Long Term Measurement Network for FIFE

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by
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Introduction

A long-term measurement network for obtaining various meteorological parameters was established during FIFE. The measured parameters are listed in Tables 1 and 2:

Table 1. Parameters measured at all long-term measurement stations.

Automatic Meteorological Stations (AMS)

Symbol	Parameter	Resolution	Accuracy
T_a	Air temperature	0.1 °C	± 0.25 °C
q	Humidity (psychrometer-nonfreezing; solid state freezing conditions)	1%	± 5%
u	Wind speed (2 or 3 components)	0.1 m sec^{-1}	5% (.5 m sec^{-1} startup)
T_d	Soil temperature (-.1 and -0.5 m)	0.1 °C	± 0.25 °C
R_r	Reflected solar radiation	1%	5%
R_n	Net radiation	1%	5%
T_s	Surface temperature	0.1 °C	± 1.0 °C
P	Precipitation	1 mm	5%
*S_m	Soil moisture	1%	2%

* Measured weekly or more frequently at each site.

Table 2. Additional parameters measured at four super-AMS sites.

Super Automatic Meteorological Stations (SAMS)

Symbol	Parameter	Resolution	Accuracy
R_S	Global radiation	1%	2%
R_D	Direct solar radiation	1%	5%
R_d	Diffuse solar radiation	1%	3%
PAR	Photosynthetically active radiation (0.4 - 0.7 um) (direct and diffuse)	1%	2%
R_{Lw}	Longwave radiation	1%	5%

A total of 16 AMS and super AMS stations were established. There were two types of AMS measurement systems: (1) Portable Automated Mesometeorological (PAM) stations supplied by the National Center for Atmospheric Research and (2) Data Control Platform (DCP) stations supplied by the U. S. Army Corps of Engineers. Initially, there were 10 PAM stations and 6 DCP stations. Due to problems with some of the DCP stations, two additional PAM stations were installed to replace two DCP stations before the beginning of Intensive Field Campaign number 4 (IFC-4), in October, 1987.

The network was established to: (1) measure the microclimatic variability within and across the FIFE research area; (2) provide input data for numerical simulation models; and, (3) collect broad band reflected and emitted radiation to help evaluate satellite imagery. Data collected by the network are important for extrapolating observations made at the various Bowen ratio energy balance and eddy correlation sites to other areas within the FIFE research area and to provide estimates of important radiation, energy and mass fluxes during periods not covered by the Intensive Field Campaigns. In addition, data collected at some stations serve as input into the calculation procedures of certain investigators, as well as providing comparison information for data collected with other measurement systems. Data collected by the network are vital to the accomplishment of the FIFE goal to validate certain algorithms, which use airborne and surface data, for relating land surface processes to satellite radiances.

The objectives of this specific project were: (1) to obtain selected instruments which were not standard equipment on the PAM and DCP stations; (2) to assist in incorporation of these instruments onto the PAM and DCP stations; (3) to help provide routine maintenance of the instruments; (4) to conduct periodic instrument calibrations; and (5) to repair or replace malfunctioning instruments when possible.

Materials and Methods

The University of Nebraska purchased all additional radiation and meteorological instrumentation required to make the measurements specified in Tables 1 and 2 that were not being made on the PAM or DCP stations. These additional instruments and the parameters they measured are listed in Table 3:

Table 3. Type and number of additional instruments and parameters measured.

Instrument Type	Number of Instruments	Parameter measured
Omega Thermistor #44301	36	Soil temperature
Eppley Precision Spectral Pyranomter	16	Reflected solar radiation
Micro Met Net Radiometer	18	Net radiation
Everest Model 4001 Infrared Transducer	16	Surface temperature
Li-Cor Quantum Sensor	8	Direct, diffuse and total solar radiation
Li-Cor PAR Sensor	8	Direct, diffuse and total Photosynthetically Active Radiation (PAR)
Shadow Bands	8	Needed to separate, diffuse & direct solar and PAR radiation
Eppley Pyrgeometer	4	Long Wave Radiation

Instrument stands to accommodate the additional instruments were made by NCAR for the PAM stations and by the University of Nebraska for the DCP stations. Those instruments attached to the PAM stations become part of the permanent inventory of NCAR once the FIFE studies are complete, while those attached to the DCP stations become the property of the University of Nebraska.

Personnel from NCAR, the University of Nebraska and Kansas State University had the primary responsibility for setting up and maintaining the

instruments listed in Table 3. In order to insure proper performance of the instruments, it was necessary to visit each site at least once a month. For those sites designated as super AMS sites (i.e. stations measuring the parameters listed in Table 2), it was necessary to make visits about three times a week to adjust shadow bands and make other necessary observations. During monthly visits to the sites, the dessicant was changed in the net radiometers, the pyranometers and the pyrgeometers. At the same time, output from the Everest infrared transducers was checked against surface temperature readings made with a hand-held infrared thermometer and also periodically against a blackbody source. All instruments were cleaned and leveled. The orientation of the instruments was checked and corrected, if necessary. Whenever instrument malfunctions were detected, a visit to the station to correct the problem was made as soon as possible.

Calibration of all net radiometers, pyranometers and pyrgeometers will be accomplished before the onset of the growing season in 1988.

Results and Discussion

In order to facilitate incorporation of all instrumentation onto the PAM and DCP stations, instruments were ordered in the fall of 1986. With the exception of the pyrgeometers and the soil thermistors, all instruments were procured and sent to NCAR and the Army Corps of Engineers before January 1, 1987. It was necessary to return the Everest surface temperature sensors to the factory for the purpose of making modifications for compatibility with the data logging systems. The soil thermistors were sent before February 1, 1987. The pyrgeometers, due to some manufacturing problems, were not received until late April 1987. Subsequently, the late arrival of the pyrgeometers did not permit their calibration before installation in the field. By the time of installation of the PAM and DCP stations in the field, all of our instruments and radiation masts were on hand, checked out and ready to be installed.

Installation of the PAM stations began in mid-April 1987, and was completed in early May. Several problems arose in the installation of the DCP stations and, in fact, the two super DCP stations were never fully operational. As a result, it was necessary to connect some of the instruments in Table 1 and those listed in Table 2 to Campbell CR21-X data loggers supplied by the University of Nebraska. After some initial problems, the CR21-X's began collecting data on May 30. As problems with the DCP's were supposedly corrected, most of the instruments were taken off the CR21-X logger during IFC 2, except for the pyrgeometers. However, problems persisted with the two super DCP stations and the instruments were removed and again placed on the CR21-Xs during IFC 3 and continued on them until the end of September when two additional PAM stations were installed as replacements for the two super DCP's.

Data collected by the CR21-X loggers are currently being checked and evaluated to identify and eliminate, where possible, errors in the data. After this analysis is done, the corrected data will be placed into the FIFE data system. Examples of data collected by both CR21-X loggers for Day 227 (August 14, 1987) are shown in Figs. 1-18. Analysis of the information contained in these Figures is not germane to this report, but two observations should be made about the data. First, the data for the pyrgeometers (Figs. 11-16) have not been converted from the raw data into parametric form because the instruments have not yet been calibrated to permit conversion of the raw numbers into infrared radiances. Plans have been made to make these pyrgeometer calibrations according to procedures described by Albrecht et al (1974) and Albrecht and Cox (1977) in early March, 1988. Secondly, although not specified in Table 1 or 2, dew data were collected during part of the growing season at the request of some of the science investigators. Examples of the dew data are presented in Figs. 17 and 18.

Conclusions and Future Work

All of the objectives stated in this proposal as part of the long-term measurement network for FIFE have been or soon will be met. All instruments and necessary instrument stands were purchased or made and were available for inclusion on the PAM and DCP stations before the beginning of the IFC-1. Due to problems beyond our control, the DCP stations experienced considerable difficulty in becoming operational and in being able to collect data from many of the desired instruments. To fill some of the gaps caused by the DCP problems, we installed Campbell CR21-X data loggers and collected data on cassette tapes. These data have been converted to parametric form and are currently being examined to eliminate errors before being sent to the FIFE information system.

Periodic checks of all instruments have been made, primarily by personnel from the University of Nebraska and Kansas State University to maintain data quality, to make necessary adjustments in certain instruments, to replace malfunctioning instruments, and to provide instrument calibration. All instruments will be calibrated before the beginning of the 1988 growing season as soon as the weather permits access to all stations and provides conditions that are not too harsh to work in for extended periods of time. Since funding for this project terminates in March, 1988, operating and travel funds to continue the routine maintenance and calibration of the AMS instruments will be included as a part of an ongoing FIFE grant awarded to the University of Nebraska.

Literature Cited

Albrecht, B., M. Poellot and S. K. Cox. 1974. Pyrgeometer measurements from aircraft. Rev. Sci. Instrum. 45:33-38.

Albrecht, B. and S. K. Cox. 1977. Procedures for improving pyrgeometer performance. J. Appl. Meteorol. 16:188-197.

