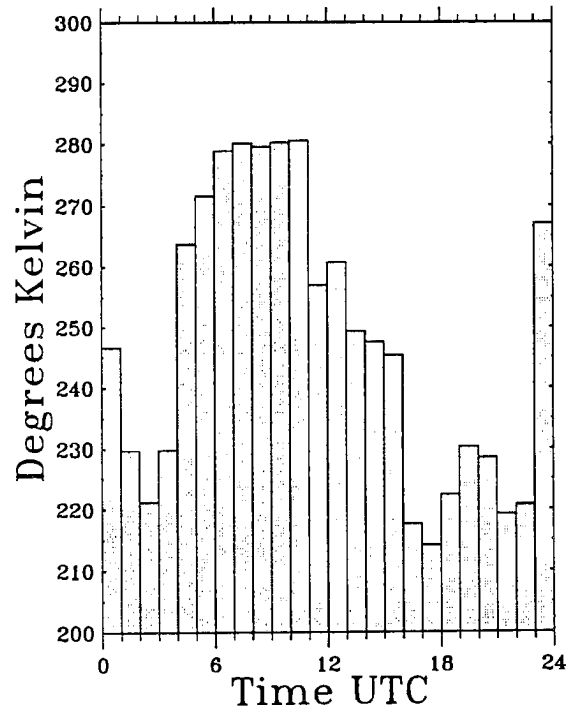
Solar Transmittance



Cloud Cover - Ceilometer

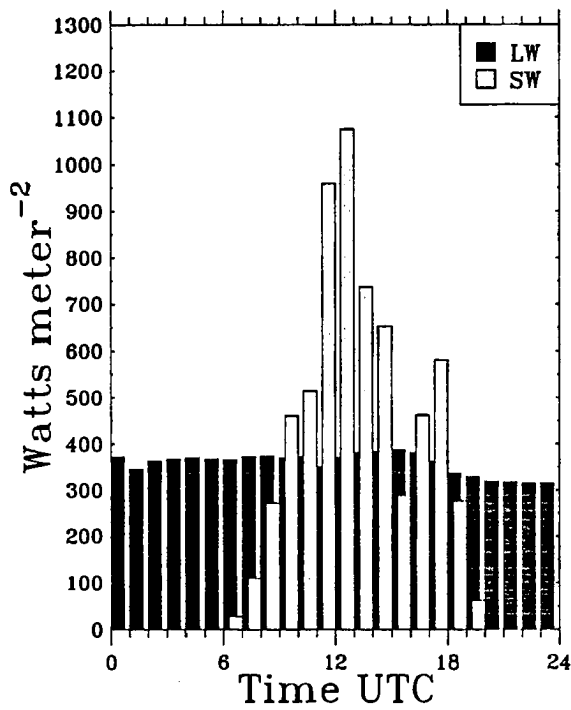


11μm Equivalent Brightness Temp

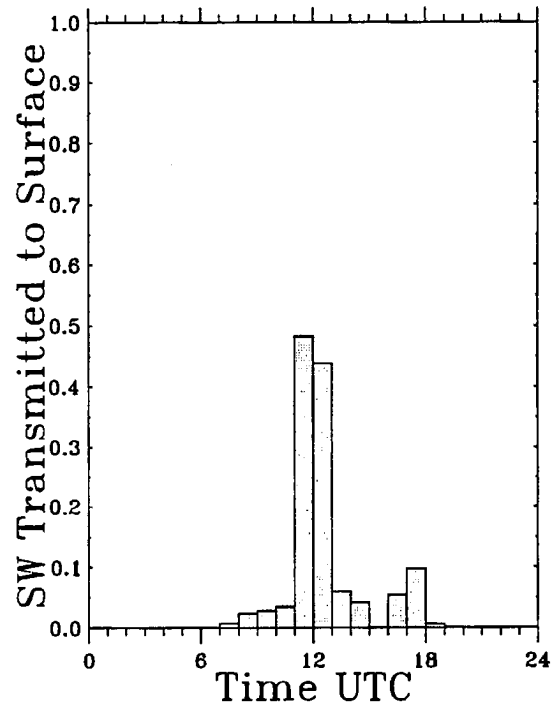


24 June (Day 176) Hourly Means

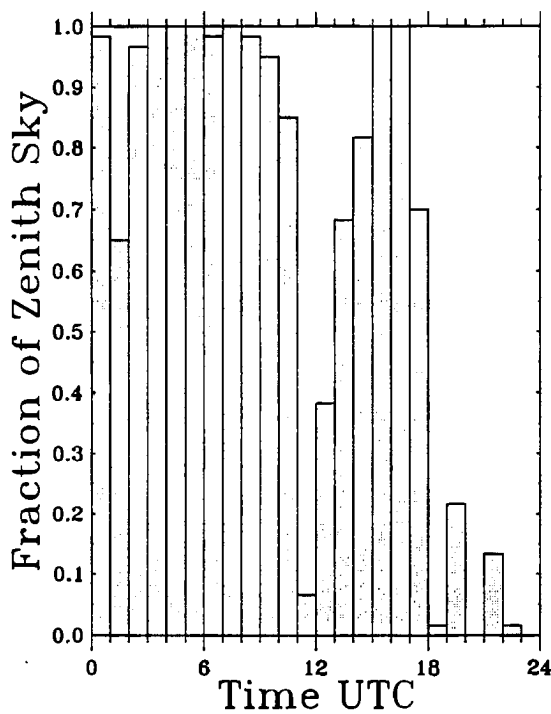
Mean Downwelling Flux



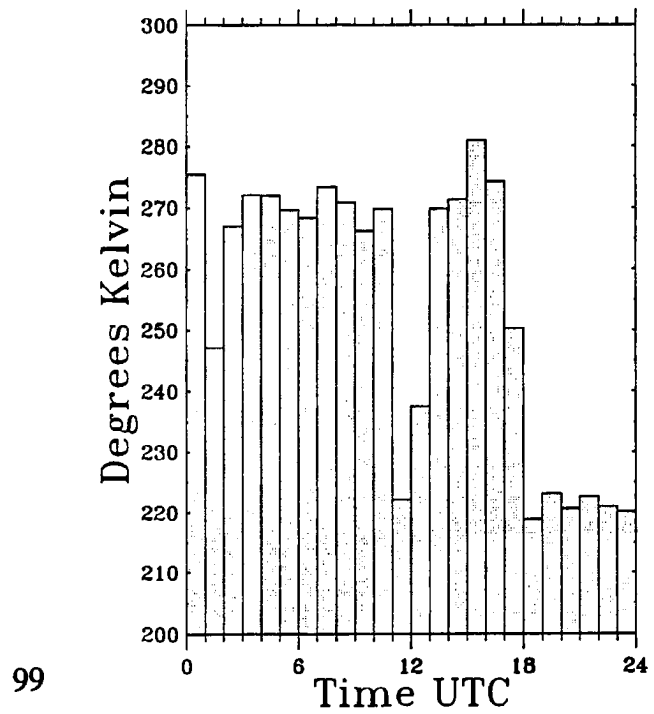
Solar Transmittance



Cloud Cover - Ceilometer

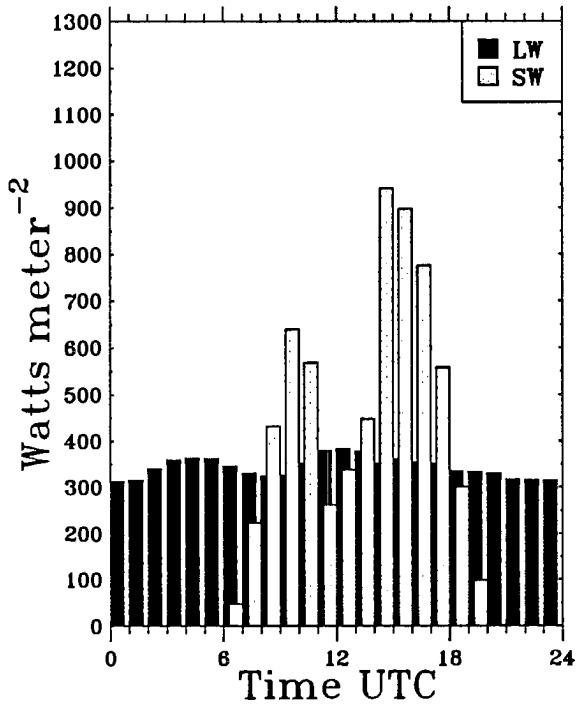


11μm Equivalent Brightness Temp

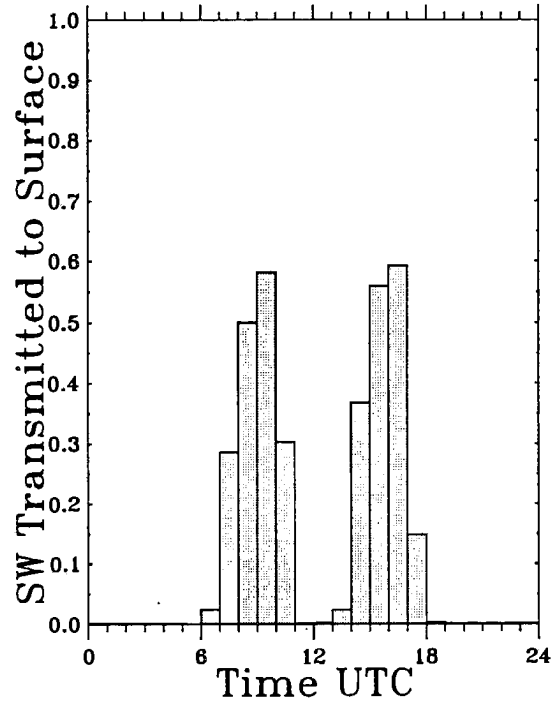


25 June (Day 177) Hourly Means

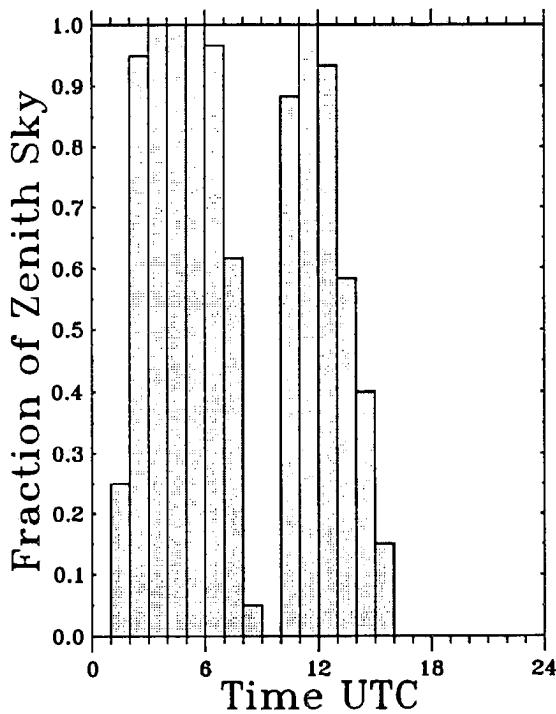
Mean Downwelling Flux



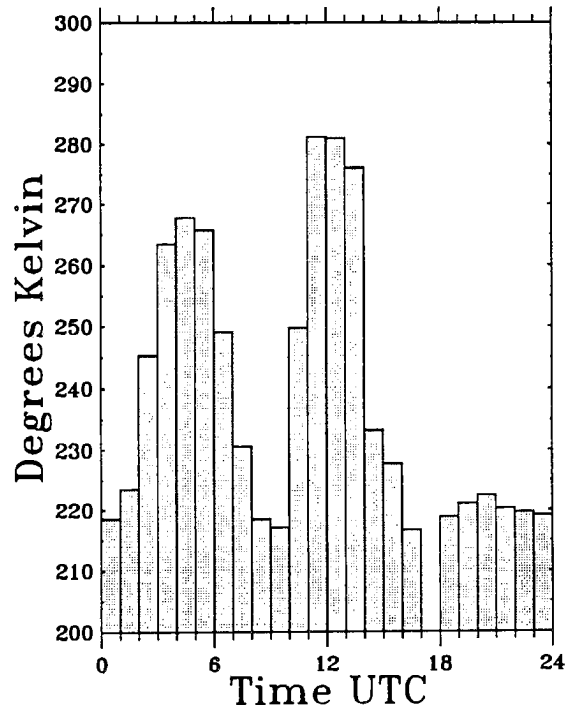
Solar Transmittance



Cloud Cover - Ceilometer

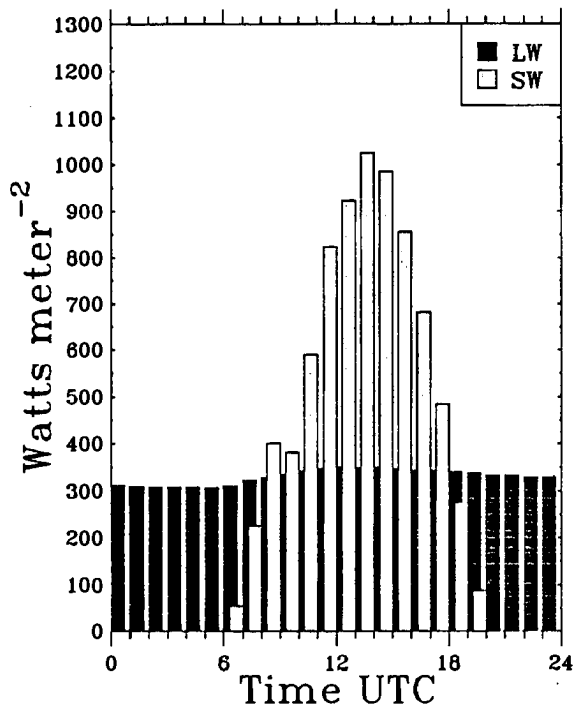


11μm Equivalent Brightness Temp

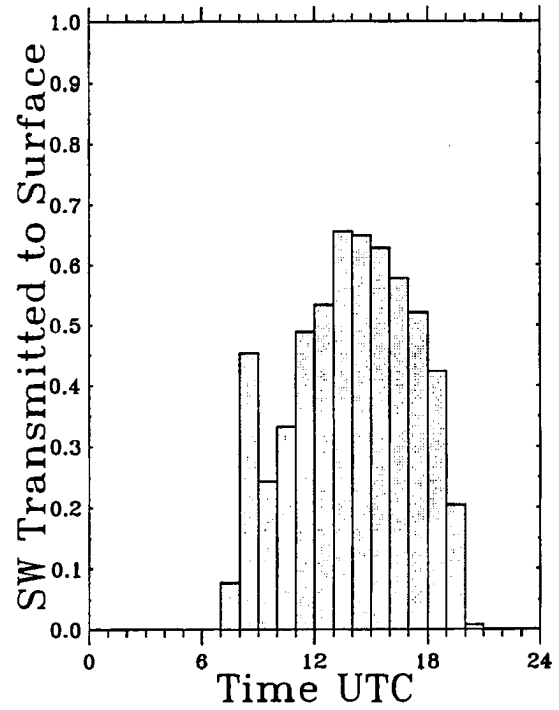


26 June (Day 178) Hourly Means

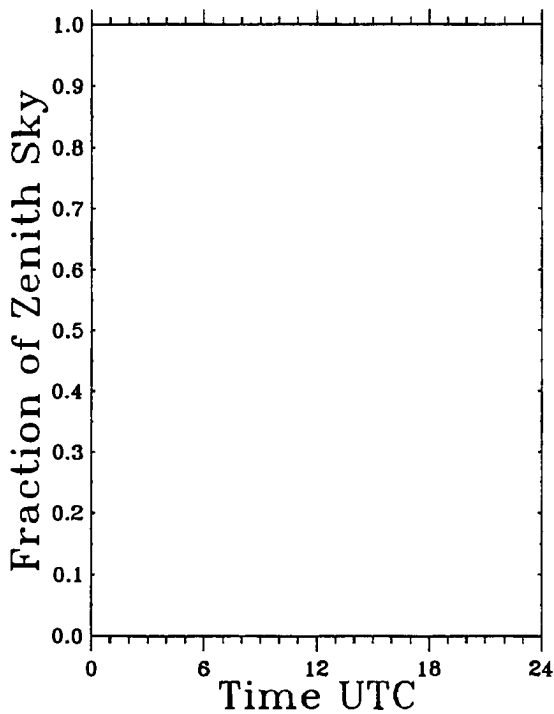
Mean Downwelling Flux



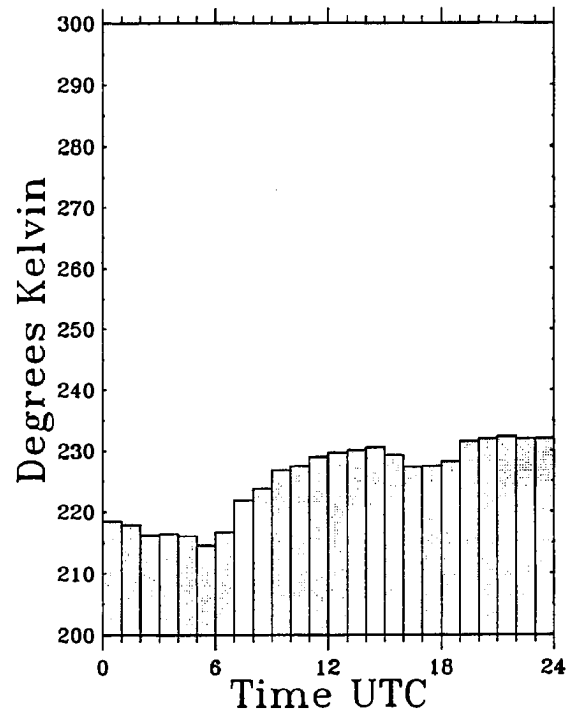
Solar Transmittance



Cloud Cover - Ceilometer

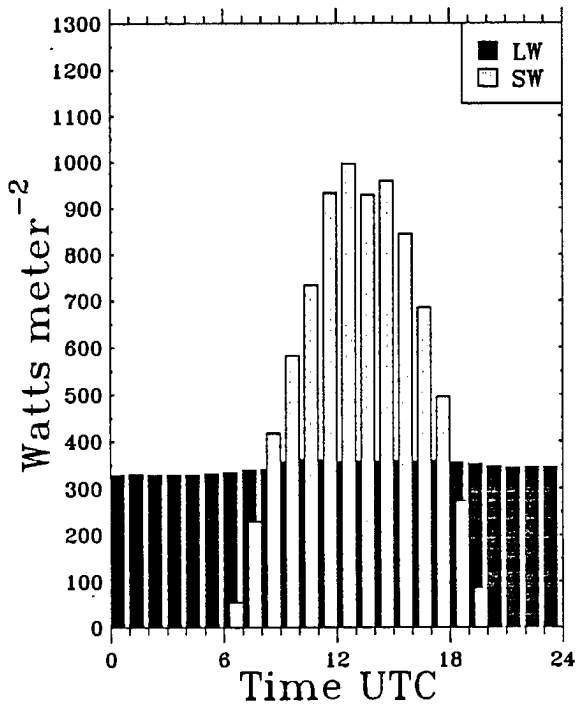


11μm Equivalent Brightness Temp

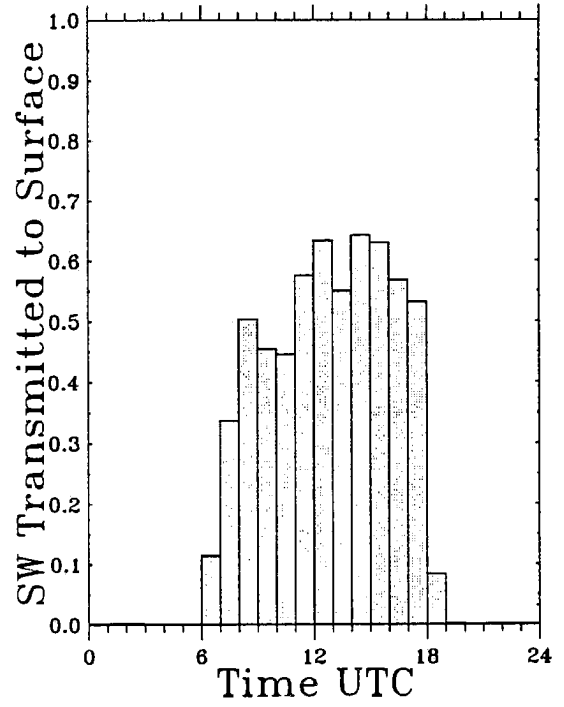


27 June (Day 179) Hourly Means

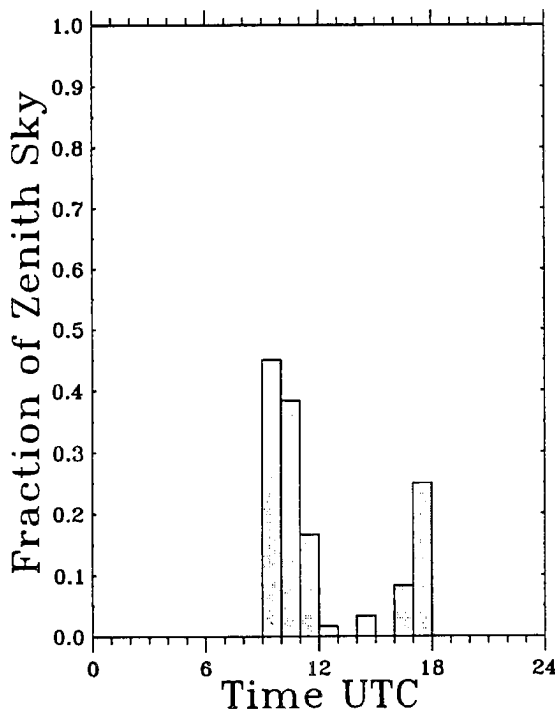
Mean Downwelling Flux



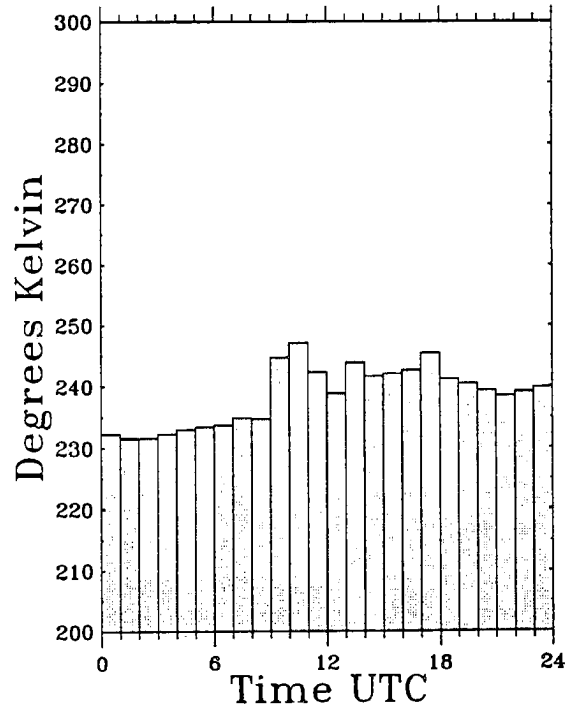
Solar Transmittance



Cloud Cover - Ceilometer

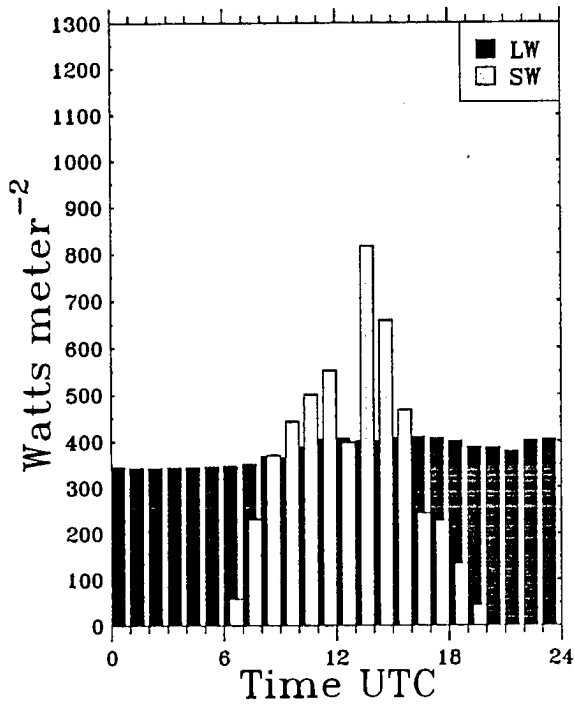


11μm Equivalent Brightness Temp

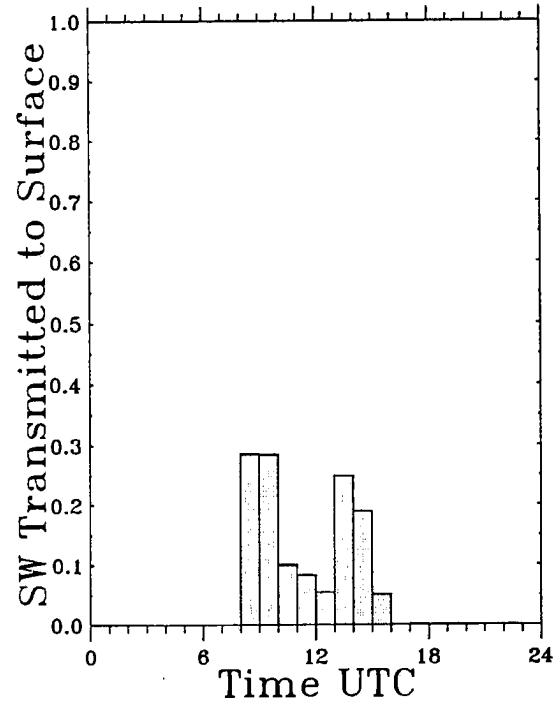


28 June (Day 180) Hourly Means

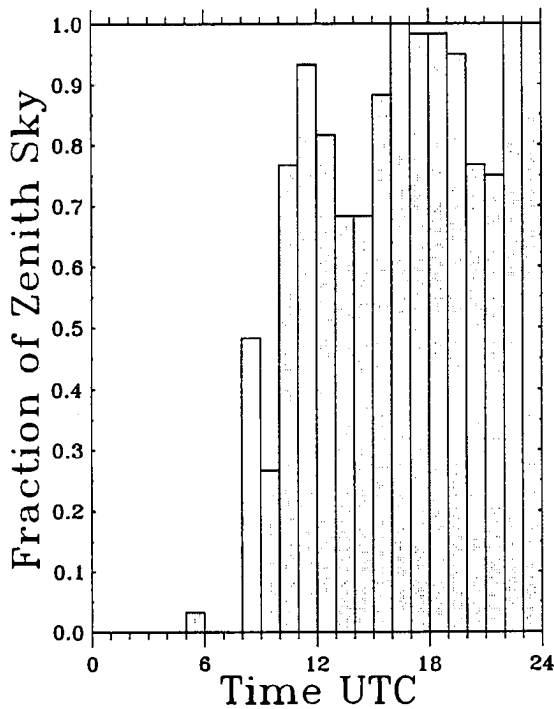
Mean Downwelling Flux



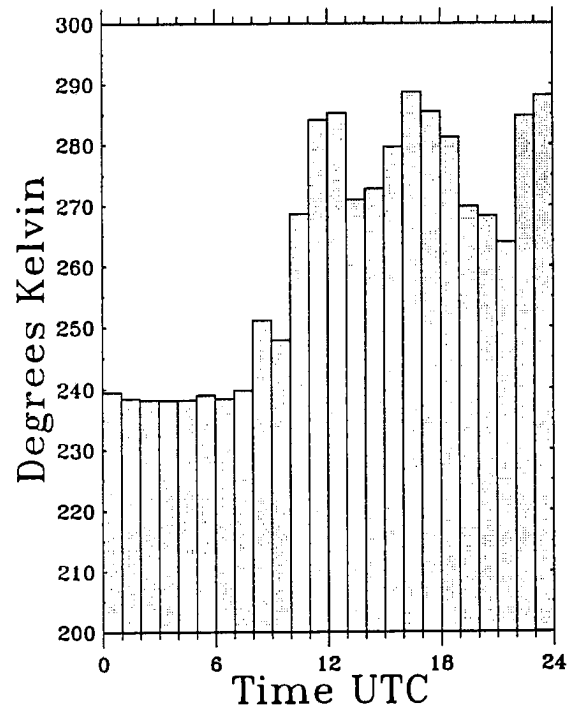
Solar Transmittance



Cloud Cover - Ceilometer

