NOAA Technical Memorandum ERL ARL-202

AIRBORNE MEASUREMENTS OF MASS, MOMENTUM, AND ENERGY FLUXES FOR THE BOARDMAN-ARM REGIONAL FLUX EXPERIMENT - 1991

PRELIMINARY DATA RELEASE

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Ronald J. Dobosy
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Atmospheric Turbulence and Diffusion Division
Oak Ridge, TN 37830

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NOTICE

ATDD Contribution File No. 92/8

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LIST OF ACRONYMS

AGL: Above Ground Level
ARL: NOAA Air Resources Laboratory, Silver Spring MD
ARM: DOE Atmospheric Radiation Measurements Program
ASK: Asterisk flight pattern (Section 4.2)
ATDD: Atmospheric Turbulence and Diffusion Division, NOAA/ARL, Oak Ridge, TN
BRR: Bombing Range Road (Figure 1)
CART: ARM Clouds and Radiation Testbed
DLR: *Deutsche Forschungsanstalt für Luft- und Raumfahrt* (German Aerospace Research Establishment)
DOE: United States Department of Energy
EOF: Eastern Oregon Farms, Incorporated, owners of the irrigated farmland at the field site.
ERL: NOAA Environmental Research Laboratories, Boulder CO
FDV: Flux Divergence flight pattern (Section 4.2)
FLN: Flux Normal flight pattern (Section 4.2)
FLX: Long-transect flight pattern for fluxes (Section 4.2)
GCM: Global Circulation Model (of the atmosphere, and perhaps ocean)
GMT: Greenwich Mean Time (same as UTC)
GPS: Global Positioning System
H: Flux of sensible heat
IFR: (Required for operation under) Instrument Flight Rules
IR3/IR5: Infrared sensors for H_2O and CO_2, developed at ATDD, capable of sampling at 10 Hz and higher rates.
LE: Latent heat flux (product of evaporation rate and latent heat of water vaporization)
Long-EZ: Model designation for airplane selected to carry MFP (Figure 3)
LORAN: Long Range Navigation system
MFP: Mobile Flux Platform (Section 3)
NOAA: National Oceanic and Atmospheric Administration, United States Department of Commerce
PDT: Pacific Daylight Time (120° W, UTC minus 7 hr.)
PRO: Vertical profile flight pattern (Section 4.2)
RMS: Root-Mean Square
UTC: Coordinated Universal Time

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ABSTRACT. During 2 - 19 June 1991 the Atmospheric Turbulence and Diffusion Division of NOAA measured flux densities of mass, momentum, and energy from an airplane in support of DOE's Atmospheric Radiation Measurement (ARM) program. Over 507 horizontal flux transects were completed, along with 24 vertical atmospheric profiles, during the 93 flight hours. Flux transects passed over both irrigated farmland and steppe. Of these transects, 274 were flown at low level over a specified, instrumented path, 75 were flown in an asterisk formation (various headings centered on a flux tower), 42 were flown normal to the usual instrumented path, and 116 were flown to define vertical flux divergence. Fluxes were measured both day and night in a wide range of weather conditions.

This report describes the variation in wind, radiation, and surface temperature, along with exchange of mass (CO_2 , H_2O , and O_3), momentum, and energy as observed along the transects. Airborne measurements are compared with those from flux towers in wheat, corn, and steppe. In general, the measurements correspond well. The largest difference occurs at the steppe tower, with stronger heat fluxes reported by the tower. This discrepancy increases as heat flux increases. The cause may be a significant vertical flux divergence or an inconsistant specification of the mean state.

1. INTRODUCTION

In June 1991, a multi-laboratory group of atmospheric scientists, led by Battelle Pacific Northwest Laboratory and including Argonne National Laboratory, Los Alamos National Laboratory, EG&G, Inc., and the NOAA Atmospheric Turbulence and Diffusion Division (ATDD), carried out a boundary-layer field experiment near Boardman, Oregon as part of the Atmospheric Radiation Measurements Program (ARM) for the U.S. Department of Energy (Doran *et al.*, 1992). The overall objective of the ARM research program is to facilitate improved treatment of radiation in global circulation models (GCM) through better parameterizations of cloud processes and their radiative effects. These effects include scatter, reflection, and transmission properties, which will be extensively studied under the ARM program. Also directly controlling the resultant effect of clouds on radiation in a GCM parameterization, are liquid water content, droplet size distribution, cloud temperature, cloud shape, cloud amount, solar zenith angle, and the like. These cloud characteristics are, in turn, strongly linked in two-way interactions with boundary-layer exchanges of moisture, momentum, and energy. On the scale of GCM grid cells, the earth's surface tends to be strongly heterogeneous. This experiment was designed to support ARM goals by addressing proper characterization of air-surface exchange of mass, momentum, and energy over large, heterogeneous regions of the earth's surface as they affect cloud formation. This boundary-layer connection to cloud formation will be strong for both synoptic-scale and locally-produced clouds.

Clouds produced by synoptic-scale processes depend on air-mass modification by air-surface exchange over large regions. These clouds, in turn, alter the surface exchange characteristics over wide areas by shading and precipitation. Techniques extrapolating point flux measurements to area-wide exchange over heterogeneous surfaces, under heterogeneous cloud cover, are vital to improvement of models for such clouds. So far, little is known relating synoptic-scale cloud characteristics to heterogeneities in the underlying surface.

Locally produced clouds have been studied in greater detail (Stull, 1988). Such clouds as cumulus may interact with the surface by receiving moisture and heat for cloud formation and by initiating various kinds of feedback once the clouds exist. Feedback can be positive or negative, and radiative, dynamic, and/or environmental in origin. Radiative feedback is generally negative, occurring when low-altitude clouds shade the surface over land. Resulting afternoon equilibrium cloud cover can vary from 10 to 90%, depending on initial atmospheric temperature and moisture profiles and the history of surface heat and moisture exchange. Dynamic feedback, also negative, occurs when thermals reach the level of free convection. Air from the thermals is then lofted through the cloud and out of the mixed layer (ML), removing warm moist air from the ML that could otherwise form new thermals and additional clouds. In contrast, environmental feedbacks are positive. As free atmosphere (FA) clouds develop from ML moisture, they also evaporate and moisten the FA environment, thus allowing easier formation of new clouds and longer persistence of existing clouds. Also, ML-driven clouds vent cooler ML air into the FA cloud layer. Subsidence around the developing FA clouds brings warmer FA air into the entrainment layer. Both transfers weaken the overlying inversion and increase the overall cloud cover.

Realistic modeling of these cloud processes requires proper parameterization of atmospheric interactions with the earth's surface. On the scale of a GCM grid volume, this interaction is greatly complicated by surface heterogeneity of unknown effect on the aggregate air-surface exchange of mass, momentum, and energy. The Boardman experiment features measurements in an area divided into two distinct surface types.

Although each surface type is internally heterogeneous, the heterogeneities become unimportant relative to the contrast between the two types. This experiment seeks to develop a single statement describing the effect of a heterogeneous surface on the exchange of mass, momentum, and energy by quantifying the influence of various components of that surface. This goal can be addressed with particular clarity at the experimental site. Future experiments at other sites containing more typical heterogeneities may reveal similar spatial structures to those presented here, though with a weaker signal engulfed in more noise. We expect the relatively clear spatial structure in the Boardman data to guide interpretation of more typical heterogeneities observed elsewhere.

Participating groups made a comprehensive set of measurements relevant to air-surface exchange, including plant ecology and physiology, soil moisture and character, wind speed and direction, air temperature and humidity, and air-surface exchange of momentum, heat, moisture, CO_2, and O_3. Details are discussed by Doran *et al.* (1992). The meteorological measurements were made from towers at several locations in irrigated farmland and steppe, and from a low-flying airplane operated by ATDD.