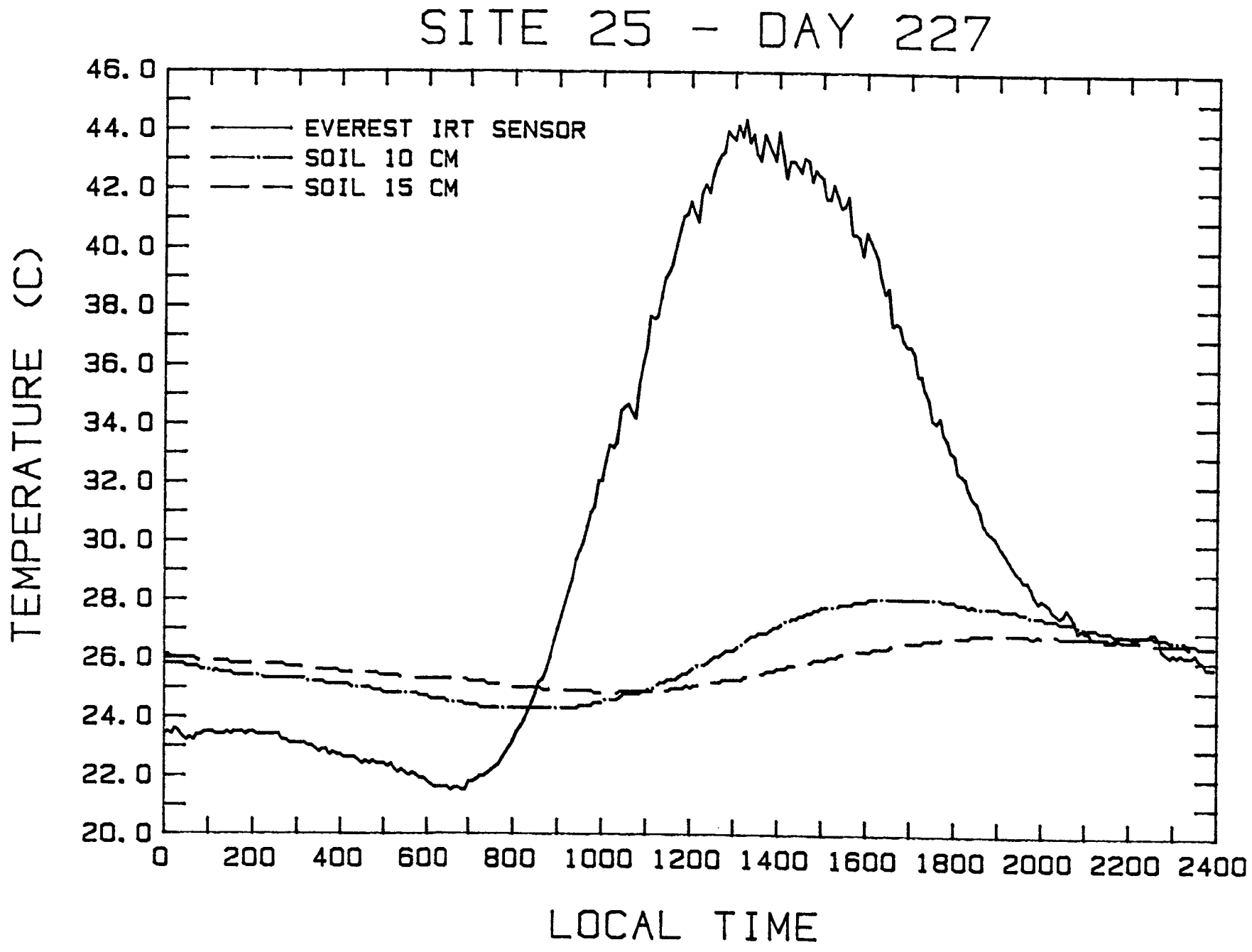

Fig. 1. Daily pattern of surface temperature sensed by the Everest Infrared Transducer and soil temperature at 10 and 15 cm depths on Day 227 (August 14), 1987 at FIFE site 25.

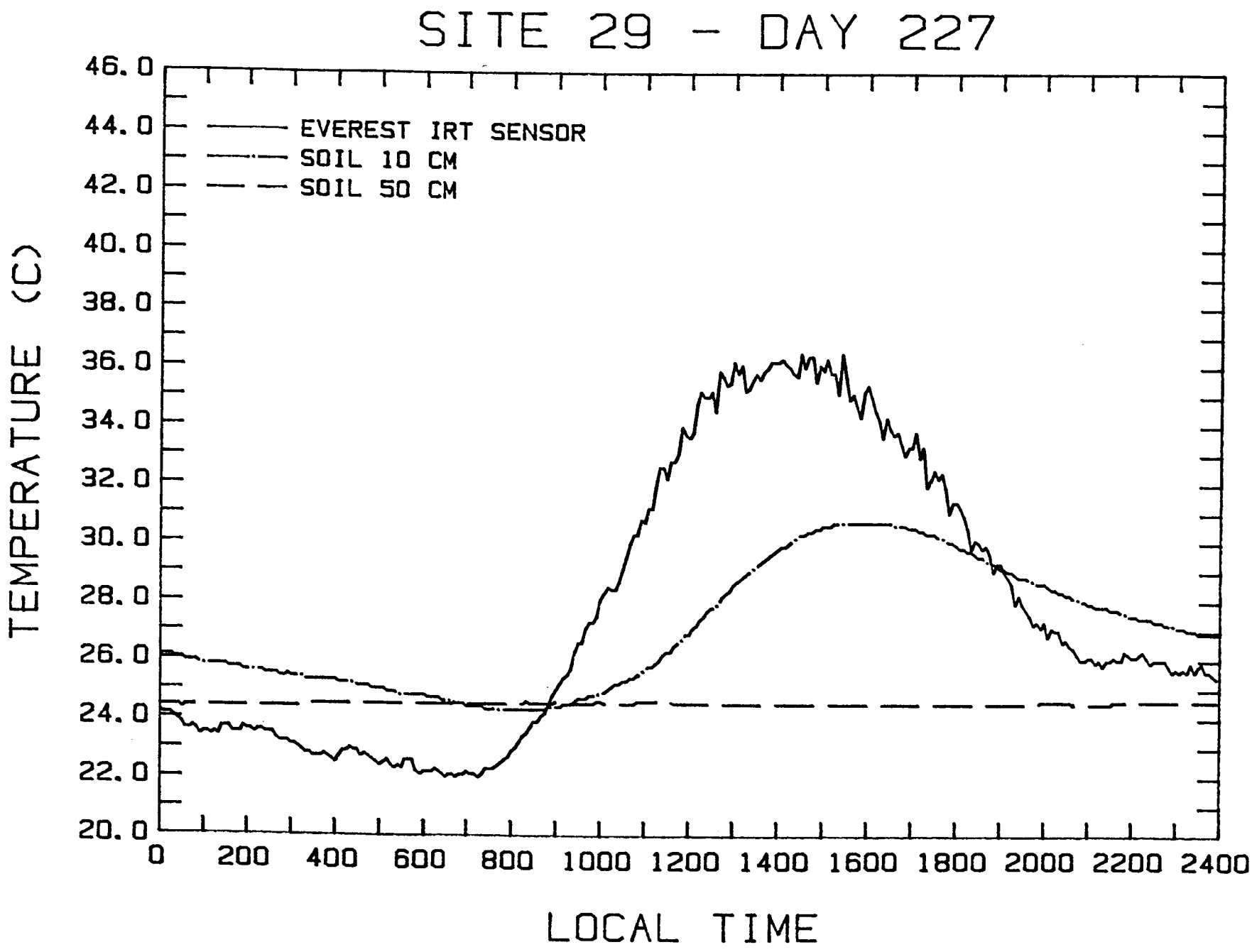

Fig. 2. As in Fig. 1 for FIFE site 29.

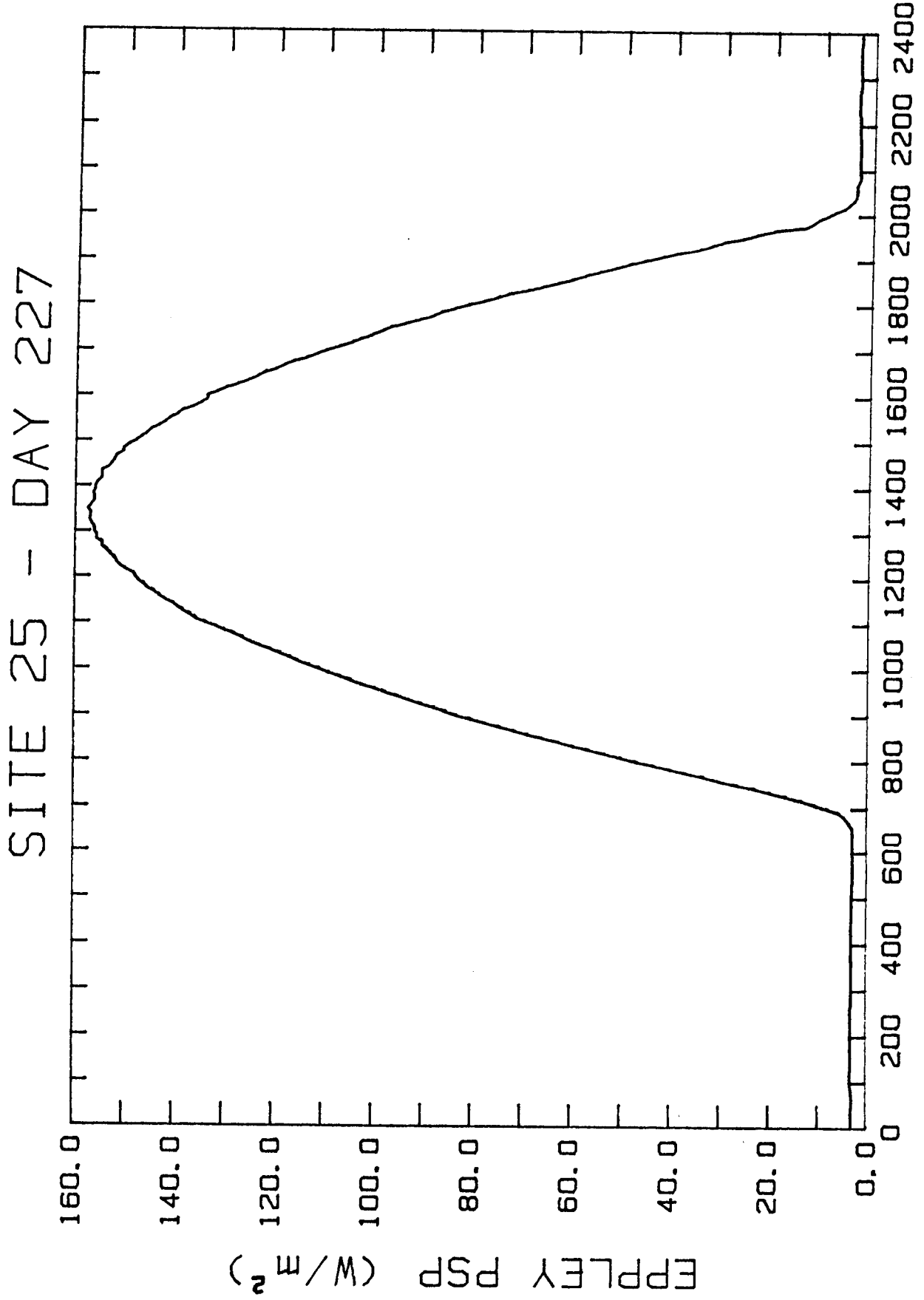

Fig. 3. Daily pattern of reflected solar radiation measured with an inverted Eppley Precision Spectral Pyranometer (PSP) on Day 227 (August 14), 1987 at FIFE site 25.