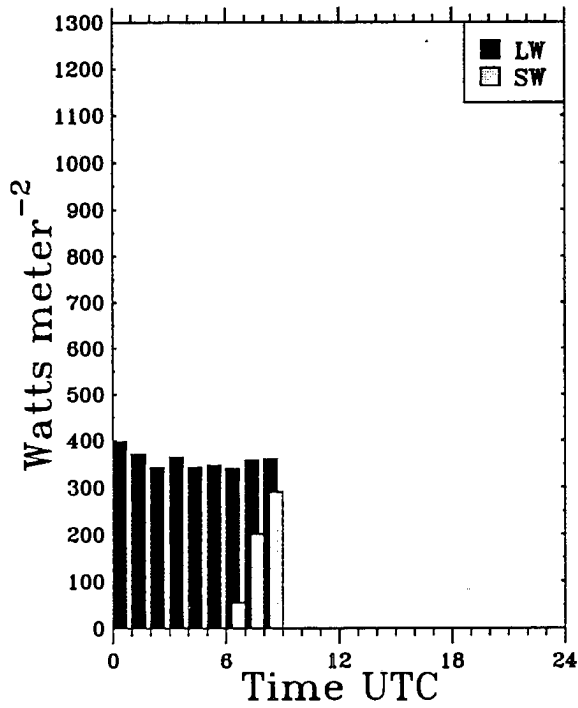


11μm Equivalent Brightness Temp

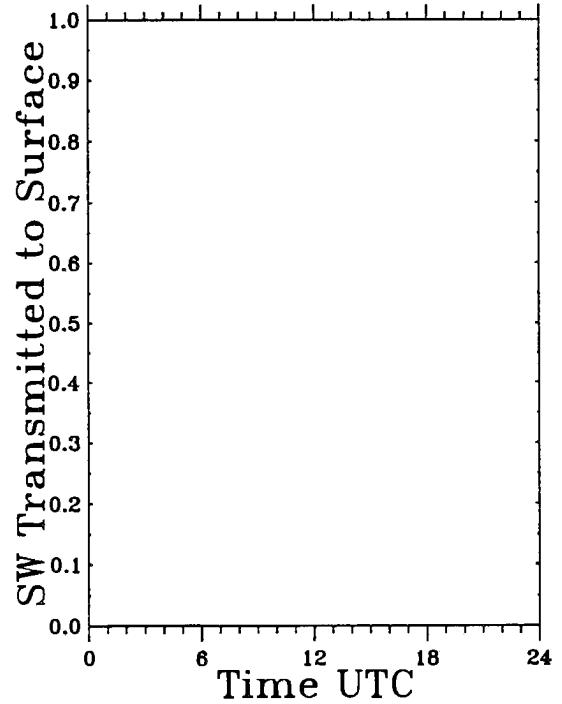


29 June (Day 181) Hourly Means

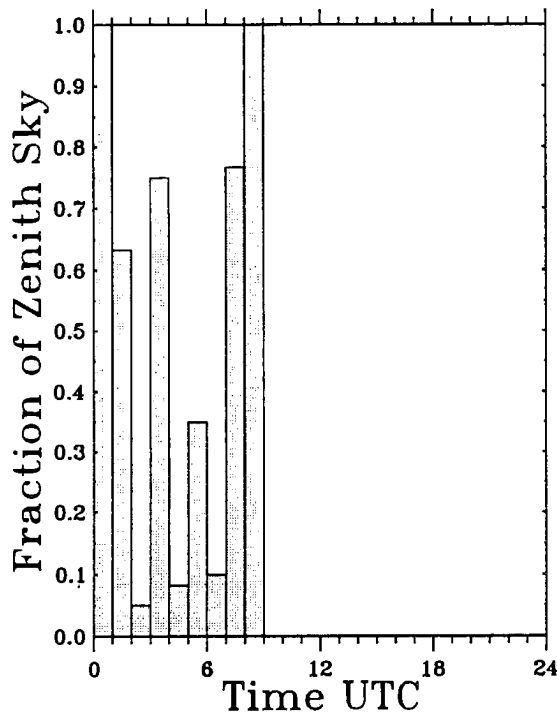
Mean Downwelling Flux



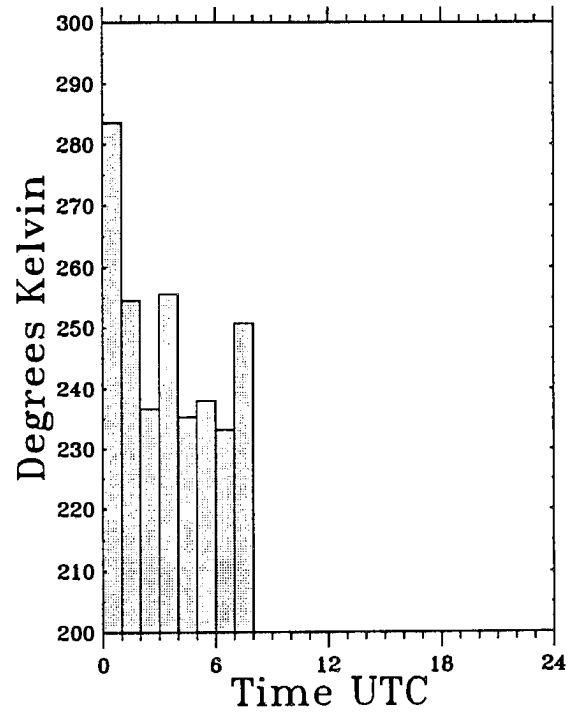
Solar Transmittance



Cloud Cover - Ceilometer

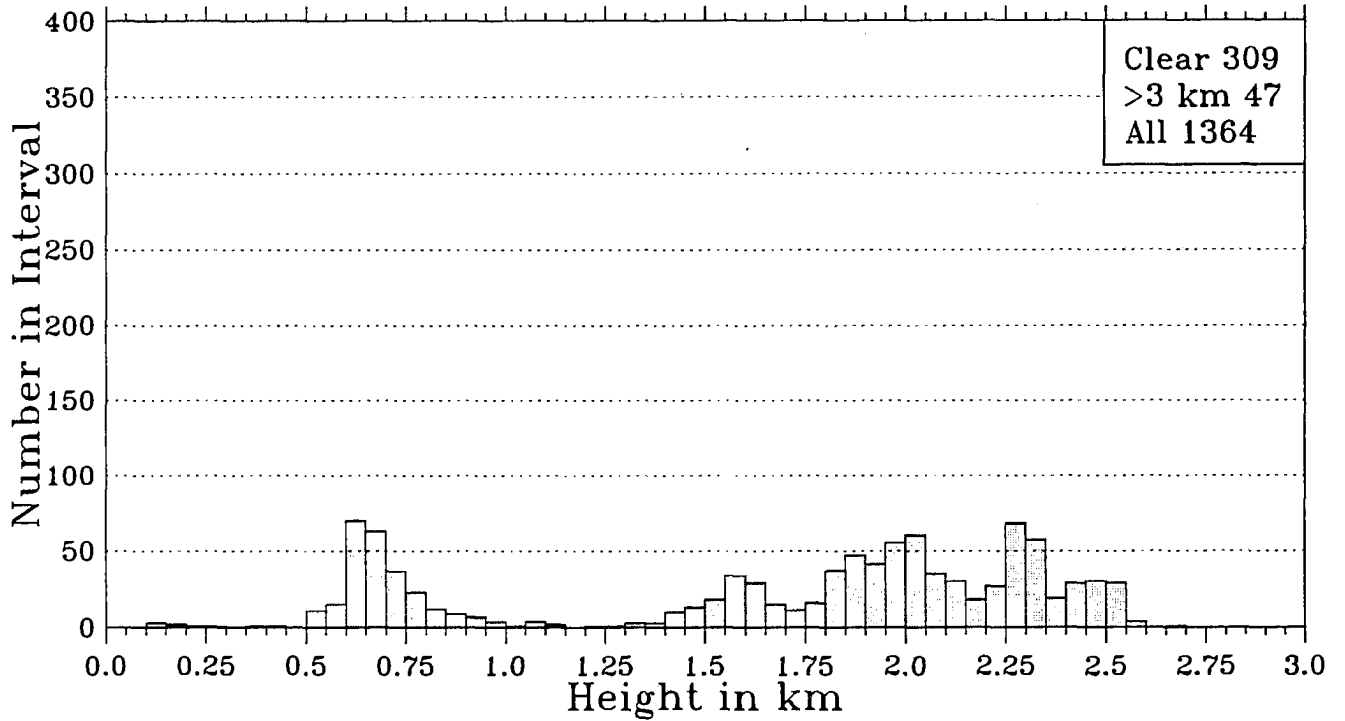


11μm Equivalent Brightness Temp

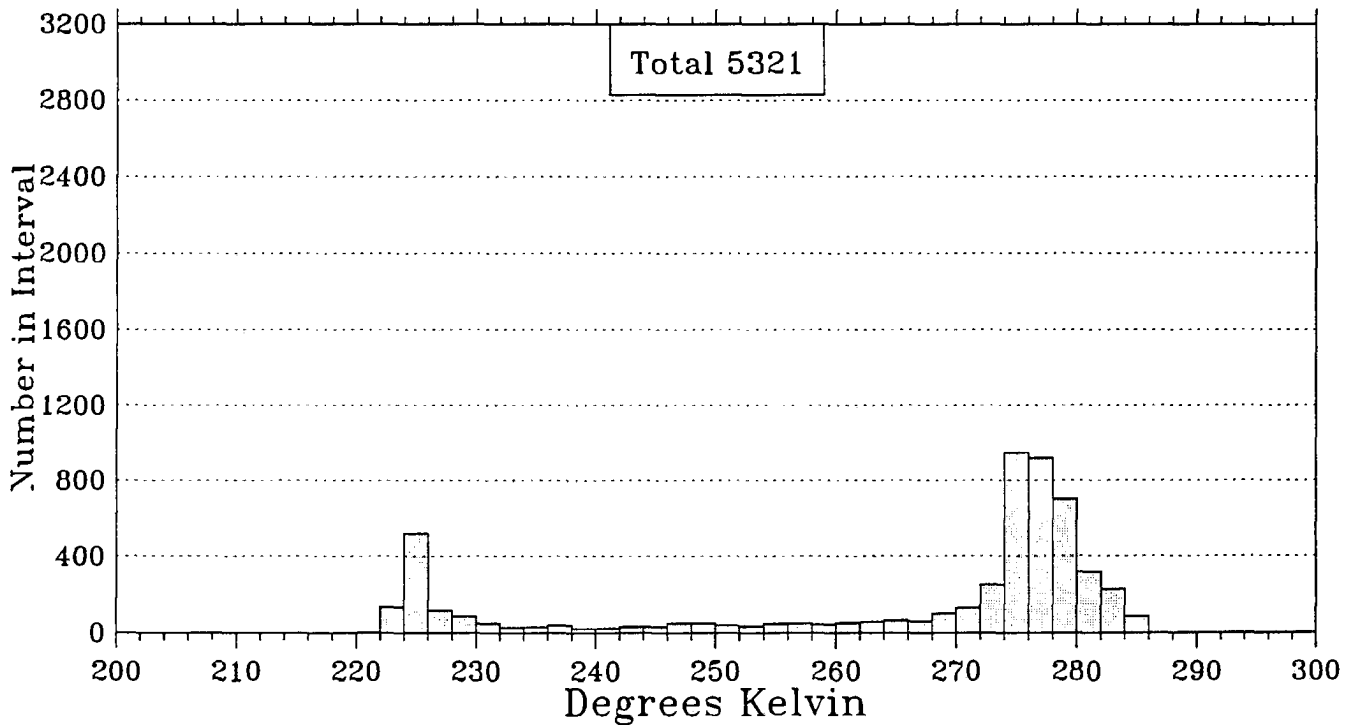


1 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

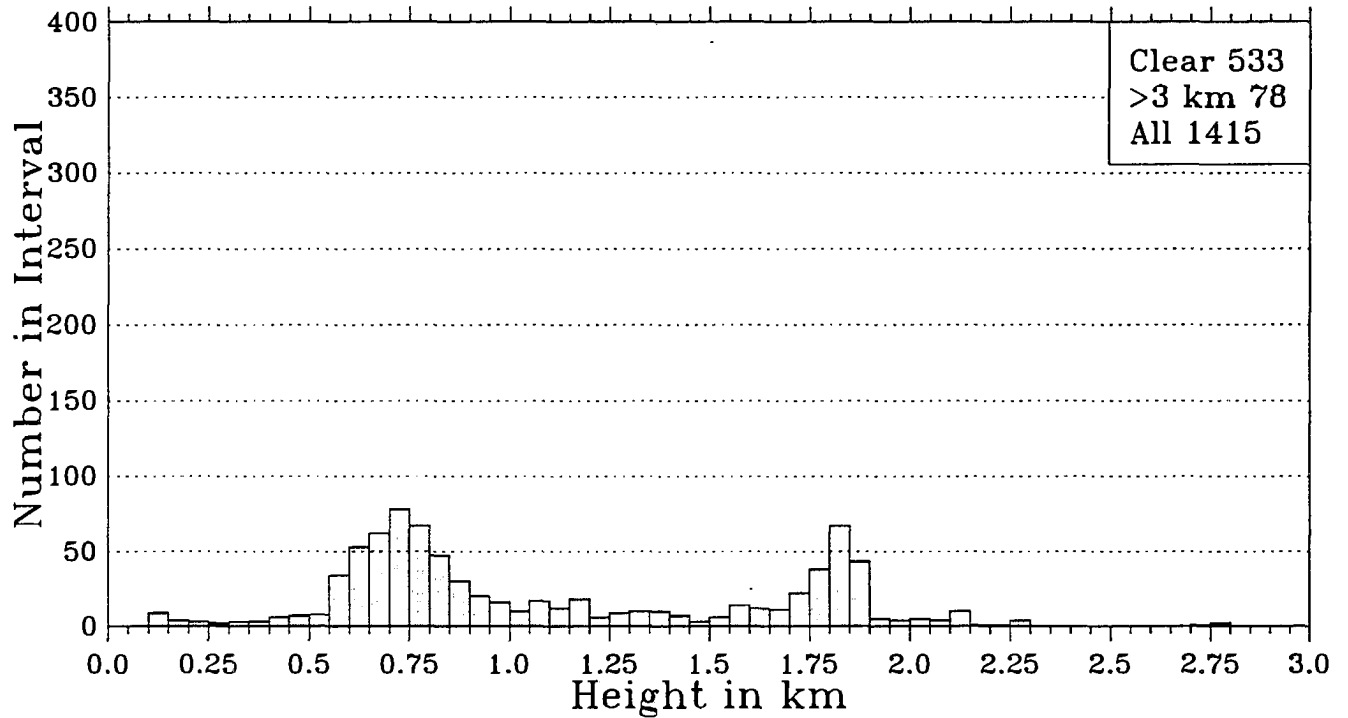


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

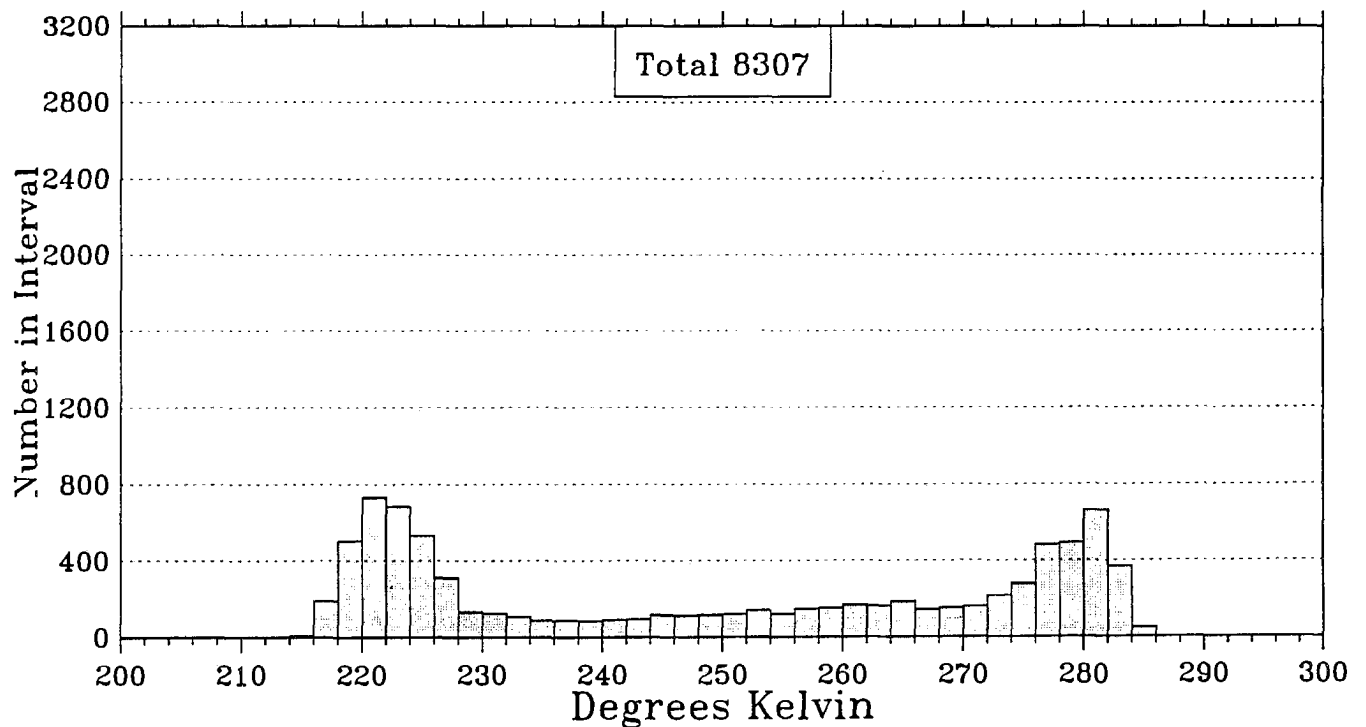


2 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

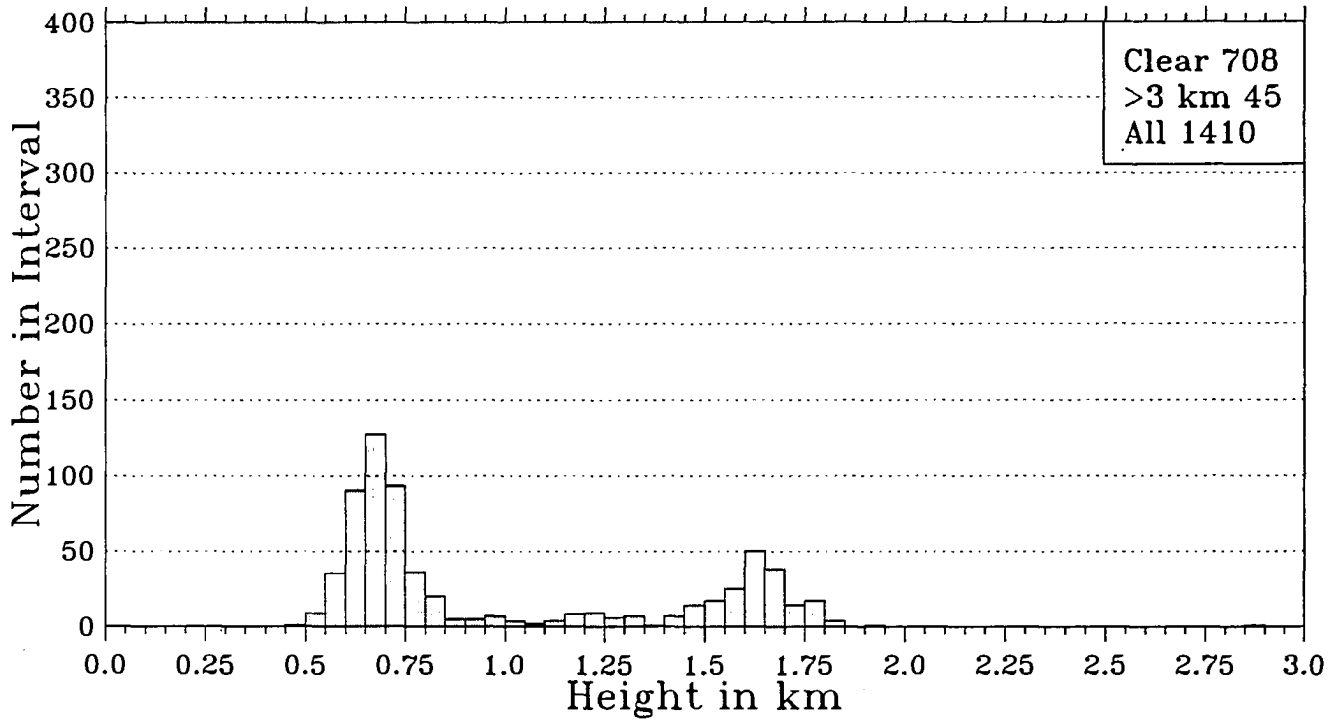


11 μ m Equivalent Brightness Temperatures (2°K Bins; 8640 Samples/Day)

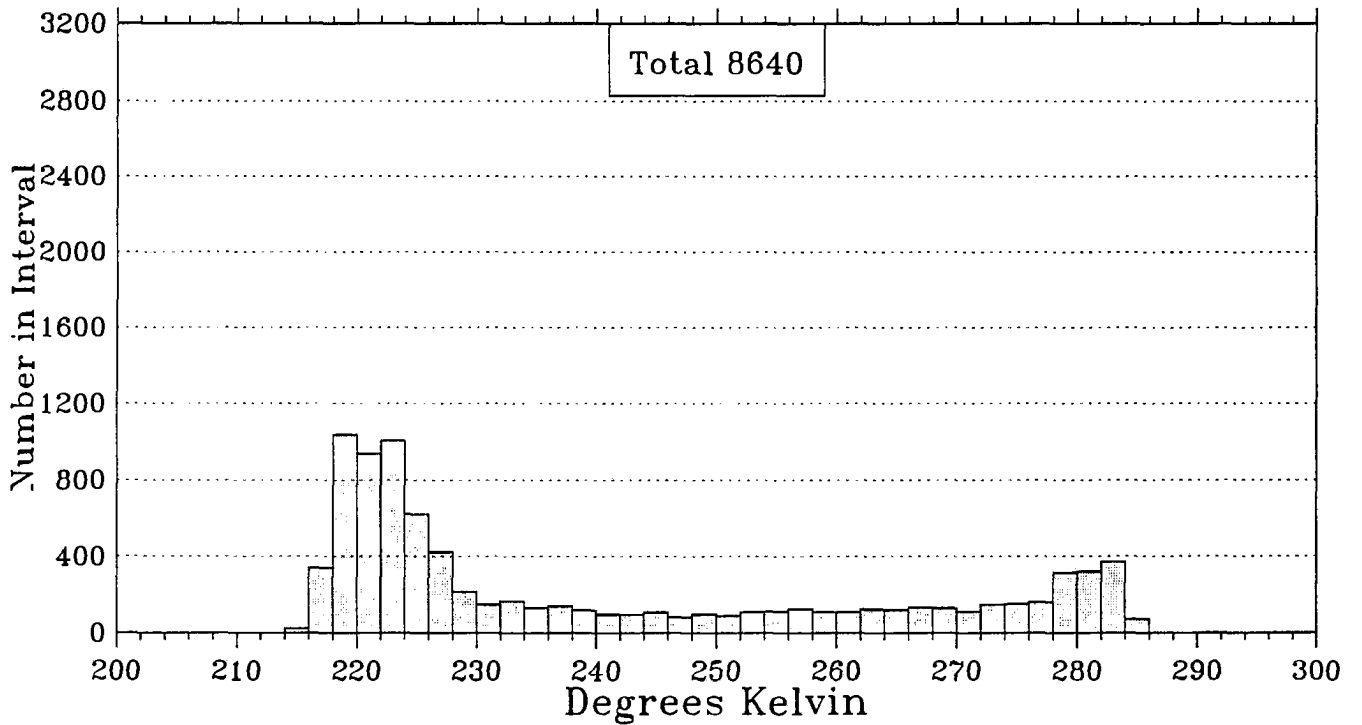


3 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

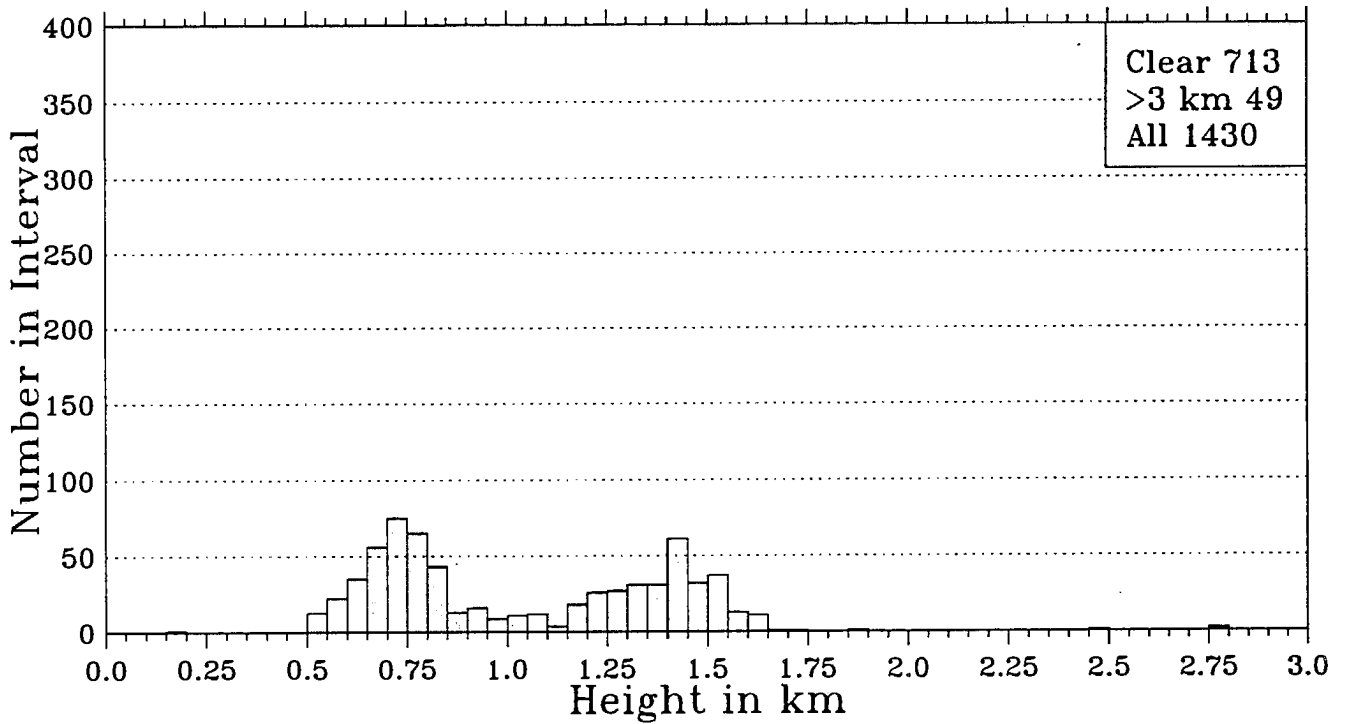


11 μ m Equivalent Brightness Temperatures (2 $^\circ$ K Bins; 8640 Samples/Day)

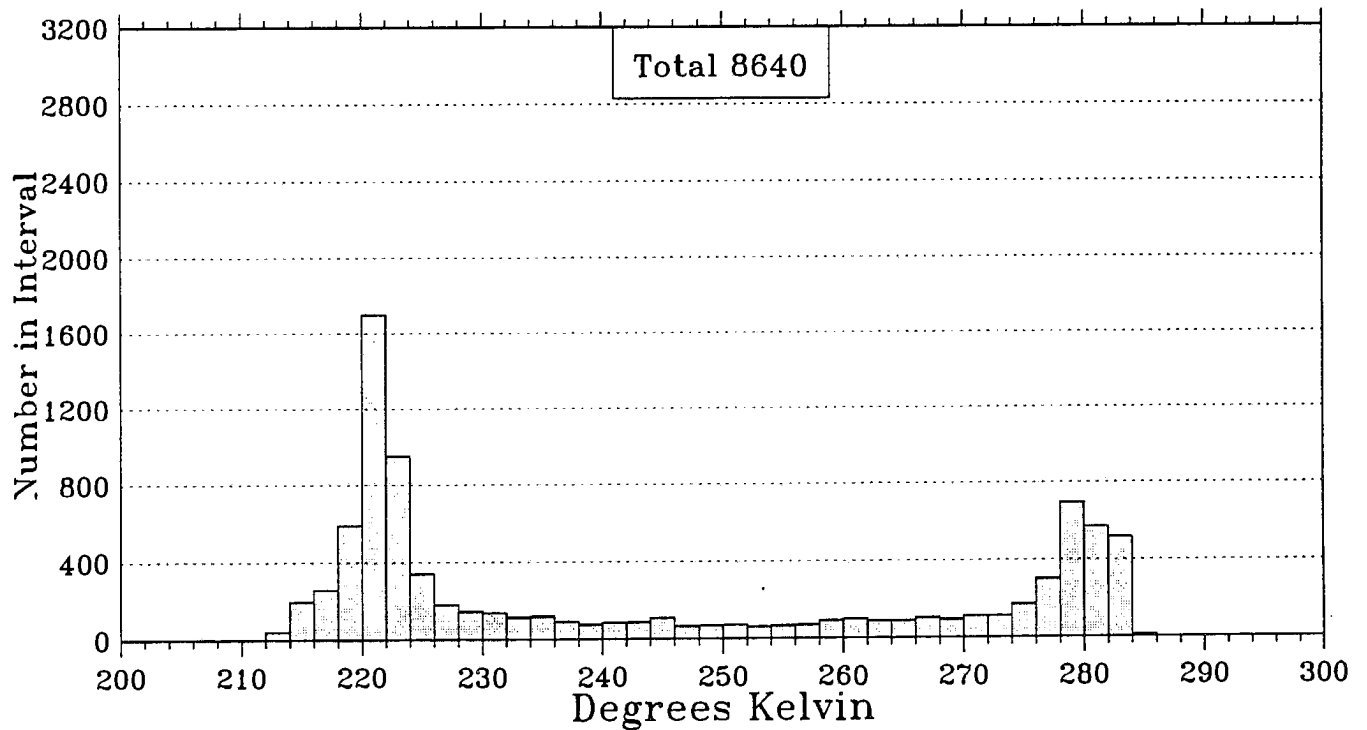


4 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

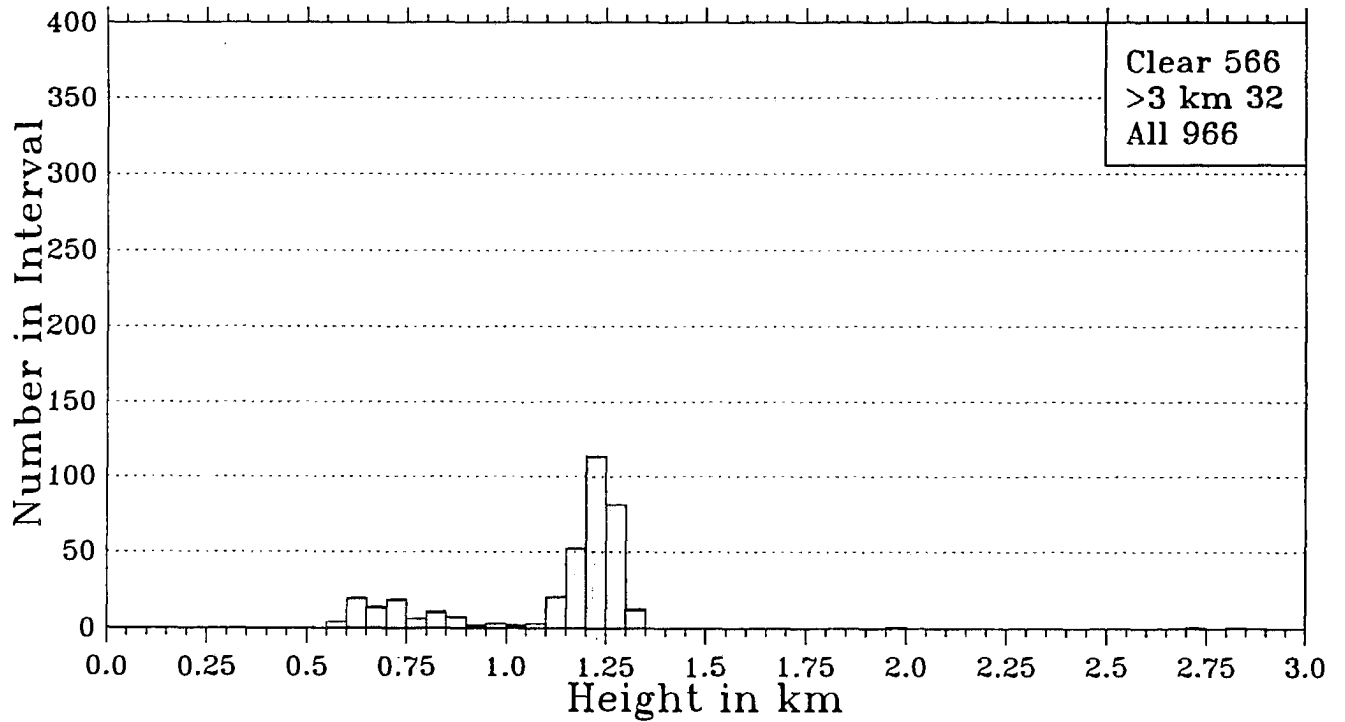


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

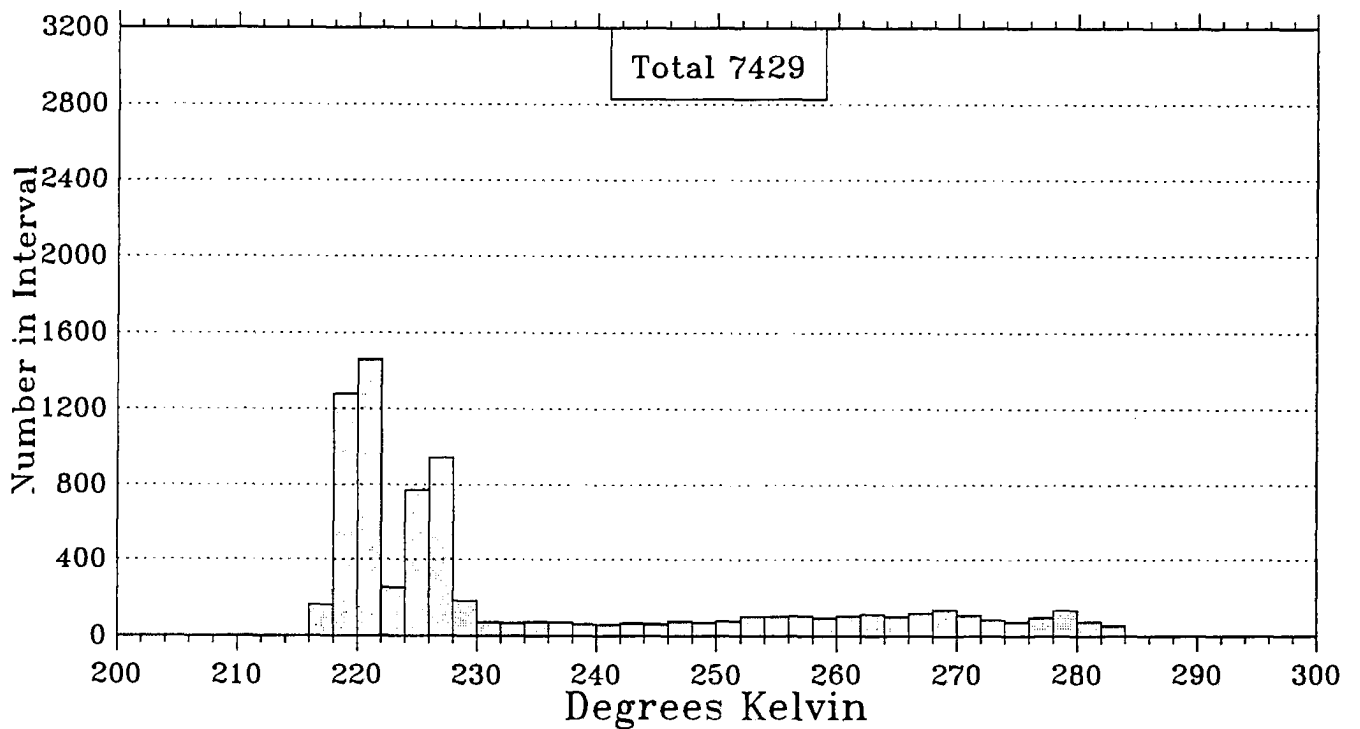


5 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

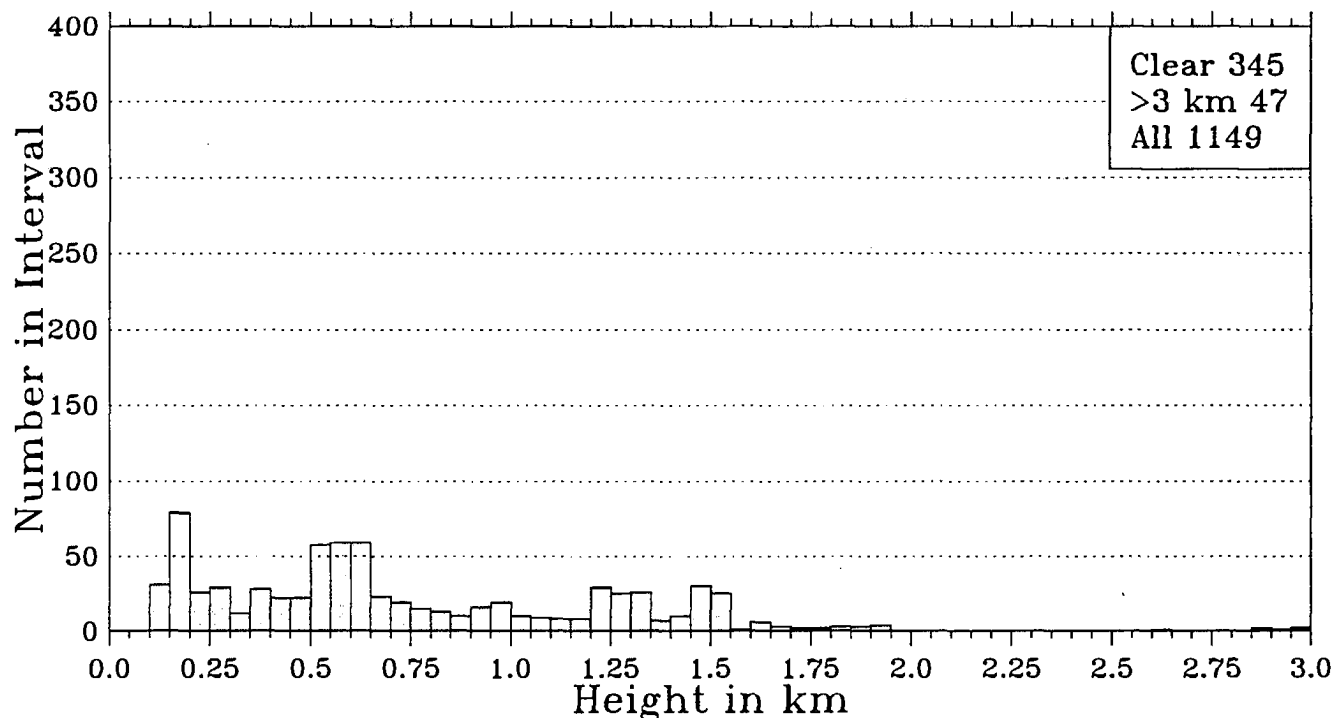


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

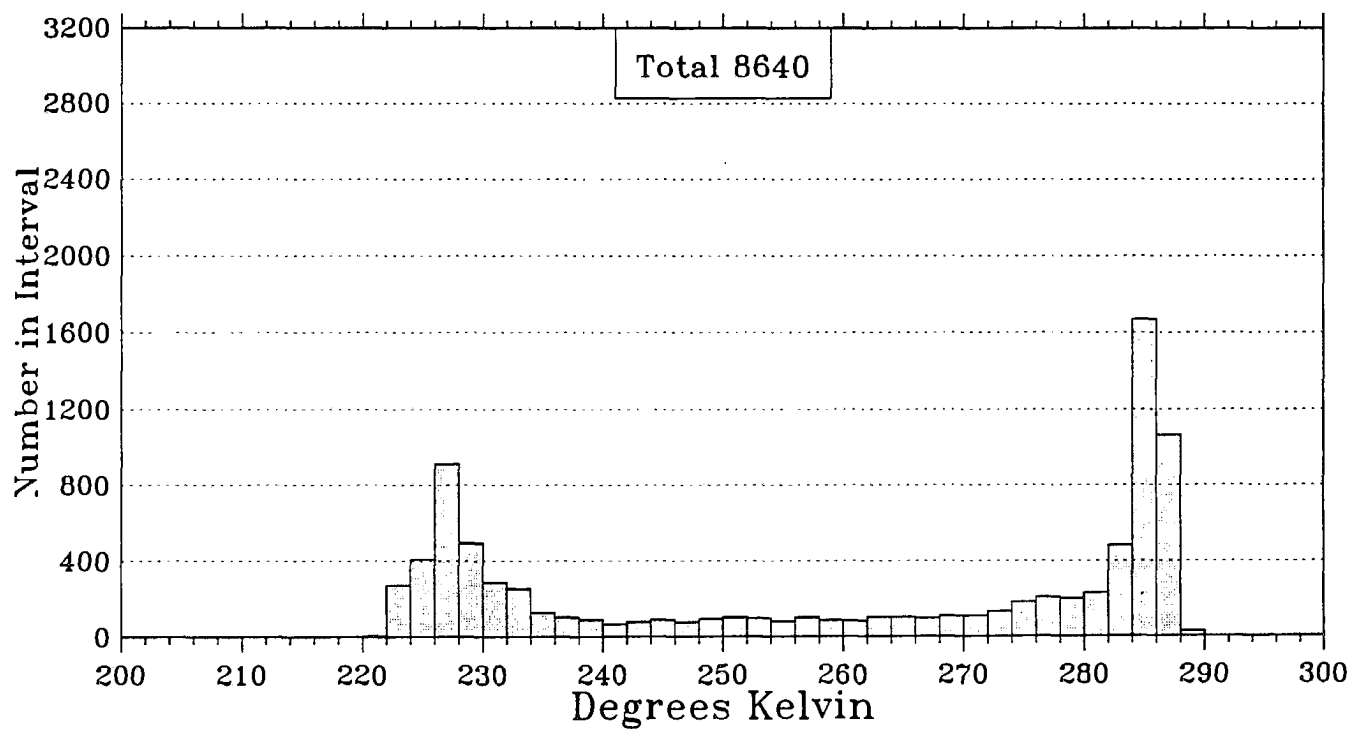


6 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

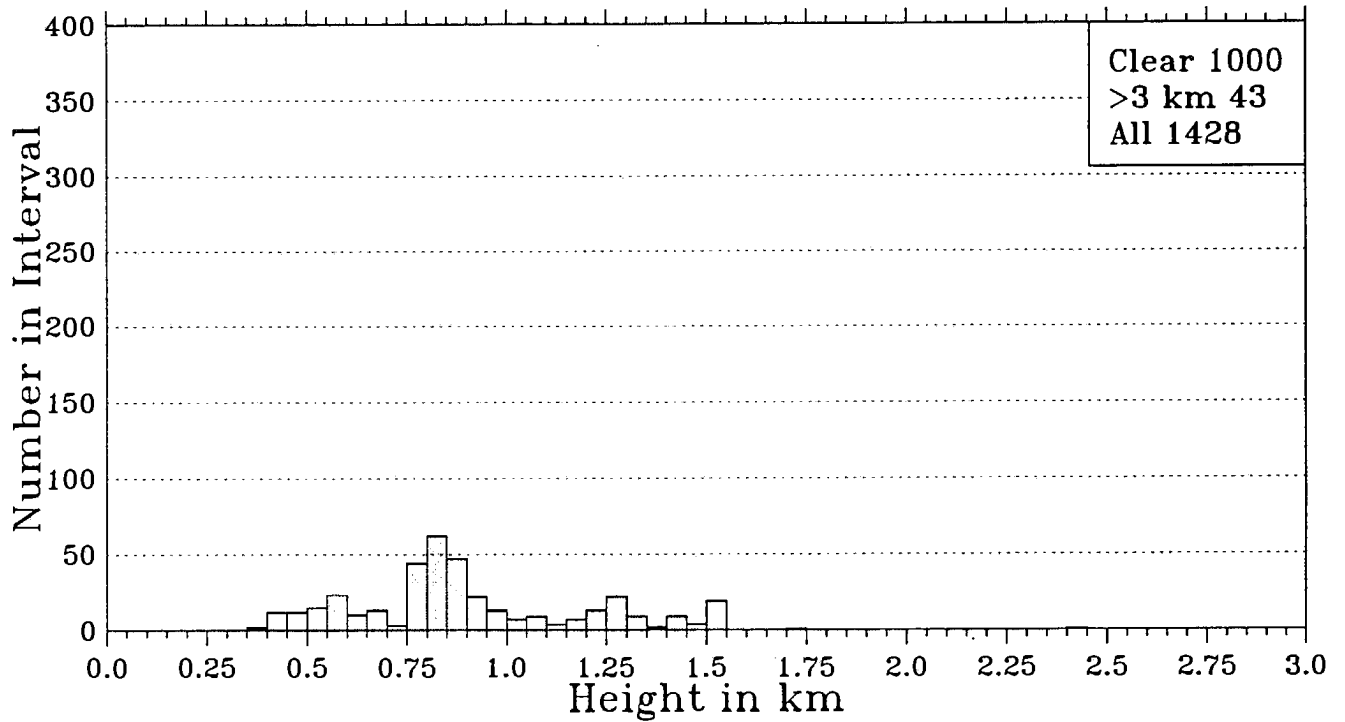


11 μ m Equivalent Brightness Temperatures (2 $^\circ$ K Bins; 8640 Samples/Day)