This report describes the airplane measurements. Results from ATDD's two flux towers and other groups are not presented except for comparison with the airplane measurements. Data interpretations presented in this report should not be taken as final or all-conclusive. Use of the data is encouraged given appropriate acknowledgement of ATDD's involvement. Considering the massive quantity of data collected (400 megabytes in "raw" compressed binary format), the complexity of the data reduction process, and the number of sensors required, errors are anticipated. The authors request notification of any errors that are encountered.

2.0 SITE DESCRIPTION

Fundamentally, the Boardman experiment seeks to determine the proper way to extrapolate from individual point measurements within a large heterogeneous region, to an estimate of the region's bulk air-surface exchange. A site for the experiment was sought, characterized by a small number of major surface types whose heat and moisture fluxes differed markedly. Ideally, each surface would have a scale of about 10 km so that locally induced circulations or other significant modifications to the boundary layer structure could be identified. Limiting the number of surface types would reduce the number of overlapping internal boundary layers. A relatively flat site was desired, to minimize topographic effects.

The selected site, near Boardman, Oregon, is dominated by two sharply contrasting land surface types. These are native dry steppe and artificially irrigated farmland, as shown in Figure 1. The terrain is flat to gently rolling with a slight slope toward the Columbia River to the north. Some steeper gullies can be found along stream beds in the western part of the experimental area. The Columbia River flows west-southwest, forming the northern boundary of the study area. Prevailing winds are from the west-southwest, following the river valley. Along the flight transect in Figure 1, the irrigated farmland and steppe regions are separated by a straight, well-defined, north-south boundaries. This farm-steppe-farm pattern introduces a pronounced 10 km heterogeneity. A number of well-defined but relatively weak heterogeneities of 1 km scale exist within the interior of the crop regions. The boundary of primary interest is marked by Bombing Range Road on Figure 1.

The steppe had extremely low soil moisture at the time of the experiment. Steppe grasses were either dormant or seeding, although shrubs were in an active growth phase. The farmland (shaded in Figure 1) was irrigated by center-pivot systems and contained hundreds of mostly-circular fields covering 75-90% of the total farm acreage. There were four principal crops: alfalfa, corn, wheat, and potatoes. The area between crop fields was primarily dirt roads, bare ground, and dry vegetation.

The farm area in Figure 1 covered by the indicated flight transect, is shown in detail in Figure 2. This area is farmed by Eastern Oregon Farms, Inc. Circular crop fields are 800 m in diameter. Note that crops of the same type are not necessarily grouped in adjacent circles. The flight path shown in Figure 1 is the transect over which the airplane collected 274 low-level flux runs. Figure 1 also shows ground-based flux-tower locations which were on or near the indicated flight path. This flight path was also used for 116 multi-altitude flux-divergence runs.

The overall contrast from irrigated farmland to steppe was expected to be clearly observable. Detectability of the smaller variations between individual fields was also expected. As a result, the experimental site should allow examination of the effects of both dominating surface discontinuities and minor surface heterogeneities.

Long-term climatological data for the experimental site are given in Table 1. The climate classification of the site is given as "BSk" or mid-latitude steppe (Trewartha, 1957).

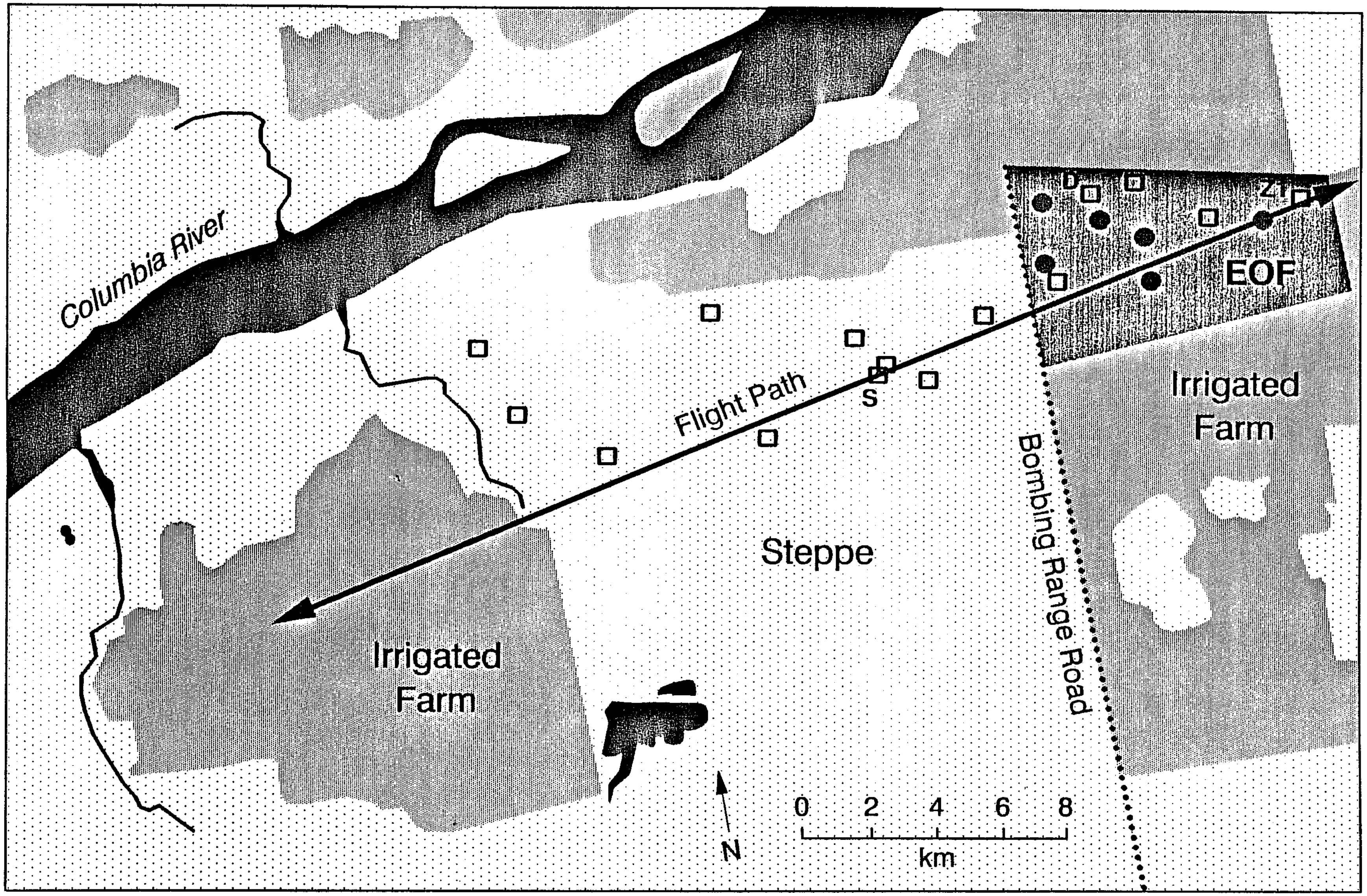


Figure 1. A diagram of the experimental area. Black areas represent bodies of water, dotted areas are steppe, the dark shaded area identifies the irrigated farmland of Eastern Oregon Farms (EOF), and the light shaded areas are other irrigated farmlands. Squares identify eddy correlation instrument sites, and circles locate Bowen ratio energy balance stations. Letters S, D, and Z1 identify steppe, corn, and wheat flux towers respectively.