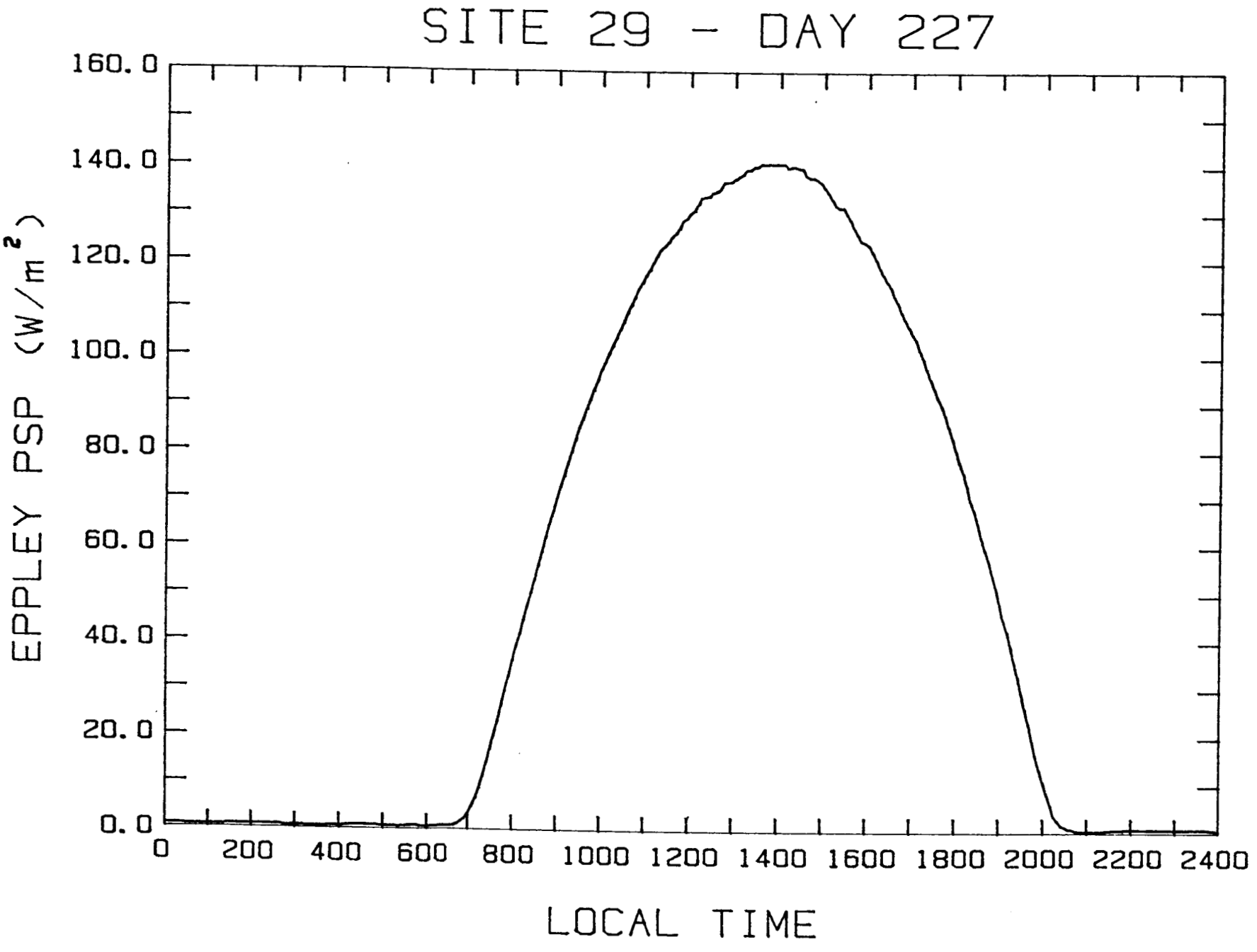

Fig. 4. As in Fig. 3 for FIFE site 29.

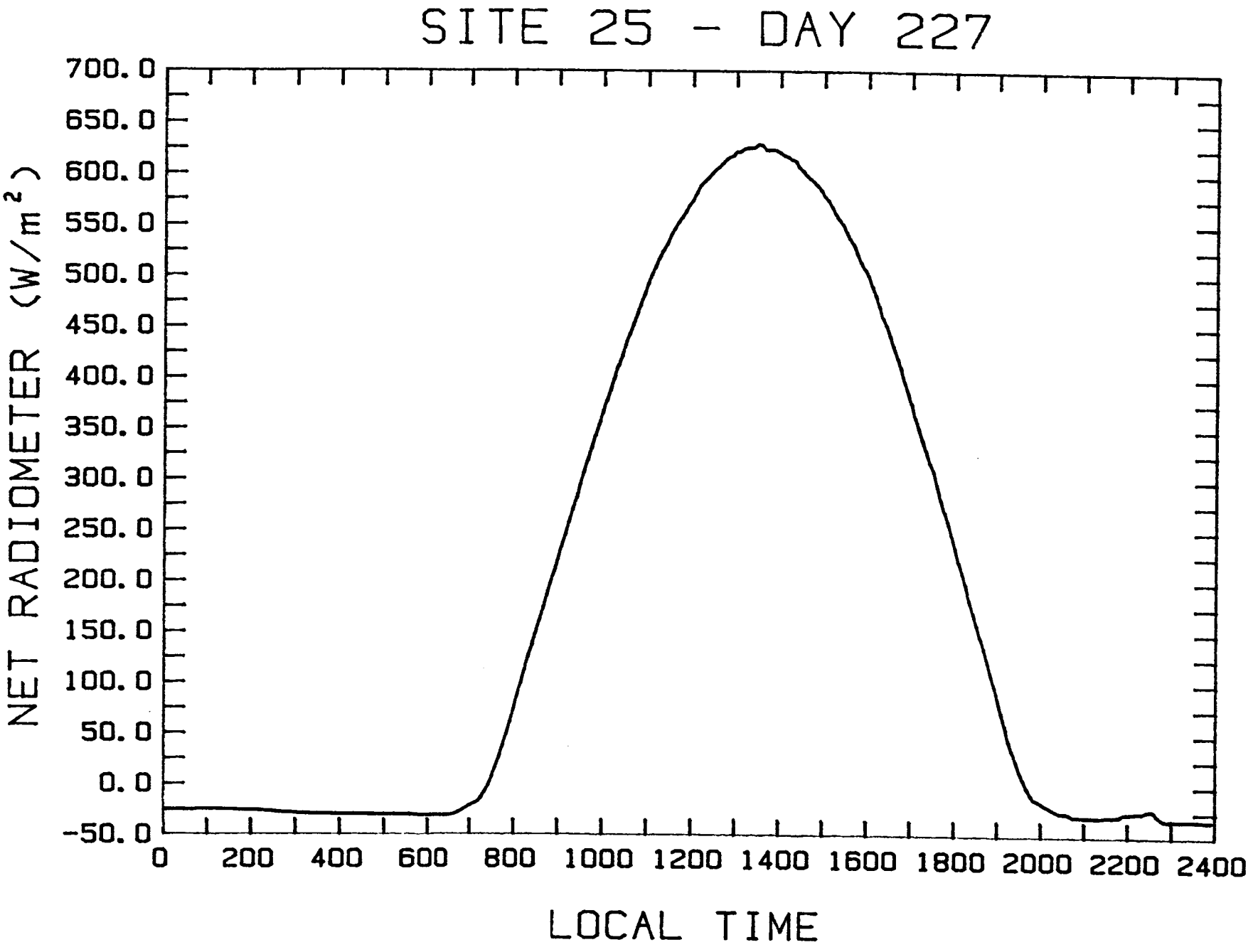

Fig. 5. Daily pattern of net radiation on Day 227 (August 24), 1987 at FIFE site 25.