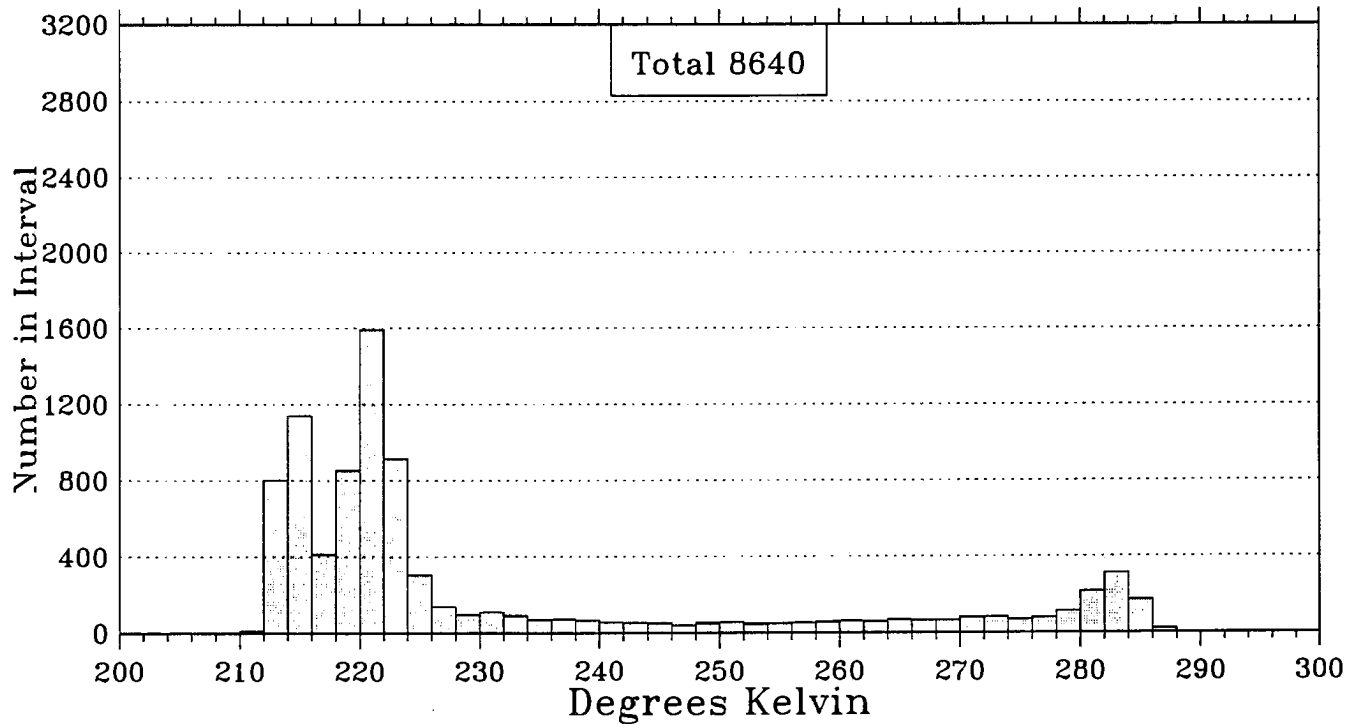


7 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

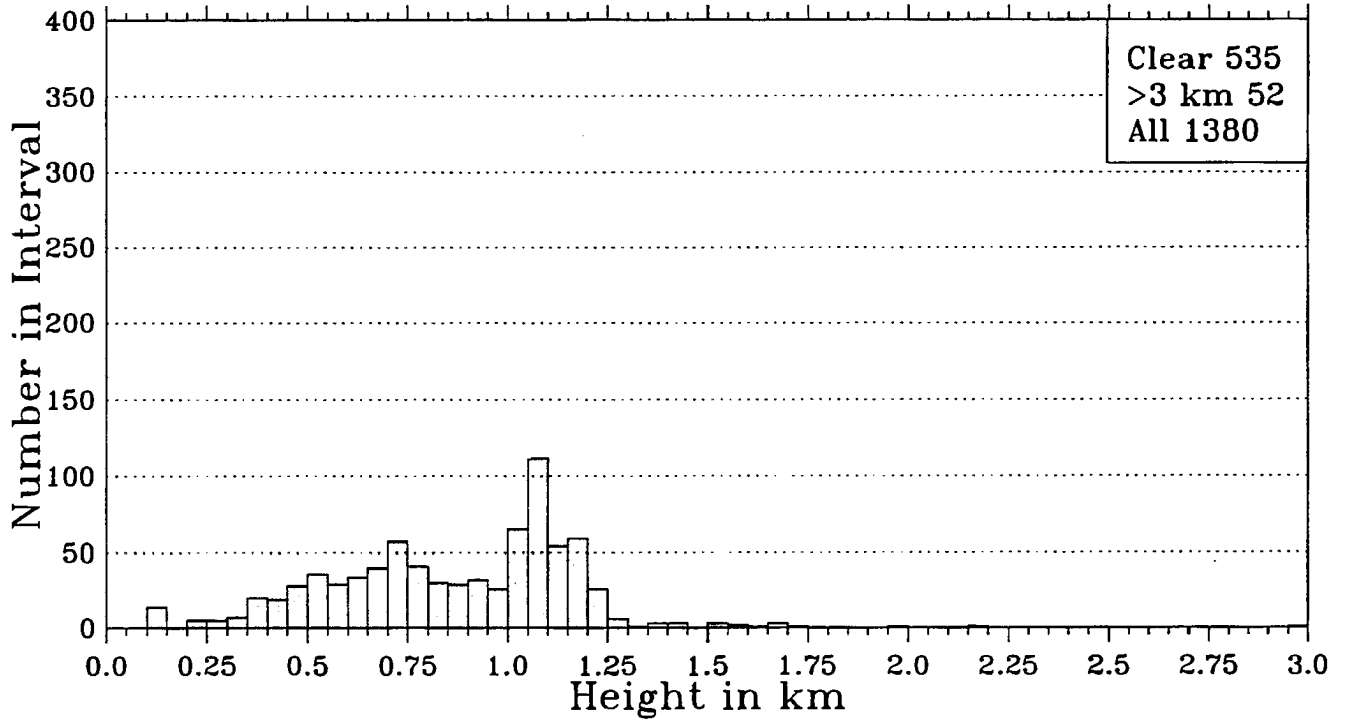


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

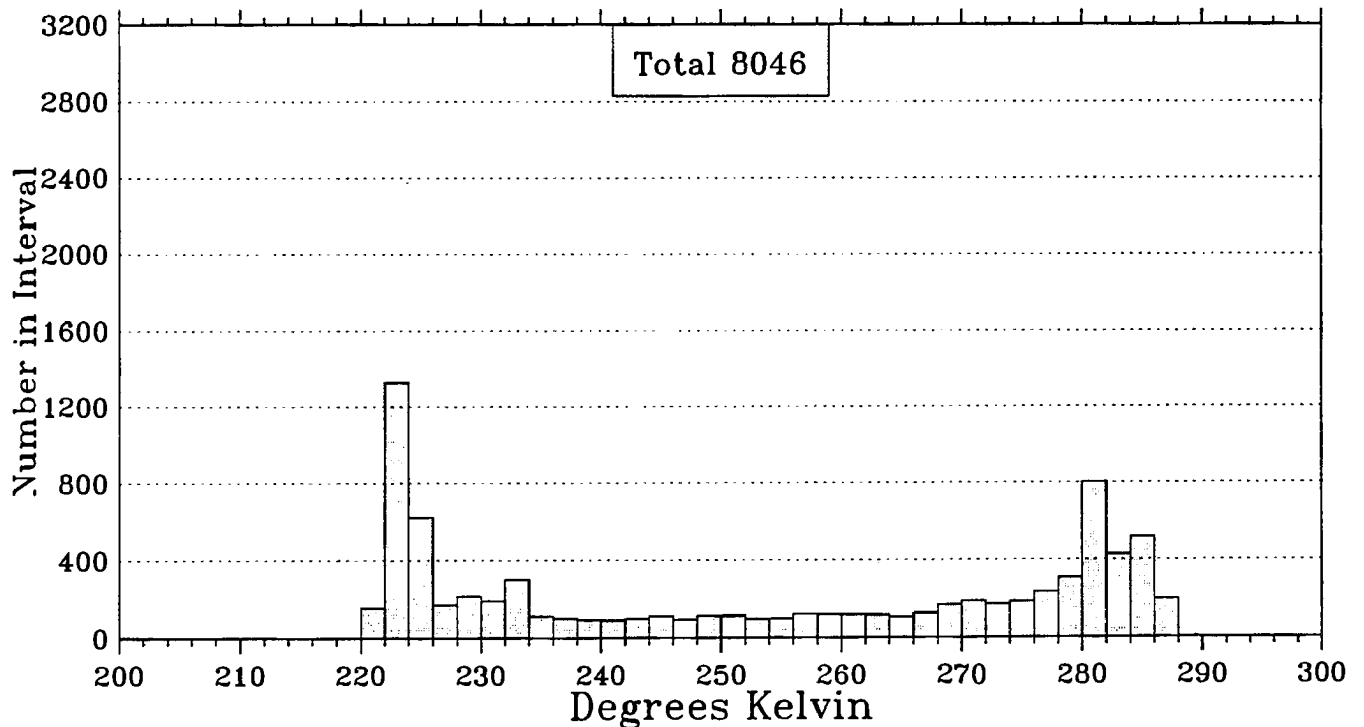


8 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

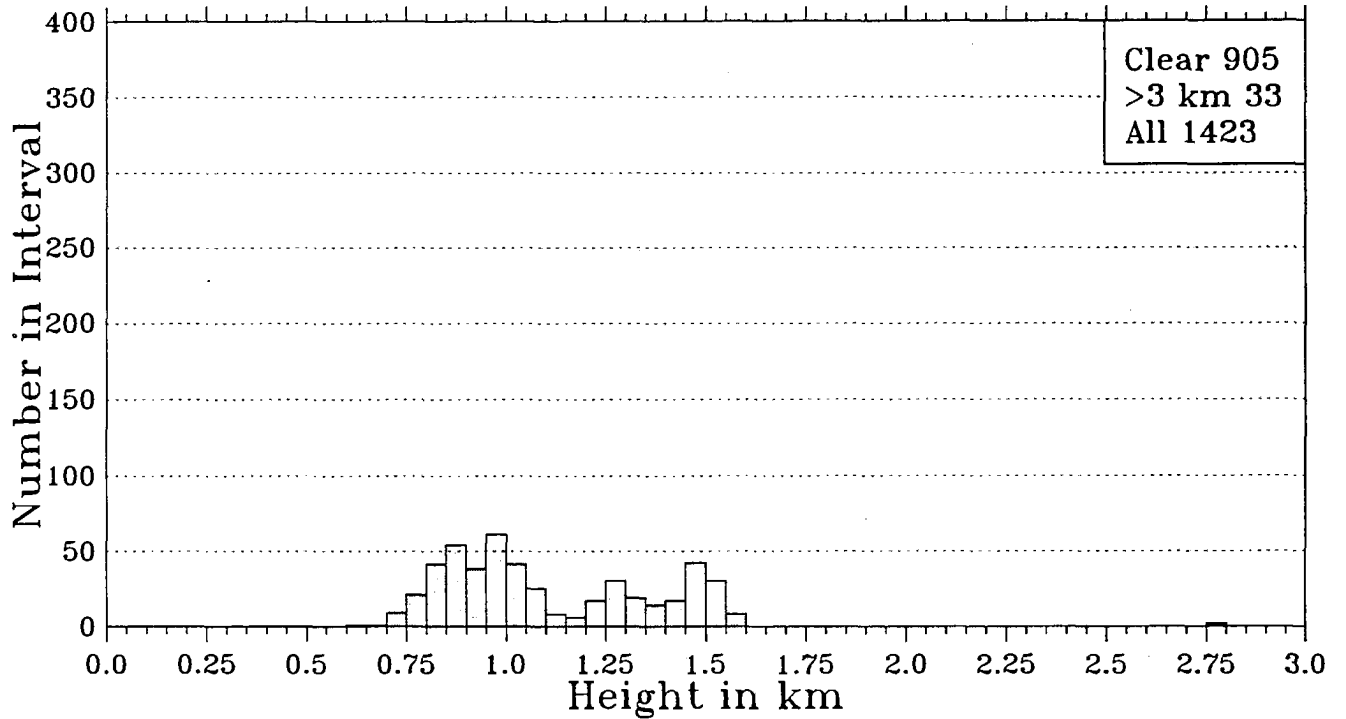


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

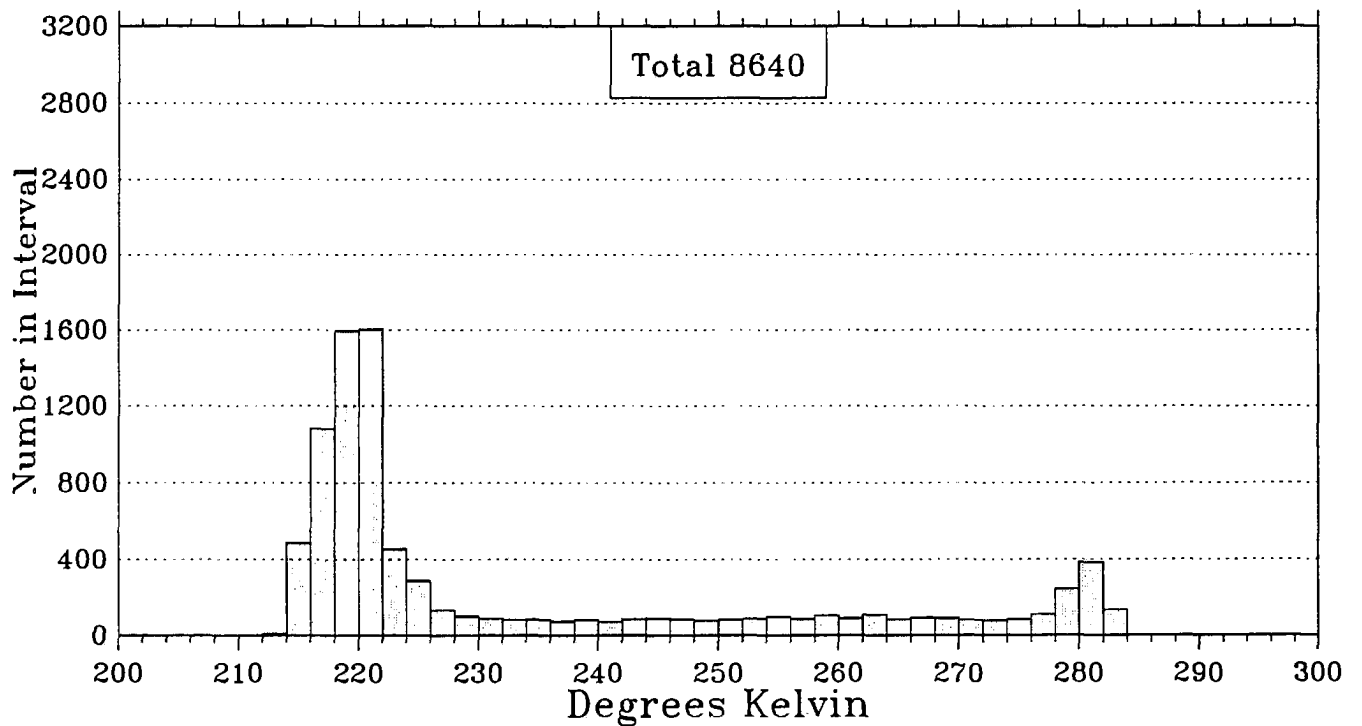


9 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

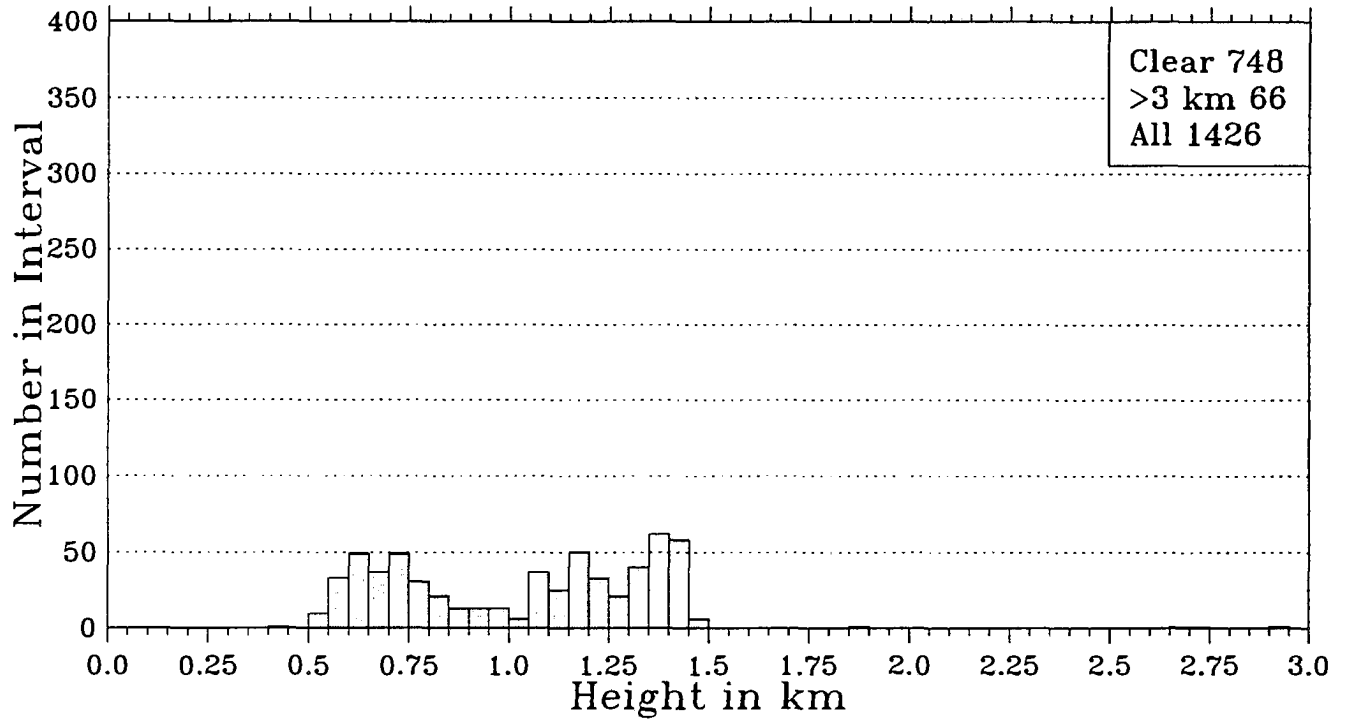


11 μ m Equivalent Brightness Temperatures (2°K Bins; 8640 Samples/Day)