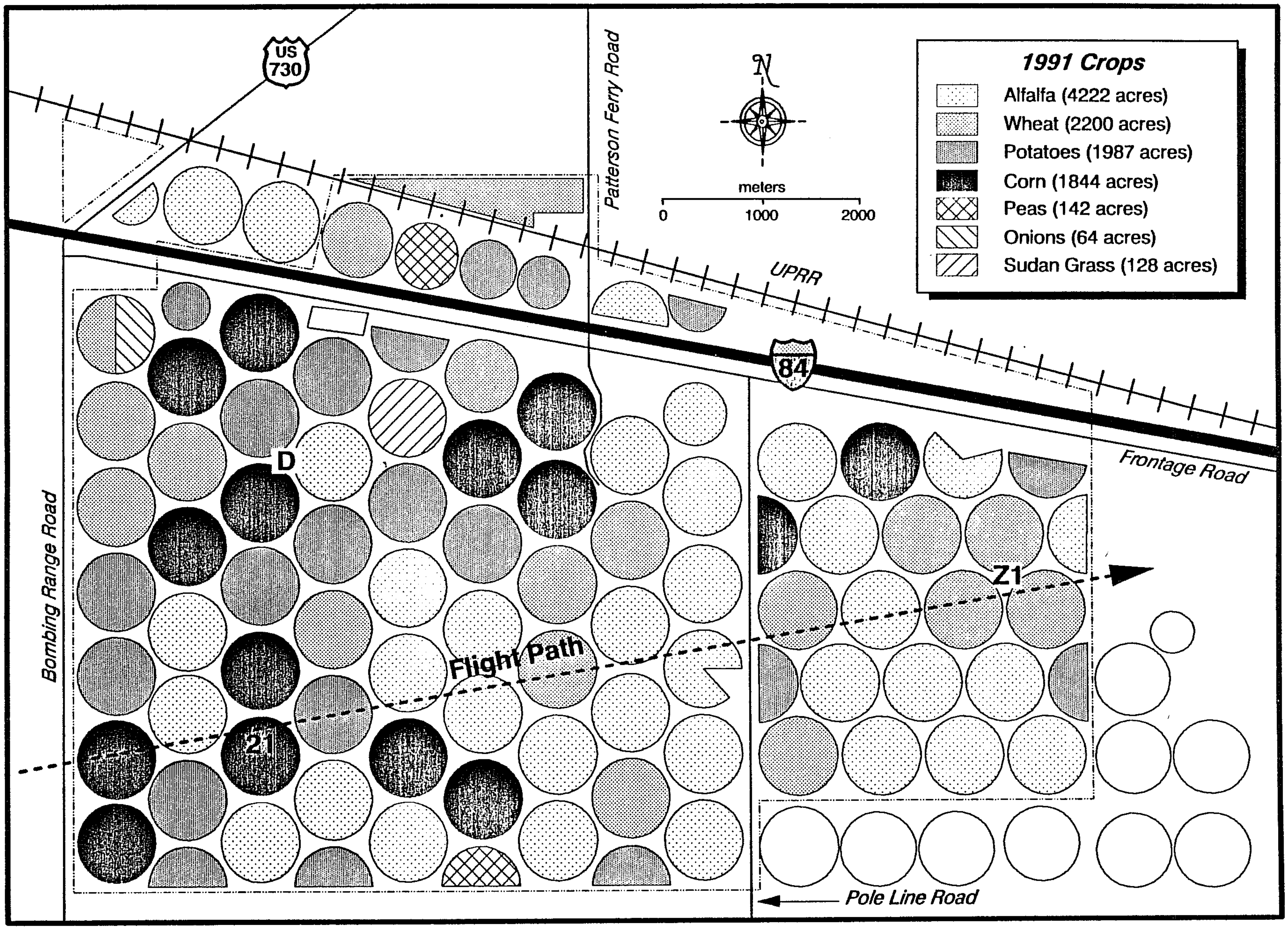


Figure 2. The distribution of crops at Eastern Oregon Farms (EOF) in 1991. Corn and wheat flux towers were located at D and Z1 respectively.

Table 1. Climate statistics for Boardman, OR (National Climatic Data Center, 1990); Latitude 45°49'N, Longitude 119°49'W, 119m AMSL.

Description	JA	FE	MR	AP	MY	JN	JL	AG	SP	OC	NV	DC	AN
Abs Max Temp (°C)	23	23	31	35	41	42	46	46	39	32	26	22	46
Mean Max Temp (°C)	4	8	14	21	25	28	33	32	26	19	11	6	19
Mean Min Temp (°C)	-4	-2	2	4	9	12	15	14	9	5	1	-2	5
Abs Min Temp (°C)	-33	-31	-12	-8	-3	3	3	3	-6	-10	-24	-34	-34
Days Temp GE 32°C	0	0	0	-	-	6	20	15	-	0	0	0	-
Days Temp LE 0°C	21	15	8	4	0	0	0	0	0	5	11	23	86
Mean Dew Point (°C)	-2	-1	2	2	3	4	6	7	5	4	2	-2	3
Mean Rel Hum (%)	77	71	65	51	40	36	30	35	48	59	76	83	56
Mean Precip (mm)	27	20	13	11	12	13	4	5	9	16	25	27	182
Mean Snowfall (mm)	147	76	5	0	0	0	0	0	0	0	38	71	337
Days Precip > 2.5 mm	2.9	2.3	1.4	1.2	1.4	1.4	0.6	0.7	1.4	1.8	2.3	2.9	20
Days Snow > 3.8 cm	1.3	0.7	0	0	0	0	0	0	0	0	0.3	0.6	2.9
Days with Tstorms	0	0	0	0	2	1	0	3	0	0	0	0	6
Days Wind > 8.7 ms^{-1}	10	8	12	12	7	9	7	4	8	8	12	4	8
Days Wind >14.4 ms^{-1}	0.5	1.0	1.5	1.6	0.8	0.7	0.1	0	0.1	0.5	1.4	0.8	0.8

3.0 MEASUREMENT SYSTEM DESCRIPTION

The airplane used in the 1991 Boardman experiment carried ATDD's mobile flux platform (MFP) and measured the mean and turbulent flux parameters listed in Table 2. The MFP's design makes it useful as a high precision turbulent boundary layer research tool. It is easily adaptable to other instrumentation. Additional flux instrumentation for NO and CH_4 is under development. A NO_2 sensor became available to the MFP in late-1992. Details about the MFP's instrumentation and use at the 1991 Boardman experiment are given in the sections that follow.

Table 2. Parameters Measured By the ATDD Mobile Flux Platform (MFP).

Mean Parameters	Turbulent Flux Parameters
Winds (U, V, W)	Momentum
Position (X, Y, Z)	Sensible Heat
Temperature, Dew Point	Latent Heat
H_2O, CO_2, O_3	CO_2
Radiation, Surface Temp.	O_3

3.1 Airplane description

A variant of the Rutan "Long-EZ", a two passenger high-performance airplane, was selected to carry the MFP (see Figure 3). Aerodynamic characteristics of the Long-EZ are well suited for long-duration high-fidelity turbulent flux measurements. The "pusher" configuration leaves the front of the airframe free of propeller-induced disturbance, engine vibration, and exhaust. The small, light-weight, laminar-flow airframe has an equivalent "flat plate" drag area of only 0.2 m^2. The nose region thus has minimal flow disturbance, and is ideal for measurement of winds, temperature, and trace species using the unique turbulence probe developed at ATDD (Crawford and Dobosy, 1992). The canard design has a low stall speed with no spin hazard. The plane has superior pitch stability in turbulent conditions. These factors, combined with low wing loading, allow safe, low-speed (50 ms^{-1}), and low-level (10 to 20m AGL) turbulence measurements within the boundary layer, a difficult venture for instrumented aircraft in the past.