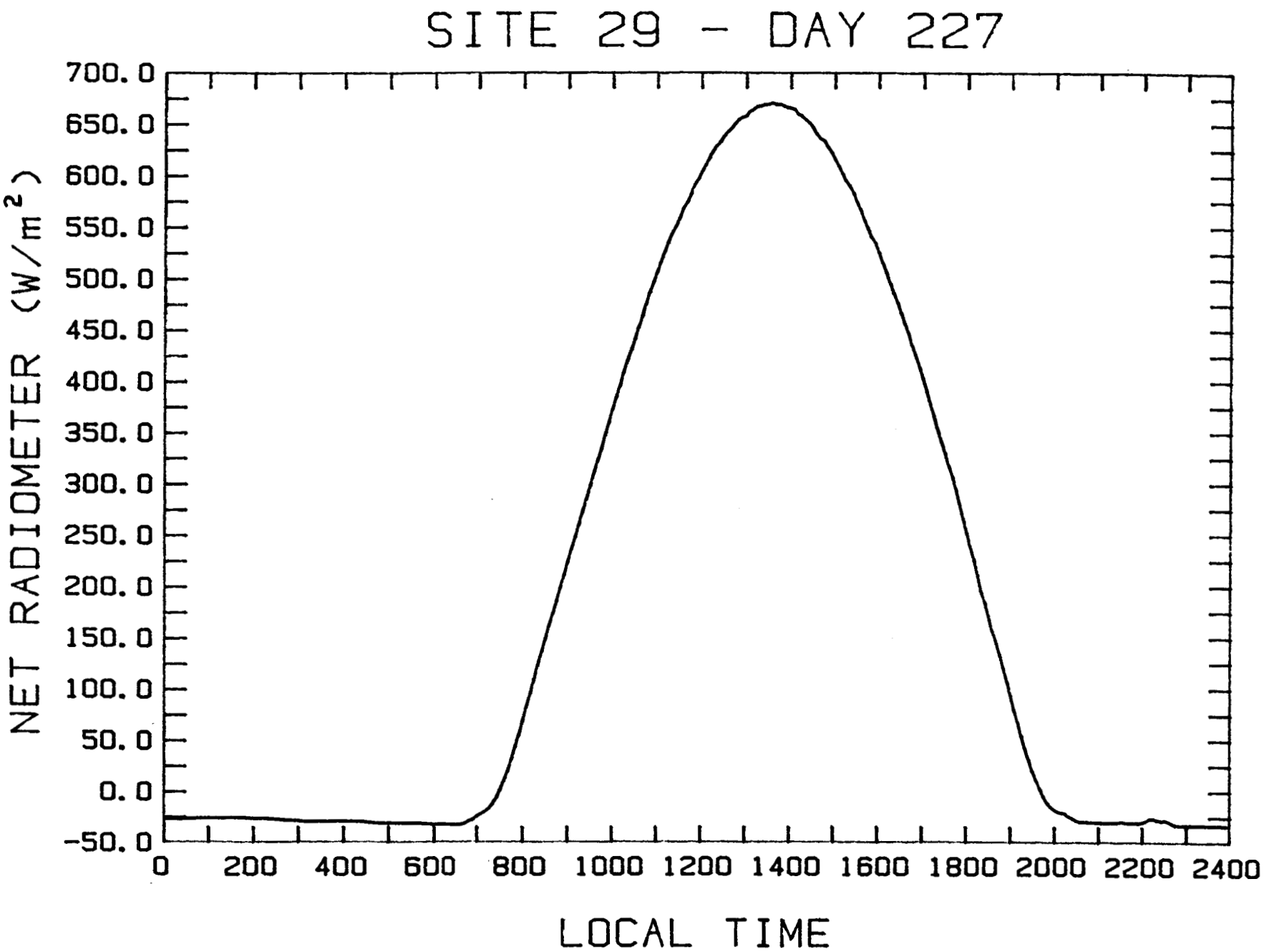

Fig. 6. As in Fig. 5 for FIFE site 29.

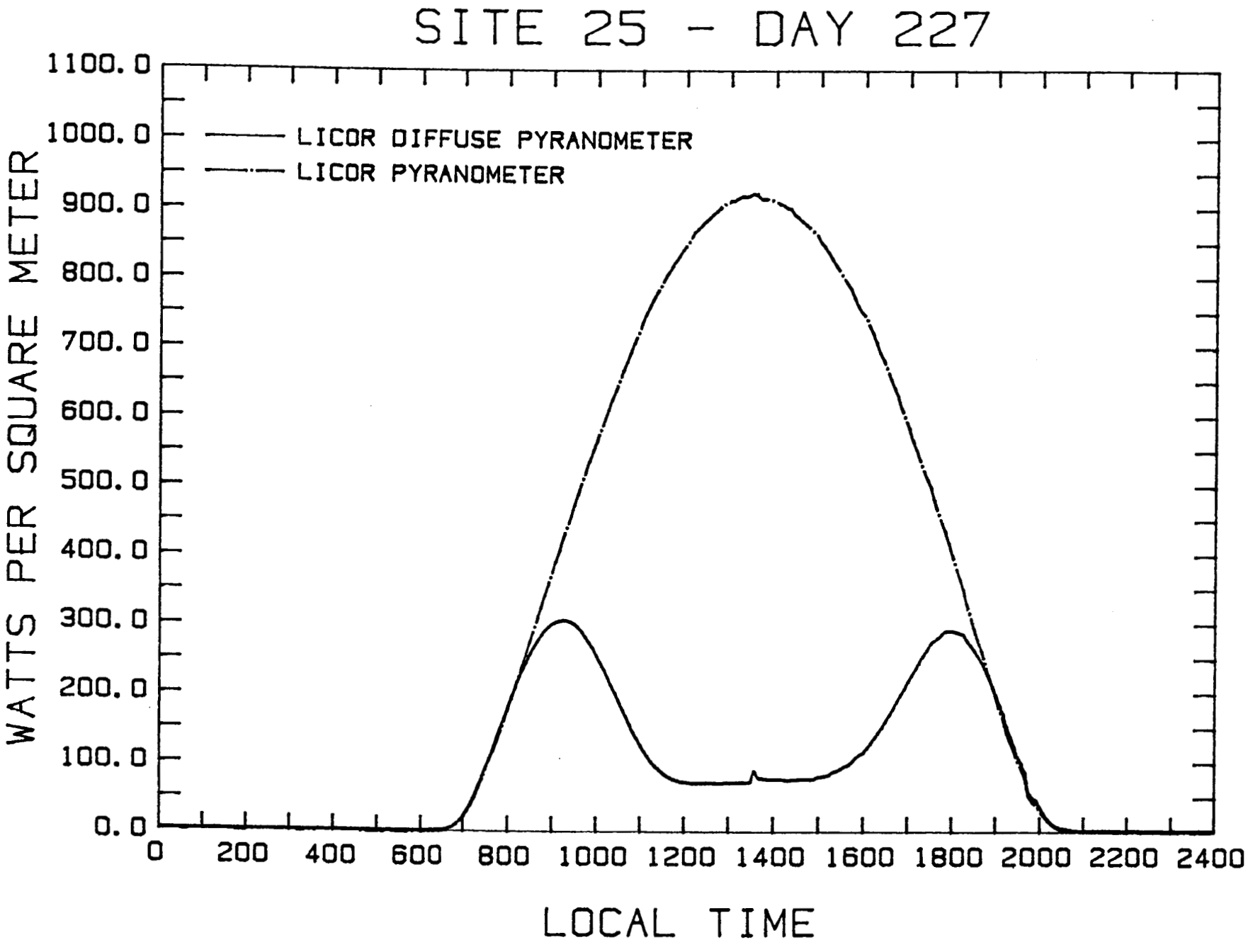

Fig. 7. Daily patterns of total and diffuse solar radiation as measured by Li-Cor Pyranometers on Day 227 (August 14), 1987 at FIFE site 25.

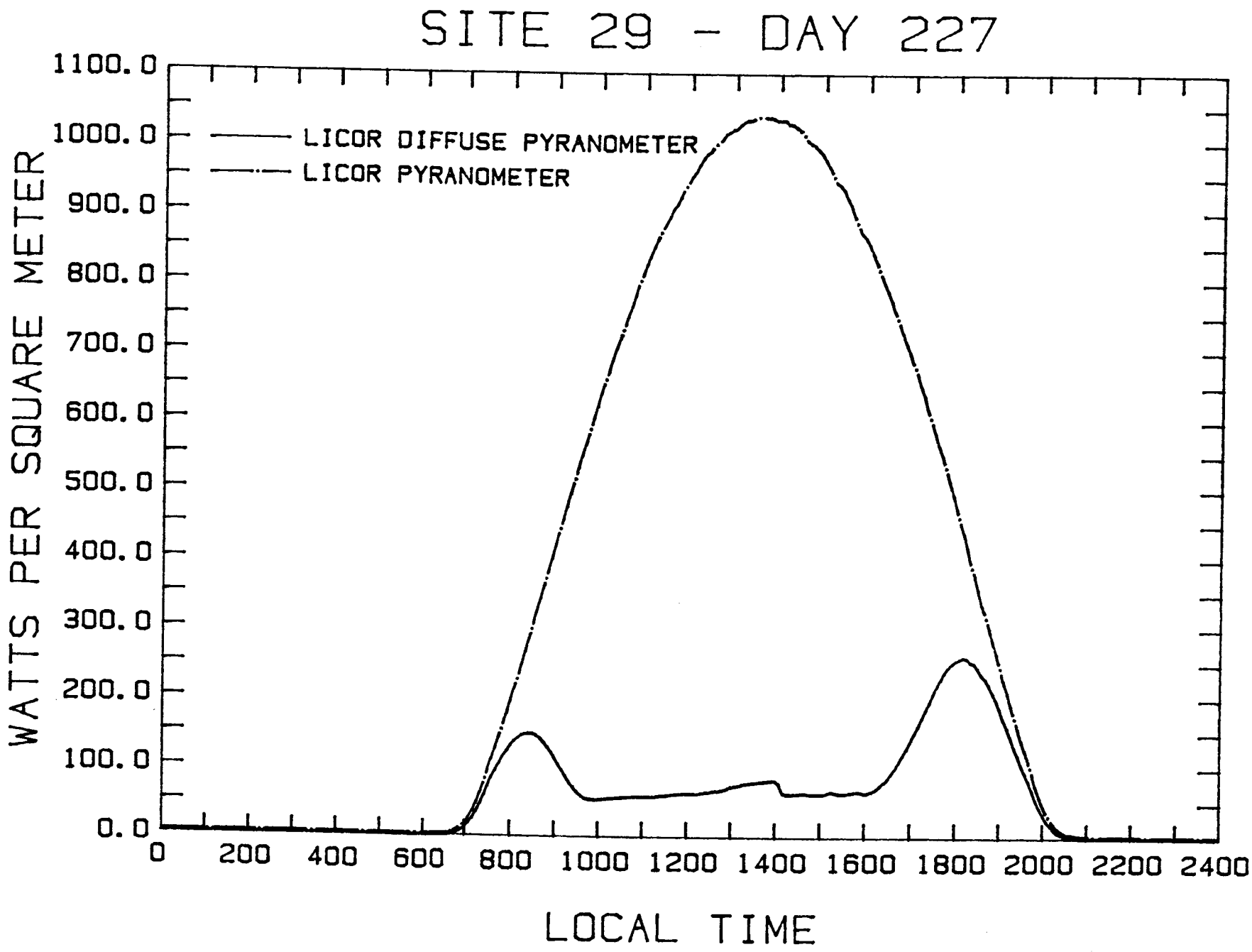

Fig. 8. As in Fig. 7 for FIFE site 29.