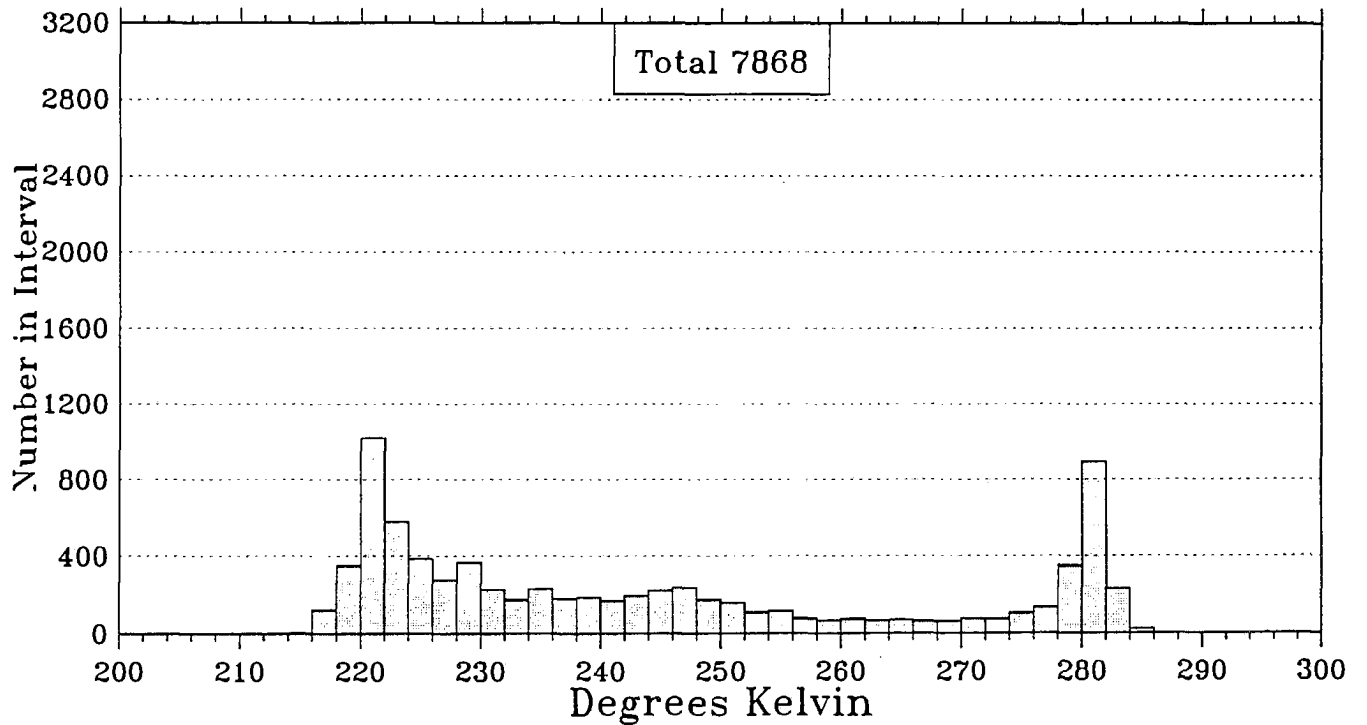


10 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

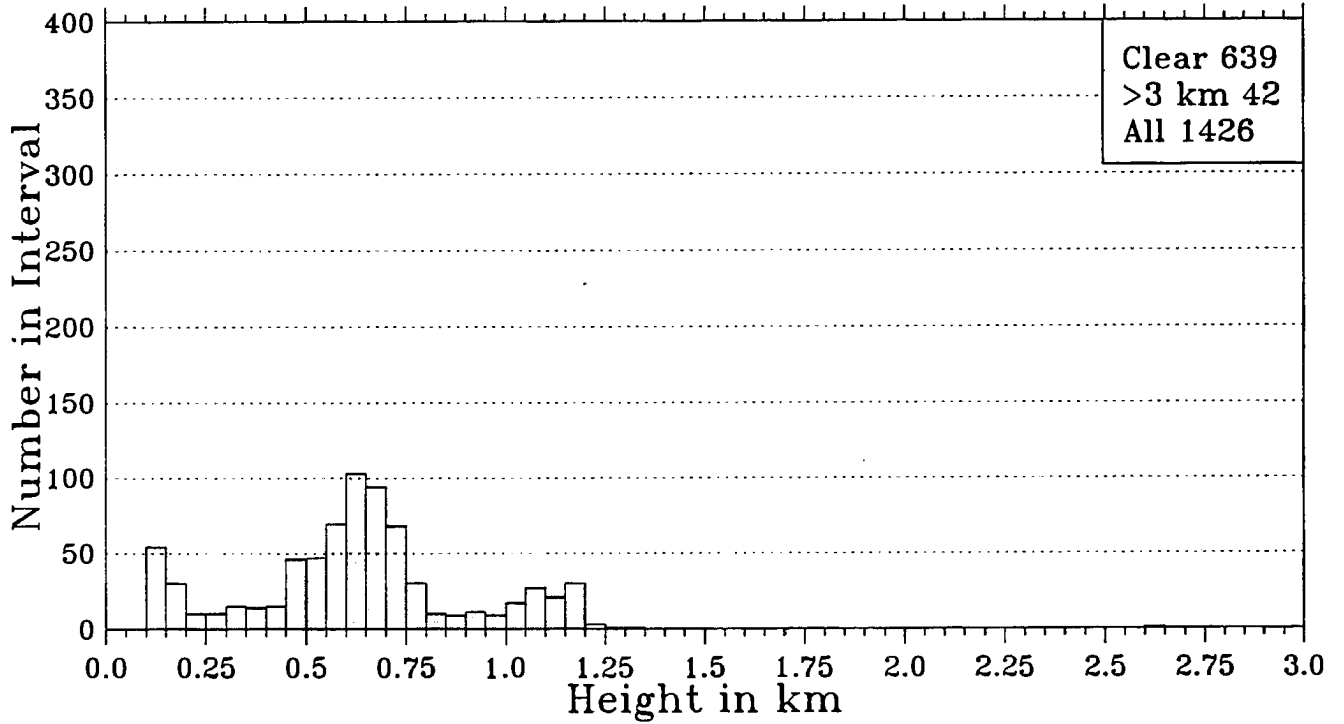


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

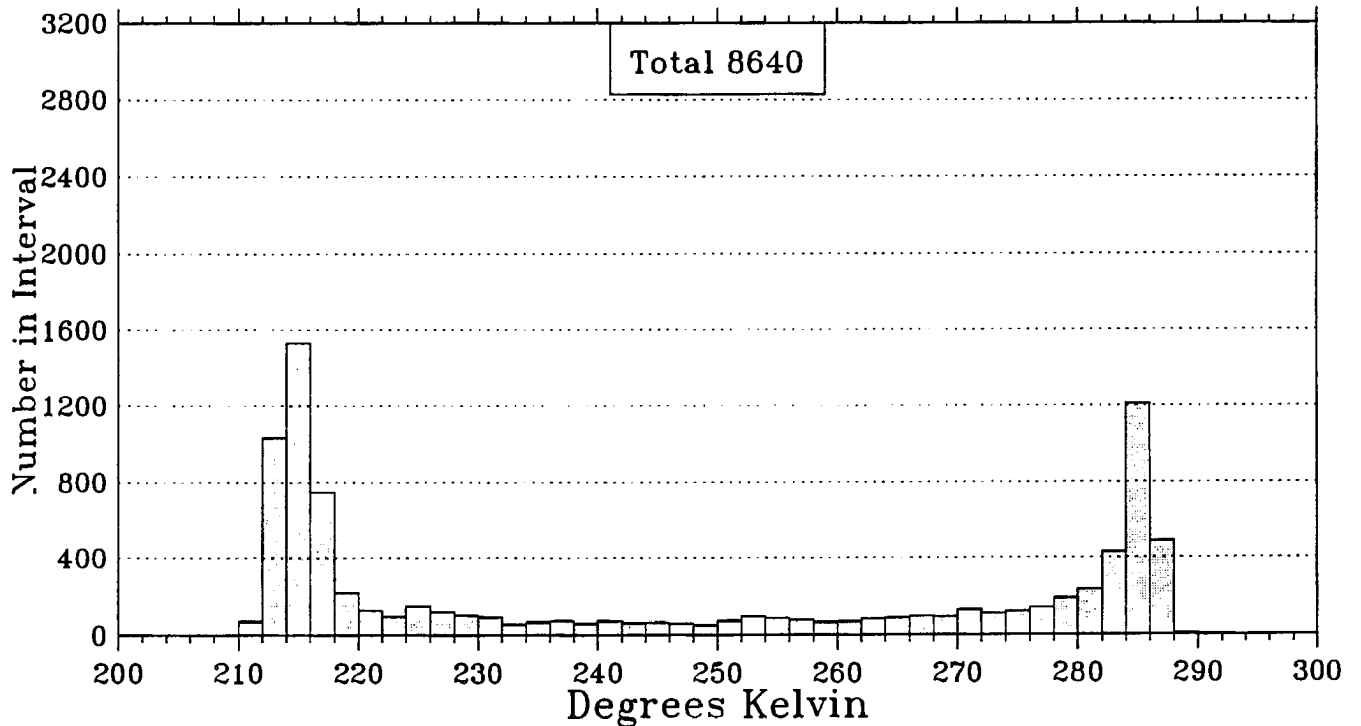


11 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

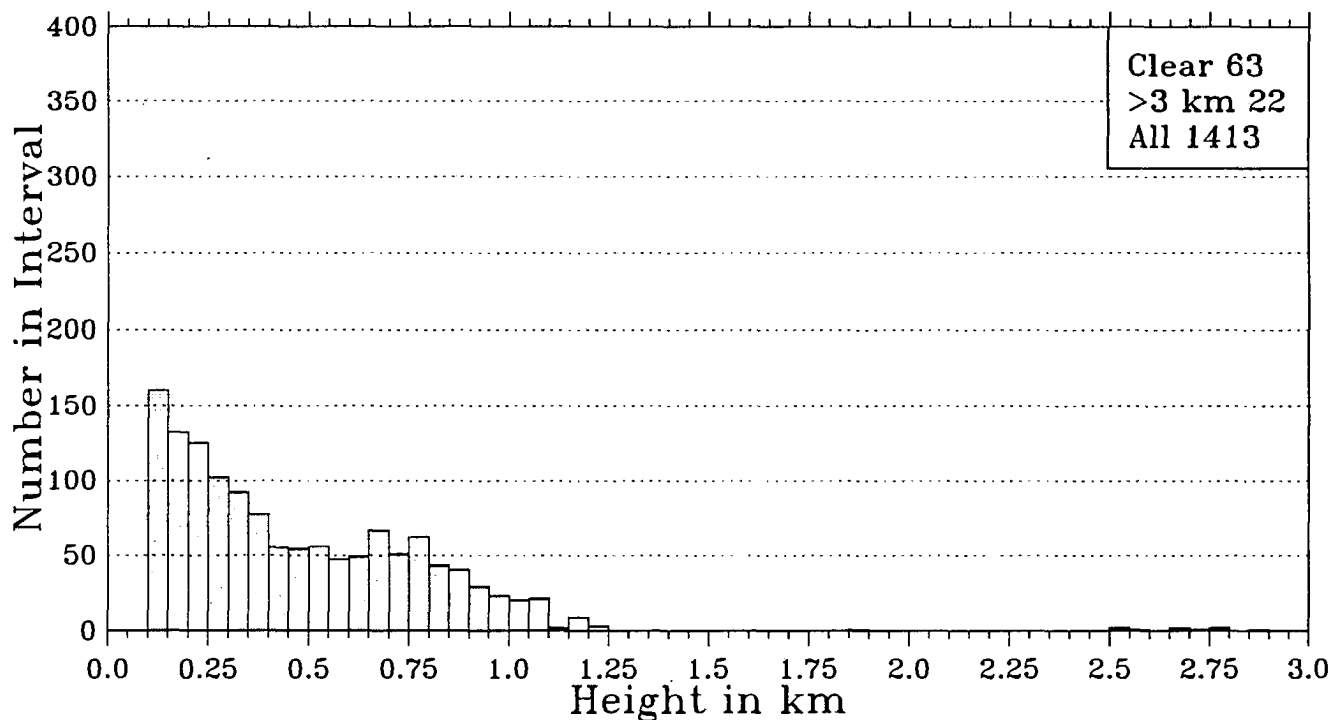


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

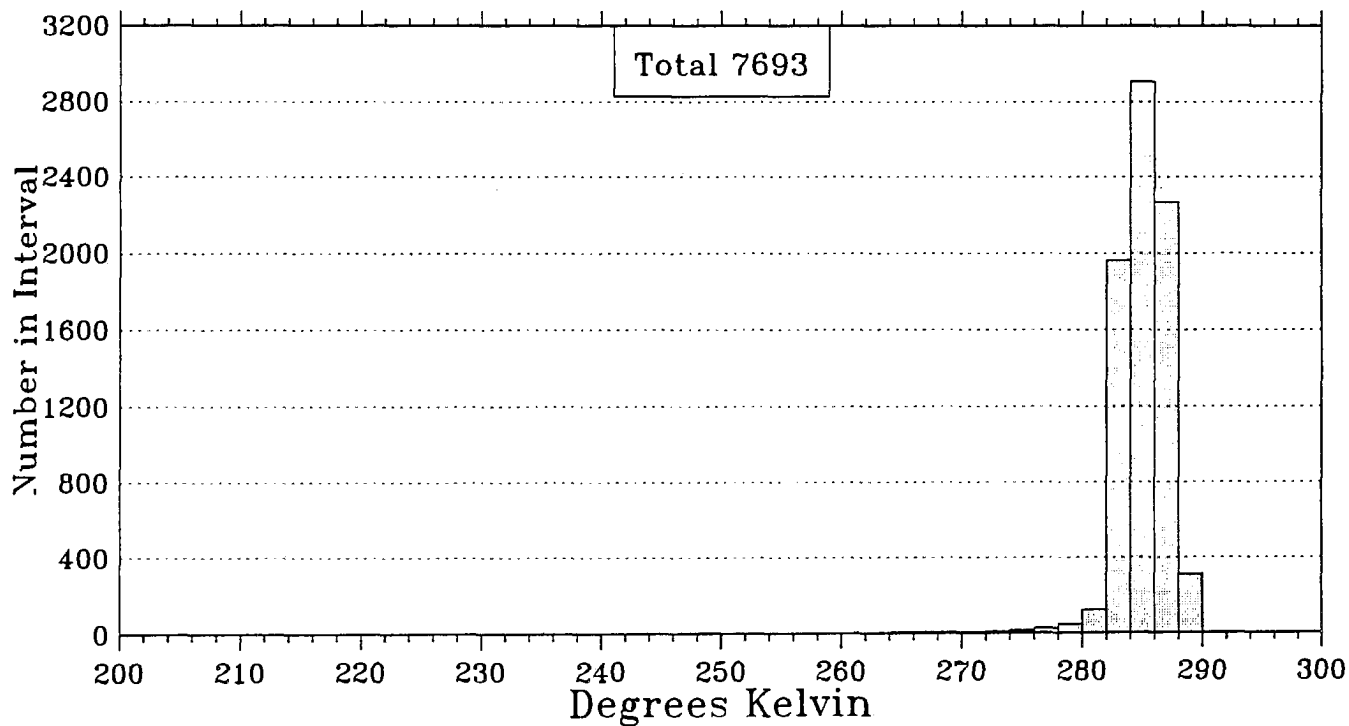


12 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

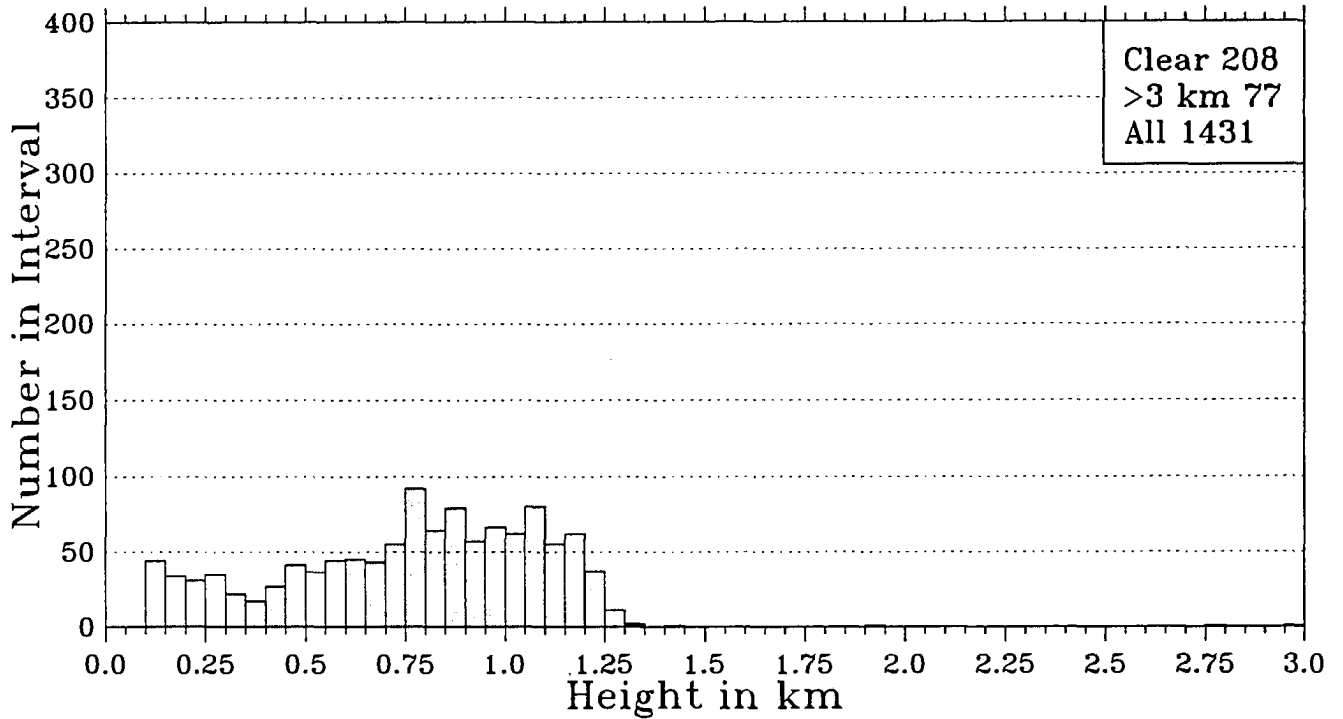


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

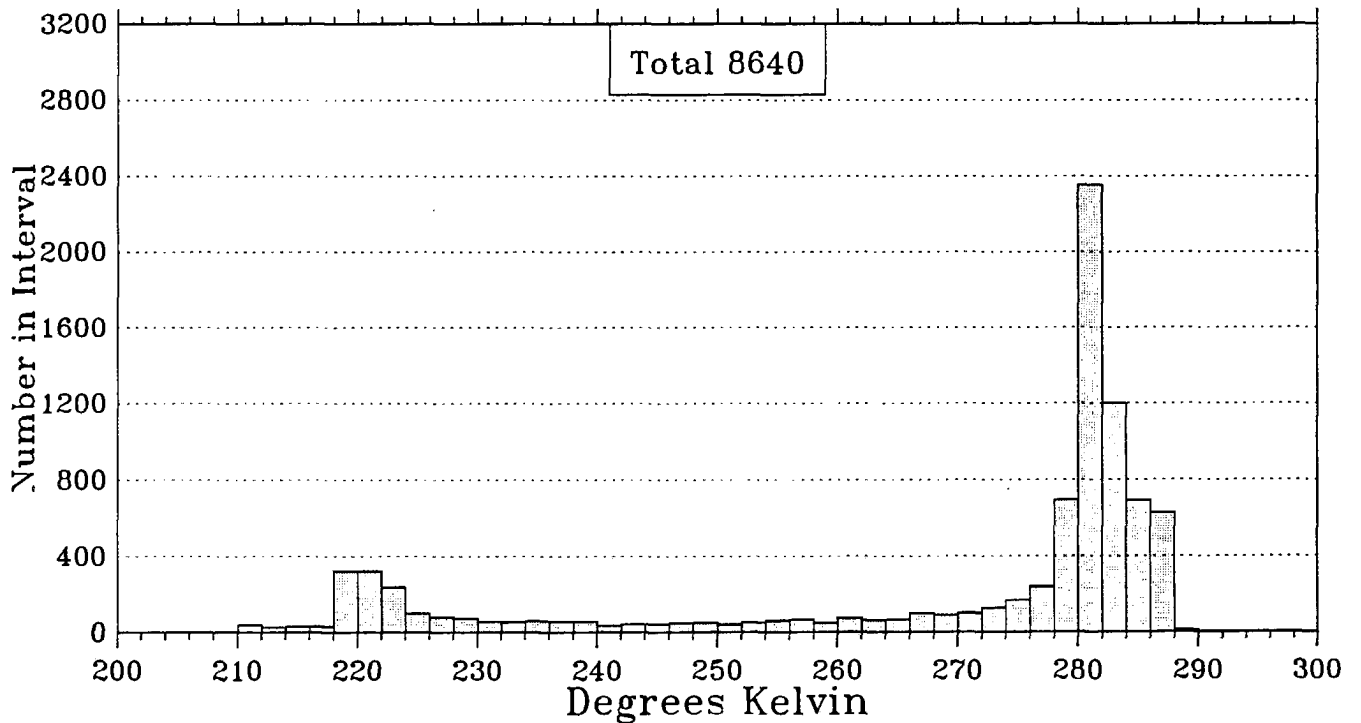


13 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

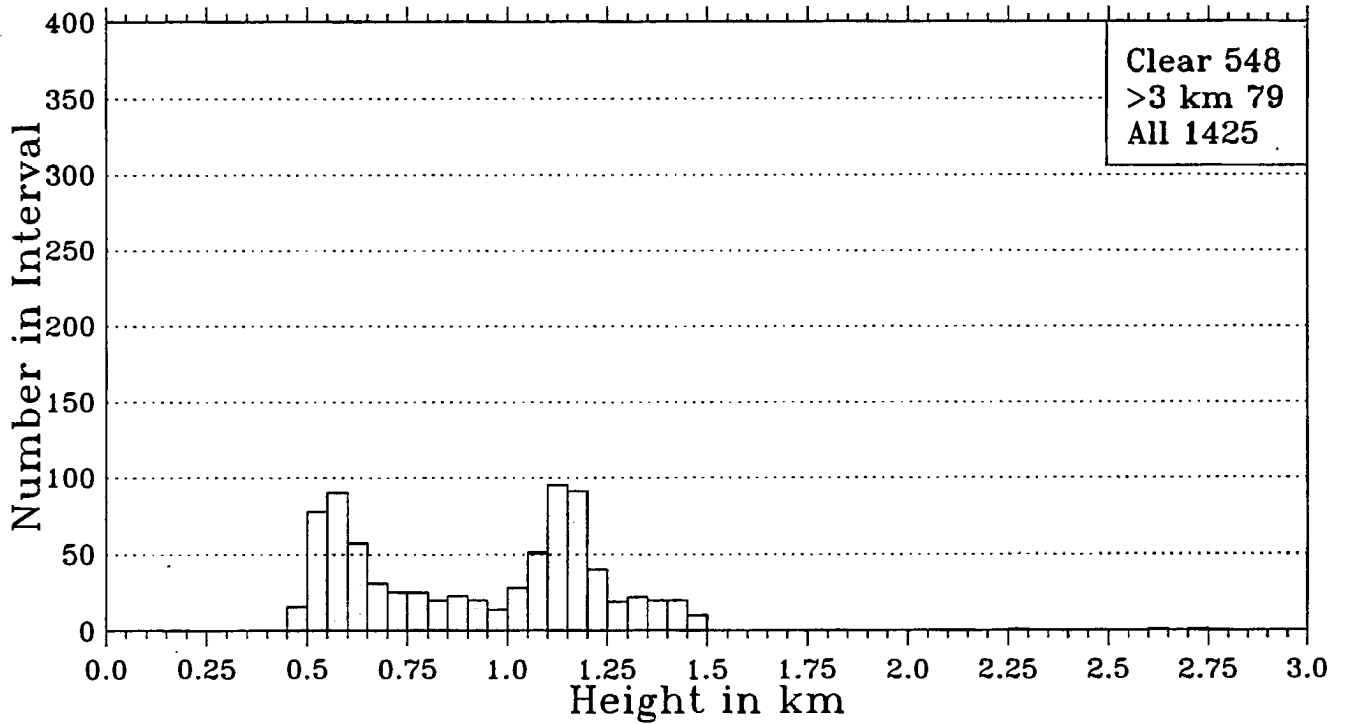


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

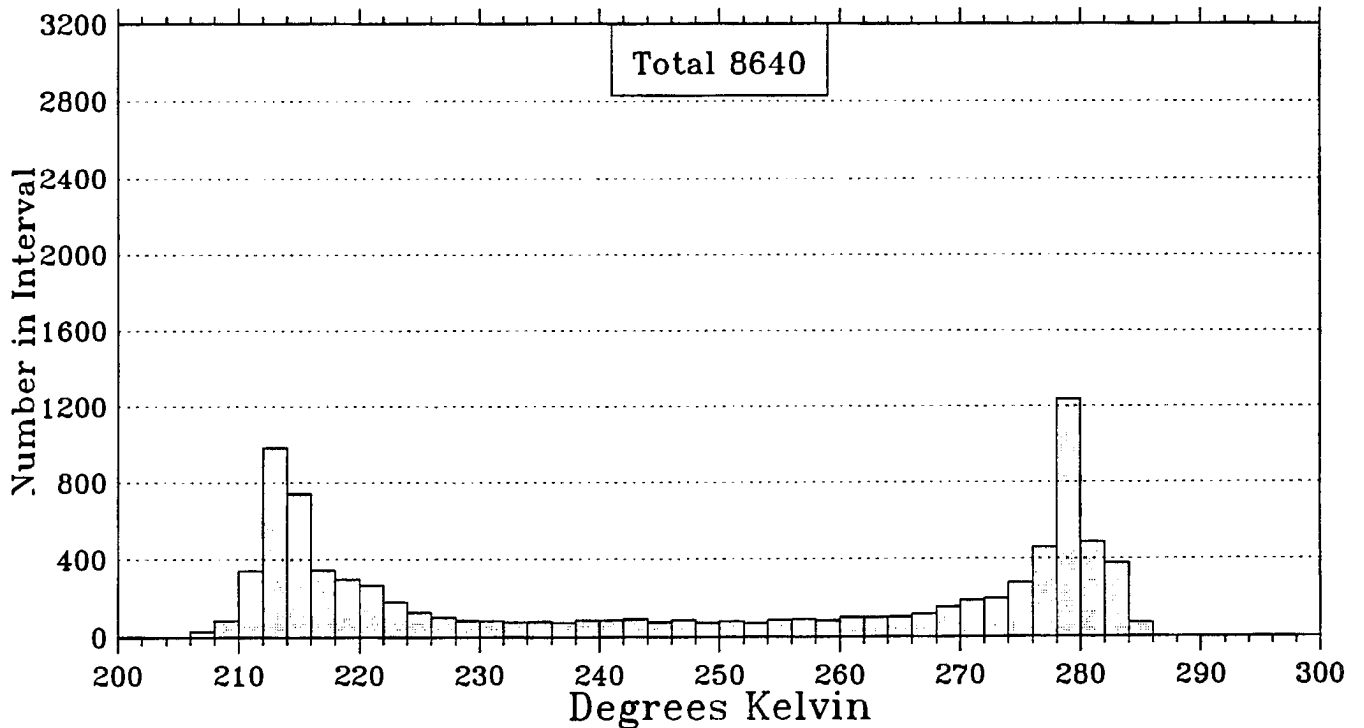


14 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

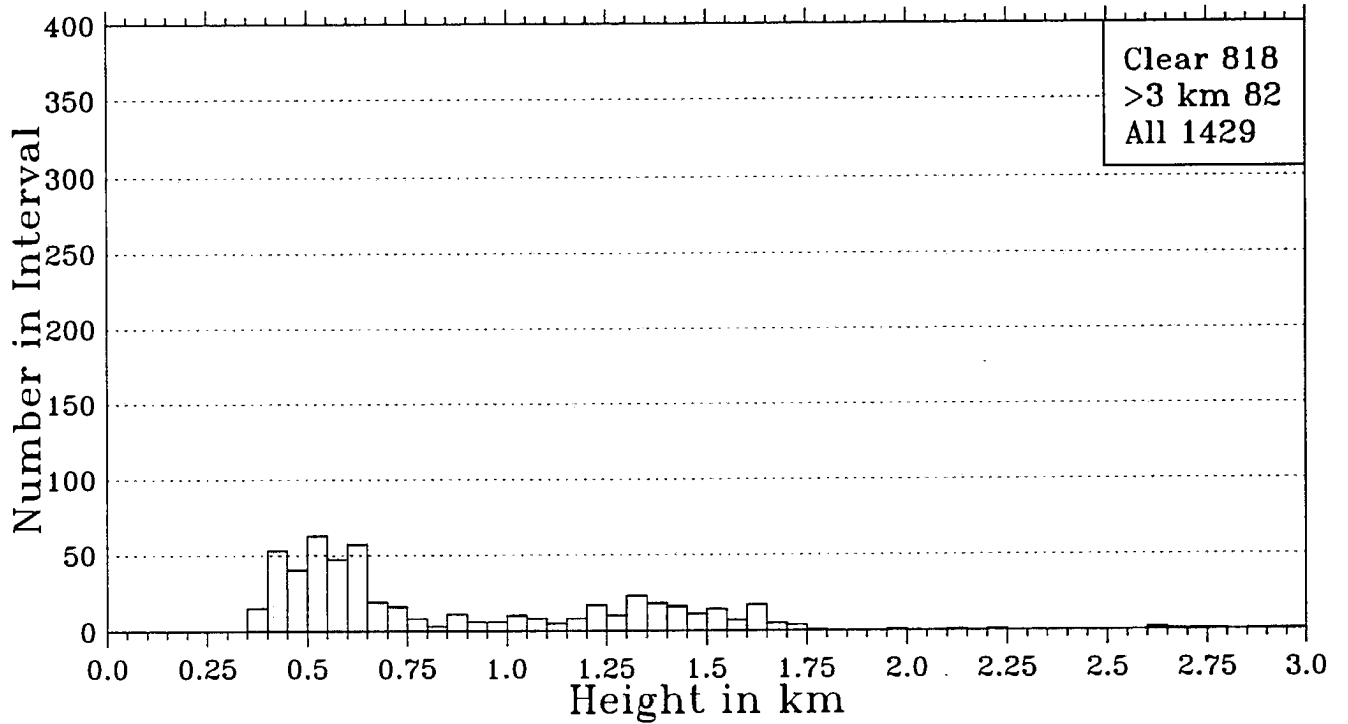


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

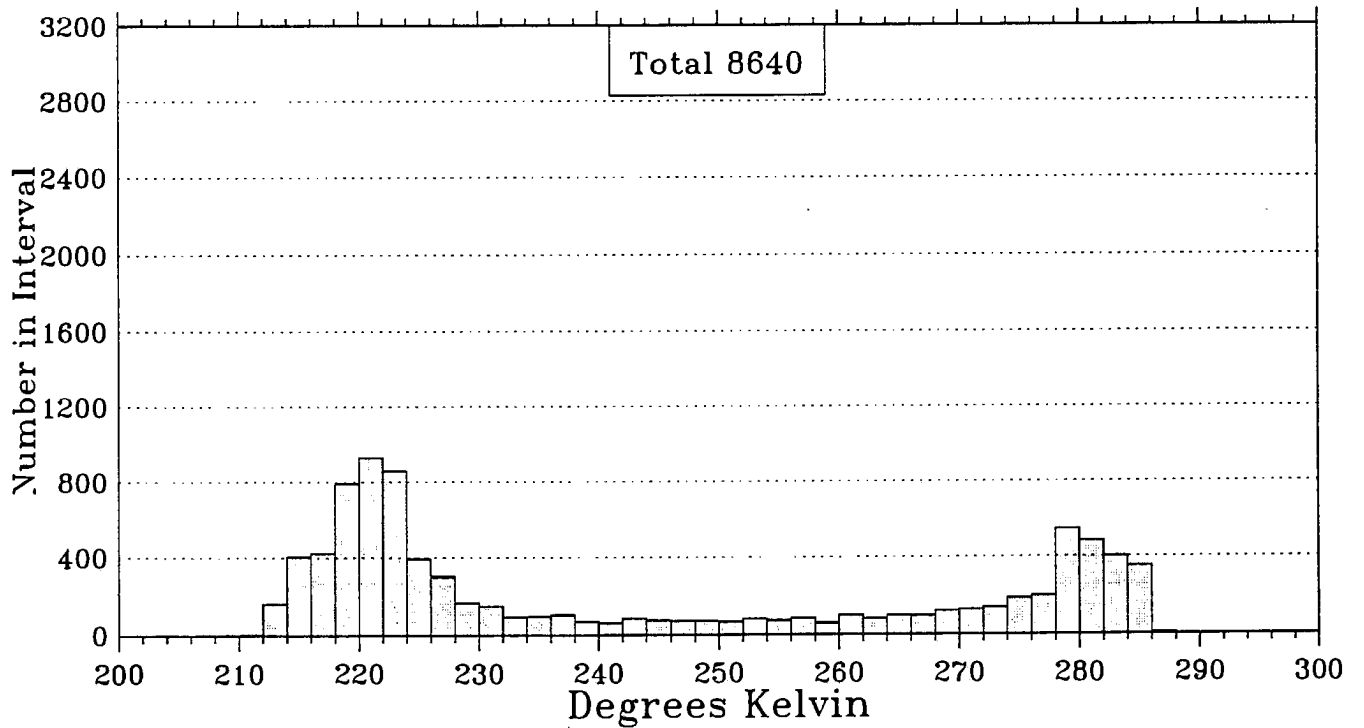


15 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

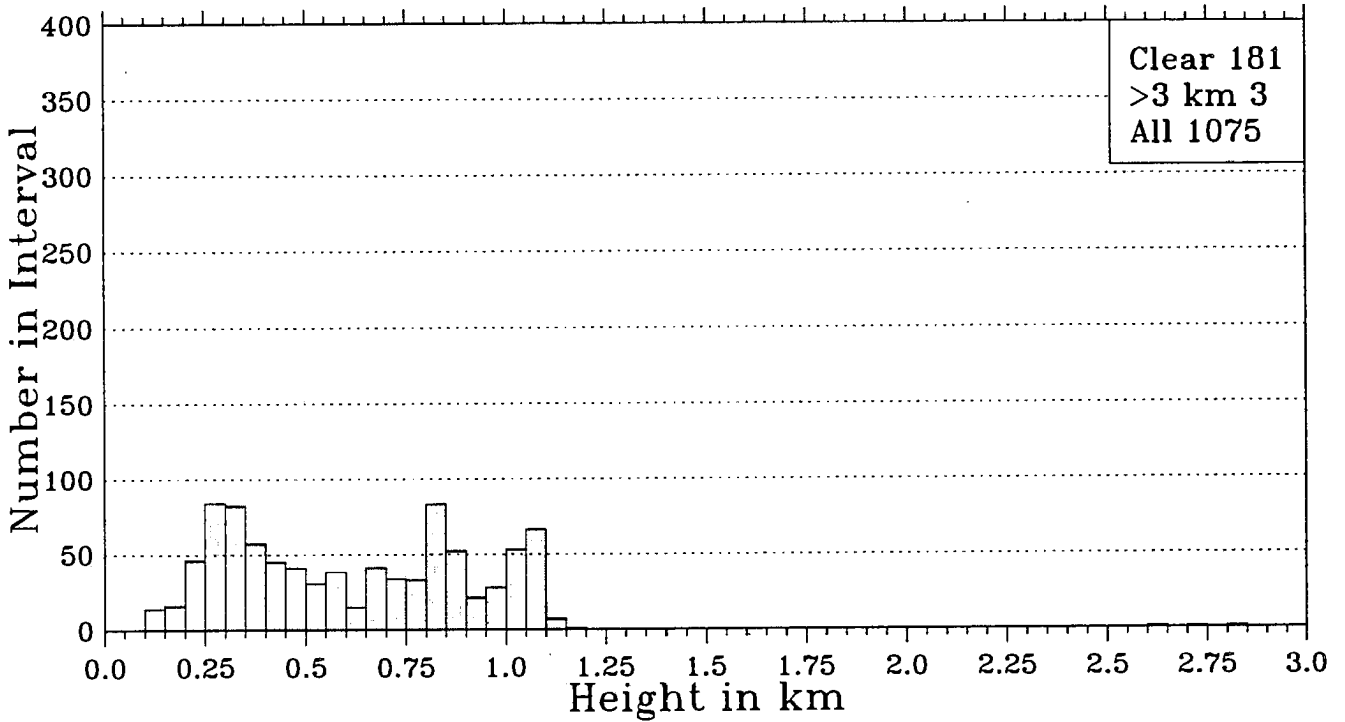


11 μ m Equivalent Brightness Temperatures (2°K Bins; 8640 Samples/Day)