Table 3 lists the Long-EZ aircraft's specifications and performance characteristics. Since the airplane has a transit speed of 90 ms^{-1} and a range exceeding 3,300 km, experimental measurements anywhere in the world are possible. The airplane is IFR-equipped (including weather radar), and has a ceiling exceeding 9 km AMSL. The airframe is of fiber composite construction, conforming to the +9 to -6 G-load requirements of the acrobatic class airframe. This fatigue-resistant and high-strength characteristic provides safe operation even in high levels of thermal or mechanical turbulence. To enhance flight safety, a ballistically-deployed parachute system, opening in 1.4s, allows emergency recovery of the pilot, airplane, and instrumentation.

Figure 3. The Long-EZ airplane used to carry the airborne flux system.

Table 3. NOAA/Long-EZ/N3R Airplane Specifications.

Specifications		Performance	
Type Certificate	Experimental	Stalling Speed	27 ms^{-1}
Powerplant	Lyc-O-320 160 HP	Maximum Speed	93 ms^{-1}
Electrical	65 amp 12VDC	Ceiling	9000 m
Empty Weight	430 kg (950 lb)	Range	3300 km
Gross Weight	725 kg (1,600 lb)	Endurance	10 to 18 hr
Fuel Capacity	200 kg (435 lb)	Fuel Use	8.2 to 19 $kg\text{-}hr^{-1}$
Wing Area	9.3 m^2	Flow Blockage	0.2 m^2

3.2 Eddy correlation technique

Flux measurements for mass, momentum and energy were obtained using the eddy correlation technique. This method is a direct measure of turbulent air-surface exchange. On a fixed platform, such as a tower, the surface exchange of a species ϕ is given by

$$F_{\phi} \equiv \overline{(\rho w)'\phi'} = \overline{(\rho w)\phi} - \overline{\rho w}\,\overline{\phi} \tag{1}$$

where ϕ is the mixing ratio of the species of interest, w is the vertical wind component, and ρ is the total air density (the sum of the dry air and water vapor densities). The overbars indicate an average of the quantity over a large enough time (or space) to adequately sample all relevent scales. Primes denote a deviation from the averaged values.

The eddy correlation technique takes a sample from the mass, momentum, and energy patterns of a flow and determines the average flux as a covariance. The averaging time or space must be large enough to sample the largest turbulent features adequately, but small enough that the large-scale patterns do not change significantly. Since daytime thermal plumes are to be treated as turbulence, averages over a distance of about 10 km are required for airborne measurements. This distance is not practical for the land-use scales at Boardman. Instead, shorter spatial averages and multiple passes were made to achieve the necessary sample sizes. The required sample size was also reduced due to the low flight altitudes. Since thermals are less organized close to the ground, the thermal turbulence has smaller sacle.

In order to compare airplane measured fluxes to those at the surface, one must consider flux divergence below the airplane. For measurement of air-surface exchange, the farther a flux-measuring device is from the surface, the more important is flux divergence. Thus, the effect of flux divergence on the airplane measurements (at 12 to 30m) is greater than that on the tower measurements (at 4m above ground). Relevent features for a quantity whose flux is being measured include atmospheric storage, determined by local time tendency, and mean transport, both horizontal and vertical. The importance of these factors is enhanced by surface heterogeneities that produce organized flows and gradients of temperature, trace gasses, and the like. These factors are discussed in connection with the comparison between airplane and tower heat fluxes (See Section 6.5).

On a moving platform such as an airplane, covariance flux measurements must be corrected for variation in transit speed (Crawford *et al.*, 1993). This factor is a result of the correlation between airplane speed and local vertical velocity. When an airplane enters an updraft, the autopilot (or pilot) maintains constant altitude by decreasing attack angle. As the airplane pitches over, it accelerates. The result is a faster transit through up-drafts than down-drafts, biasing the simple time covariances. Theoretically correct distance-based covariance fluxes, based on the transformation $dx = S\,dt$ (where S = airplane speed), are determined as follows:

$$F = \frac{\overline{w\Phi S}}{\overline{S}} - \frac{\overline{wS}\;\overline{\Phi S}}{\overline{S}^{2}} \tag{2}$$

The authors are not aware of the application of this correction technique in other similar aircraft measurements. The correction is more important for small airplanes (having small inertia) and when thermal turbulence becomes more organized (low wind, mid-boundary-layer altitudes, and high thermal turbulence conditions). Although a sizable portion of the 1991 Boardman data were taken in high wind conditions (which reduce wS and ϕS correlations), the importance of the correction was first noted during this experiment. The significance of the correlation was particularly apparent between farmland and steppe transects during light wind conditions. Over the steppe, large thermals frequently caused speeds to vary by ±15%. All fluxes reported here were computed using Equation (2).

3.3 Velocity and temperature measurements

Three-dimensional wind component and temperature measurements were obtained with a sensitive fast-response turbulence probe (Crawford and Dobosy, 1992). The velocity vector at the probe is obtained by adding the velocity $\mathbf{V}_a$ of the air relative to the probe to the velocity $\mathbf{V}_p$ of the probe. This gives the velocity $\mathbf{V}$ relative to earth:

$$\mathbf{V} = \mathbf{V}_p + \mathbf{V}_a. \tag{3}$$

The algorithm used to determine the probe velocity vector ($\mathbf{V}_p$) uses input from accelerometers to obtain high frequency contributions (Crawford *et al.* 1990). Input from a Global Positioning System (GPS, Dobosy and Crawford, 1992) was used to obtain low frequency contributions (LORAN was used during infrequent periods when GPS was not available). The velocity vector relative to the probe ($\mathbf{V}_a$) is computed from pressure differences observed on the probe. The probe is unique in that it co-locates the sensors (acceleration, pressure and temperature) needed for accurate high frequency measurements of wind and temperature. The probe is mounted axi-symmetrically on the airplane. Sensors used in the algorithm for air motion computation are summarized in Table 4.

Table 4. NOAA/Long-EZ/N3R Turbulence, Wind, and Position Instrumentation Specifications.

Variable	Location	Range	Resolution	Sensor
Acceleration[1] Sensors				
X	P[2] & CG[5]	± 1g	.0005g	SenSym-SXL02G
Y	P & CG	± 1g	.0005g	SenSym-SXL02G
Z	P & CG	+2/-1g	.001g	SenSym-SXL02G
Pressure Sensors				
Dynamic	P	0-24 mb	.005 mb	MS[3]-160PC01D37
Yaw	P	± 12 mb	.005 mb	MS-160PC01D36
Pitch	P	± 12 mb	.005 mb	MS-160PC01D36
Static	P	700-100 mb	.04 mb	Setra System
Delta Static	P	± 12 mb	.005 mb	MS-160PC01D36
Gyros[4]				
Pitch	CG	± 83 deg	.15 deg	Honeywell JG7044A-35
Roll	CG	± 175 deg	.15 deg	
Yaw Rate	CG	± 6 deg-s^{-1}	.05 deg-s^{-1}	Honeywell-GG13A
Position				
Lat/Lng	CG	Limited	± 100 m	LORAN
Lat/Lng	CG	Global	± 25 m	Global Pos Sys
Altitude	CG	Global	± 25 m	Global Pos Sys
Altitude	CG	Global	5%	Radar
Heading	P	0-360	0.1°	KVH IND/MC201

Notes:

1. ATDD designed and fabricated support circuitry for these transducers.
2. Probe
3. Micro Switch, a Honeywell Division
4. ATDD R&D is developing a more accurate non-gyro approach.
5. Center of gravity

3.4 Chemical species measurement

Table 5 provides specific information on the MFP chemical sensors. The fast response H_2O/CO_2 sensor is a 20 cm open-path infrared analyzer described by Auble and Meyers (1992). Noise levels for H_2O and CO_2 concentrations are less than 10 mg-m^{-3} and 300 μg-m^{-3} RMS, respectively (for frequencies between 0.005 and 10 Hz). The fast O_3 sensor design follows that of Ray *et al.* (1986). The detection principle is ozone chemiluminescence with eosin Y dye dissolved in a fluid carrier. The sensitivity was enhanced by use of a 50% ethylene glycol, 40% ethanol, and 10% water carrier. Additional slow-response sensors include: net and short wave radiation; dew point and surface infrared temperature, H_2O/CO_2 (LI-COR, Inc.), and O_3 (DASIBI 300AH) gas analyzers.