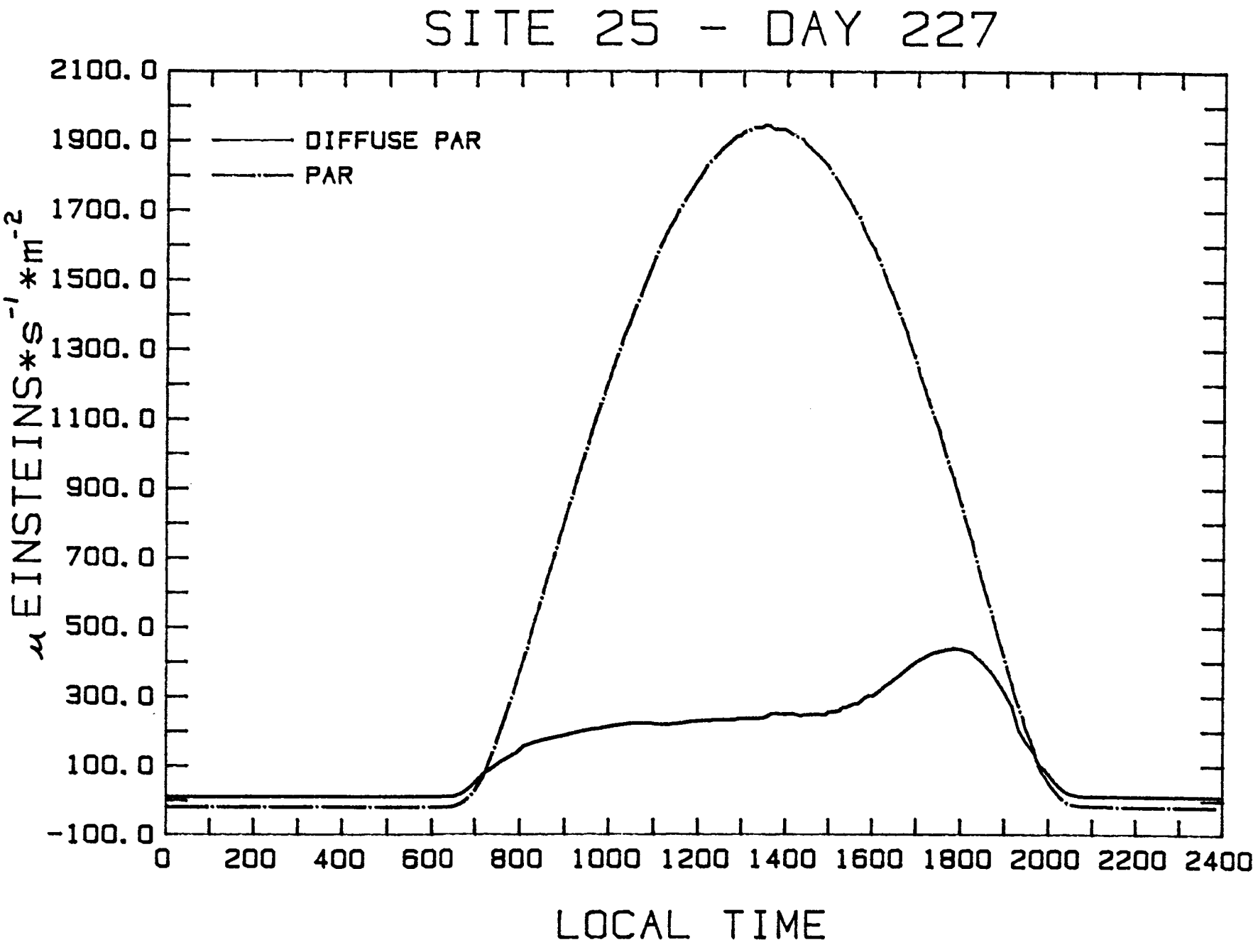

Fig. 9. Daily patterns of total and diffuse photosynthetically active radiation (PAR) on Day 227 (August 14), 1987 at FIFE site 25.

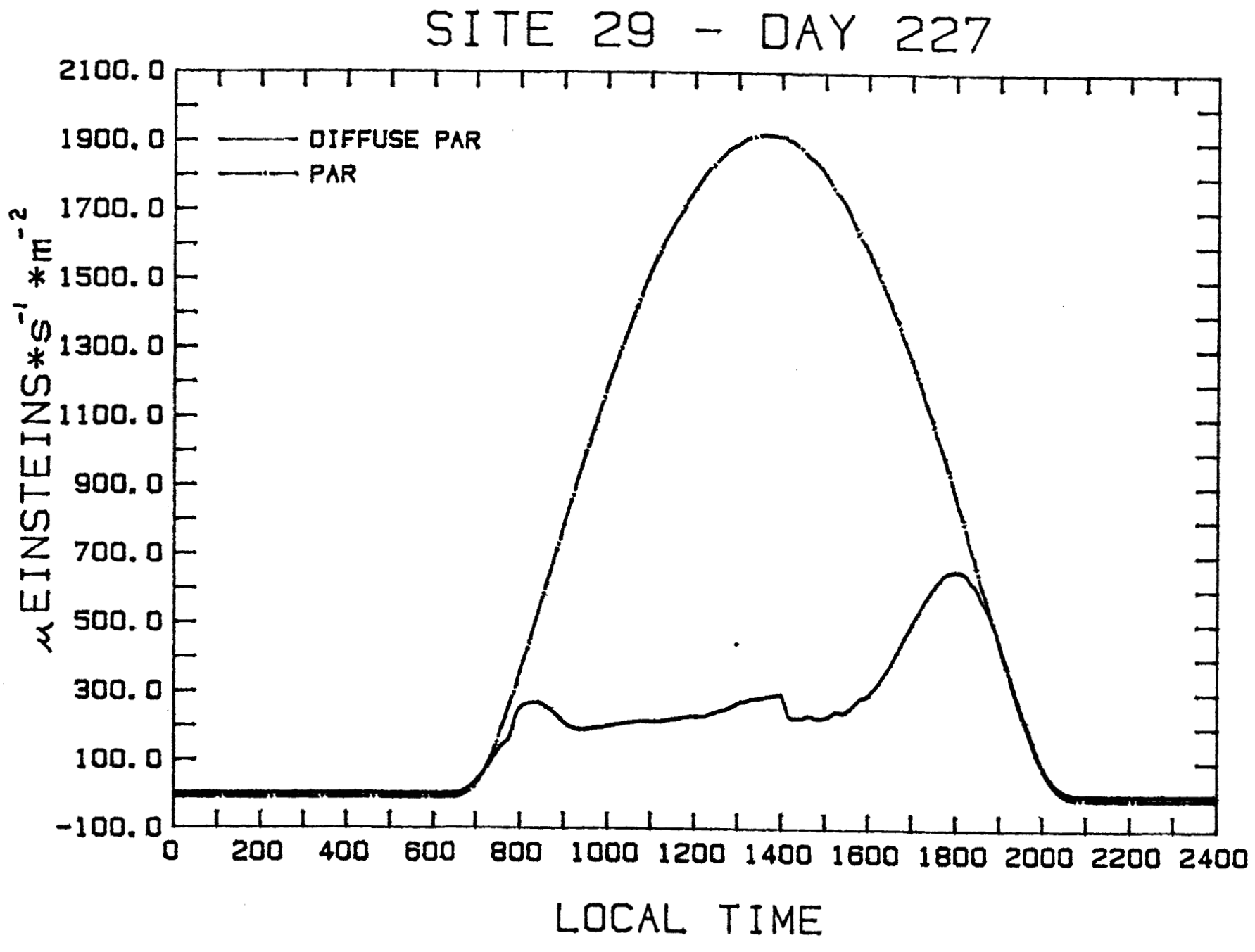

Fig. 10. As in Fig. 9 for FIFE site 29.