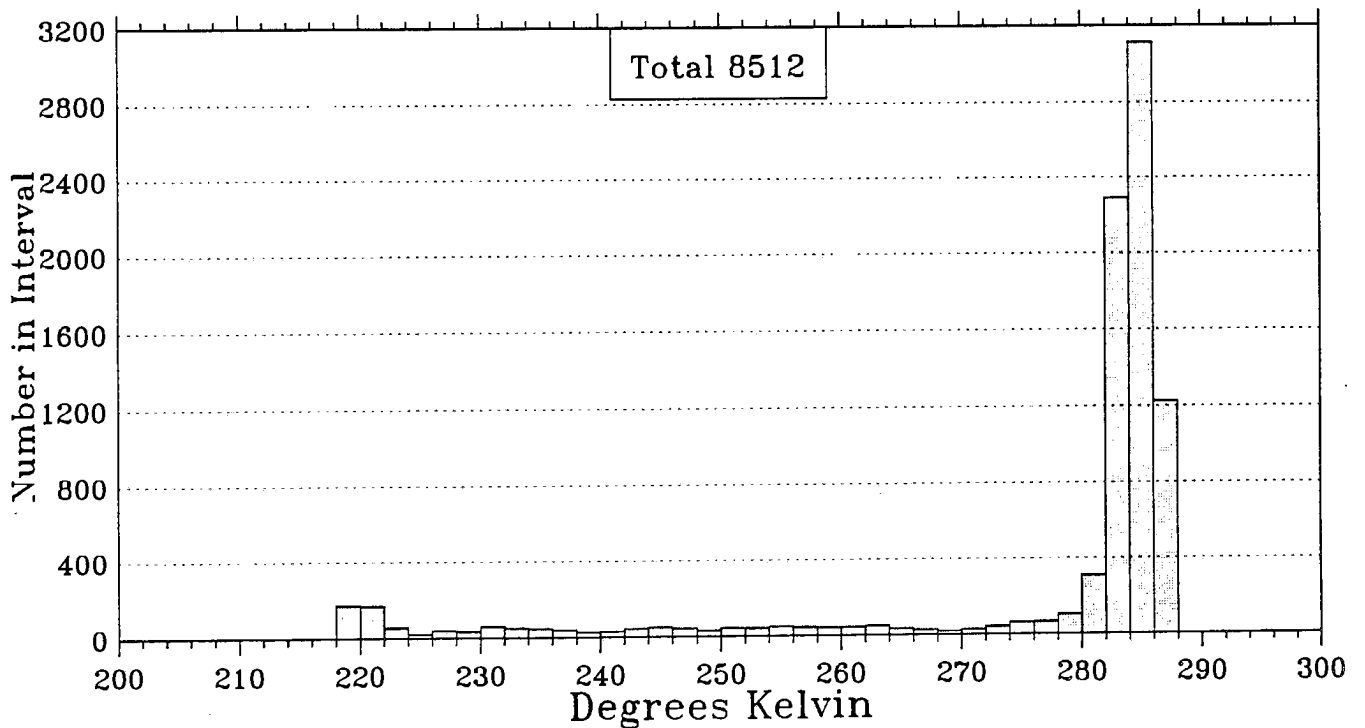


17 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

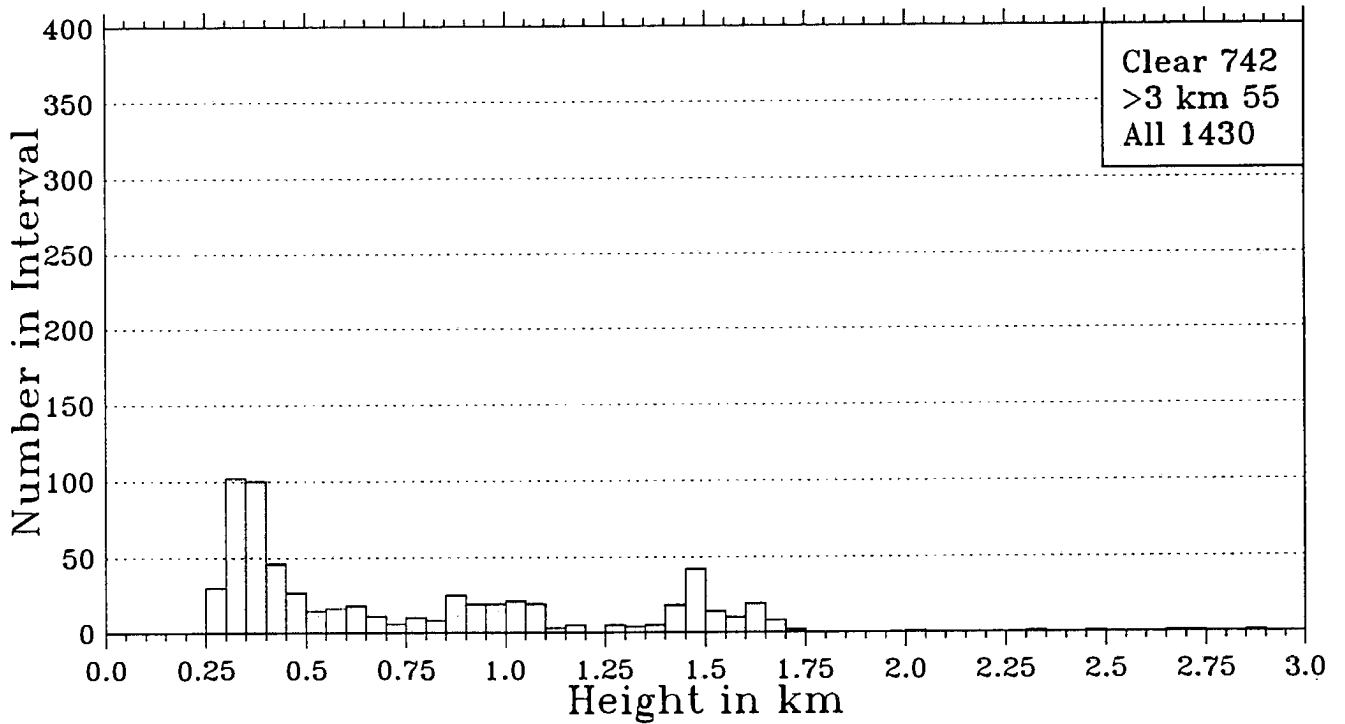


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

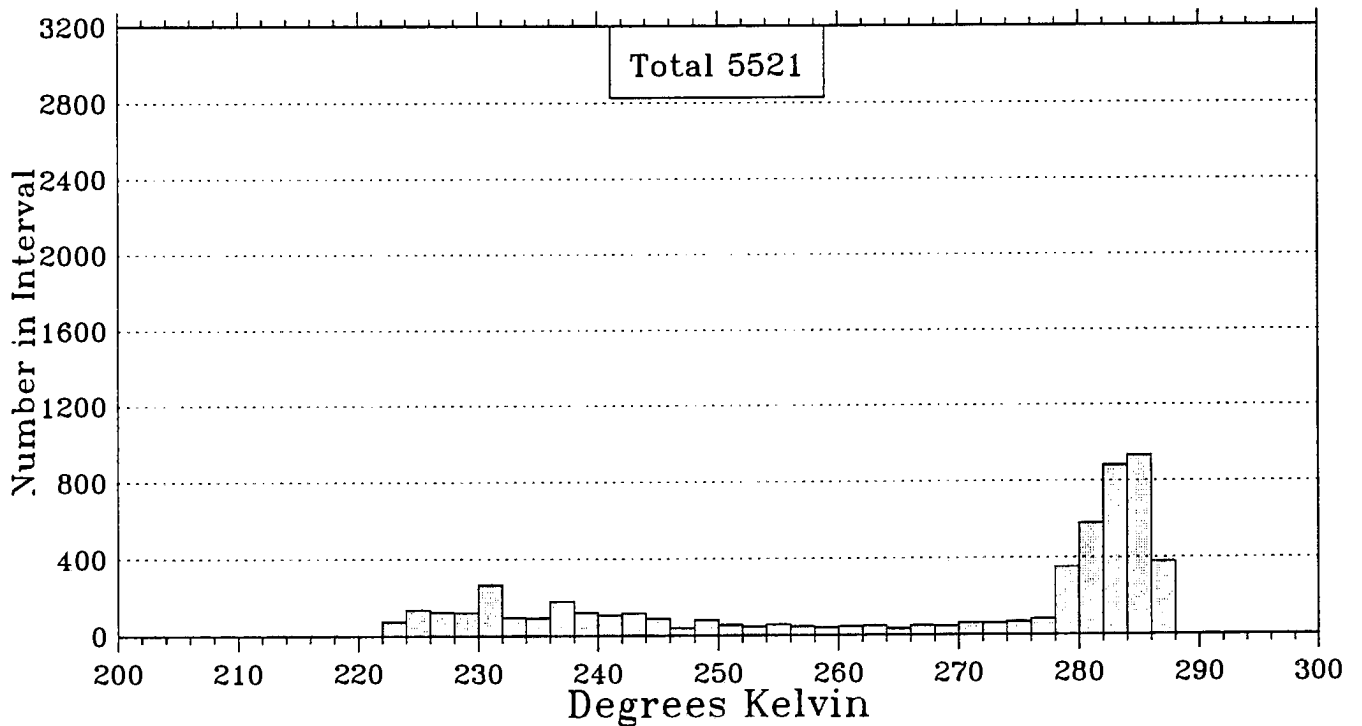


16 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

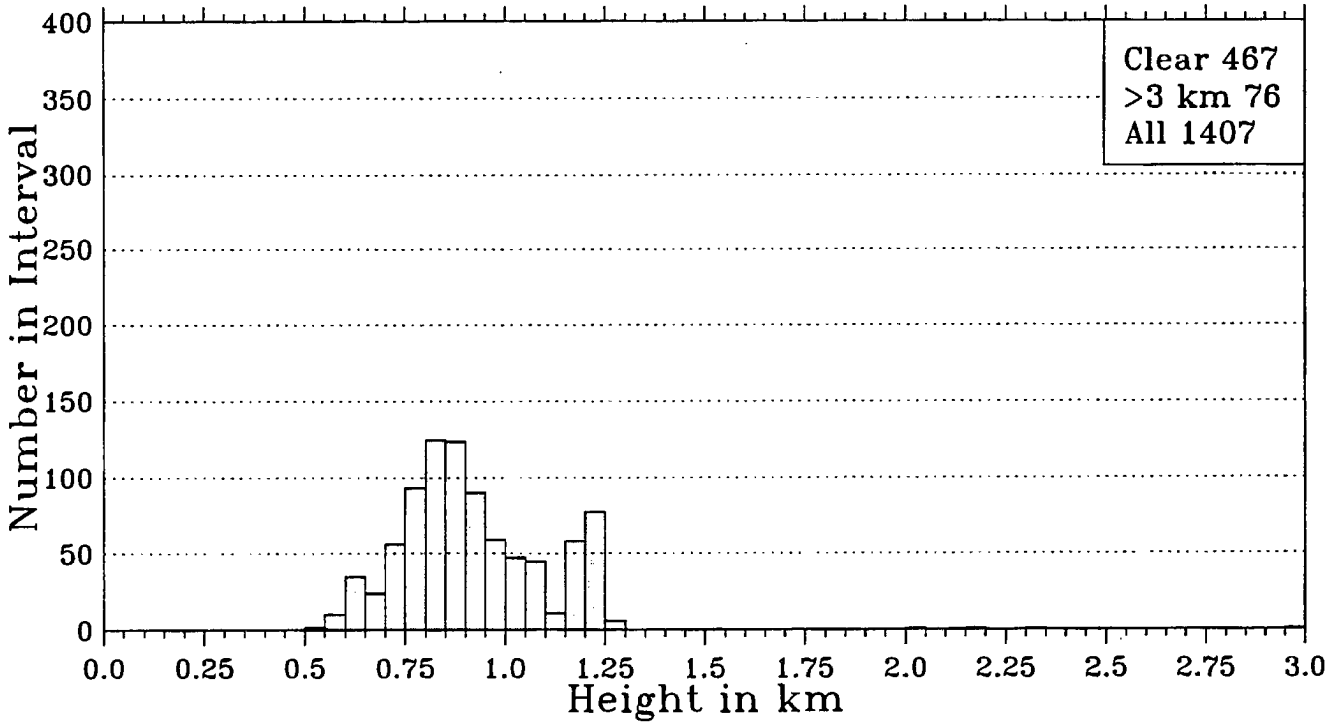


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

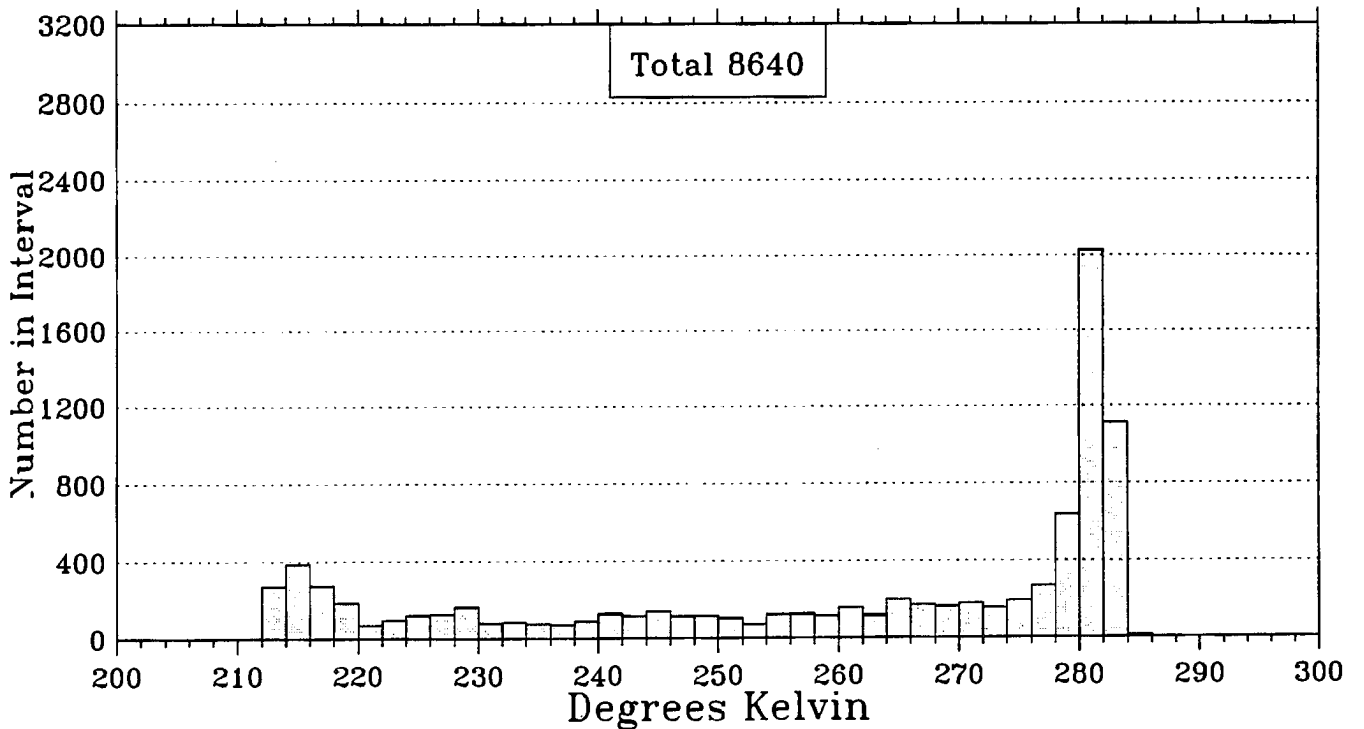


18 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

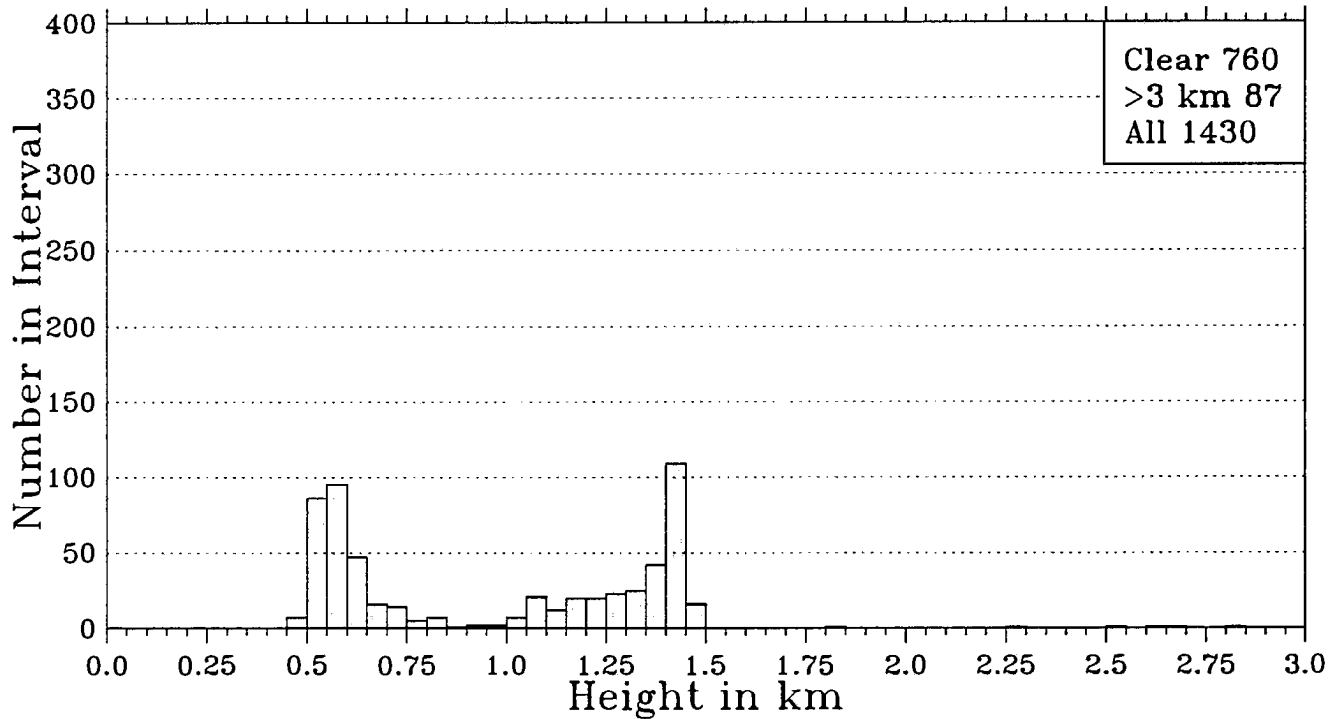


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

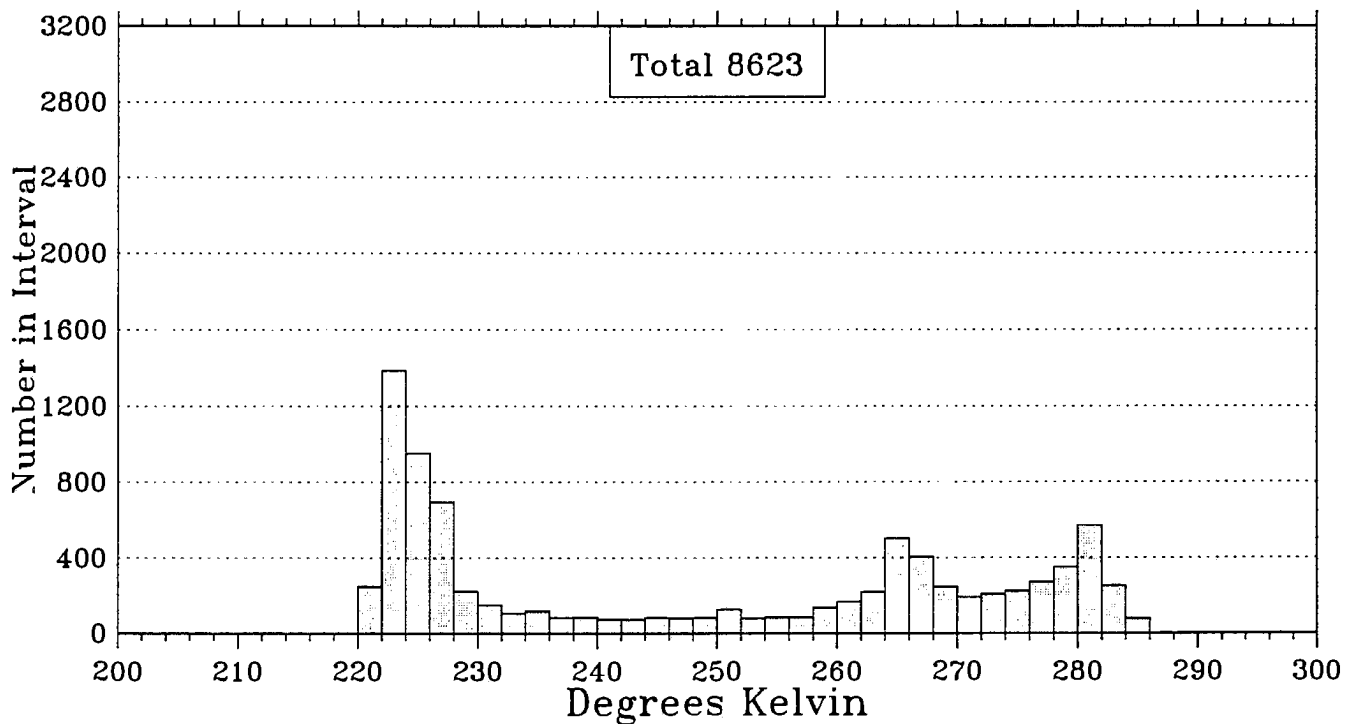


19 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

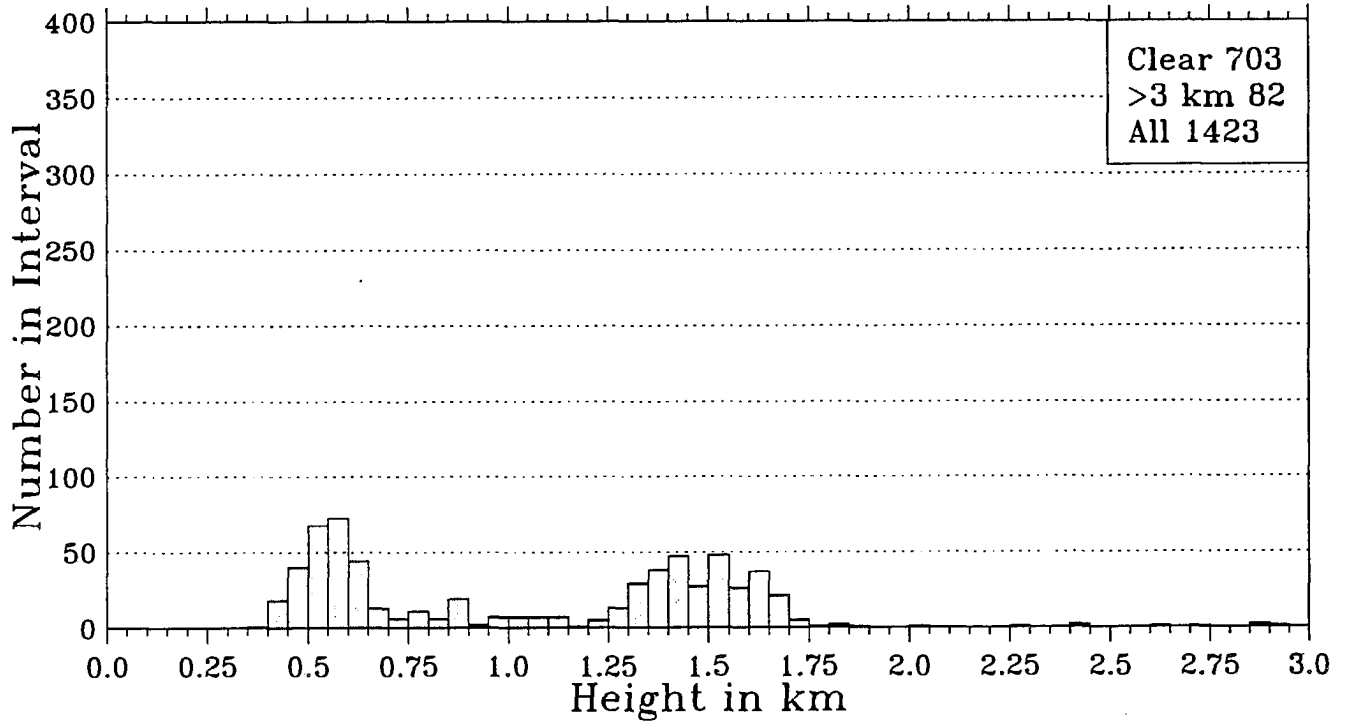


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

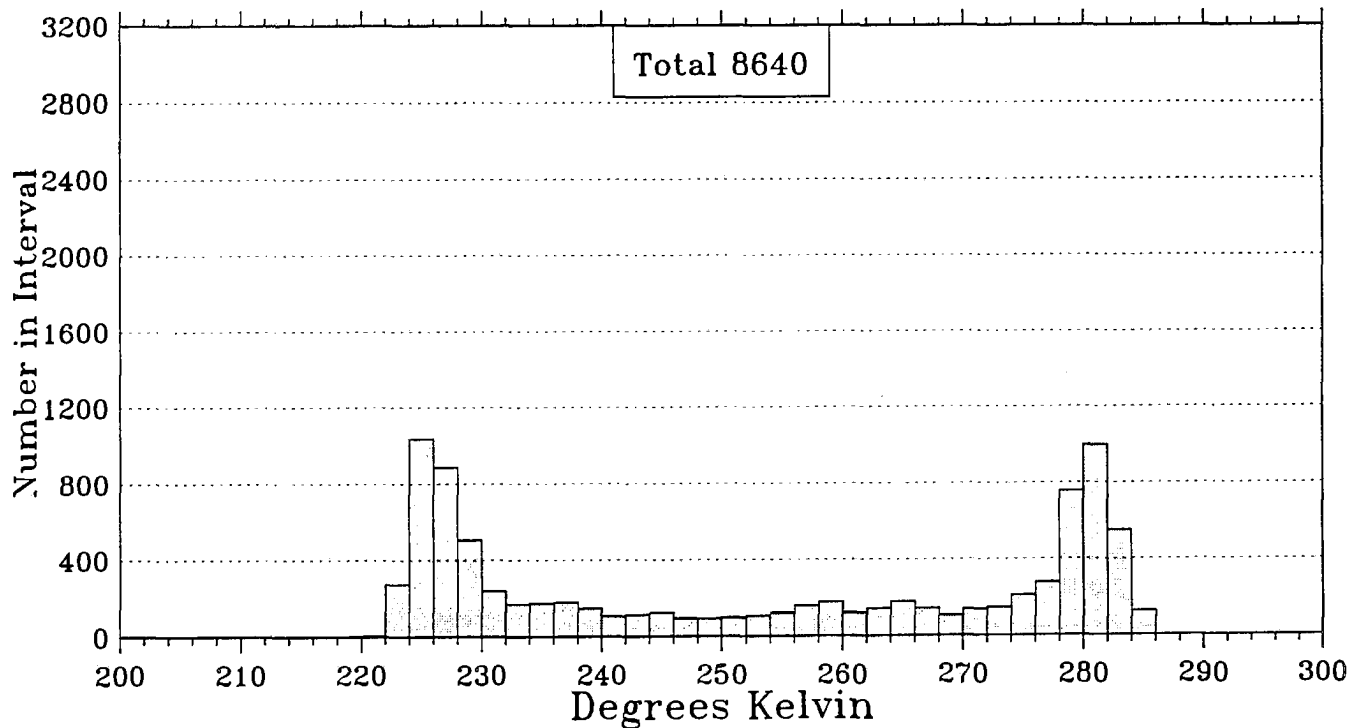


20 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

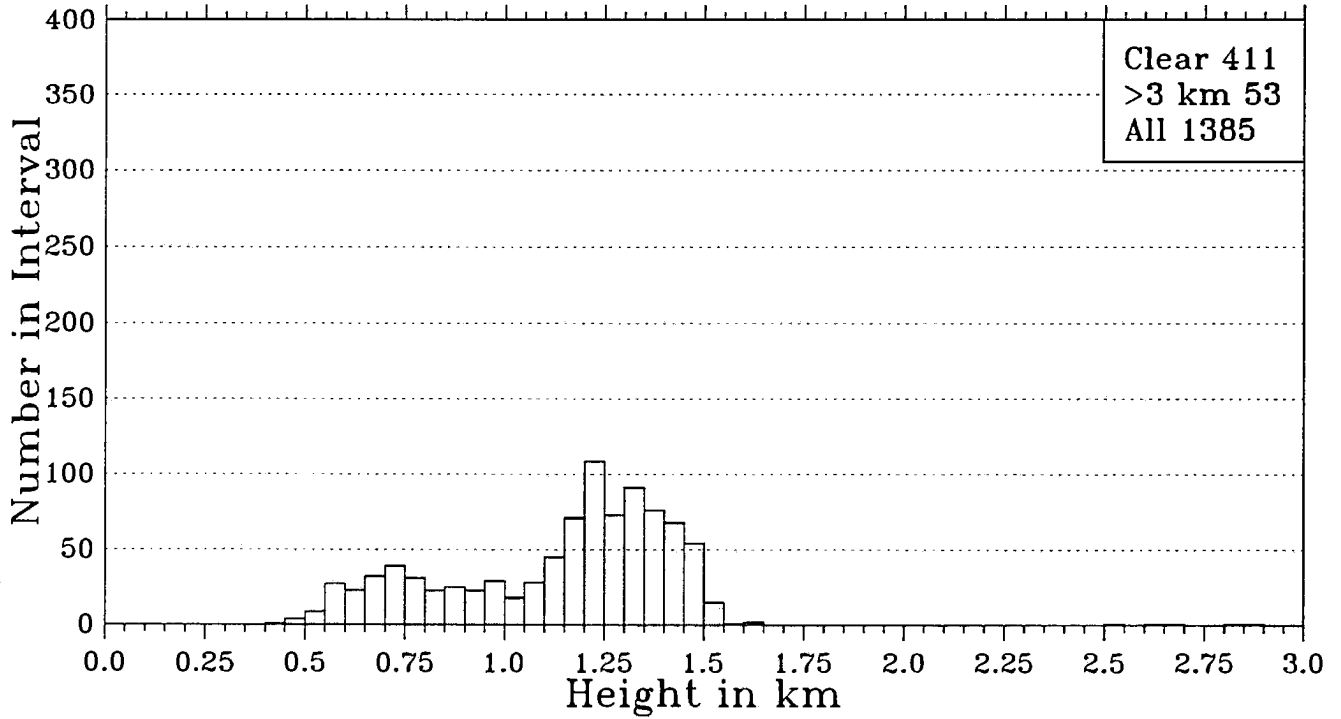


11 μ m Equivalent Brightness Temperatures (2 $^\circ$ K Bins; 8640 Samples/Day)