Table 5. NOAA/Long-EZ/N3R Chemical-Radiation-Temperature Specifications.

Variable	Use	Range	Resolution	Sensor
Chemical Sensors				
H_2O	Mean	40°C Dewpoint	<1%	LI-COR LI-6262
H_2O	Flux	3 to 20 gm/m^3	4 mg-m^{-3}	ATDD Design
CO_2	Mean	0 to 3000 PPM	±1 PPM	LI-COR LI-6262
CO_2	Flux	200-500 PPM	±0.1 PPM	ATDD Design
O_3	Mean	0 - 500 PPB	±0.3 PPB	DASIBI 1003AH
O_3	Flux	0 - 200 PPB	±.05 PPB	ATDD Design
Radiation				
Net	Mean	0 - 1200 W	±0.3 W	Rad.Ene.Bal.Sys Q*6
Short Wave	Mean	0 - 1300 W	±0.3 W	LI-COR LI-200s
Temperature Sensors				
T	Mean	-7/+65°C	±0.02°C	Hy-Cal BA-507-B
T′	Flux	±15°C	±0.005°C	Thermistor
H_2O	Mean	-40 to +60°C	±0.25°C	EG&G chilled mirror
Sfc IR T	Mean	-30 to +100°C	±0.1°C	Everest Mod 4000

3.5 Data processing

Fast response analog signal data were first conditioned with 10 Hz low-pass anti-aliasing four-pole Butterworth filters before being converted to 90 Hz digital signals. The 90 Hz digital signal was passed through a three-point Hanning filter, subsampled at 30Hz, and written to disk for post processing. Slow response analog signal data were also digitized at 90 Hz but instead were passed through a two stage digital filter before being subsampled at 1 Hz for recording. The first stage was a three-point centered average, subsampled at 30 Hz. The second stage was a 60 point triangle filter rejecting frequencies above 1 Hz.

Heat, momentum, water vapor, CO_2, and O_3 fluxes were computed during post processing using (2) and having the means (but not trends) removed. The large trends observed indicate the need to explore various trend removal methods in future analyses. Path average fluxes were derived from either 40 or 90 s data segments. The 50 ms^{-1} sampling speed of the airplane allows variability up to a 4.5 km scale to contribute to the covariance. Larger-scale variability should be unimportant at such a low flight altitude. As outlined by Webb *et al.* (1980), necessary data corrections for pressure, temperature, and water vapor fluctuations were eliminated by converting sensor outputs to mixing ratios (*i.e.* the species mass density divided by the mass of dry air).

In covariance computations, lag or phase errors between the w' time series and that of any species of interest must be removed. Use of fast sensors and identical low-pass filters mitigates these problems. Still, phase differences are created by imperfect sensors and spatial separation. The distance from the probe to any other sensor will introduce a phase lag proportional to that distance divided by the air speed. The H_2O/CO_2 sensor is about 1 m behind the probe while the O_3 sensor is back about 3 m. Thus, at a 50 ms^{-1} flight speed, the expected lag is 1/50 and 3/50 s respectively. Experimentally, lags are precisely determined from the cross-correlation, or cross-correlogram of the two time series. Only the O_3 signal required a time lag adjustment.

4.0 EXPERIMENT DESIGN

During the planning of the experiment, several hypotheses, addressing various aspects of the fundamental question, were posed for testing by airplane measurements. These are listed in the Operations Plan reproduced below. Anticipating difficulty in measuring fluxes at night, for reasons of flight safety and low mean flux values, we planned the majority of observations for daytime (0900 to 1500 PDT), with a few hours of transition measurements added to test our ability to measure time variations.

4.1 Listing of the Operations Plan

ATMOSPHERIC RADIATION MEASUREMENTS AIRPLANE OPERATIONS IN OREGON

1 - 22 June 1991

GENERAL

A. All airplane measurements use UTC (PDT + 7 hr). Standard procedure for all ATDD Mobile Flux Platform operations to minimize errors in data recording.

B. Schedule 100 hr to be partitioned

1. Day (16 Z to 22 Z, 09 to 15 PDT)	55 hr
2. Night (06 Z to 12 Z, 23 to 05 PDT)	28 hr
3. Transition (Morning and Evening)	17 hr

C. Scientific objectives of two types
   1. How to infer area-wide surface energy balance in the presence of a sharp discontinuity in surface characteristics, including, but not limited to:
      a. Influence of internal boundary layer structure
      b. Validity of present parameterizations for Global Circulation Models
   2. How to account for the sources of variance to allow meaningful interpretation of the data.

D. Airplane's role is in observing spatial variability in fluxes and controling parameters. Flights will be carefully coordinated with towers, which will observe the temporal changes.

HYPOTHESES

A. Fluxes and associated parameters over irrigated farmland and steppe individually have homogeneous statistical structure in the absence of clouds.

B. Inference of the area-wide surface energy balance over an heterogeneous surface is signifantly improved by using a limited set of higher-order spatial statistics (Which ones to be determined by data analysis and model results).

C. Variability due to cloud shadows on partly-cloudy days has an important and accountable influence on the area-wide surface energy balance.

D. Fluxes at flight-level are horizontally homogeneous under overcast sky, in strong winds, and at night. In particular spatial transition between irrigated farmland and steppe becomes insignificant.

E. Secondary circulations between irrigated farmland and steppe account for significant transport of heat and moisture under low-wind conditions and must be included in any energy-balance parameterization.

F. Current parameterizations in GCM's are inadequate for unresolved surface heterogeneities.

EXPERIMENT PROCEDURES AND SCHEDULE

A. ASK: Pair of asterisks (Straight paths, 6-8 different headings evenly spaced through 360°, centered on a tower)
  1. One over desert; one over crops
  2. Flown during sunny day (Cloud cover less than broken)
  3. Flight time 5 hr
  4. Repeat at night and on windy afternoon to test hypothesis D.

B. FLX: Multiple transects along same path, same altitude, crossing between irrigated farmland and steppe and passing within 400 m of at least two towers measuring three-dimensional eddy correlations.

C. FDV: Transects over the same ground path, but at several altitudes, arranged to cancel temporal trends at each altitude. Goal is to account for vertical flux divergence.

D. CML: Vertical sinusoidal pattern across inversion base, found by sodar, to observe mean profiles through top of convective mixed layer.