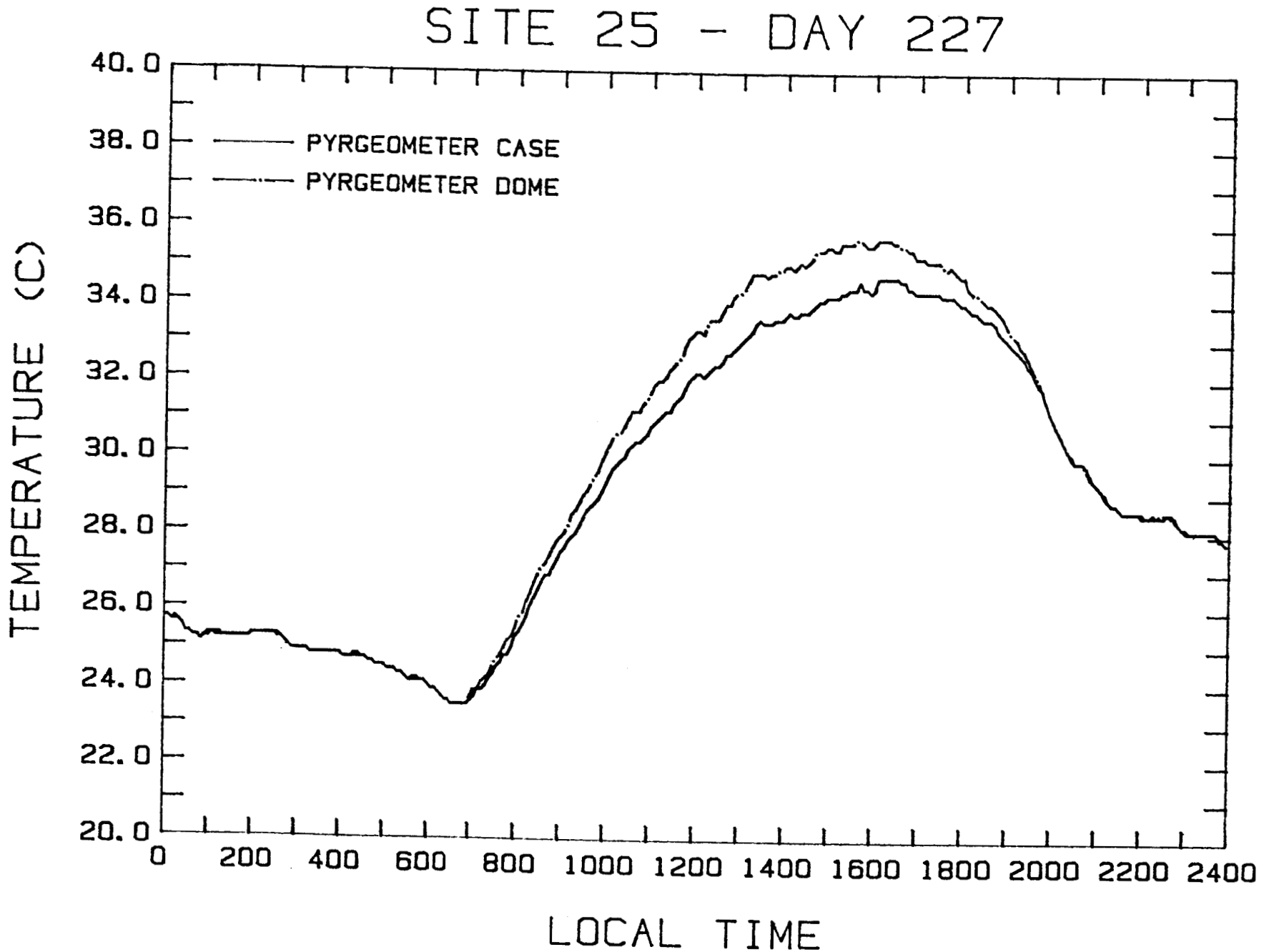

Fig. 11. Temperature of the pyrgeometer case and dome on Day 227 (August 14), 1987 at FIFE site 25.

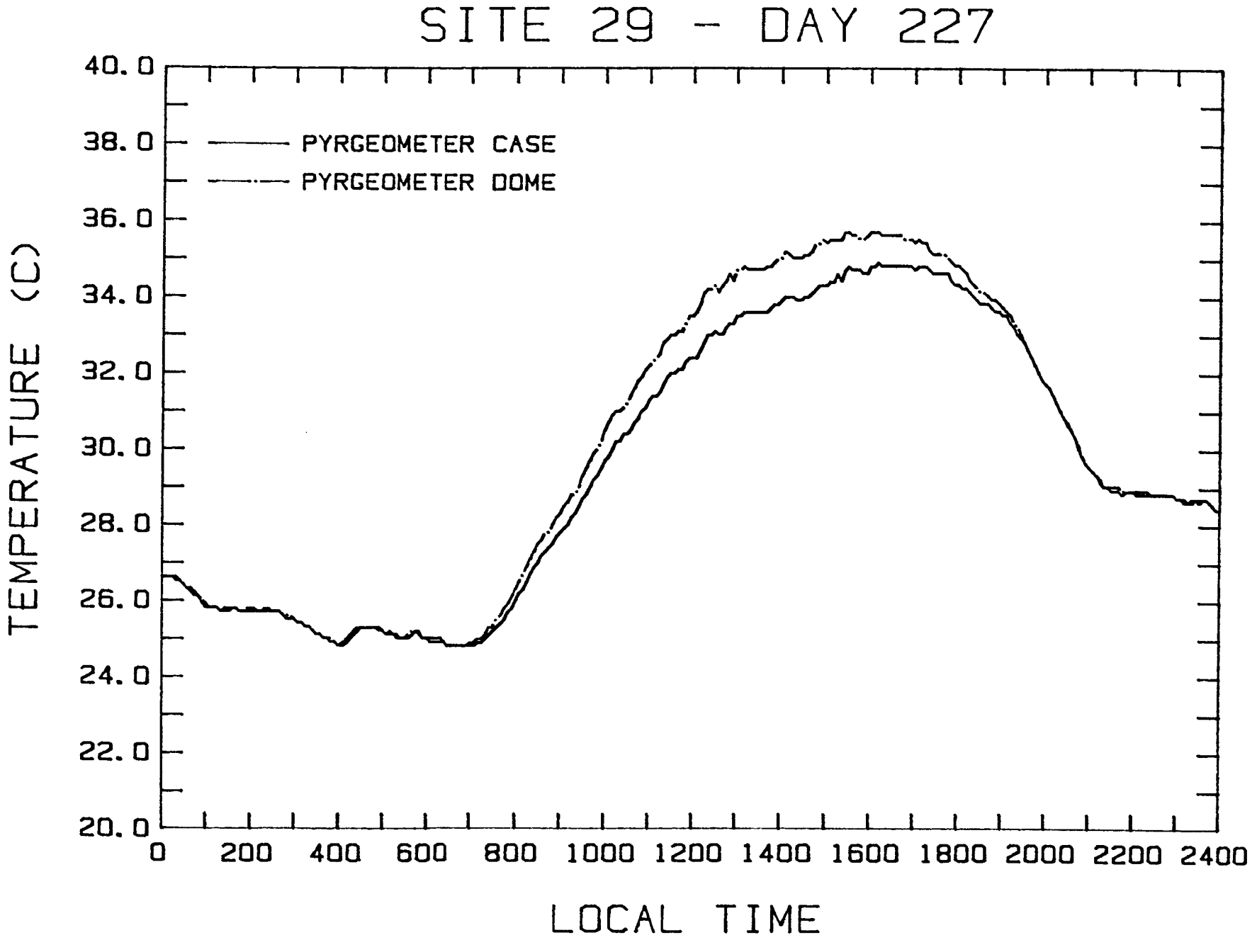

Fig. 12. As in Fig. 11 for FIFE site 29.

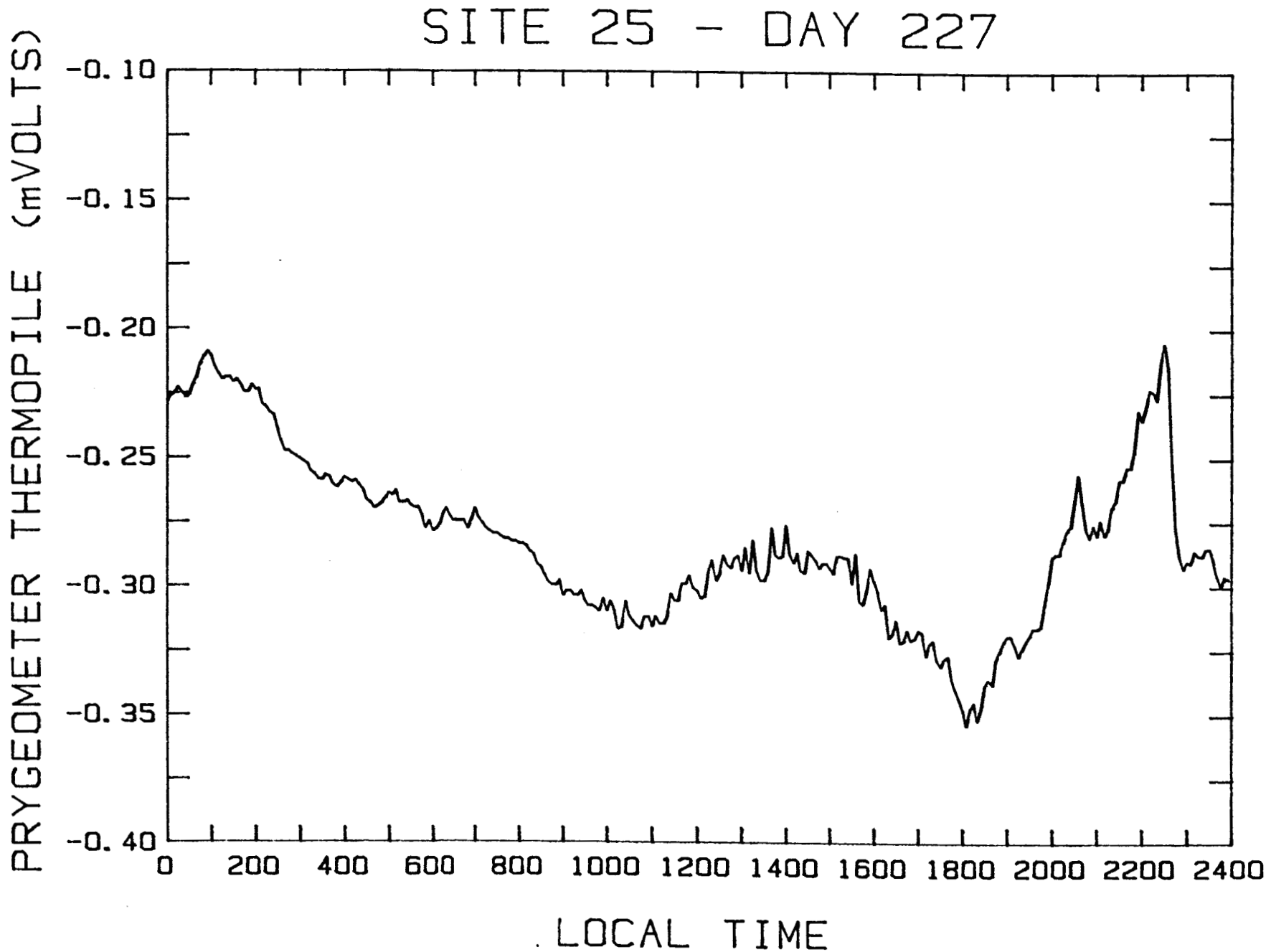

Fig. 13. Signal output from the pyrgeometer thermopile on Day 227 (August 14), 1987 at FIFE site 25.