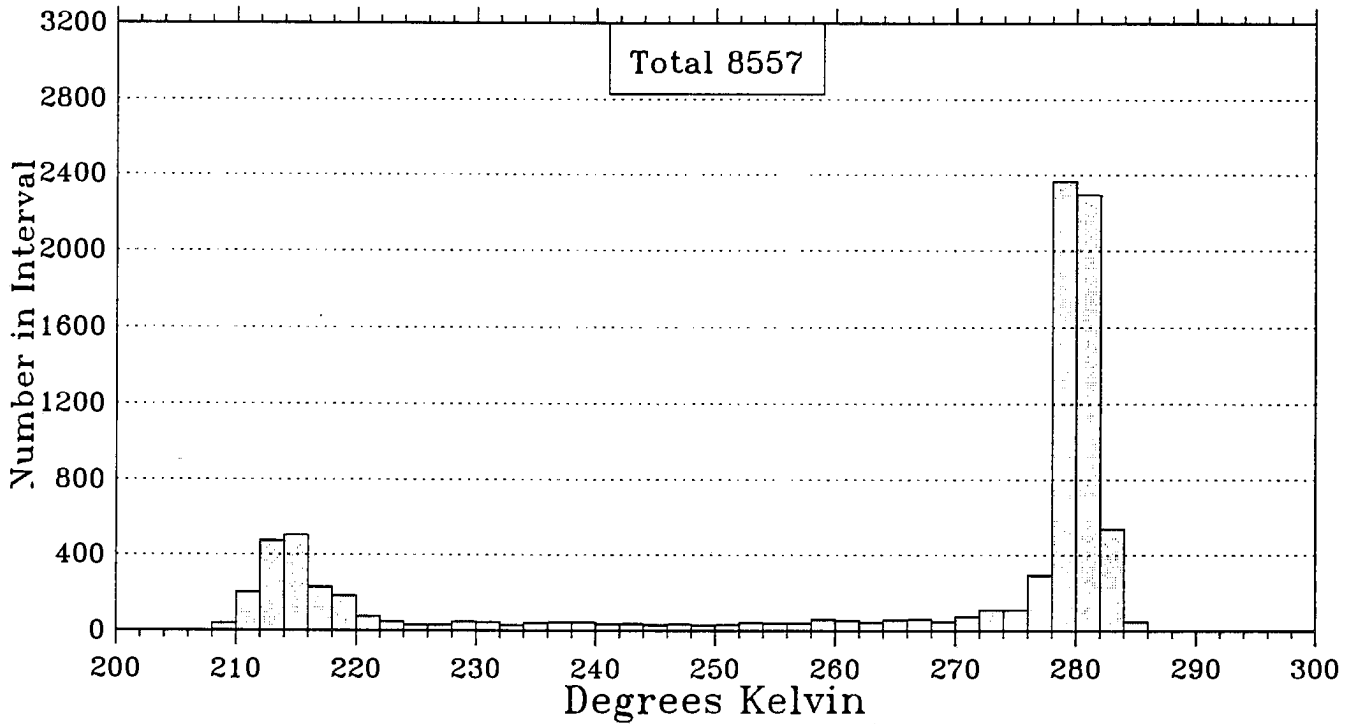


21 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

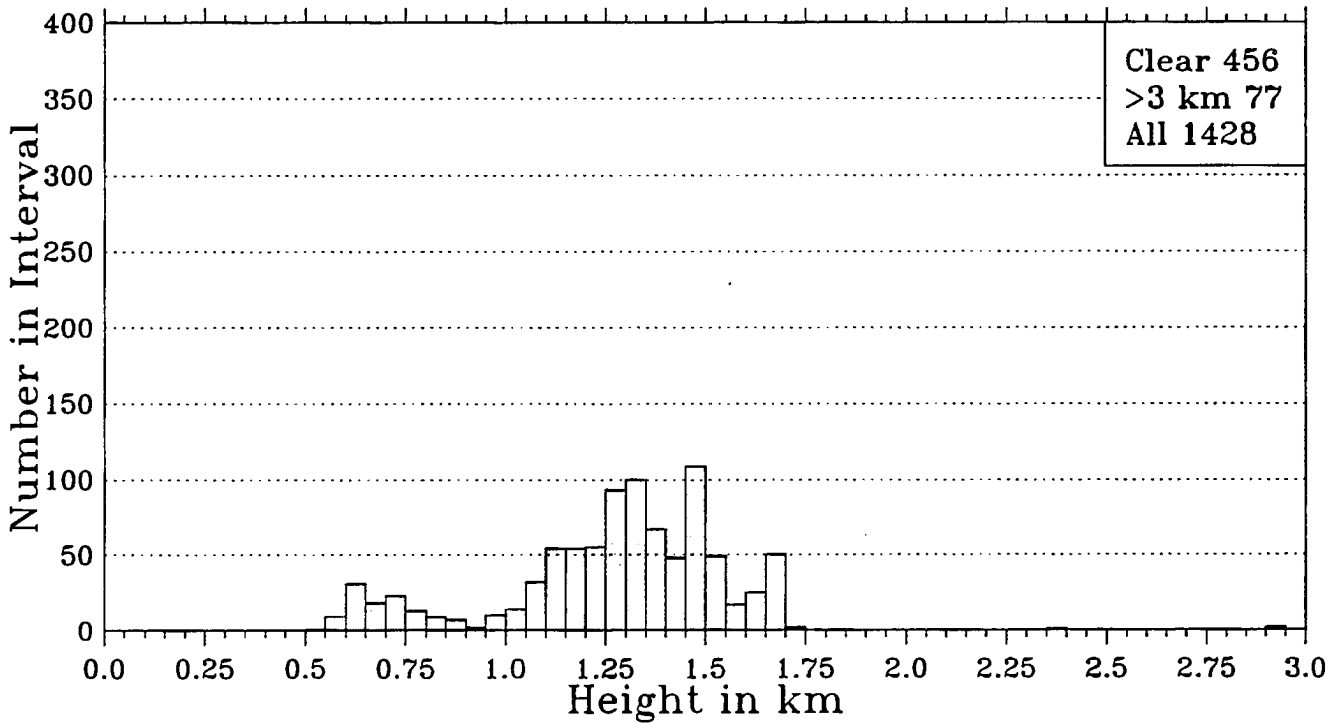


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

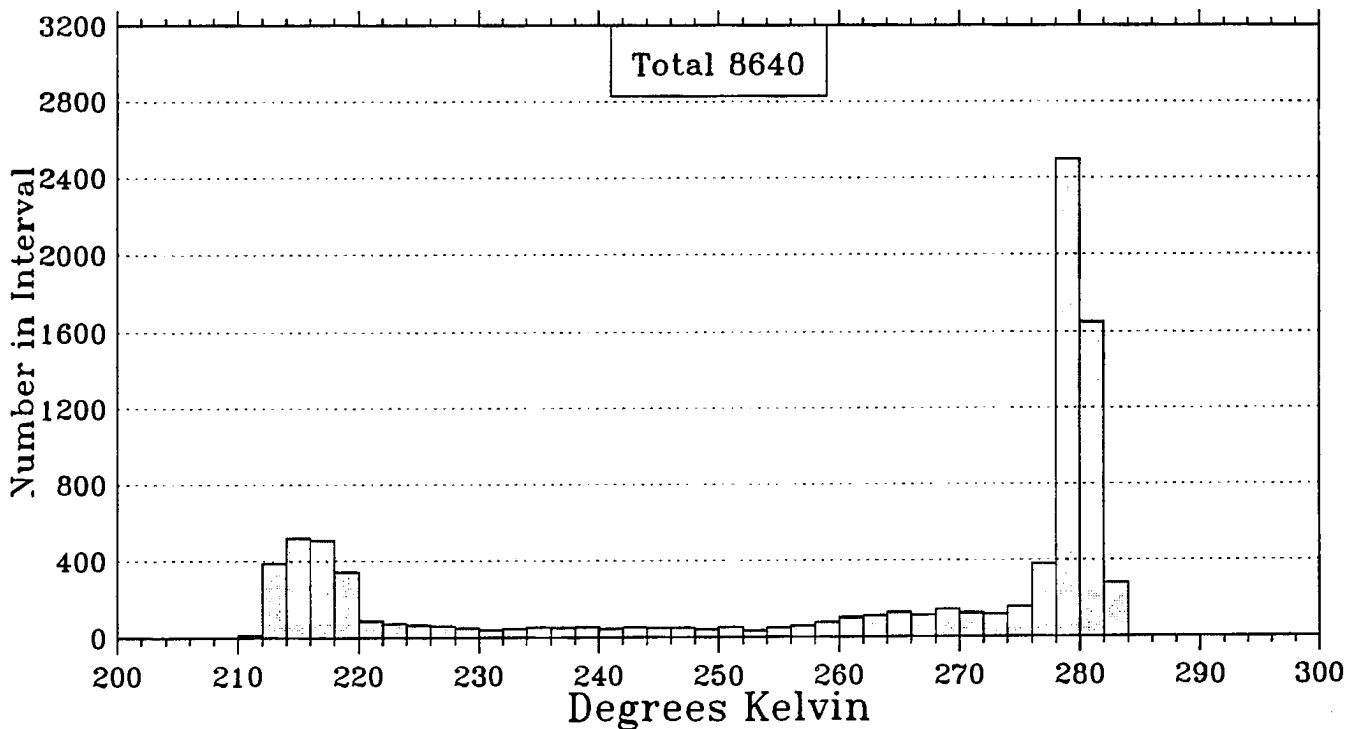


22 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

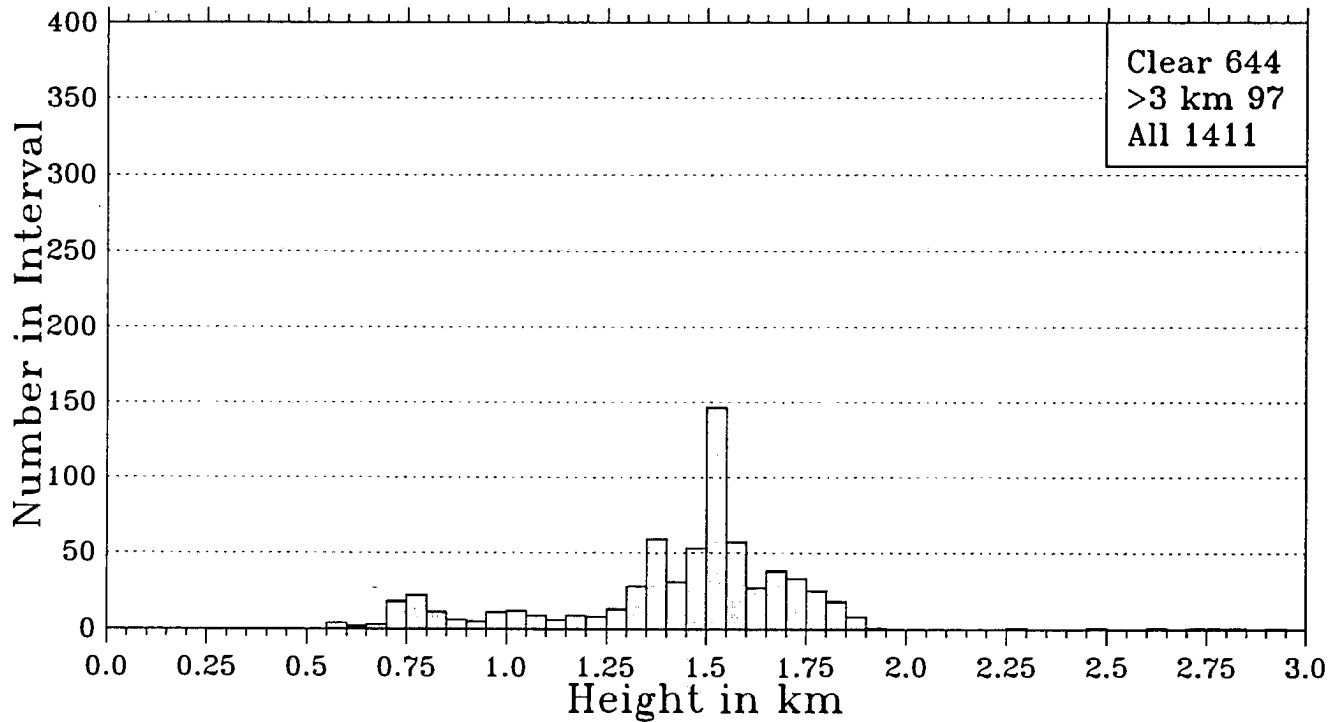


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

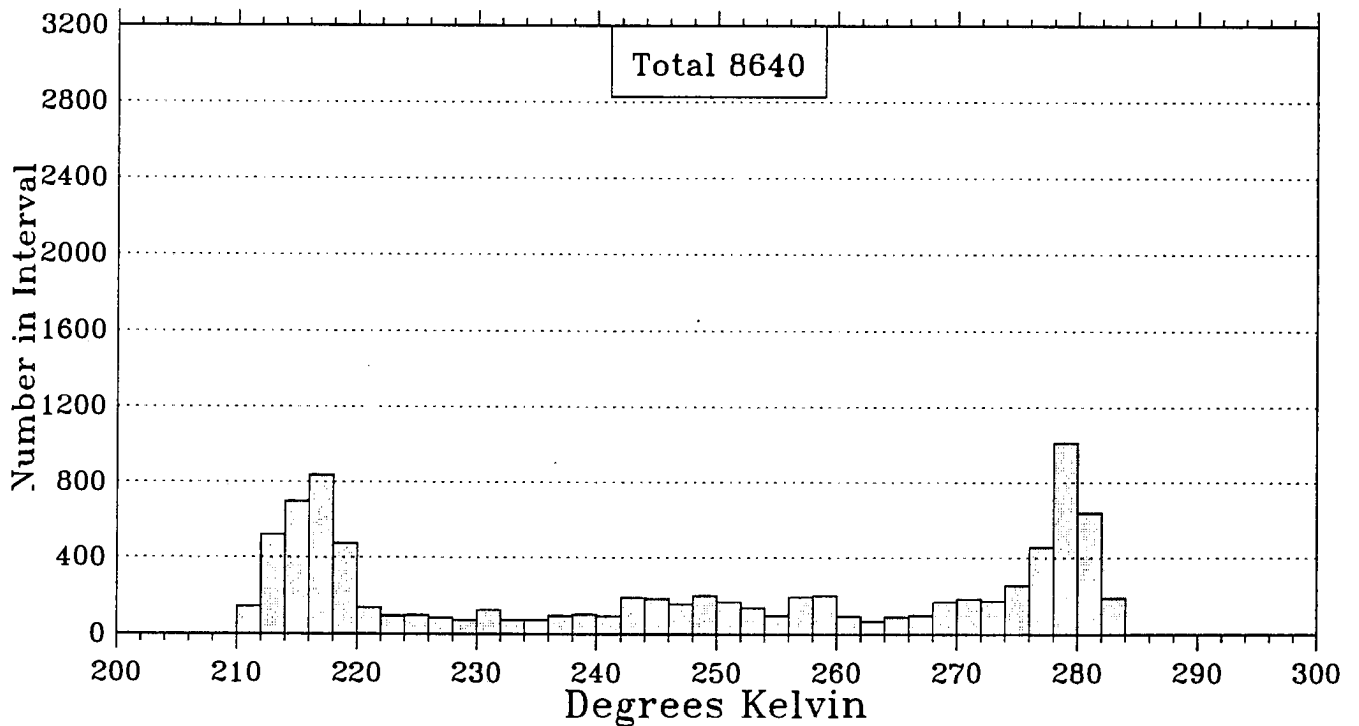


23 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

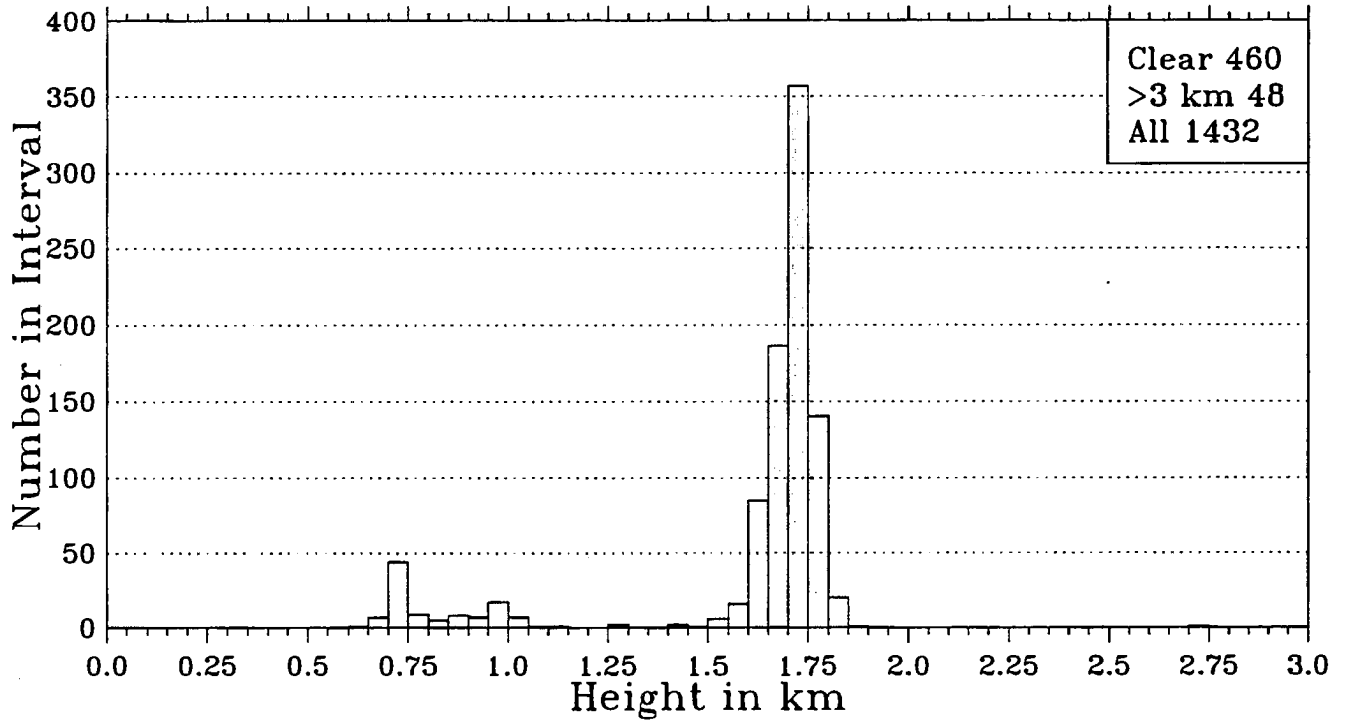


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

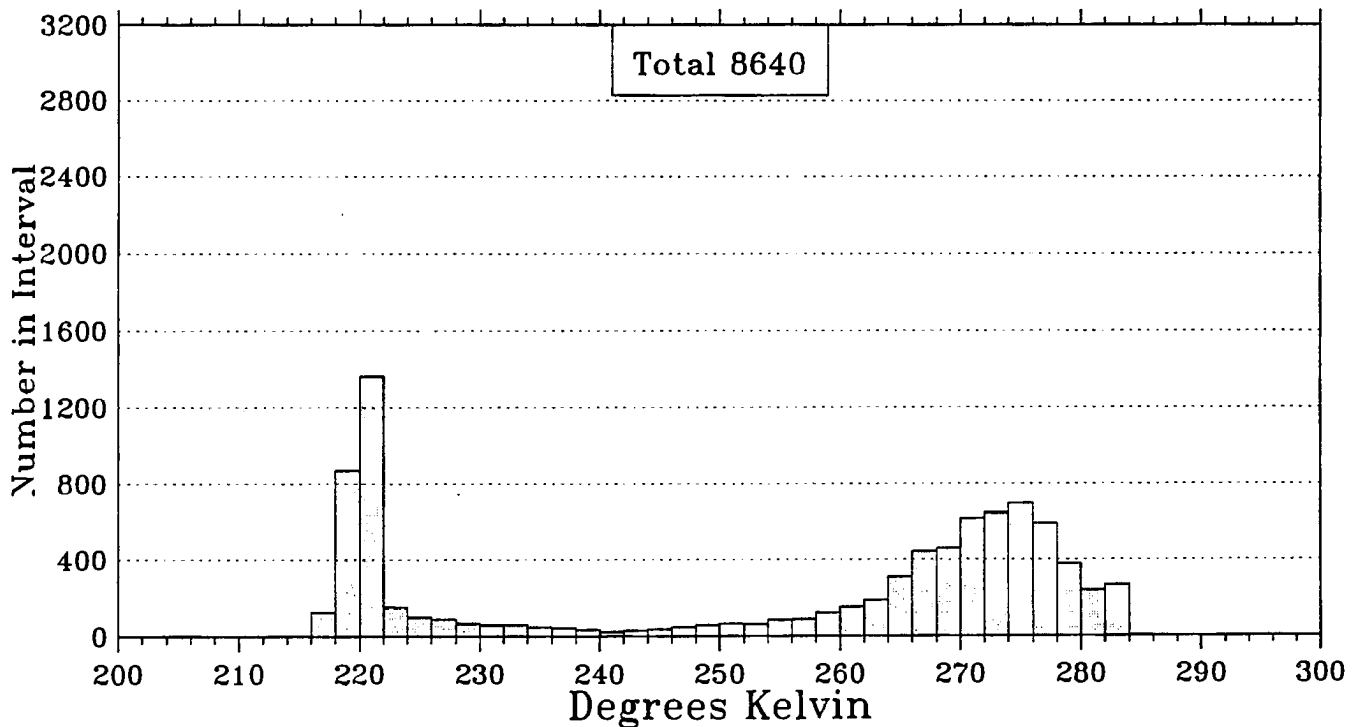


24 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

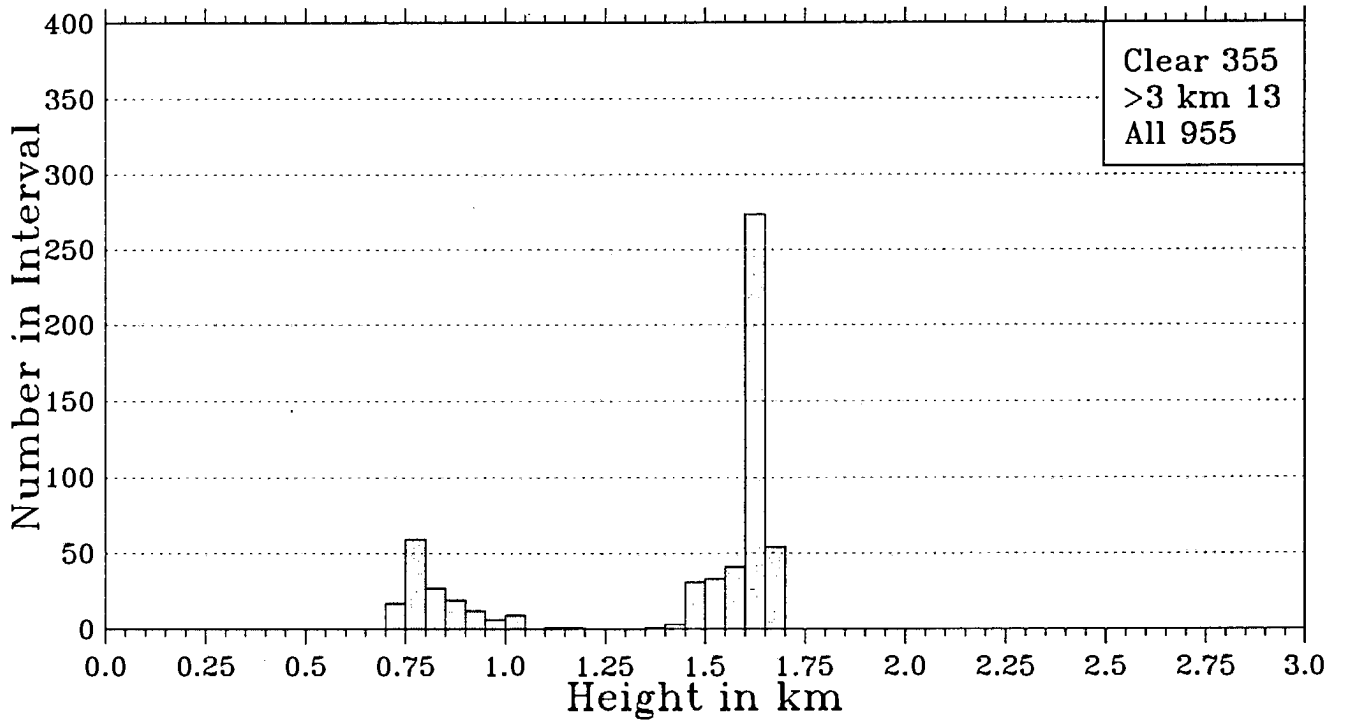


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

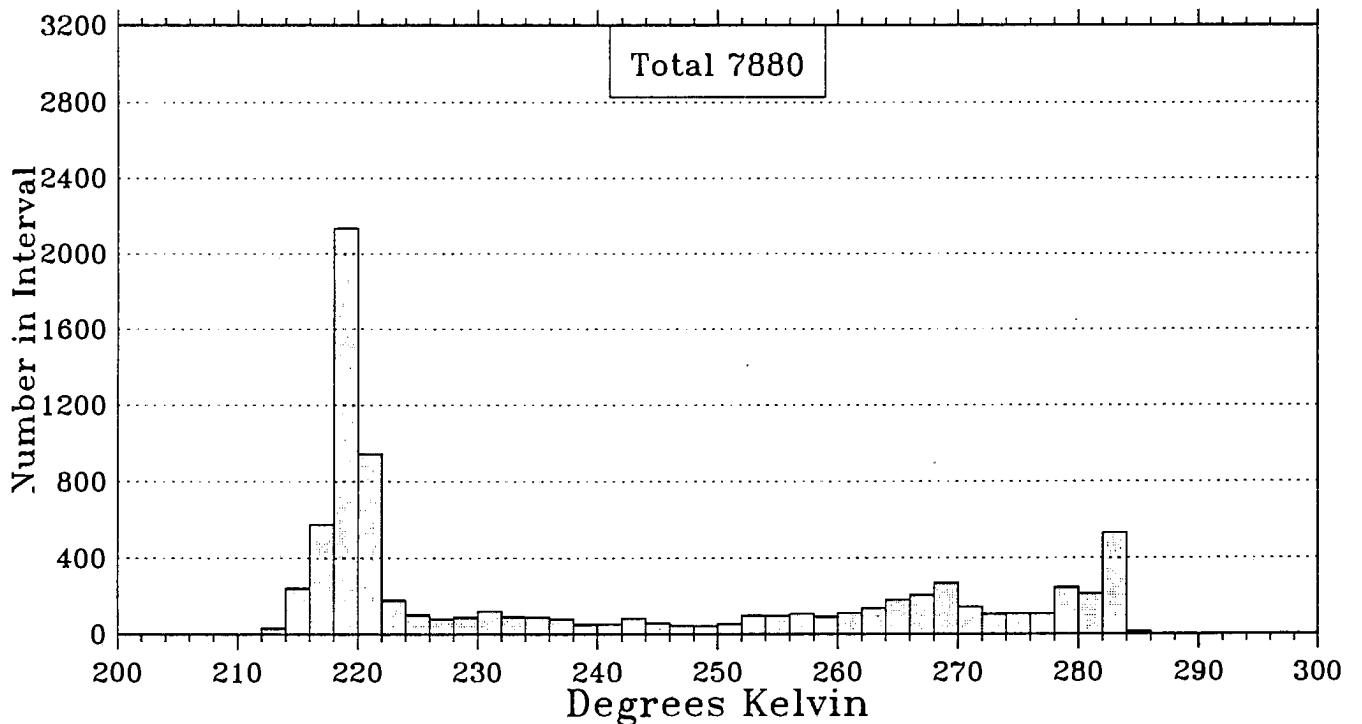


25 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

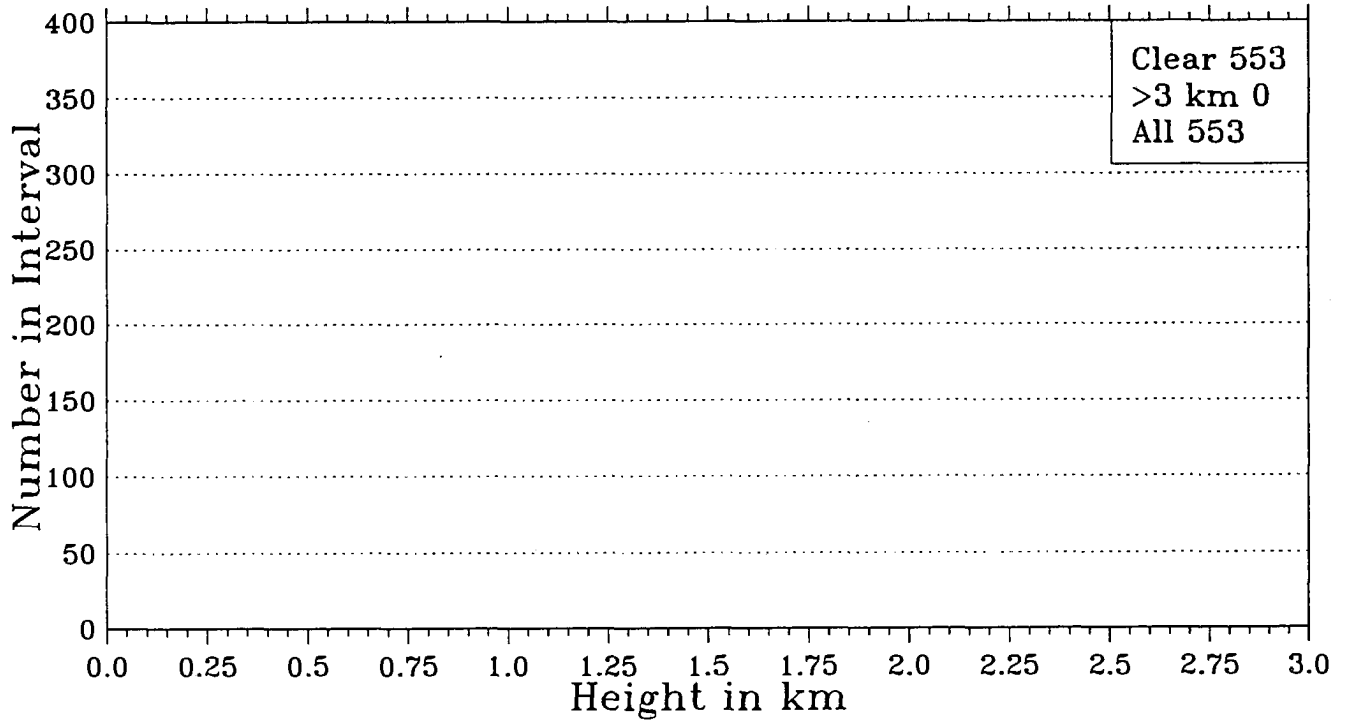


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

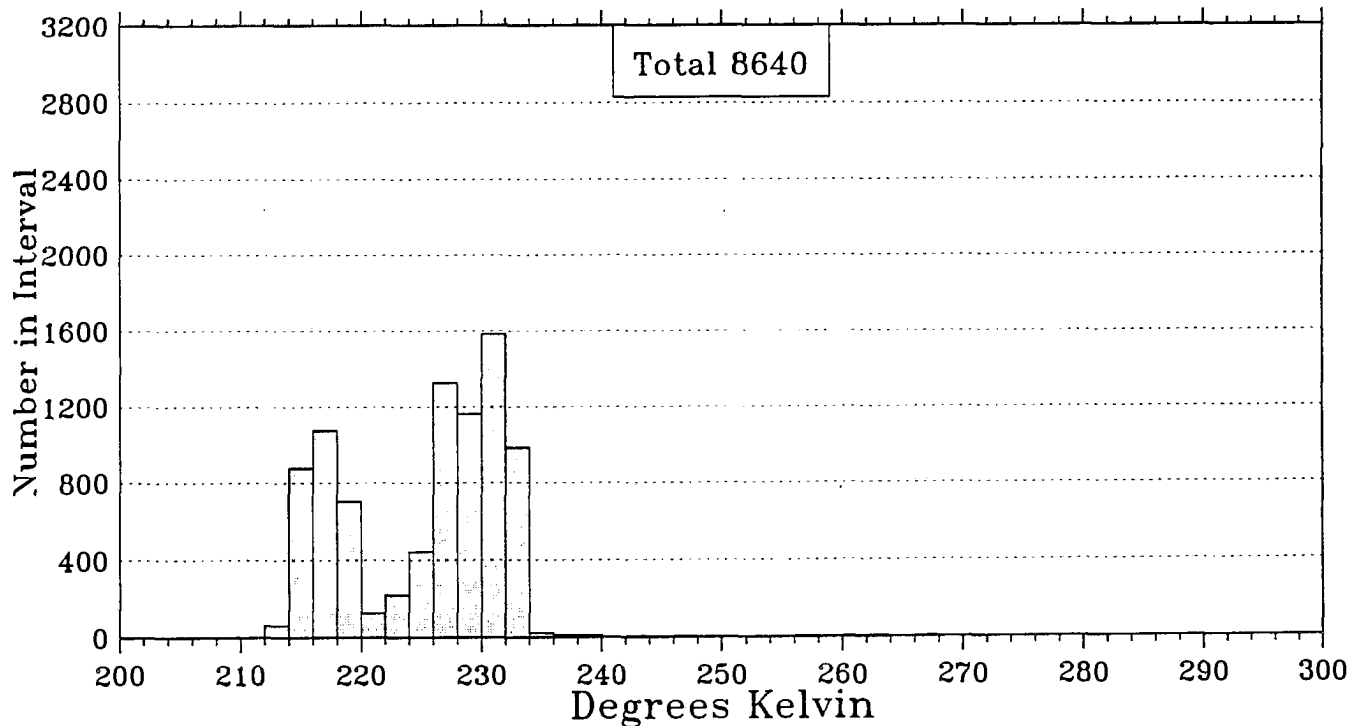


26 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

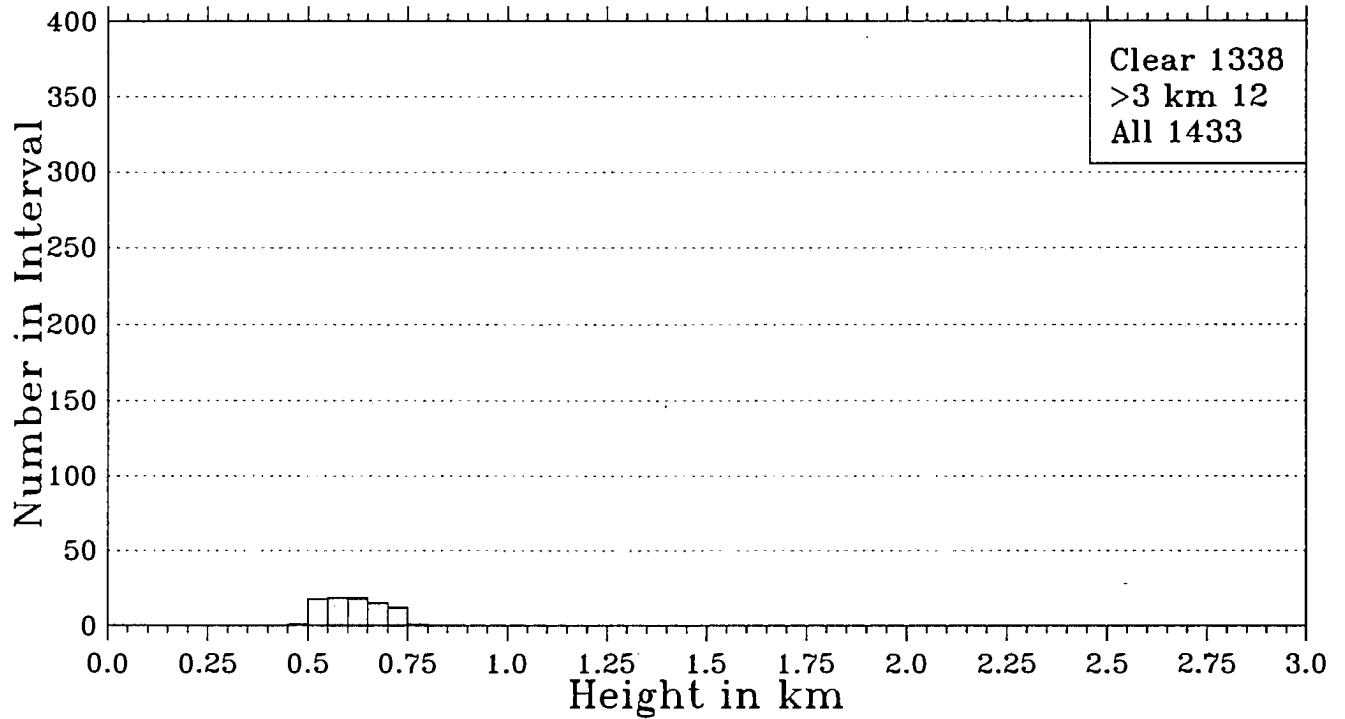


11 μ m Equivalent Brightness Temperatures (2°K Bins; 8640 Samples/Day)

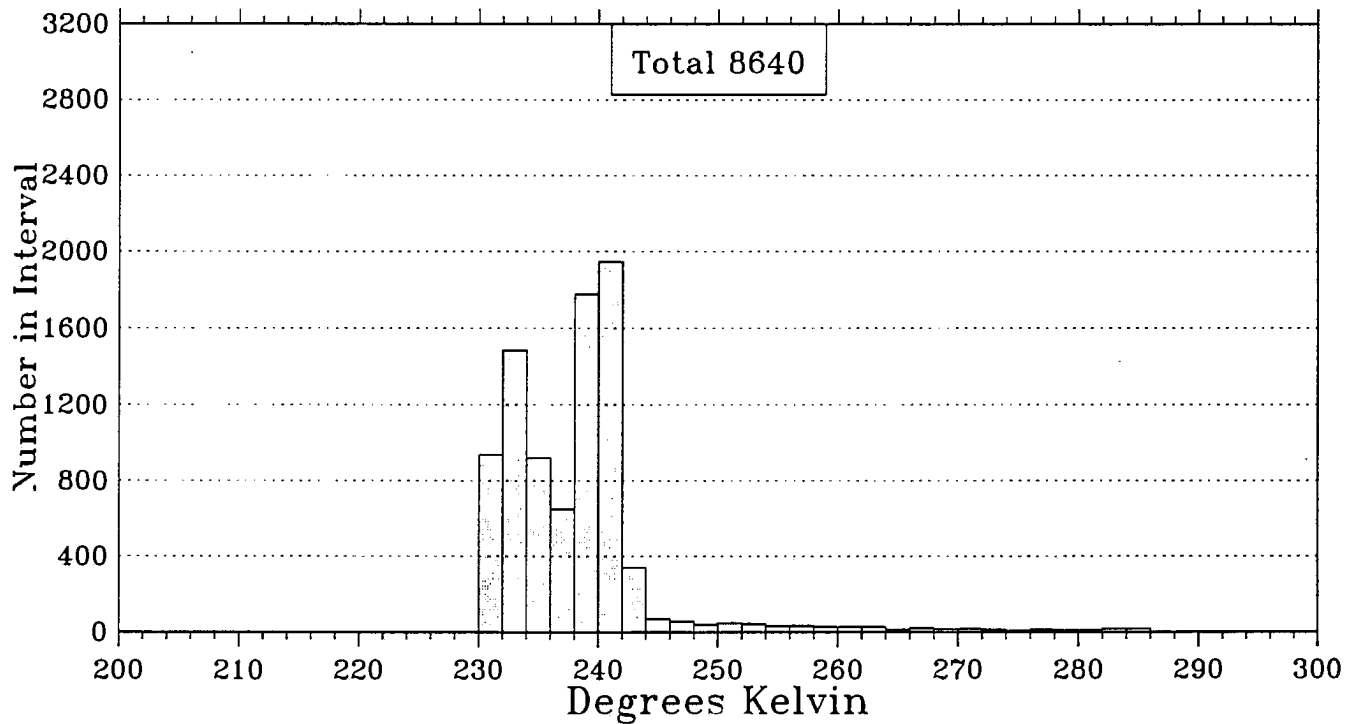


27 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

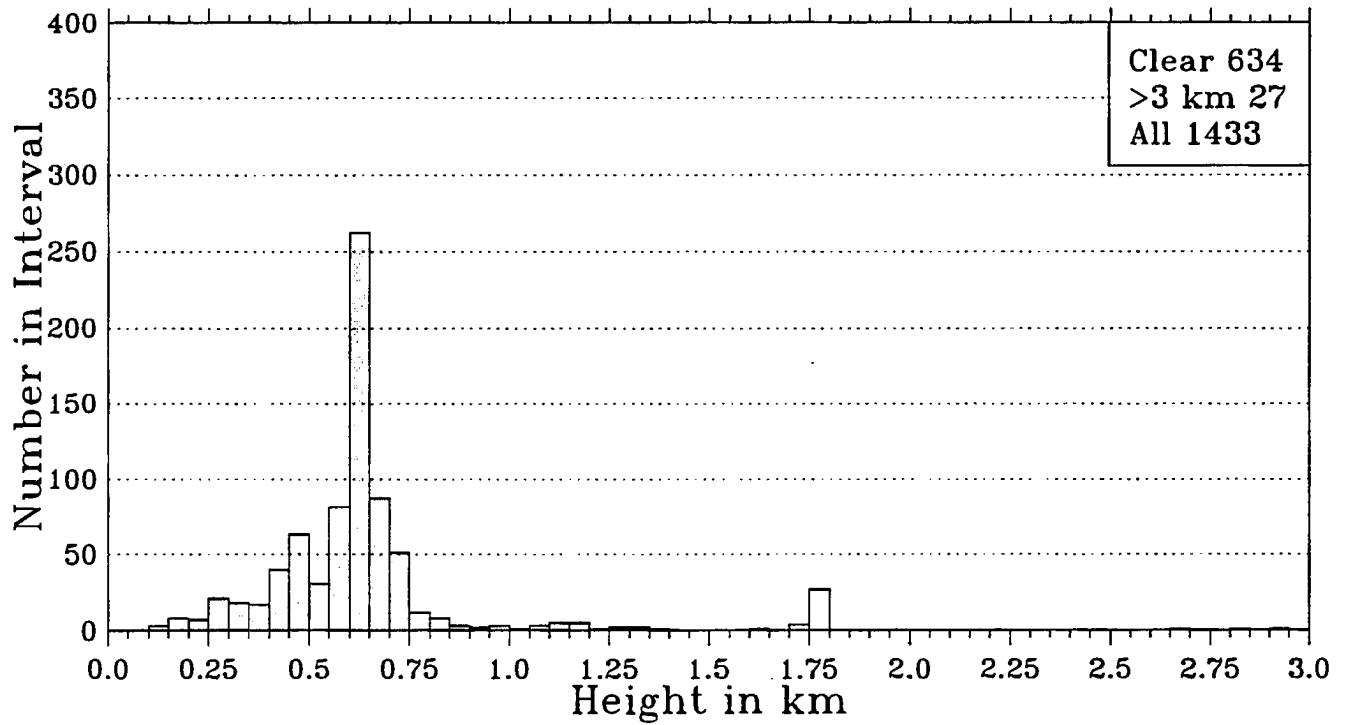


11 μ m Equivalent Brightness Temperatures (2 $^\circ$ K Bins; 8640 Samples/Day)

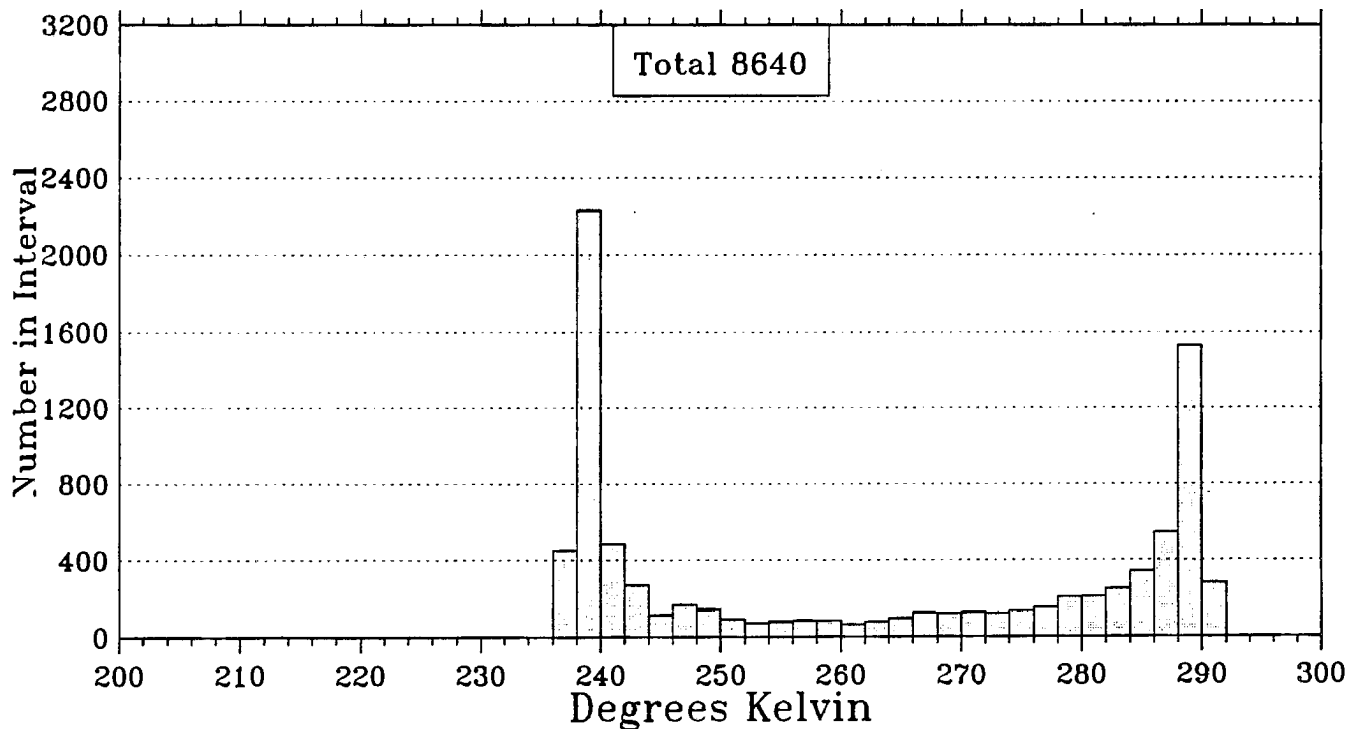


28 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)

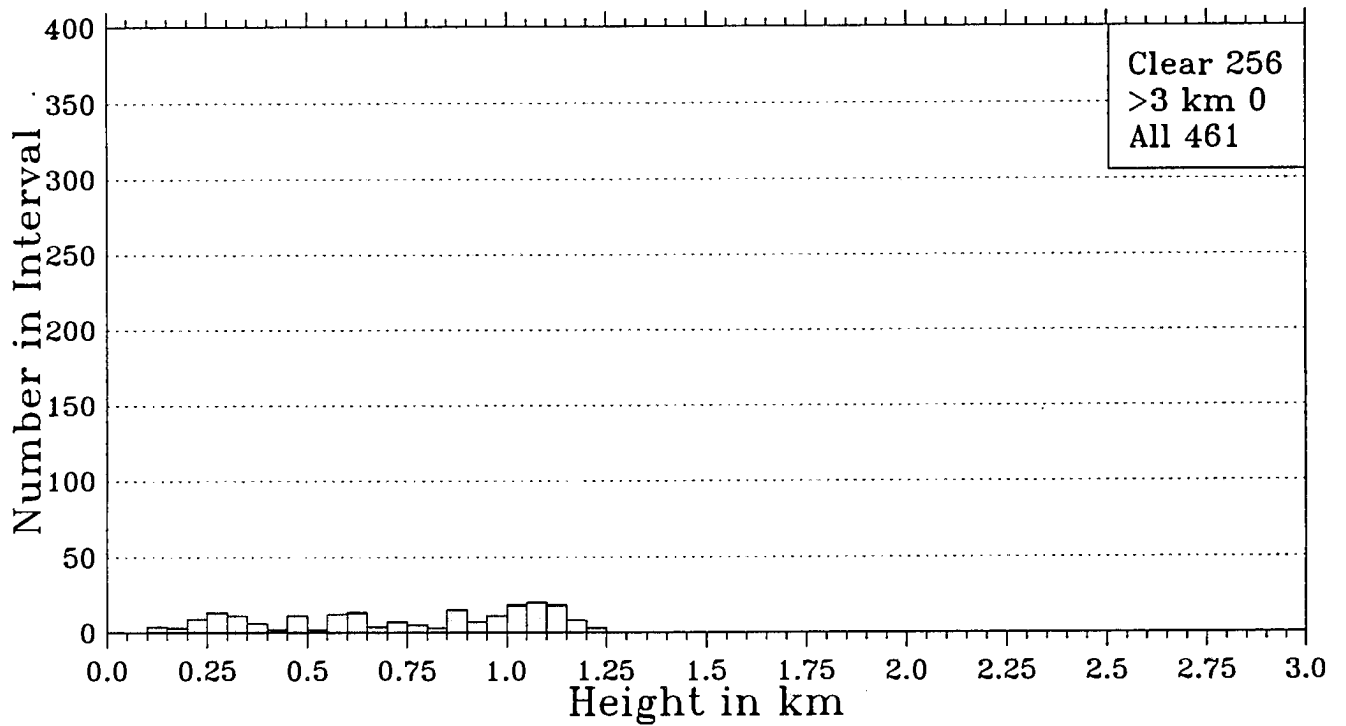


11 μ m Equivalent Brightness Temperatures (2 $^{\circ}$ K Bins; 8640 Samples/Day)

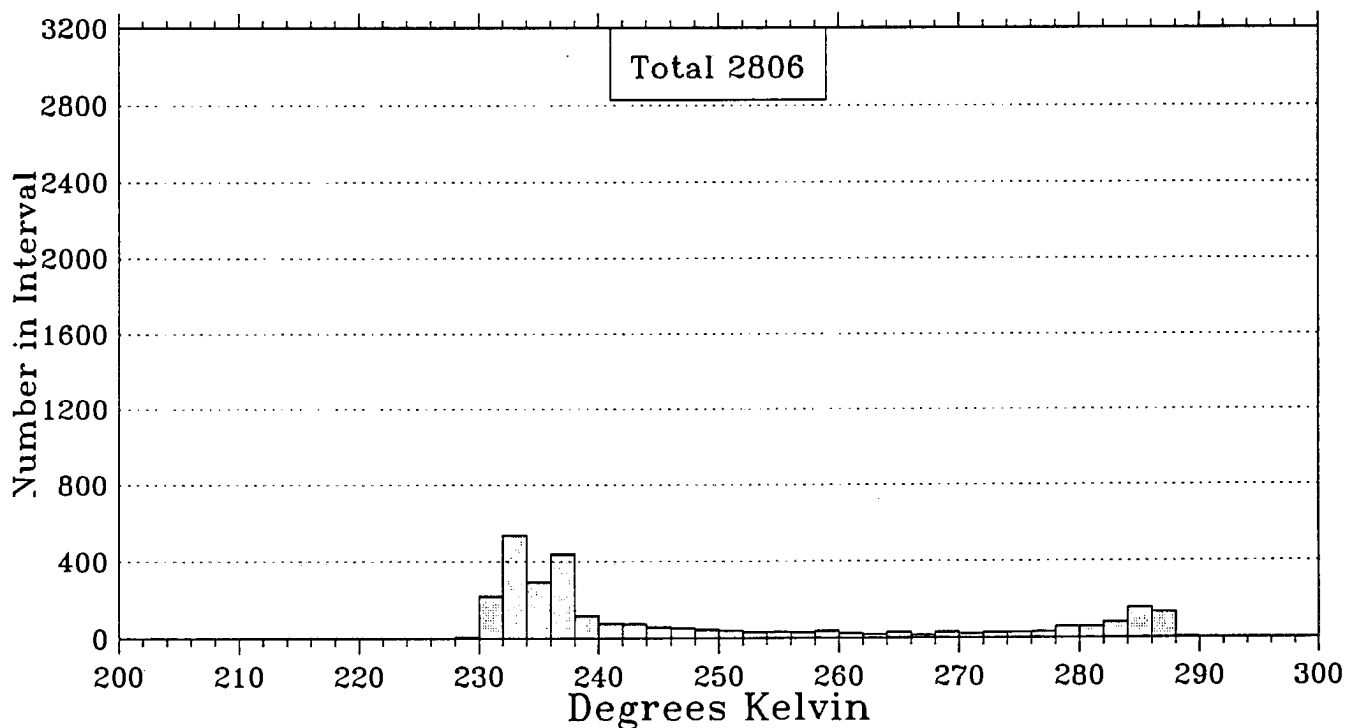


29 June Ceiling, Brightness Temperature Frequency

Ceiling by LIDAR (50m Intervals; 1440 Samples/Day)



11 μ m Equivalent Brightness Temperatures (2°K Bins; 8640 Samples/Day)



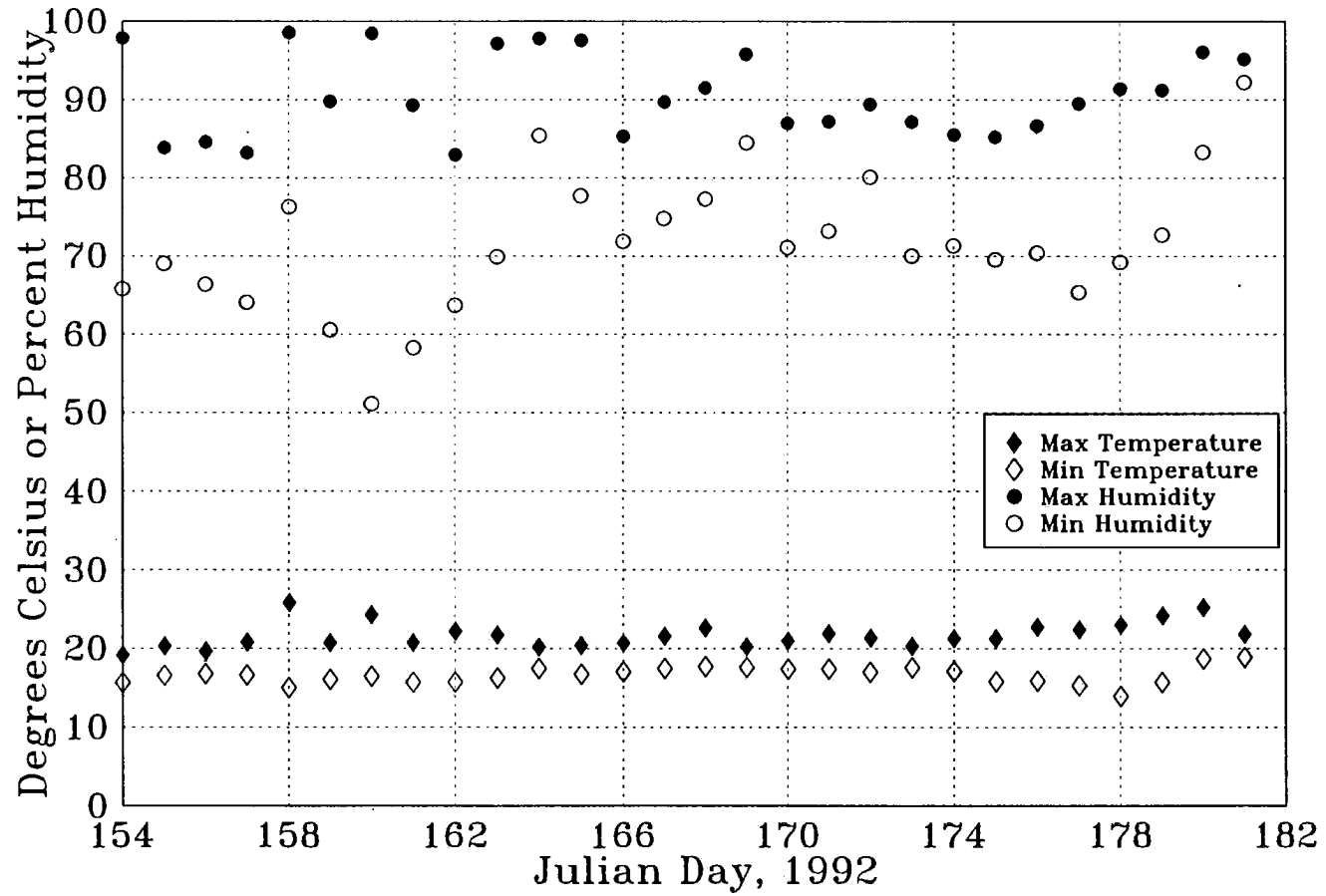
7. Frequency Distributions for the Experiment

The figures on pages 135 to 144 display variables for the 28 day experiment period. These analyses show the daily variability of the meteorological, radiation and cloud parameters over the course of the experiment.

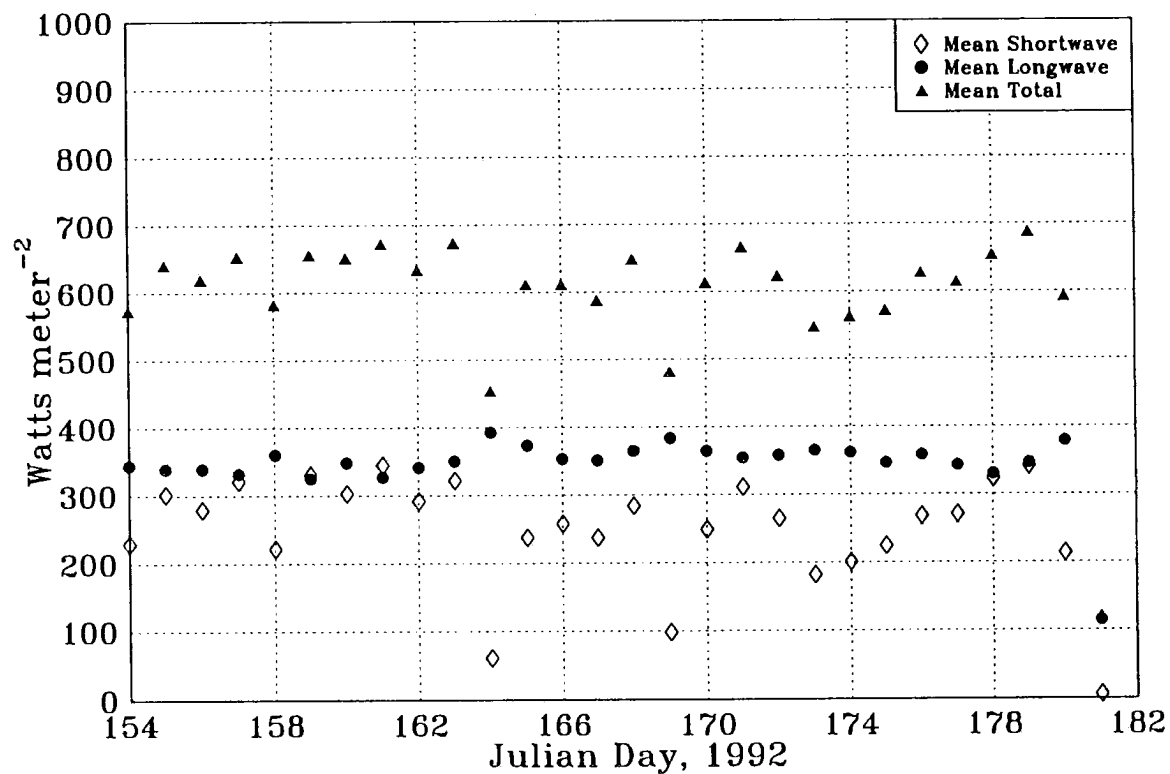
Data are presented in several ways: time series, frequency distributions, mean values and standard deviations. The histograms show a statistical summary over the period from June 1 to June 28, 1992 of the eight variables plotted in sections 2 and 3. Each histogram plot shows the frequency of occurrence over a range of measurements. The ordinate represents the actual number of occurrences of the measurements in a particular bin over the entire period. The range and units of the abscissa depend on the variable plotted. Bin sizes vary from plot to plot in order to resolve as much structure in the histogram as possible.