E. PRO: All flight patterns include a spiral profile at start, at end, and at least every 3 hr.

FLIGHT TIME ALLOCATION DOE ARM, 1 - 22 June 1991, Boardman, Oregon				
Pattern	**Day**	**Night**	**Dawn Dusk**	**Remarks**
Asterisks (ASK)	10 hr	10 hr	0 hr	Preferrably cloudless, this pattern only.
Single path (FLX)	27 hr	15 hr	12 hr	Basic production runs. One 8-hr daytime flight if safe.
Single ground path, multiple altitudes (FDV)	12 hr	3 hr	5 hr	Night success uncertain
Convective mixed layer (CML)	6 hr	0 hr	0 hr	
Vertical profiles (PRO)	-	-	-	Spiralform vertical flux profiles; frequency depends on circumstances
Total	55 hr	28 hr	17 hr	Total 100 hr

4.2 Comments on flight patterns

The airplane operations plan above lists five basic flight patterns: Asterisk (ASK), long-transect flux runs (FLX), flux divergence (FDV), convective mixed layer (CML), and profiles (PRO). Time limitations, very deep convection, and poorly defined mixed layer boundaries forced the elimination of the planned CML flights. A "flux normal" (FLN) pattern was added to supplement ASK information. General descriptions of implemented flight patterns are given in the paragraphs that follow. Sections 5 and 6 describe the actual operations and results of these patterns.

Asterisk patterns (ASK), named for their general shape, were designed to provide assessment of the importance of spatial heterogeneity over irrigated farmland and steppe, along with anisotropy with respect to the wind, sun, *etc.* Ideally, the asterisk patterns should have straight paths about 10 km long (200 s ± 60 s), oriented at 30° to 60° intervals around the compass. Some adjustments were required for asterisks over the farmland due to space limitations. A measurement tower was to be positioned in the center of the pattern.

Low-level flux runs (FLX) were to be flown at 10 m to 20 m AGL along a single transect, half over irrigated farmland, half over steppe, anchored to instrumented towers in both regimes. Typical path length was 24 km, with some longer. FLX runs were planned to allow superposition of multiple runs, increasing sample sizes for better determination of the spatial structure of air surface exchange over this sharply heterogeneous region.

Flux divergence runs (FDV) were designed to examine the vertical variation of fluxes over the instrumented transect. Flights were to be flown in pairs, in opposite directions at each of three altitudes from 12 m to about 300 m AGL. Time trend effects could be removed by the "stair step" ascending and descending sampling pattern (which usually would have about ten passes per divergence series).

Profiles (PRO) were designed to obtain measurements of vertical flux behavior from the surface to various heights, depending on clouds, air space restrictions, fuel, and time constraints. The flights were to be flown in spirals, climbing then descending to sample the vertical variation of mean scalar quantities (temperature, moisture, and trace gas concentrations). A profile was planned for the beginning and end of each flight (approximately every 3 hr). Supplemented by Tethersondes, these profiles could be used to sample atmospheric stability, mixed layer heights and moist layers.

Flux normal patterns (FLN), having the same general objective as asterisks, were conceived during the field operations themselves. They sacrifice variety in path orientation to gain frequent replication. Like asterisks, flux normal runs suffer from space limitations over the farmland. As their name implies, flux normal patterns are perpendicular to the instrumented transect line and the prevailing wind direction (WSW).

5. FLIGHT OPERATIONS: 2-20 JUNE, 1991

The 1991 Boardman experiment was implemented from 2-20 June, 1991. The distribution of flight times included more transition hours than planned because mid-day was favored for military use of the bombing range. Basic characteristics of actual flight operations are presented in Table 6.

Asterisk (ASK) patterns over the steppe were flown primarily on 4 June in late morning (0900 to 1300 PDT), with winds veering from northwest to northeast. Farmland ASK's were flown on 2 and 8 June. The first set of farmland ASK's was full of difficulties, being one of the initial operations of the experiment. As a result, only one farmland ASK was usable. A steppe ASK was flown on 10 June, which provided additional support for the results of 4 June. Typical patterns of farmland and steppe asterisk flights are given in Figures 4 and 5. The somewhat deformed pattern of the farm ASK was imposed by space limitations. Of the total number of flux runs, 75 (or 15%) were asterisk formations.

The 274 single-path (FLX) patterns flown account for the majority (54%) of the experiment's flights. The instrumented transect over which these flights were made is illustrated in Figure 1. Anchoring 3-D flux towers along the transect are also identified in the figure. Some FLX runs extended beyond the normal 24 km length to lengths up to 41 km. Lists of FLX transects can be found in Appendix A. Appendix B is a set of graphs showing FLX results.

Flux divergence (FDV) patterns constituted 116 flights in the experiment (23% of total flights). Flux divergence was flown on 9 June and most dates after 11 June. Lists of FDV transects can be found in Appendix A. Vertical profiles of flux divergence results are in Appendix C.

Due to various restrictions, profiles (PRO) were not flown as frequently as planned. At least two PRO flights were flown during most days of the experiment. A few were flown in a different pattern from that described in Section 4. Appendix D graphs the results of most of the 24 PRO flights.

FLN runs were flown primarily on 12 June, a day when the temperature sensor was not functioning properly because of cold temperatures. For this reason and a number of others, the 42 FLN measurements are of secondary importance in this report.

Calibration maneuvres, ALT, PCL, UPD, YAW, PCA, ROL, and WC, shown in Table 6, allowed for the adjustment of coefficients and correction factors, primarily in wind calculations (Bögel and Baumann, 1991). The vertical velocity component, fundamental to flux calculations, was of particular interest.

Table 6. Overview of 1991 Boardman Airborne Data Collection

June	Time UTC	Type***	Run Length	General Remarks	Weather Conditions
2	1714-1725 1730-1930 1939-2019 2020-2032	1-PRO 8-FLX 8-ASK 1-PRO	Surface to 1375 m 41 km transects 9 km deserts Surface to 1300 m	DASIBI, LiCore not installed Marginal dew point ventilation First use fast O_3, no calibration IR3 H_20/CO_2 sensor problem	Clear Cold front to immediate NW (2100) Temp. 25.5°C* Aircraft winds 10 ms^{-1}
3	1833-1847 1848-2051 2052-2111	1-PRO 12-FLX 1-PRO	Surface to 1000 m 28 km transects Surface to 3000 m	IR3 H_2O/CO_2 problem; CO_2 span changed 0_3 fast sensor fluid pump failed Requested to leave complex at 2022	Mostly clear; a few Cu clouds; ceiling 2900m Temp. 14 to 18°C Aircraft winds 5 ms^{-1} Net radiation 514 to 585 Wm^{-2}
4	0101-0236	10-FLX	24km transects	Repaired fast O_3 fluid pump	Temp. 18 to 16°C Aircraft winds 11 ms^{-1} Net radiation 190 to -26 Wm^{-2}
4	1614-1622 1624-1958 1959-2005	1-PRO 43-ASK 1-PRO	Surface to 500 m 12 km transects Surface to 500 m	IR3 problem; CO_2 offset set to 2V Note that terrain falls toward river; will fly at constant AGL	High clouds increase, 3 to 7/10; ceiling 6100m* Temp. 11 to 17°C Tower winds 2 to 3 ms^{-1} Net radiation 311 to 567 Wm^{-2}
5	0217-0226 0227-0230 0231-0234	2-PCL 1-UPD 1-YAW	12 km transects 8 km transect 7 km transect	Calibration run Installed DASIBI, IR5, & LiCore Pitch calibrated over river	3/4 cloudcover; ceiling 4000m* Temp. 19 to 18°C Tower winds 2 ms^{-1} Net radiation 3 to 27 Wm^{-2}
6	0044-0056 0056-0340	1-PRO 16-FLX	Surface to 875 m 24 km transects	First application of DASIBI & LiCore	Cloudy; some raindrops noted 24-hr antecedent rainfall Temp. 18 to 14°C Aircraft winds 5 ms^{-1} Net radiation 174 to -26 Wm^{-2}
6	1855-1905 1906-2227 2228-2241	1-PRO 17-FLX 1-PRO	Surface to 1025 m 24 km transects Surface to 1050 m	PRO started over farm and finished over steppe Ground station moved to airport	Cloud base 1200m (2135) Radar echoes in vicinity Temp. 17 to 20°C Aircraft winds 4 ms^{-1} Net radiation 292 to 432 Wm^{-2}