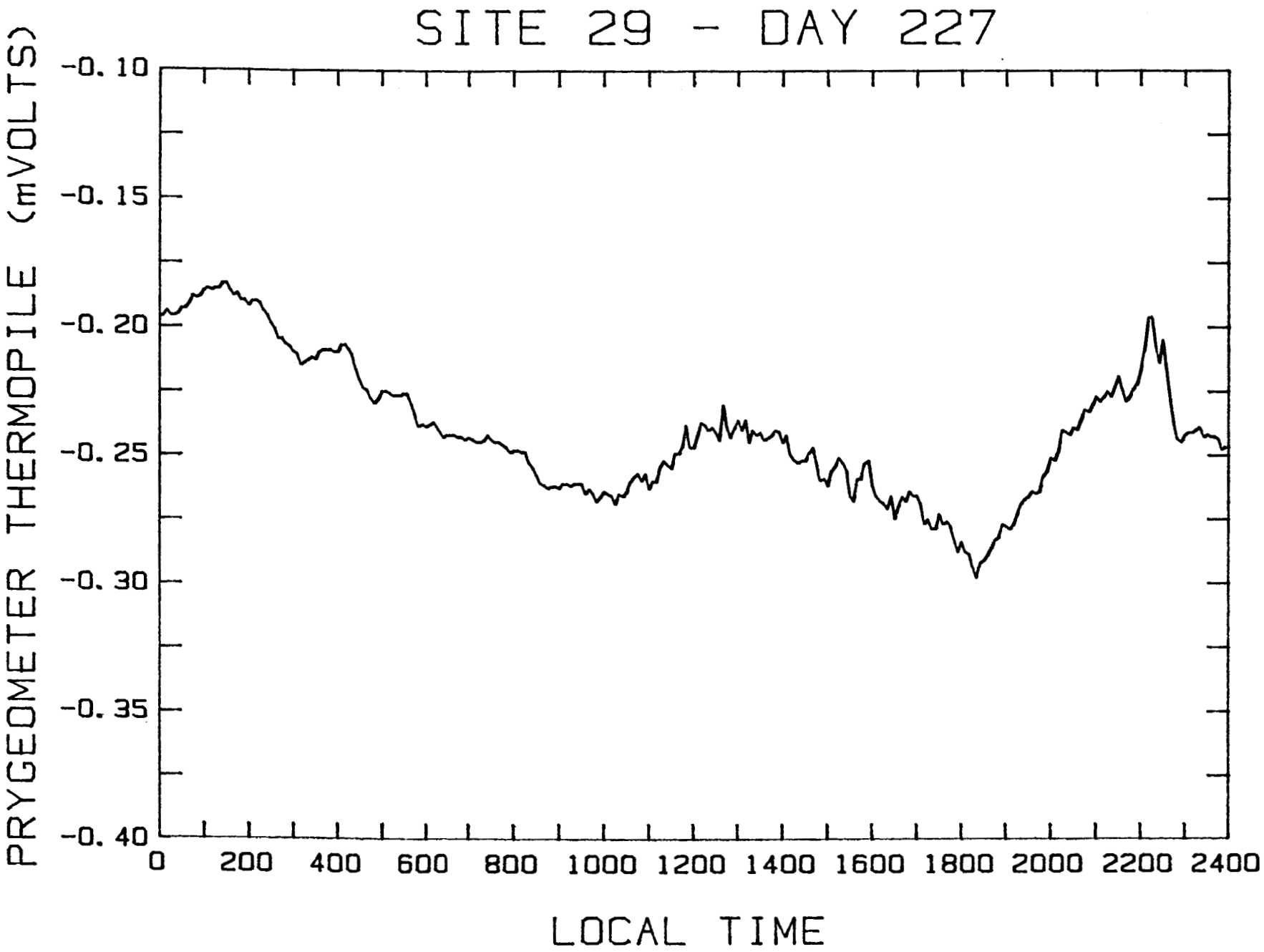

Fig. 14. As in Fig. 13 for FIFE site 29.

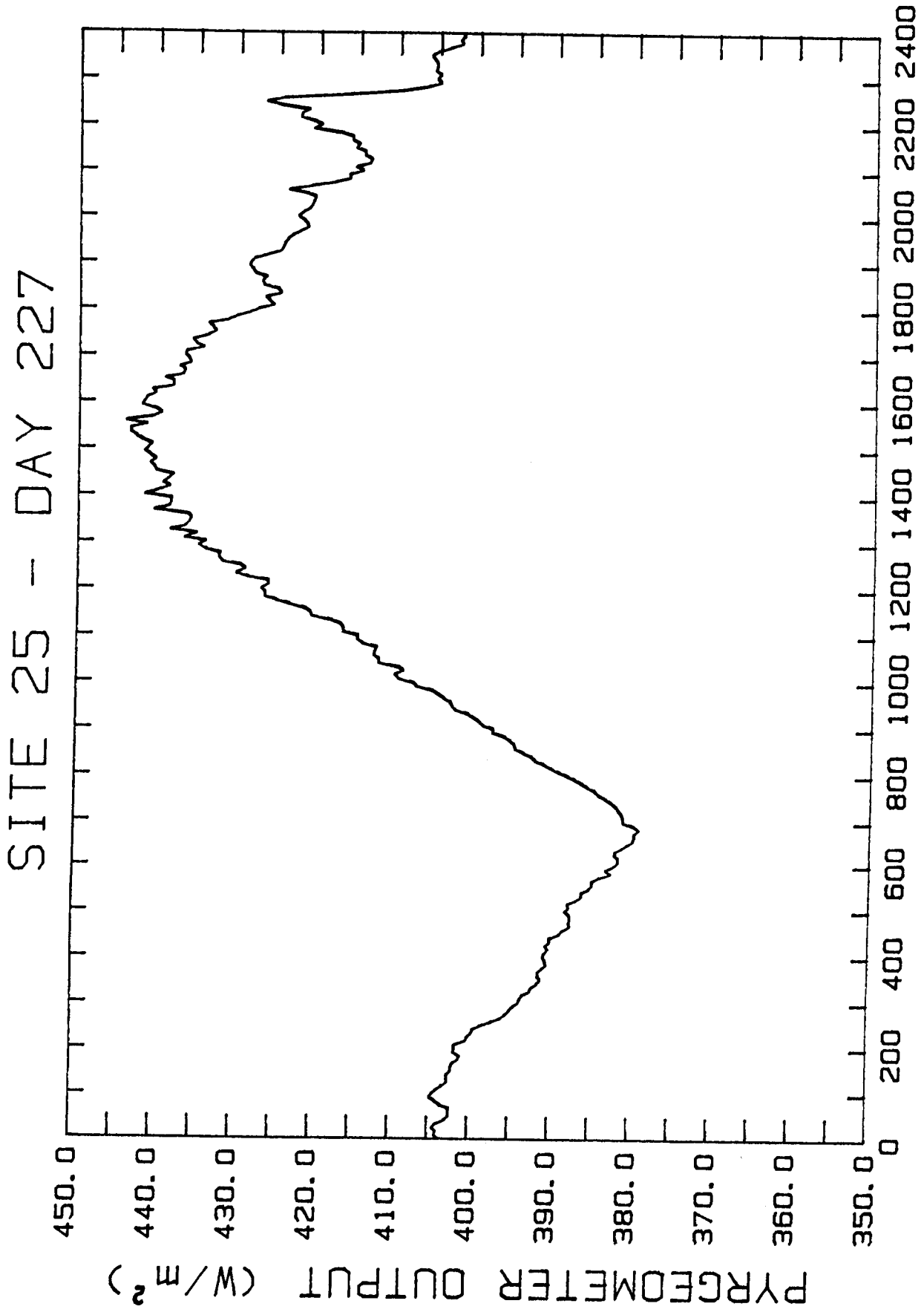

Fig. 15. Uncorrected thermal radiance from the pyrgeometer on Day 227 (August 14), 1987 at FIFE site 25.