In each plot, the mean value over the period is shown in the box at the top center with the standard deviation in the measurements printed below. In the top right box, the total number of occurrences in the histogram is shown. This number is less than the total possible due to instrument power losses or data collection failures. In the histogram of measured ceilings on page 144, the number of plotted values is the total number of measurements minus the clear number. The number of occurrences outside the plotted range, if any exist, is shown in the box at the top right corner of each plot.

Daily Temperature and Relative Humidity Extrema



Daily Mean Downwelling Fluxes

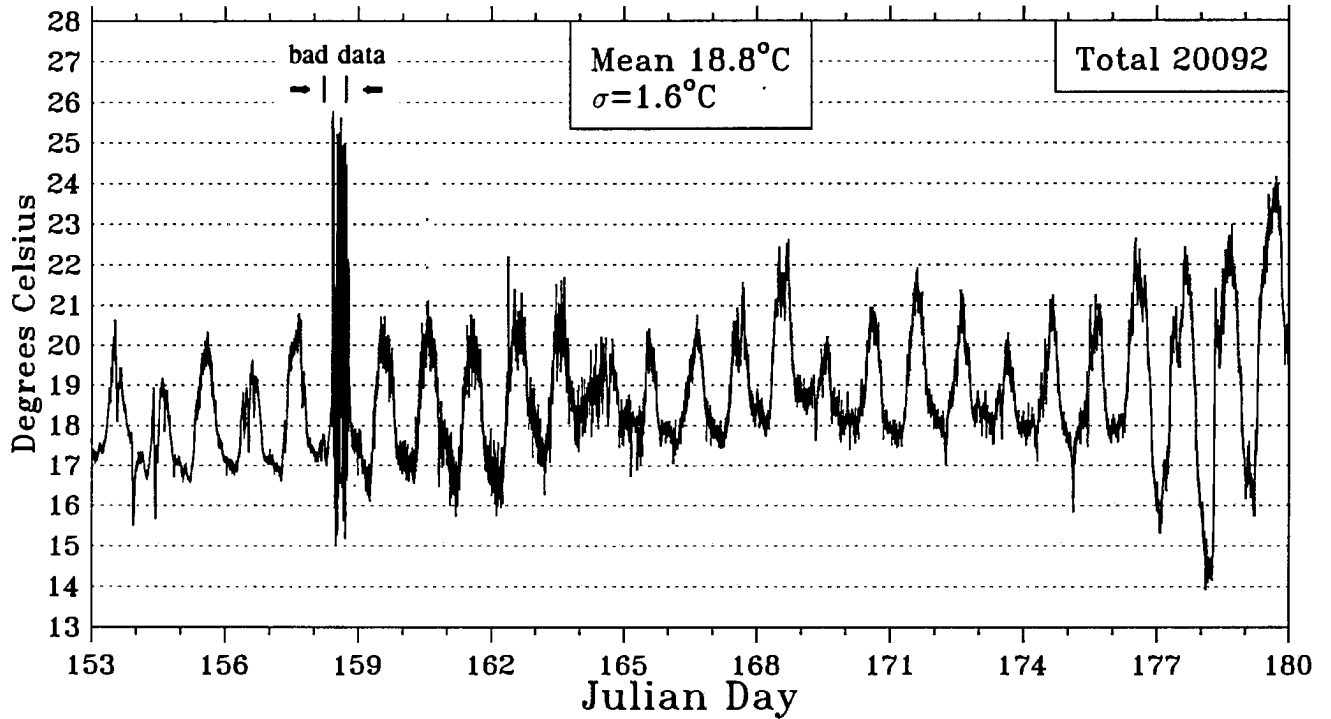


Mean and Standard Deviation
of Daily Averages

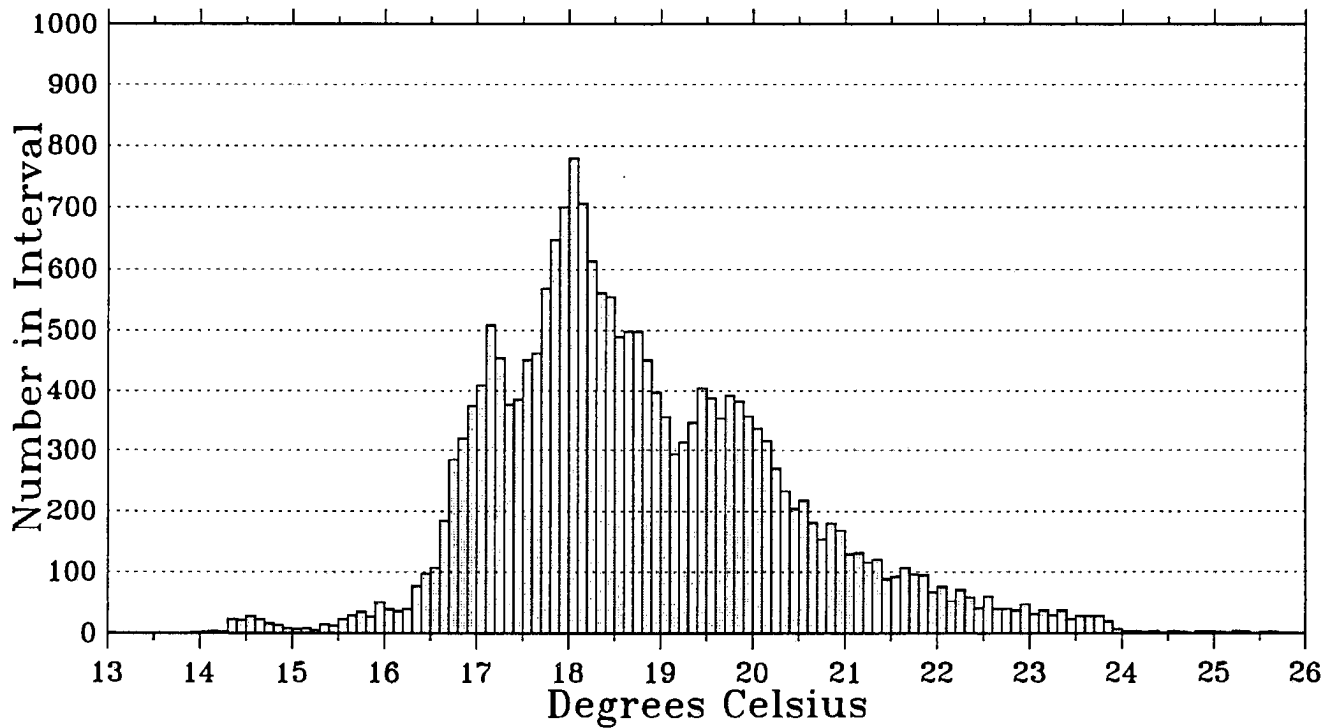
	Mean w m ⁻²	Std. Deviation w m ⁻²
Solar	258.1	68.2
Longwave	353.1	16.8
Total	611.2	70.2

1-28 June Surface Temperature

Surface Temperature (720 Samples/day)

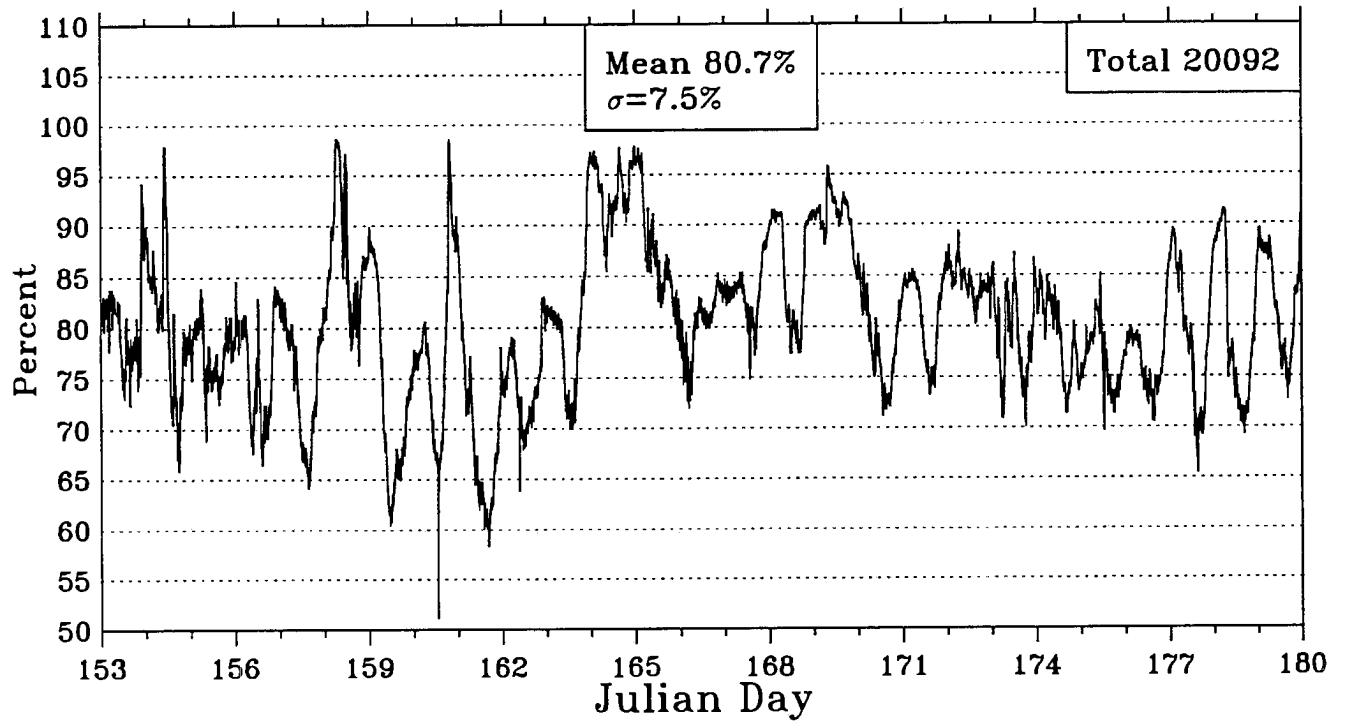


Surface Temperature Occurrence Histogram (0.1°C Intervals)

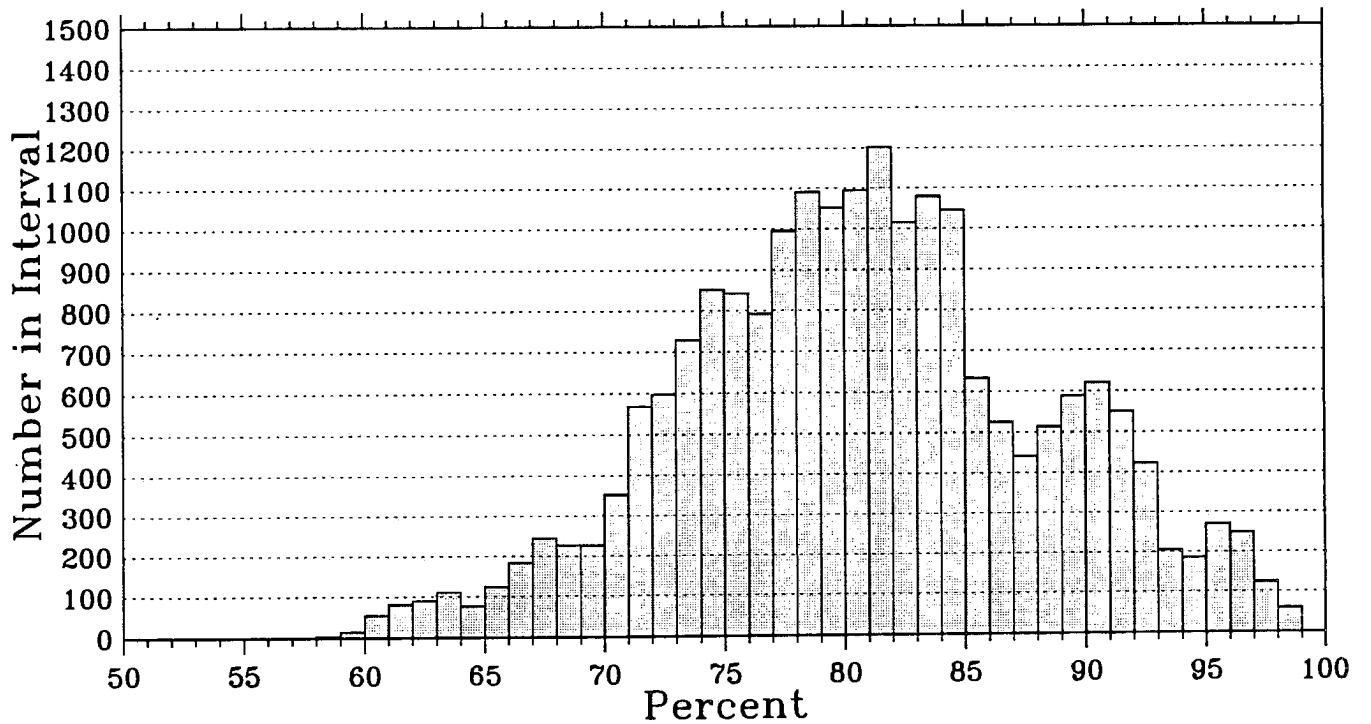


1-28 June Relative Humidity

Relative Humidity (720 Samples/Day)

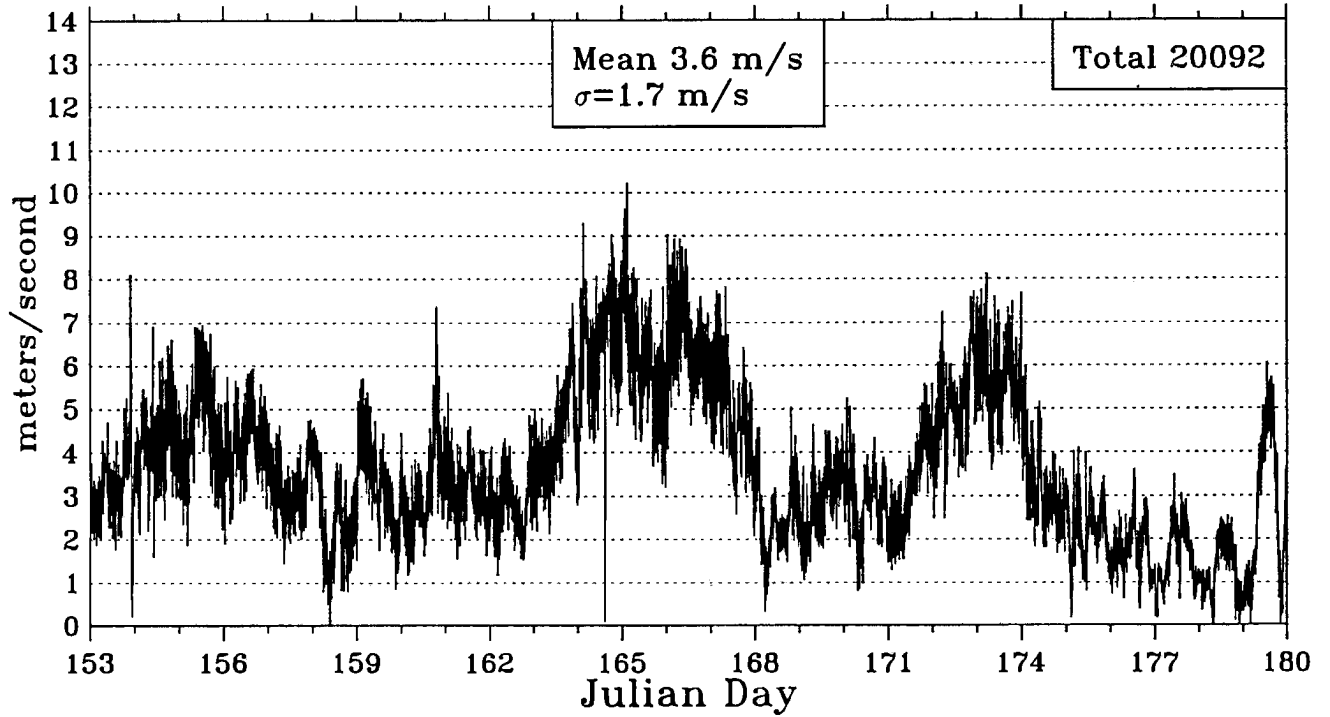


Relative Humidity (1% Intervals)

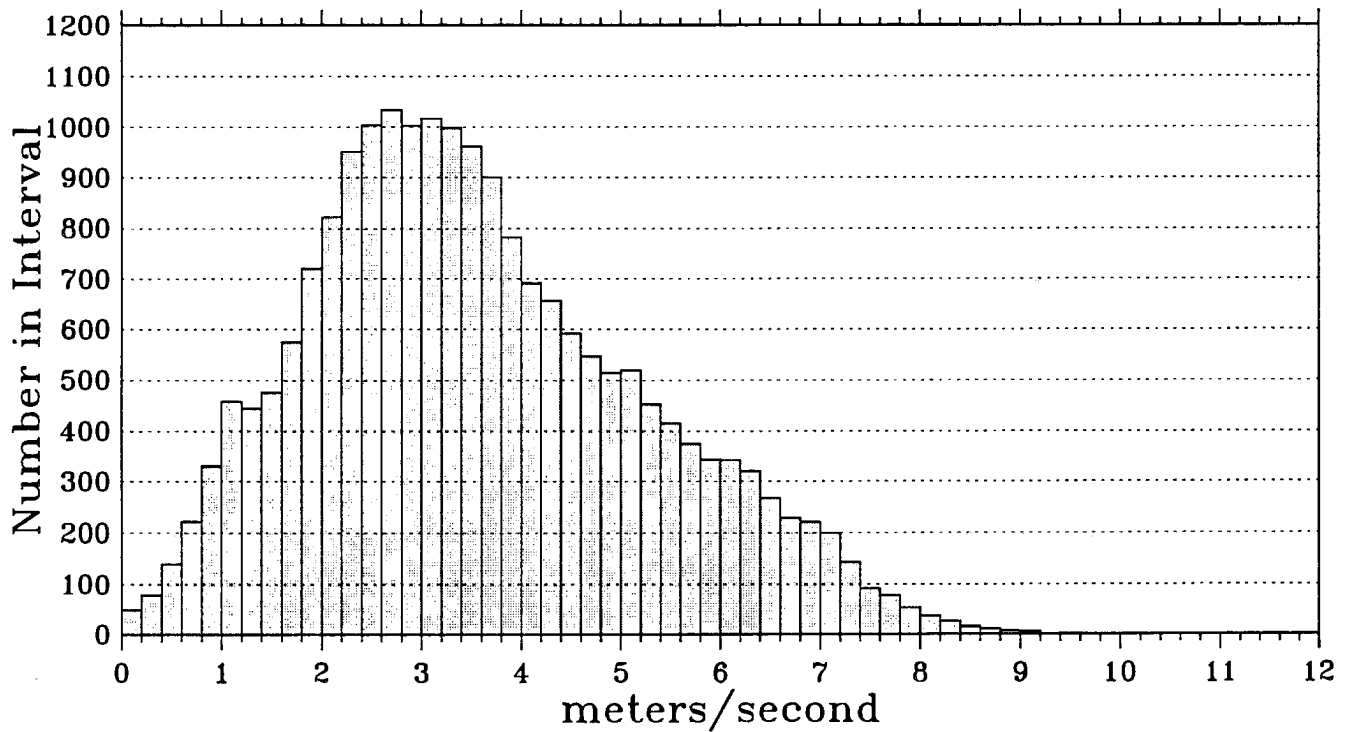


1-28 June Surface Wind Speed

Deviation of the Wind Speed (0.2 m/s Intervals)

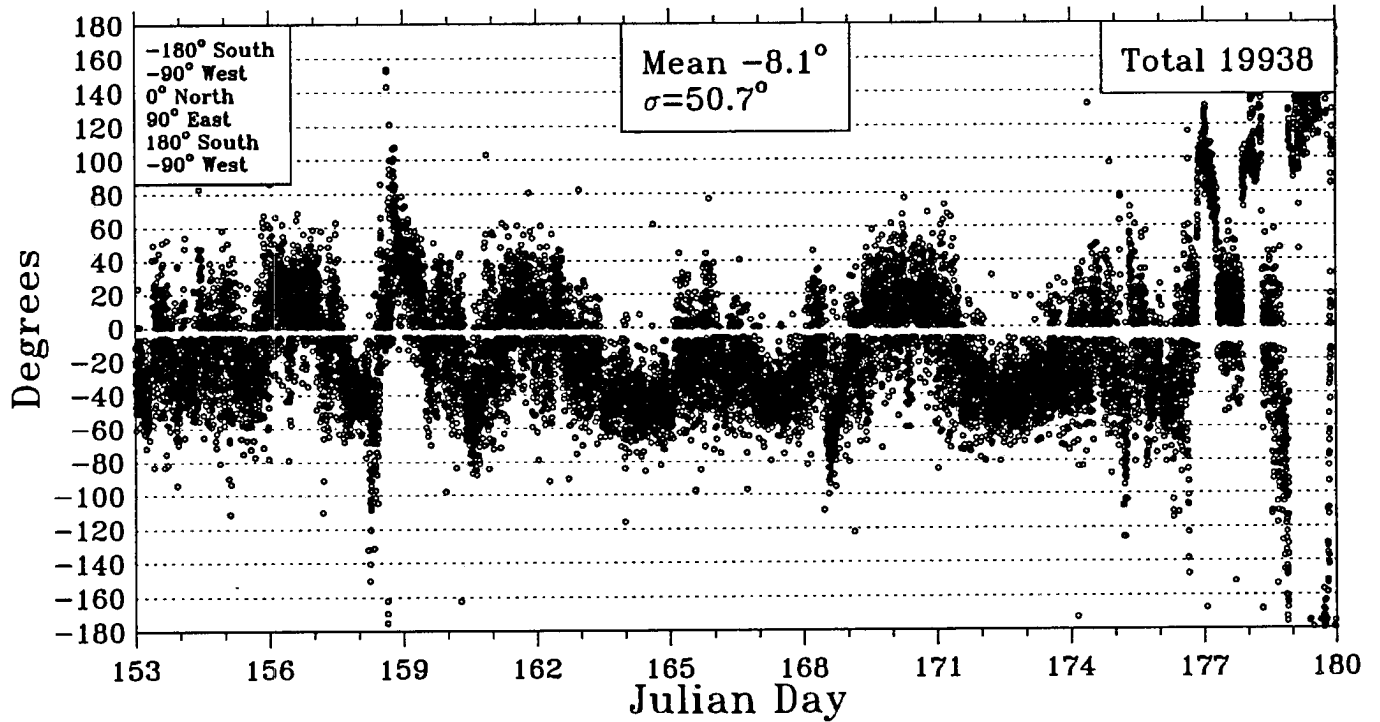


Wind Speed (0.2 m/s Intervals; 720 Samples/Day)

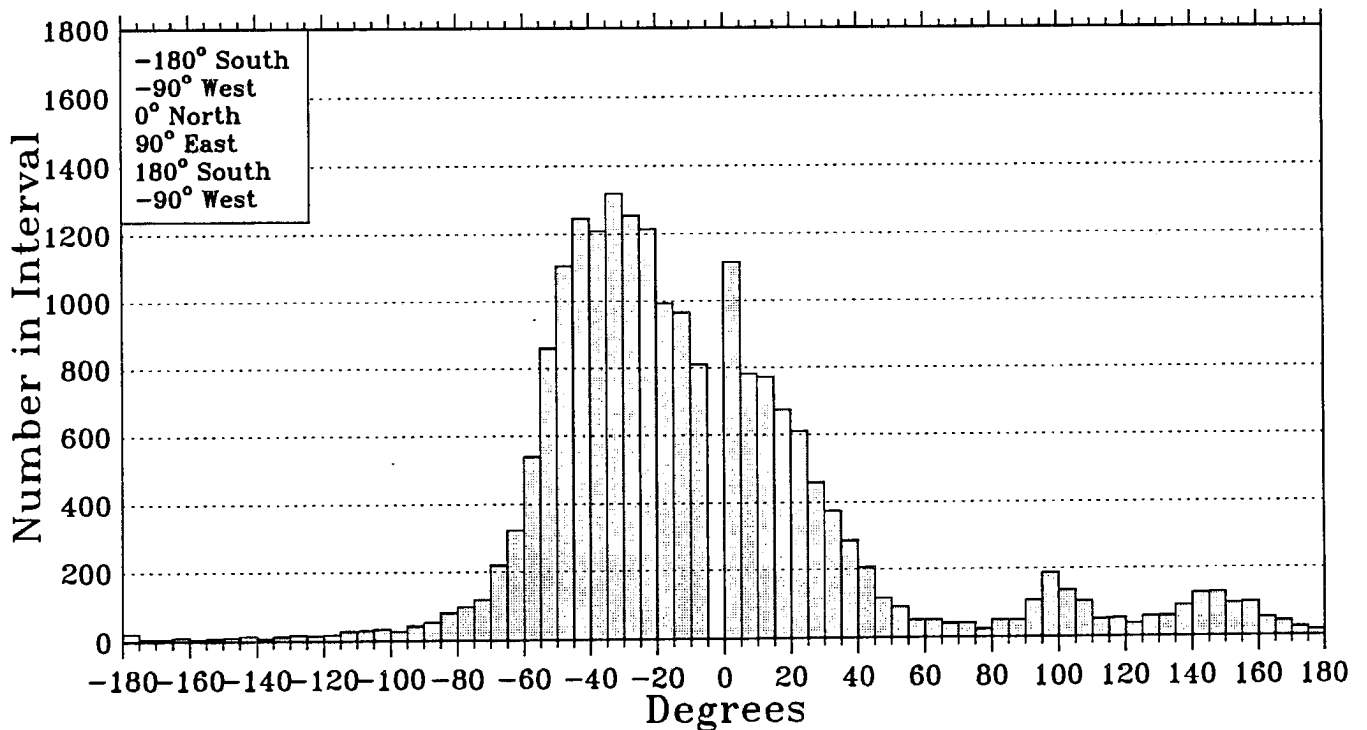


1-28 June Surface Wind Direction

Wind Direction (720 Samples/Day)

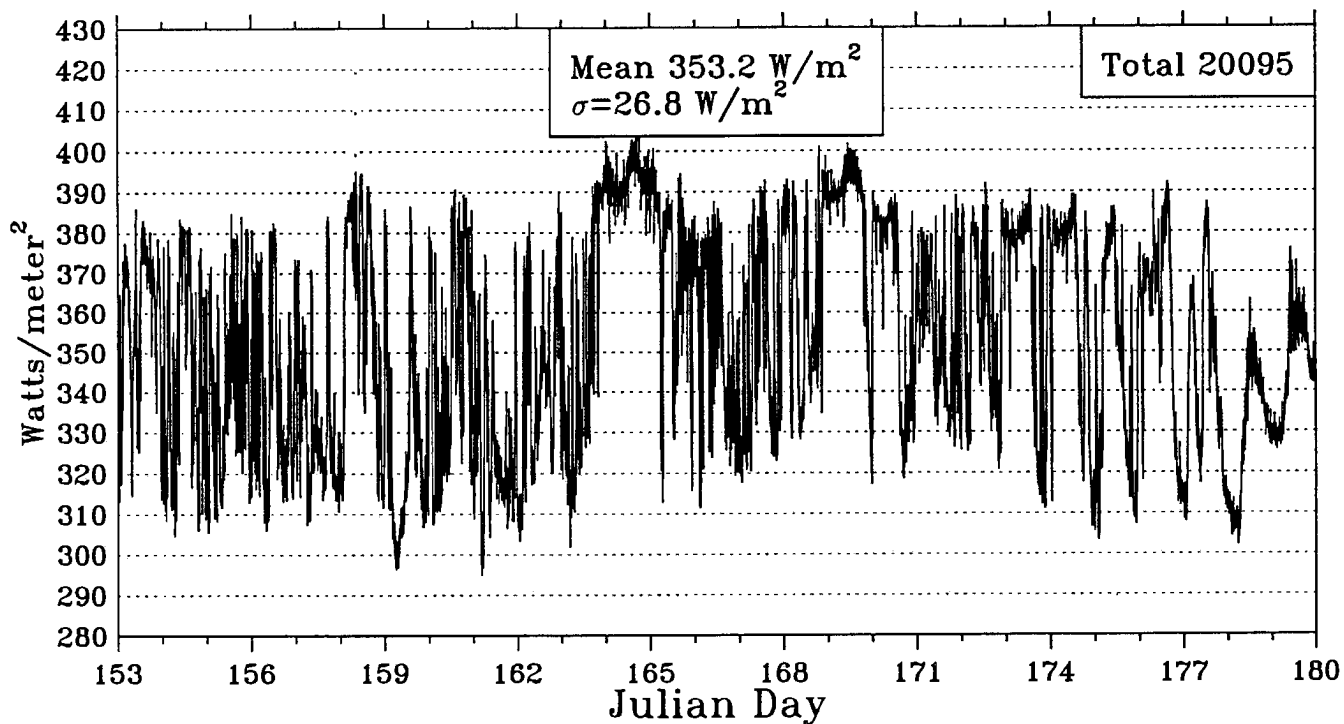


Wind Direction (5° Intervals; 720 Samples/Day)

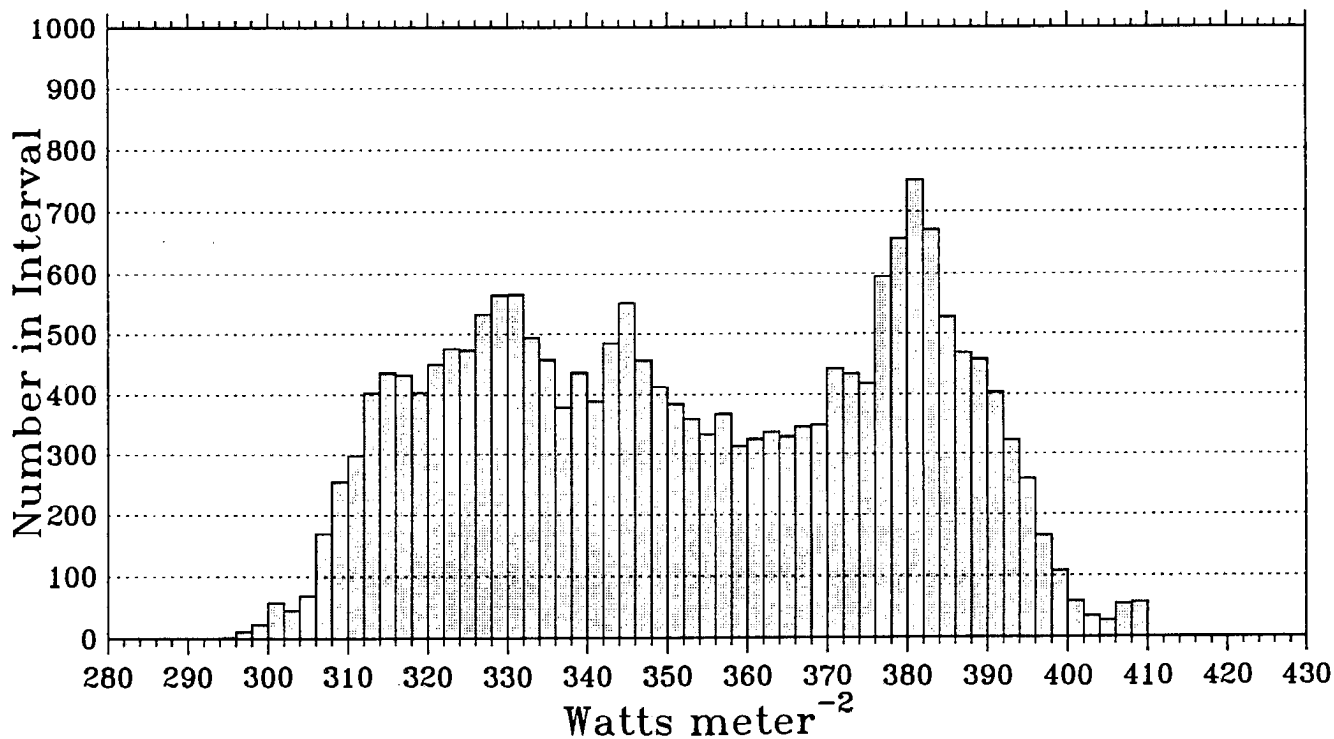


1-28 June Infrared Irradiance

Infrared Irradiance (720 Samples/Day)

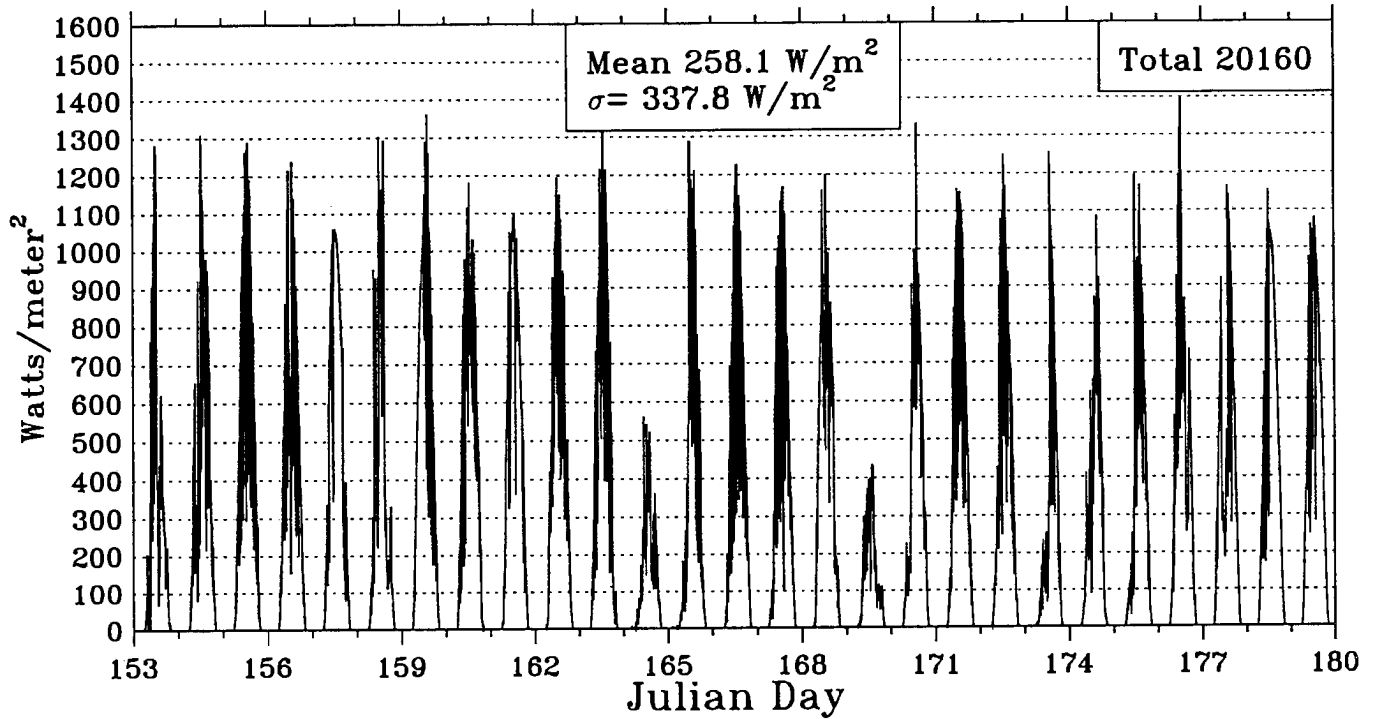


IR. Irradiance Occurrence Histogram (2 W/m² Intervals)