June	Time UTC	Type***	Run Length	General Remarks	Weather Conditions
7	1650-1707 1710-1919 1919-1927	1-PRO 14-FLX 1-PRO	Surface to 1300 m 25 km transects Surface to 500 m	FLX terminated due to military aircraft Post-flight inspection found 0_3/LiCore sample inlet not extended / problem	Cu clouds, base 1375m; sky clearing Temp. 19 to 21°C Aircraft winds 10 ms^{-1} Net radiation 424 to 555 Wm^{-2}
7/8	2302-2306 2306-0140	1-PRO 15-FLX	Surface to 875 m 26 km transects	Held out of bombing range by RNG CNTL for 5 min	Cloudy Temp. 22 to 20°C Aircraft winds 7 ms^{-1} Net radiation 332 to 45 Wm^{-2}
8	1508-1524 1525-1633 1700-1825 1828-1846	1-PRO 14-ASK 9-FLX 2-PRO	Sfc. to 1300m 11km transects 22km transects Sfc. to 6000m	Difficult to run good ASK over EOF** LiCore inlet not fully extended upon landing Landed to reset data system	Mostly clear; shallow Cu clouds at 1075 to 1375m; cirrus late Temp. 15 to 21°C Aircraft winds 3 ms^{-1} Net radiation 182 to 519 Wm^{-2}
8	2256-2354	7-FLX	25 km transects	DASIBI not working Db sound vs alt test	Temp. 24°C Aircraft winds 3 ms^{-1} Net radiation 391 to 221 Wm^{-2}
9	1030-1315 1319-1424 1456-1805	12-FDV 6-FLX 18-FLX	34 km transects 26 km transects 27 km transects	Begin flight in darkness (1651) Identified ground references 1st wing rock @ Bombing Range Rd. to phase GPS/LORAN Landed to clean probe T' sensor over ranged	Calm night; clear day Temp. 13 to 10°C (night); 10 to 22°C (day) Aircraft winds 3 ms^{-1} Net radiation -40 Wm^{-2} (night); to 477 Wm^{-2} (day)
9	1913-2121	19-FLX	23 km transects	DASIBI quit working Tethered balloons	Clear Temp. 22 to 27°C Aircraft winds 3 ms^{-1} Net radiation 560 to 588 Wm^{-2}
10	1705-1808 1810-1905 1906-2107 2107-2128	6-FLX 10-ASK 12-FLX 1-PRO	24 km transects 11 km transects 24 km transects Surface to 1825 m	No LiCore data DASIBI intermittent O_3 sensor calibrated Tethered balloons	Partly cloudy, 3/10; ceiling 7600 m*; clear late Temp. 23 to 32°C Aircraft winds 2 ms^{-1} Net radiation 412 to 570 Wm^{-2}

June	Time UTC	Type***	Run Length	General Remarks	Weather Conditions
12	1507-1550 1601-1740 1745-2023 2024-2052	5-FLX 25-FLN 17-FDV 2-PRO	24 km transects 7 km transects 24 km transects Surface to 2450 m	Solar flare expected; may affect compass Fast O_3 not turned on T' sensor over ranged	Partly cloudy; decreasing from 7 to 3/10; ceiling 1525 m*; (1745) scat Cu building Temp. 13 to 18°C Aircraft winds 9 ms^{-1} Net radiation 198 to 576 Wm^{-2}
13/14	1817-1841 1841-1901 1904-2330 2332-2341 2344-0009 0015-0052	2-PRO 7-FLN 13-FDV 1-FLX 6-FLN 4-FLX	Surface to 2300 m 5 km transects 29 km transects 24 km transects 9 km transects 24 km transects	O_3, LiCore, & IR5 calibrated Ground station keyboard and monitor blown off box; found 25m downwind NO COMMENTS AFTER 2052	3/4 cloudcover; ceiling 1675m* (2004) raindrops noted; (2009) Virga observed Temp. 16 to 18°C Aircraft winds 8 ms^{-1} Net radiation 617 to 158 Wm^{-2}
14	1413-1520 1527-1538 1542-1557 1647-1708 1708-1745 1747-2016	8-FLX 4-FLN 2-FLX 1-PRO 4-FLX 16-FDV	24 km transects 8 km transects 22 km transects Surface to 1800 m 24 km transects 24 km transects	May have lost some data due to GPS falling off box (6/13)	Clear early; partly cloudy later; ceiling 1525m Temp. 10 to 18°C Aircraft winds 9 ms^{-1} Net radiation 61 to 575 Wm^{-2}
15	1042-1313 1313-1328 1423-1626 1628-2022 2022-2035	14-FDV 1-PRO 13-FLX 21-FDV 1-PRO	24 km transects Surface to 1500 m 24 km transects 24 km transects Surface to 1150 m	Begin flight in darkness Started FDV with no PRO A lot of irrigation in progress Tethered balloons	Increasing cirrus to altostratus Occluded frontal passage Temp. 12°C to 1300, then 22°C Aircraft winds 4 ms^{-1} Net radiation -25 to 528 Wm^{-2}
17	1453-1515 1516-1709 1733-1834 1836-1902 1904-2017 2018-2247 2251-2259 2300-2302 2303-2305 2306-2307	1-PRO 12-FLX 7-FDV 3-FLX 8-FDV 12-FLX 2-PCA 1-UPD 2-YAW 1-ROL	Surface to 2050 m 24 km transects 24 km transects 24 km transects 24 km transects 24 km transects 8 km transects 6 km transect 4 km transects 2 km transect	Calibrations performed over river with 1.5 hrs of bug accumulations Pitch, yaw, and roll calibrations performed Tethered balloons	Mostly clear (1600) 3-4/10 cloud cover; ceiling at 7600m* Some Cu clouds (non-ag area) Temp. 12 to 22°C Aircraft winds 3 ms^{-1} Net radiation 186 to 586 Wm^{-2}

June	Time UTC	Type***	Run Length	General Remarks	Weather Conditions
18	1857-2056	13-FLX	24 km transects	Calibrated O_3, CO_2, IR5, LiCore; cleaned microbead thermistor Tethered balloons	Heavy overcast; clearing late; solar radiation greater SW Temp. 19 to 22°C Aircraft winds 2 ms^{-1} Net radiation 275 to 504 Wm^{-2}
19	0004-0120	8-FDV	25 km transects	Cleaned mirrors on IR5, CO_2 sensor Radar-altimeter calibration over river Pitch calibration	Decreasing cloudiness Temp. 23 to 24°C; 20°C late Aircraft winds 3 ms^{-1} Net radiation 299 to -15 Wm^{-2}
	0123-0313	12-FLX	24 km transects		
	0314-0322	2-WC	wind circles		
	0324-0326	1-ALT	6 km transect		
	0332-0351	2-CAL	21 km transects		
19	1833-1911	4-FLX	24 km transects	Low flux runs attempted	Rainshowers Temp. 18 to 19°C Aircraft winds 2 ms^{-1} Net radiation about 160 Wm^{-2}
19/20	2358-0149	12-FLX	24 km transects		Heavy clouds; frequent rain Stationary front to immed NE (0107) Rain over farm area only Temp. 16 to 18°C Aircraft winds 8 ms^{-1} Net radiation 47 to 18 Wm^{-2}

* Denotes weather observation from Pendleton, OR (about 80 km ESE of Boardman experiment site).