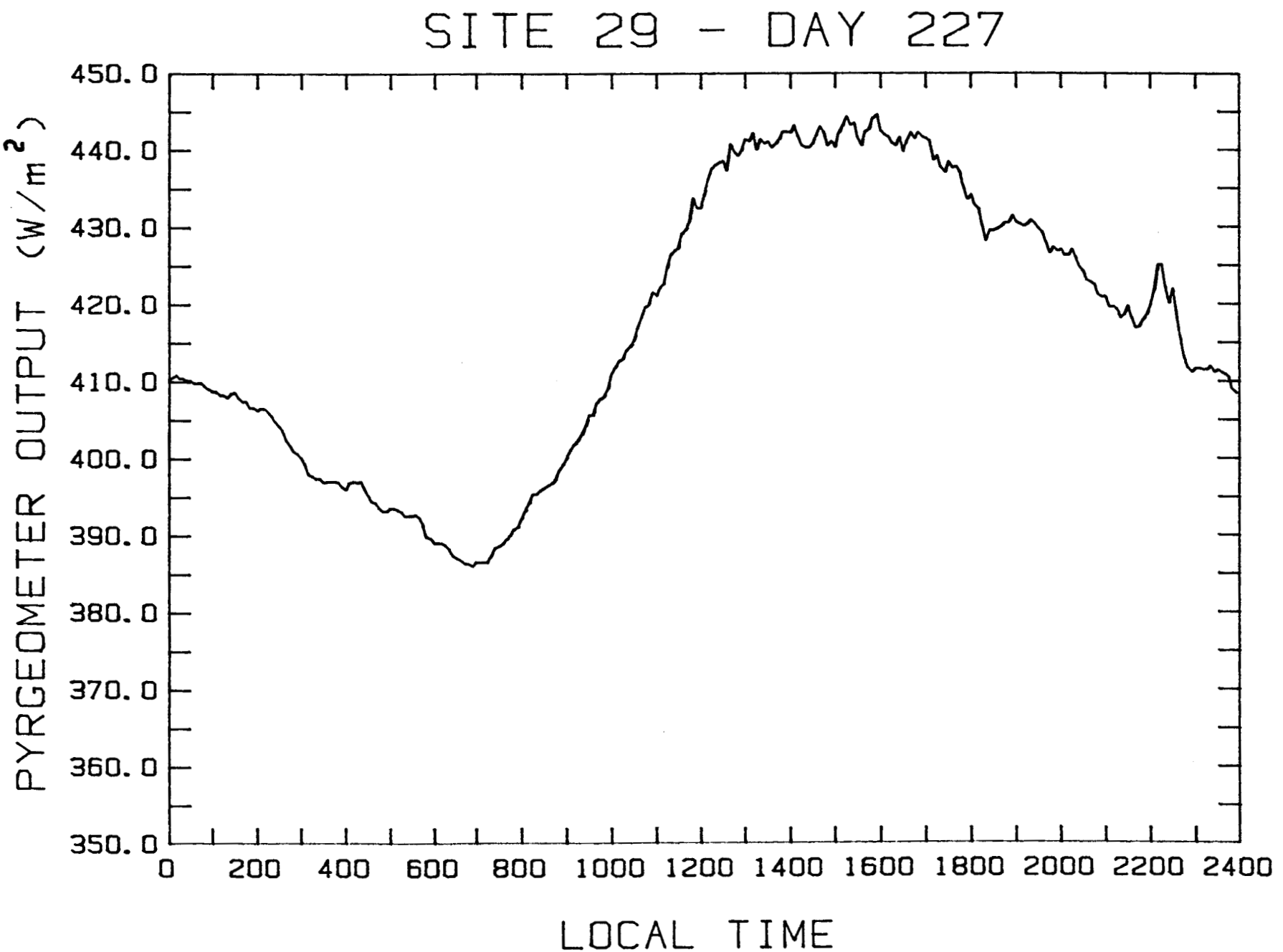

Fig. 16. As in Fig. 15 for FIFE site 29.

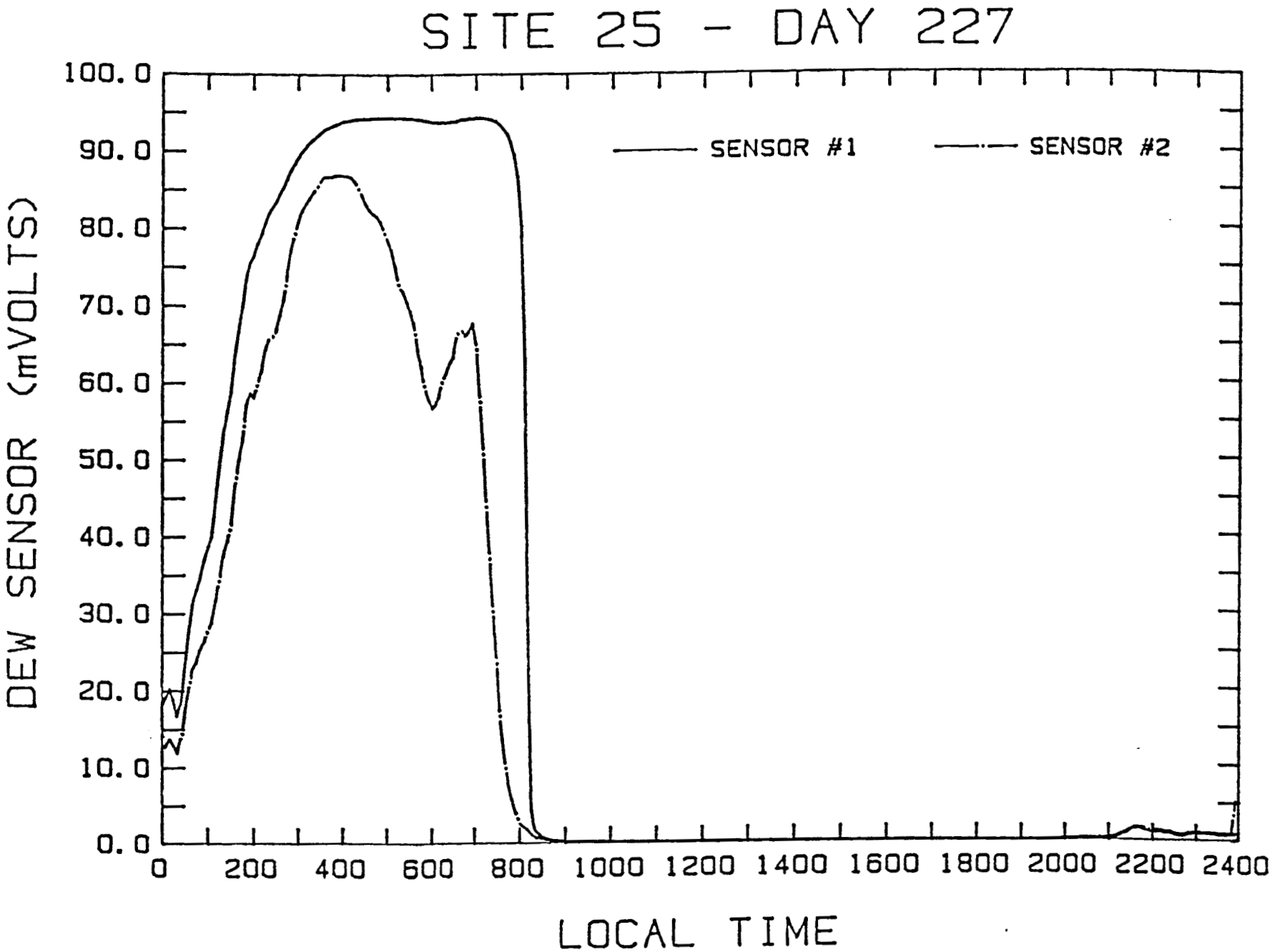

Fig. 17. Output from two dew sensors on Day 227 (August 14), 1987 at FIFE site 25.

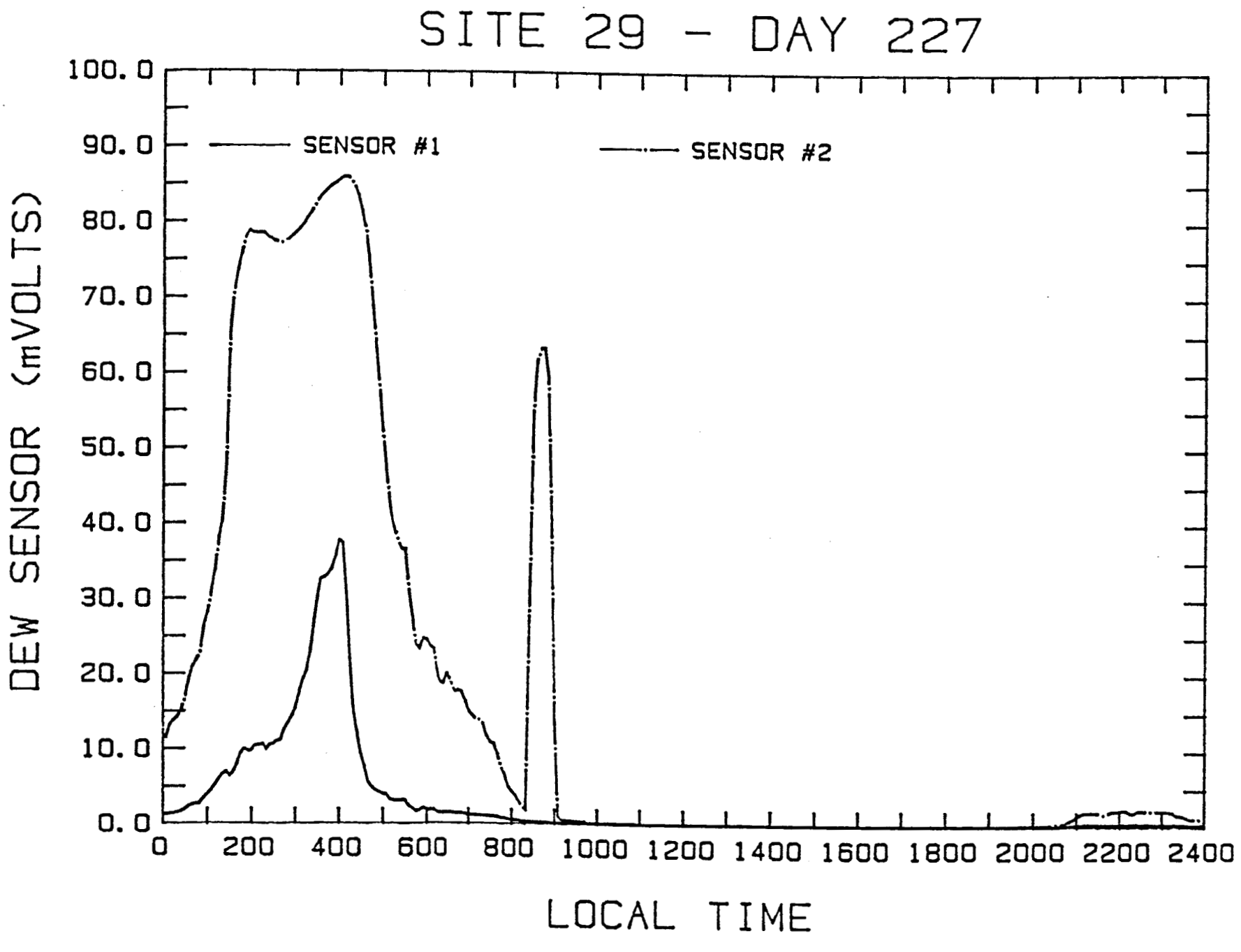

Fig. 18. As in Fig. 17 for FIFE site 29.