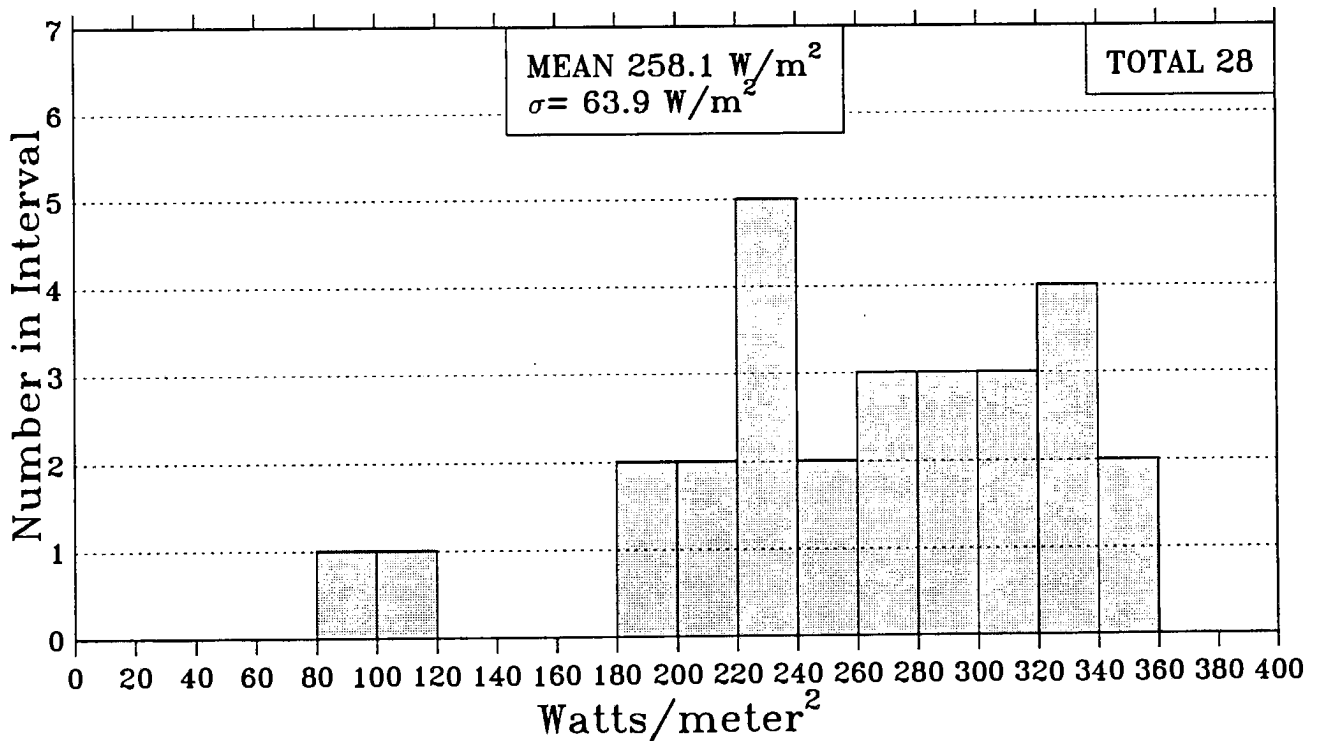


1-28 June Solar Irradiance

Solar Irradiance (720 Samples/Day)

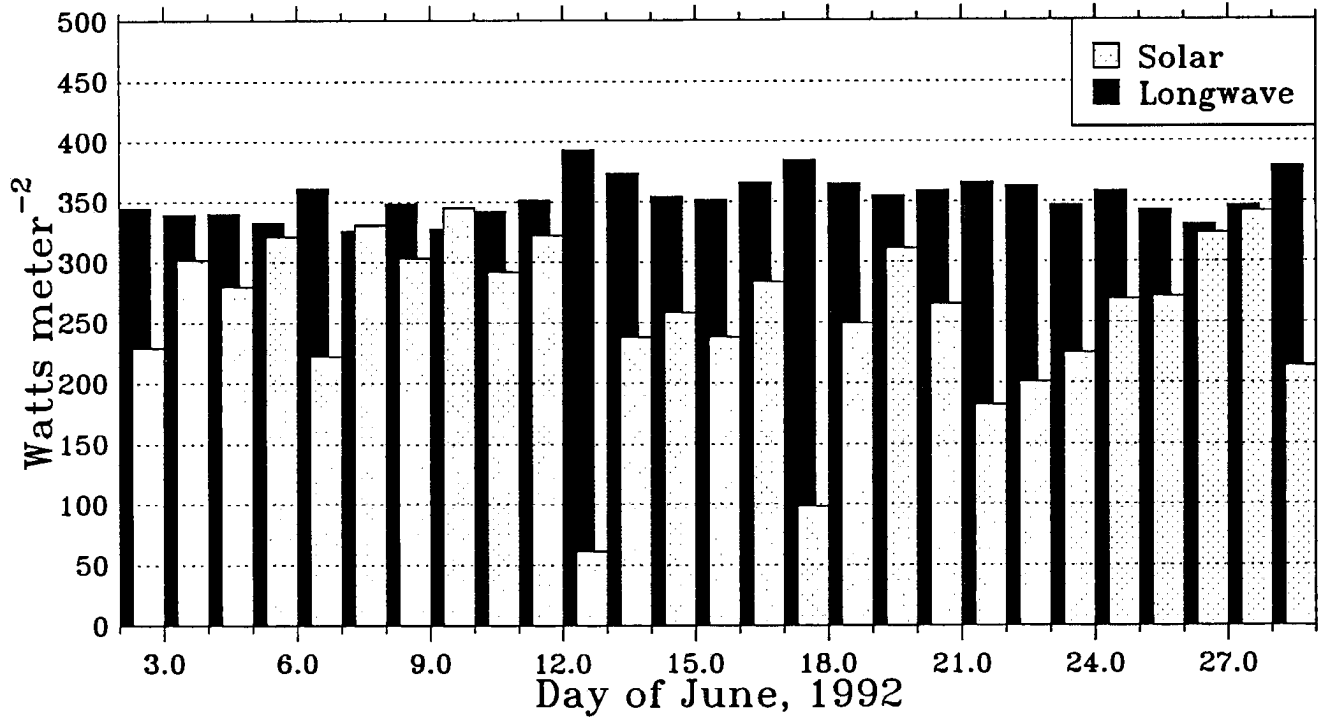


Mean Daily Solar Irradiance Occurrence Histogram (20 W/m² Intervals)



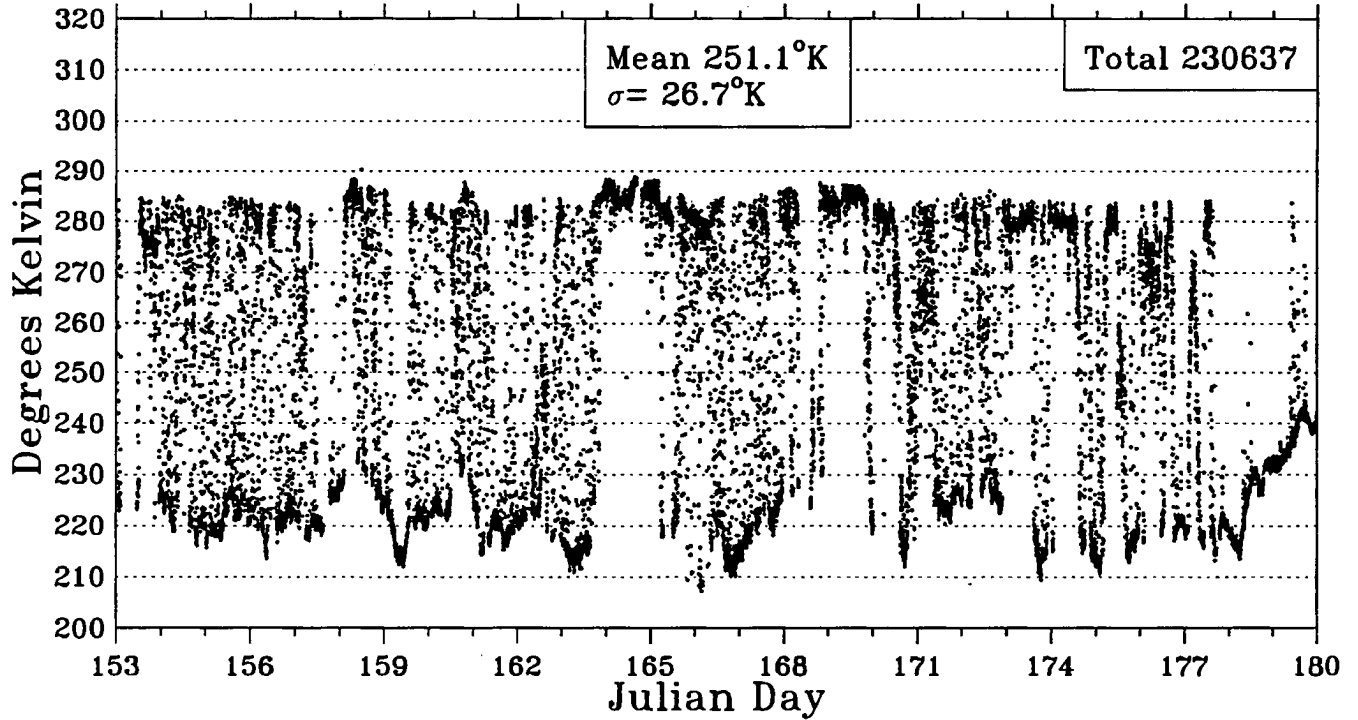
1-28 June Daily Mean Downwelling Irradiance

Mean Solar and Longwave Irradiance

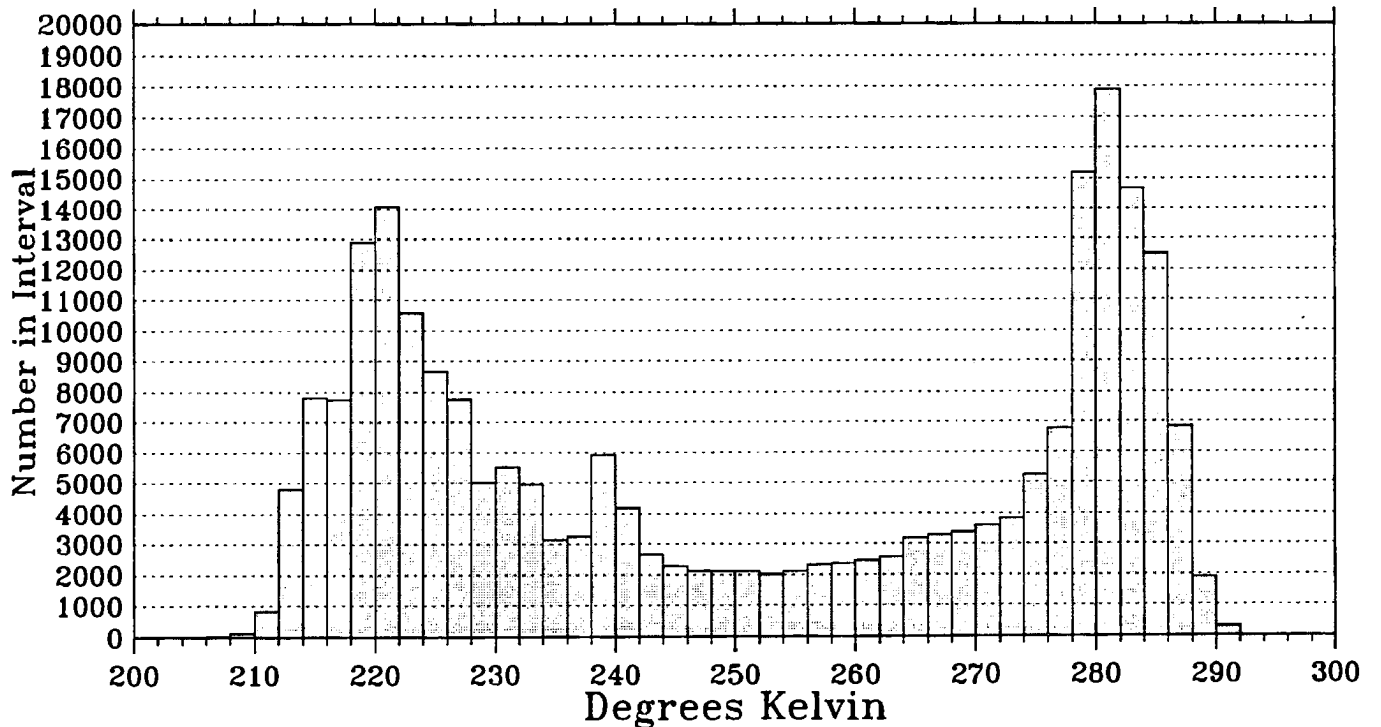


1-28 June 11 μ m Equivalent Brightness Temperature

11 μ m Brightness Temperature (8640 Samples/Day)

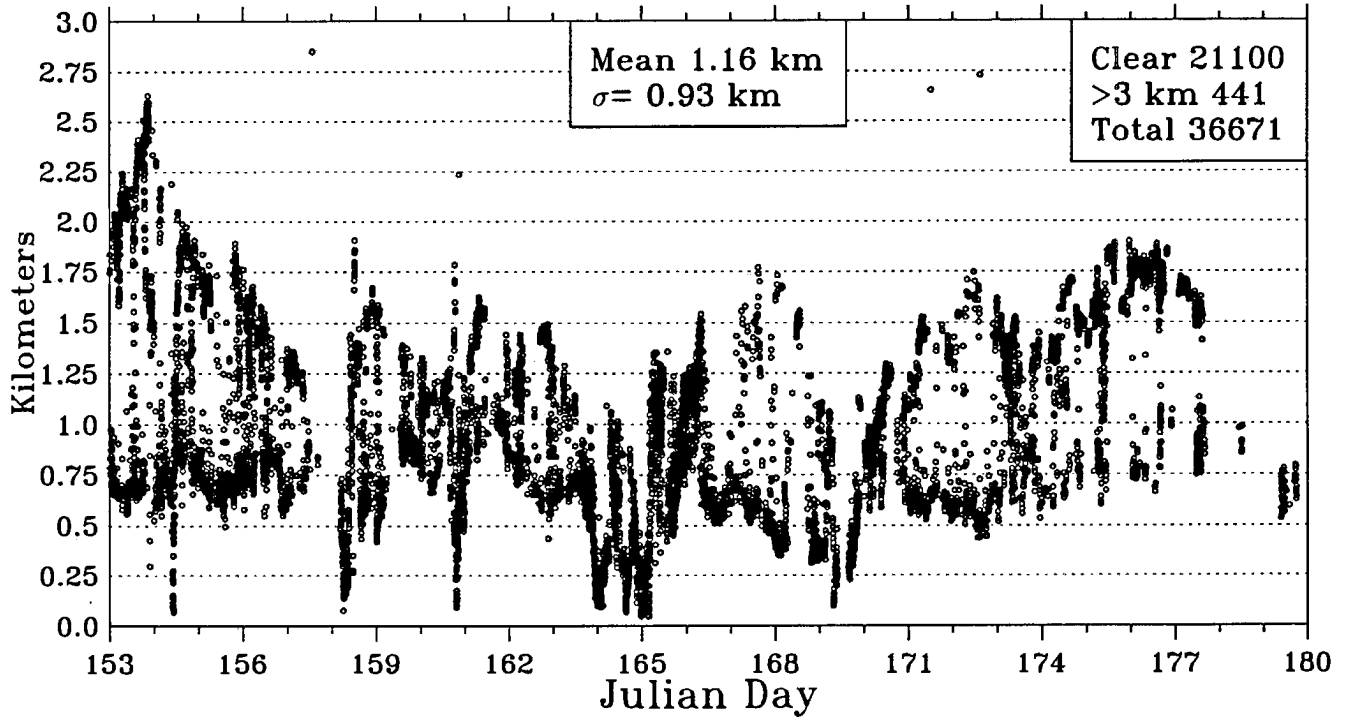


11 μ m Brightness Temperature Occurrence Histogram (2°K Bins)

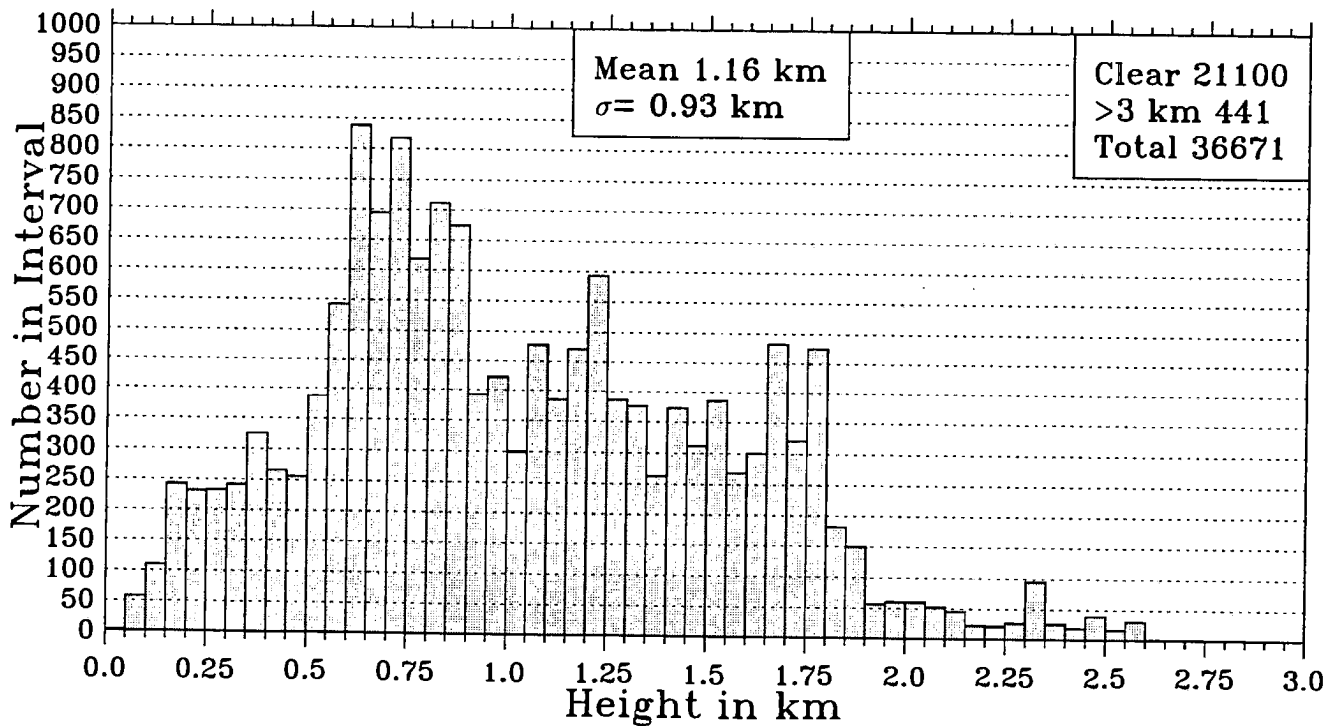


1-28 June Ceiling Measurements

Ceiling (1440 Samples/Day)



Ceilings (50m Intervals; 1440 Samples/Day)



8. Acknowledgements

We wish to acknowledge the following individuals for the key roles they played in the deployment and data acquisition phases of ASTEX: P. Anikin, C. Cornwall, J. Davis, P. Hein, J. Kleist, T. McKee, D. Randall, W. Schubert and D. Wood. Our appreciation also goes to Melissa Tucker for her efforts on our behalf while we were in the field and in organizing and assembling this manuscript.

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APPENDIX A: RAWINSONDE ASCENT TIMES AND COMMENTS

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
1	June 01	02:03	03:05	18.5	Good flight 70mb
2	June 01	04:56	05:35	12.0	Temperature and RH quit at 200mb just like #1.
3	June 01	08:04	09:16	22.0	1st sonde bad; good flight 40mb.
4	June 01	10:55	12:04	23.9	Lost AFC near 150mb to 30mb
5	June 01	14:00	14:56	17.8	Lost T and DP at 90mb
6	June 01	16:56	18:19	26.0	Good flight. Launch at 5:57. Reached 30mb at 7:15 Cut off at 21 mb.
7	June 01	23:01	23:46	13.5	Drizzle/15min(heavy). Good flight.
8	June 02	05:02	05:28	9.9	Lost track at launch until 895mb. Balloon burst at 280mb.
9	June 02	07:58	09:20	24.3	Launch at 8:58. Had to change pressure because it was a approx. 6 mb off.
10	June 02	10:57	12:19	23.9	no comment
11	June 02	16:57	18:18	22.6	Sonde in and out about 135mb due to 13 degree elev. and 120 azimuth (behind mountain).
12	June 02	20:08	21:12	19.5	Difficulty in getting signal strength large enough. Had to turn off and on again. Lost track at launch; used manual to acquire.
13	June 02	23:28	00:16	14.1	Flight good. Terminate to get report.
14	June 03	01:52	02:36	12.7	Lost at launch;got back at 990mb. Good flight, lost T, RH at 200mb.
15	June 03	04:57	05:20	6.1	Launch fine. Frequency shift: 1680-1671 prior to launch; 1671-1666 so quickly AFC missed. Balloon burst at 147mb.
16	June 03	07:57	09:09	22.1	no comment
17	June 03	11:02	12:14	20.9	1st balloon had holes
18	June 03	16:57	17:27	7.8	1st hydrogen balloon
19	June 03	23:05	00:15	20.7	Sonde seemed erratic went OK
20	June 04	05:00	06:13	21.3	Bad wind. Auto track stuck on hill. Good flight-50mb.
21	June 04	07:57	09:09	23.8	no comment
22	June 04	11:01	12:14	25.0	no comment

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
23	June 04	14:01	15:16	24.3	no comment
24	June 04	16:50	18:15	25.5	no comment
25	June 04	22:51	00:10	24.9	Perfect flight
26	June 05	05:05	06:16	21.5	1 balloon broke. 3/4 full. Launch good
27	June 05	07:55	09:06	23.7	no comment
28	June 05	10:51	12:15	24.7	no comment
29	June 05	13:50	15:15	25.3	no comment
30	June 05	16:47	18:02	24.8	no comment
31	June 05	22:55	00:12	24.8	Winds below 700mb questionable. Signal strength was low and tracking was to SW but balloon was to SSE.
32	June 06	05:02	06:17	21.5	Drizzle during second half of flight. Turned to light rain at 06:05.
33	June 06	07:58	09:15	20.7	no comment
34	June 06	10:51	12:06	24.5	no comment
35	June 06	13:46	15:03	25.3	Some data lost in stratosphere
36	June 06	16:54	18:14	22.2	Debris 10% Sc,Cu 50%
37	June 06	23:03	23:30	7.7	Could not auto track. No wind data. Flight terminated early.
38	June 07	04:59	06:44	25.2	Good launch. Auto track acquired after about 100m height. Balloon burst at about 13 mb.
39	June 07	08:06	09:28	26.5	Clear sky
40	June 07	10:56	12:17	24.5	Some data lost below about 100m height. Cu 5%, Cist 10%.
41	June 07	16:49	17:48	19.1	30% Cu, watched balloon go through cloud edge
42	June 07	22:51	00:19	22.0	Fractional cloudiness was small at launch but balloon went right up through a low cloud. Some interesting behavior of T & RH at cloud top-perhaps due to sensor wetting.
43	June 08	04:56	06:42	15.0	This sounding was made with a low ascent rate (2.1 m/s) in lower half. An excellent sounding with much detail.
44	June 08	08:30	09:50	26.0	Delayed launch due to generator maintenance. 30% Cu

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
45	June 08	10:57	12:14	24.1	30% Cu here, stratus to north
46	June 08	13:59	15:44	25.3	Thin Sc
47	June 08	16:50	18:12	20.0	Sc and Cu
48	June 08	22:48	00:19	19.5	Light rain at 12:31 winds around 140 mb and above have low elevation.
49	June 08	01:44	04:04	24.9	Winds above 100 mb look questionable due to low elevation. Burst at 19mb.
50	June 09	04:53	05:21	5.8	Did not auto track at launch but was acquired in first 200m. Sonde had very low signal. Lost it at 500m.
51	June 09	08:05	09:17	19.3	Bad humidity sonde, not aspirated
52	June 09	11:07	12:13	18.6	no comment
53	June 09	14:07	15:18	22.5	no comment
54	June 09	17:03	18:08	20.8	1st sonde bad: no signal
55	June 09	22:52	23:31	11.7	Radar has 15km region over us. No drizzle at launch; very light when sonde at 650 mb. Good sounding to 319 mb, but suddenly quit there.
56	June 09	01:52	03:21	24.0	Excellent flight. Burst at about 30mb.
57	June 10	04:55	05:47	14.5	Good sounding. Sonde quit at about 150mb.
58	June 10	07:54	09:14	25.1	Surface levels lost. Opr error
59	June 10	13:03	14:28	23.5	no comment
60	June 10	16:55	18:16	26.2	no comment
61	June 10	19:42	21:28	25.5	Scattered Cu, some Cist. Lost first 300m.
62	June 10	22:47	00:15	24.2	Dark, light shower
63	June 10	02:01	03:57	28.9	Cu. Burst at about 15 mb
64	June 11	04:49	06:13	21.3	Mostly clear
65	June 11	08:09	09:18	17.5	Ceiling 8:14:03 888 mb Cu hum
66	June 11	11:03	12:19	22.7	Cu hum
67	June 11	14:03	15:19	18.9	Cu hum

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
68	June 11	16:53	18:17	21.7	Sc
69	June 11	20:05	21:17	9.9	Cu, Ci, St. Lost signal for awhile, twice.
70	June 11	22:46	00:05	20.8	Drizzle
71	June 12	01:50	03:36	24.5	Drizzle
72	June 12	04:45	06:17	23.0	Cloudy
73	June 12	08:07	09:18	18.2	Cloudy - adjusted pressure
74	June 12	10:51	12:19	26.3	Cloudy
75	June 12	13:51	15:19	26.1	Cloudy - rain
76	June 12	16:52	18:17	20.8	Cloudy
77	June 12	20:06	21:23	17.3	Sc
78	June 12	22:49	00:15	21.0	Drizzle
79	June 13	01:53	03:14	11.4	Drizzle. Humidity not good
80	June 13	05:38	06:39	17.0	Clear Sc Software problem-delayed launch.
81	June 13	07:50	09:28	25.3	Good sounding to 30mb
82	June 13	10:47	12:19	23.4	Good sounding
83	June 13	14:01	15:32	24.7	Good sounding to 30mb
84	June 13	16:52	18:20	22.0	Good sounding to 41mb
85	June 13	19:58	21:29	23.5	Sc, RH suspect in upper troposphere.
86	June 13	22:59	00:17	21.0	Sc, dramatic RH drop in above cloud, RH suspect again - very low in mid troposphere.
87	June 14	01:52	03:25	27.7	Sc BINOVC similar to last sounding.
88	June 14	05:42	06:17	7.9	Sc BINOVC; RH<95% in cloud; ceilometer cloud base=1100m, ceilometer cloud top=1400m.
89	June 14	07:54	09:25	26.4	Good sounding up to 150mb. Signal weak above this. Burst at 32mb.
90	June 14	10:52	12:10	16.4	Hygristor shield fell off at launch. Radiation error in humidity? Signal lost at 100mb.
91	June 14	13:53	15:37	25.3	Good sounding to 12.4mb
92	June 14	16:47	18:20	22.4	Did not auto track at launch but acquired in about 30s.
93	June 14	20:09	22:00	25.3	1st sonde stopped transmitting at launch. 2nd launch accomplished to 16mb.
94	June 14 June 15	23:00	23:59	16.6	Cu. RH no good above 320mb? Cu hum. Balloon burst and sonde fell at 534 mb.

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
	June 15				Cu hum. RH no good above 350 mb?
	June 15				Cu hum. Good winds to >50 mb. RH no good above 320 mb?
95	June 15	07:57	09:13	15.3	Cu and St
96	June 15	10:50	12:19	25.4	Cu, haze
	June 15				Broken Sc, haze
97	June 15	16:56	18:19	15.8	Cu, some
98	June 15	19:49	21:41	25.3	Cu; balloon burst at 12.8 mb
	June 15				Cu to Sc. Balloon sank at 764 mb
99	June 15	23:32	00:19	17.6	Sc. Pressure bad <310 mb
100	June 16	01:58	03:18	21.7	Sc. lost at first, recovered by 1 min
101	June 16	04:54	06:24	21.9	Cu fra
102	June 16	07:58	09:34	25.4	Broken Sc. Did not auto track at launch. Lost lowest few hundred meters
103	June 16	10:55	12:19	17.2	Few ragged looking Cu
104	June 16	13:47	15:49	30.0	Scattered Cu and haze
105	June 16	16:56	18:14	15.4	Cu, haze
106	June 16	20:17	21:29	20.9	Cu fra, hum
107	June 16	22:52	00:18	23.2	Overcast, occasional drizzle
108	June 17	01:56	03:08	21.0	Overcast
109	June 17	04:52	06:18	24.1	Overcast
110	June 17	08:04	09:25	18.1	Overcast stratus; drizzle
111	June 17	10:53	12:14	18.7	Overcast stratus
112	June 17	13:54	15:29	23.7	Overcast
113	June 17	16:59	18:18	13.0	Complete overcast of stratus
114	June 17	19:59	21:11	20.7	Intermittent sonde. Partly cloudy
115	June 17	22:51	00:15	21.2	Mostly clear
116	June 18	01:49	03:13	22.7	Cloudy
117	June 18	04:53	06:11	22.9	Cloudy
118	June 18	07:53	09:46	28.0	St
119	June 18	10:55	12:41	27.9	St
120	June 18	13:54	15:28	22.1	Cloudy
121	June 18	16:51	18:17	17.4	Scattered Cu, mostly clear

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
122	June 18	20:01	21:18	21.0	Mostly clear. Lost at 90 mb, regained at 69 mb.
123	June 18	22:49	00:15	23.4	Cloudy
124	June 19	01:54	03:15	23.6	Thin clouds
125	June 19	04:53	05:54	16.3	Cloudy. Lost then reacquired sonde at launch. Sonde lost due to interference at 1671 MHz.
126	June 19	07:53	10:00	25.9	Overcast 5000 ft. Some low cloud at 3000 ft. Sonde reached 11.1 mb.
127	June 19	10:54	12:21	14.8	Scattered 2/10 5000 ft, 1/10 1500 ft.
128	June 19	13:57	15:49	25.3	50% cloud cover. Good sounding to 11.9 mb.
	June 19				10% cloud cover. Balloon burst (or leak) at 890 mb. Launched 2nd balloon.
129	June 19	17:07	18:20	16.6	10% cloud cover
	June 19				Bad sonde or something
	June 19				Bad sonde
130	June 19	20:48	22:12	22.9	Launch occurred at 20:50 GMT. Lots of trouble with other two.
131	June 19	22:53	00:11	21.9	no comment
132	June 20	01:57	03:03	17.2	no comment
133	June 20	04:54	05:55	17.4	no comment
134	June 20	07:41	09:54	31.4	Cu with St above. Reached 10.2 mb.
135	June 20	10:44	12:17	22.7	Ci and Cu
136	June 20	13:45	15:44	27.0	Broken St
137	June 20	16:46	18:19	22.6	Cu, Ci
138	June 20	19:59	21:21	18.6	Cu 5%, Haze
139	June 20	22:57	23:52	12.5	Balloon burst at 190 mb
140	June 21	02:03	04:14	25.4	no comment
141	June 21	04:58	06:18	20.8	Stratus 4200-4700 ft. Terminated at 50 mb.
142	June 21	07:51	09:10	22.7	Stratus; drizzle at 8:23Z
143	June 21	10:48	12:16	13.4	Stratus
144	June 21	13:52	14:51	13.4	Cu, broken, high stratus (next to last brown balloon).
145	June 21	16:56	18:20	14.9	Cu
146	June 21	19:45	21:16	21.8	Broken Cu. Light drizzle on launch
147	June 21	22:54	00:14	22.3	Drizzle
148	June 22	01:54	03:42	22.6	Noisy hygistor
149	June 22	04:58	06:18	20.8	Stopped at 50 mb. Overcast, light drizzle.

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
150	June 22	07:39	09:24	25.2	Cu with St above
151	June 22	10:45	12:14	25.4	Cu with St above
152	June 22	13:44	15:20	23.9	Cu with St above
153	June 22	16:41	18:32	23.6	Thin Sc, some thicker blobs
154	June 22	20:01	21:56	23.8	Cu, St
155	June 22	22:53	00:16	19.2	no comment
156	June 23	01:51	03:21	22.0	no comment
157	June 23	04:52	06:02	21.1	no comment
158	June 23	07:49	08:55	20.1	Cu below St. Lowest 50 mb lost
159	June 23	10:47	12:00	21.9	Light rain. Cu below St.
160	June 23	13:47	15:38	24.5	Broken Sc
161	June 23	16:51	18:08	22.4	Ci and some Cu
162	June 23	19:56	21:03	19.8	Cu
163	June 23	22:50	00:01	21.2	no comment
164	June 24	01:50	02:38	13.8	Widely scattered Cu. Lost signal at 139 mb.
165	June 24	05:04	06:16	22.2	Thin stratus
166	June 24	07:51	09:04	23.0	Cloud base at 857 m. Data gap near 200 mb.
167	June 24	10:44	11:48	21.7	Cu below St
168	June 24	13:54	15:16	22.5	Cu below St. Some holes
169	June 24	16:46	18:08	23.2	Cu penetrating into a broken layer cloud at 2000 ft. Bad pressure sensor.
170	June 24	19:57	21:16	15.2	Few scattered Cu 5%
171	June 24	22:58	00:15	18.8	Clear
172	June 25	01:44	03:23	22.0	Clear
173	June 25	04:58	06:15	22.2	Thin stratus
174	June 25	07:49	09:07	21.7	Sonde intermittent above 200 mb
175	June 25	10:51	12:03	22.6	no comment
176	June 25	13:51	14:53	21.5	no comment
177	June 25	16:47	18:15	24.1	no comment
178	June 25	19:44	21:32	25.1	Mostly clear
179	June 25	22:46	00:20	22.5	Clear
180	June 26	01:48	03:32	24.6	Clear. Can see stars. A little foggy at surface. RH decreased with height.
181	June 26	04:37	06:07	23.4	Clear. May be thin surface inversion. RH decreased with height initially again.
182	June 26	07:49	09:04	22.3	Lost tracking in lowest 50 mb
183	June 26	10:55	12:07	22.2	no comment
184	June 26	13:51	15:08	23.6	Did not autotrack at launch but regained in 30 s.
185	June 26	16:48	17:49	21.6	Lost track in lowest 50 mb
186	June 26	19:51	20:59	22.5	Almost completely clear
187	June 26	22:51	00:48	25.9	Clear

Sounding Number	Date	Start Time (UTC)	End Time (UTC)	Maximum Altitude (km)	Observer's Comments
188	June 27	01:59	03:17	22.8	Did not autotrack at launch but regained at about 900 mb. AFC failed between 500 mb and 425 mb.
189	June 27	04:49	06:04	22.0	Less than 10% cloud cover
190	June 27	07:50	09:02	21.1	Severe clear
191	June 27	10:49	11:54	21.1	no comment
192	June 27	13:51	14:45	17.6	Ci. Mostly clear. Lost at 83 mb. Vapor=3.69.
193	June 27	16:40	17:21	11.4	Hygristor cover fell off at launch. 4 balloons!
194	June 27	20:08	21:28	21.5	Clear except St on N horizon. Lost hygristor cover.
195	June 27	22:59	00:19	17.8	Very clear
196	June 27	01:48	03:20	22.5	No visible cloud
197	June 28	04:50	06:13	21.4	No cloud
198	June 28	07:46	09:12	23.3	Did not autotrack at launch, regained in about 10s.
199	June 28	10:45	12:04	21.2	Cumulus scattered. Sonde entered cloud soon after launch (about 300 mb).
200	June 28	13:48	15:18	23.3	Scattered Cu
201	June 28	16:47	18:05	22.0	Cloud overhead with breaks to the North.
202	June 28	20:14	21:54	22.6	Broken St
203	June 28	22:53	00:25	21.0	Cloudy; RT failed to track but we regained. Did not lose signal. Winds garbage, below 750 mb.