** EOF - Eastern Oregon Farming Company

*** Flight Types: ASK - Asterisk pattern of flux runs centered on flux tower; FLX - Flux transect; FDV - Flux divergence (typically a 3-level low to high & high to low flight); PRO - Atmospheric profile; FLN - Flux run normal to the wind; ALT, PCL, UPD, YAW, PCA, & ROL - Calibration runs; WC - wind circles

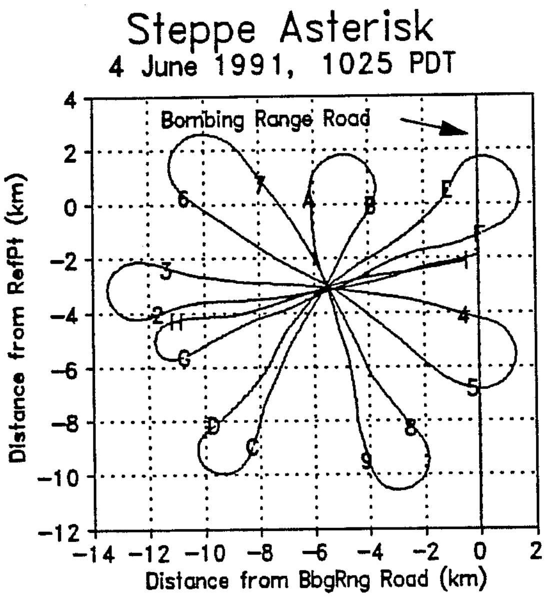


Figure 4. Path of 4 June 1991 steppe asterisk.

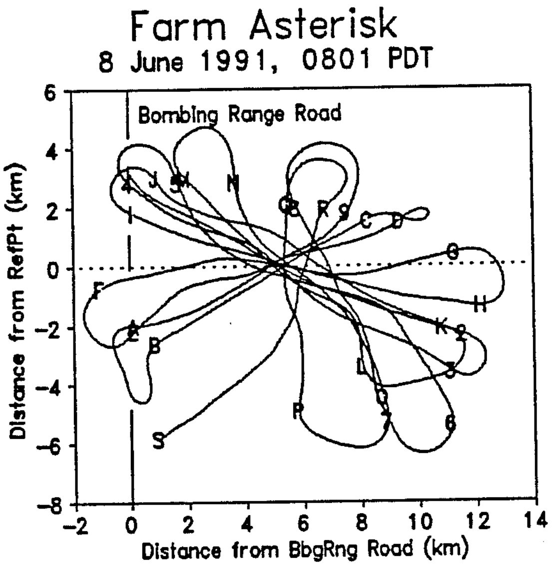


Figure 5. Path of 8 June 1991 irrigated farmland asterisk.

6. DATA ANALYSIS

6.1 Asterisk (ASK) and Flux Normal (FLN) Flight Patterns

6.1.1 Analysis procedure

The primary quantities examined in the ASK and FLN analyses were mean winds and surface heat budget terms. The nul hypothesis states that the statistics of these quantities are independent of path direction and are horizontally homogeneous within a land surface type (irrigated farmland or steppe). In this preliminary data report, analysis was confined to visual examination of the data. The primary goal was the identification of evident spatial patterns that might prove to be statistically significant in an appropriately defined test.

Dependence on path direction was investigated in the path-average values of the examined quantities from individual legs of the ASKs and from FLN runs. Heterogeneities were investigated in fluxes computed over two integration lengths: 4.5 km (90 s) and 1 km (20 s). Computed fluxes are reported every 20 s (1 km), anchored to the temporal midpoint of each path. The airplane directly measured sensible and latent heat fluxes and net radiation. Soil heat flux, unmeasurable from the airplane, was estimated as a residual. Because winds are less readily related to the immediate surface, mean winds were analyzed only for the dependence on path direction. Other techniques will be used to identify secondary circulations and other heterogeneous flow patterns in future analyses.

Examination of momentum fluxes revealed so much scatter that little could be concluded. Alternate analysis techniques are under development that may facilitate better data interpretation. On average, the ASK measurements exhibited the required downward momentum flux. However, average flux proved much smaller than individual measurements and not significantly different from zero.

6.1.2 Dependence on path direction

Flights were made in pairs in approximately opposite directions. Passes differed by 180° for FLN and 150° for ASK. For reasons yet unclear, an oscillatory pattern appears in the data, such that flights in one direction have preferrentially lower flux values than those in the opposite direction. A particularly obvious example is displayed in Figure 6. Note, however, that the flux of O_3 is unaffected by path direction. We routinely obtain fluxes as an average of two consecutive passes, in opposite directions, thereby mitigating the effect of this direction dependence. Since the O_3 fluxes corresponded to the authors' normal experience with O_3 fluxes, the discussion that follows focuses on the remaining flux variables.

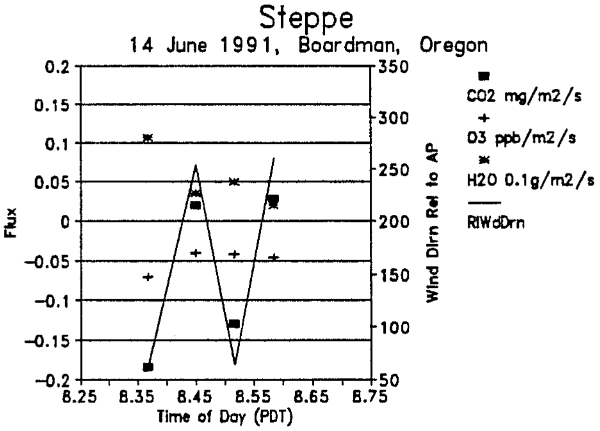


Figure 6. Particularly obvious case of interpath fluctuation in CO_2 and H_2O. Note that O_3 is unaffected.

The magnitudes of interpath fluctuations were estimated by isolating them with a high-pass [-0.25, 0.5, -0.25] filter over the sequence of path-average fluxes from each ASK pattern. This was done without regard to the variation in time interval between adjacent paths. The amplitudes of the fluctuations were then estimated as half the average absolute difference between adjacent high-passed values. A similar technique was applied to usable FLN's. Results are presented in Table 7.

Sensible heat flux, being relatively easy to measure, undergoes minimal variation with reversal of path direction. Some orientations did have stronger fluctuations than others, though not according to any readily discernable pattern. The routine procedure of averaging two consecutive passes, as previously mentioned, eliminated these fluctuations. Attempts to isolate bias in the derived fluxes as a function of path direction have not yielded clear patterns.

Table 7. Amplitude of interpath fluctuations.

Flux Measurement	IRRIGATED FARMLAND (ASK 8 June, FLN 12-13 June)		STEPPE (ASK 4 June, FLN 12-14 June)	
	Mean ± Fluctuation		Mean ± Fluctuation	
	ASK	FLN	ASK	FLN
Sensible Heat (Wm^{-2})	75 ± 5	-	233 ± 16	-
Latent Heat (Wm^{-2})	150 ± 18	191 ± 25	110 ± 36	22 ± 26
Net Radiation (Wm^{-2})	320 ± 10	-	464 ± 5	-
Soil Heat (residuum; Wm^{-2})	105 ± 26	-	120 ± 43	-
CO_2 ($mg\text{-}m^{-2}s^{-1}$)	-0.59 ± 0.071	-0.99 ± 0.26	-0.36 ± 0.21	-0.37 ± 0.06

Latent heat and CO_2 flux were measured using similar instruments and principles. Over irrigated farmland, ASK values from 8 June, especially for CO_2, have less fluctuation than FLN values from 12 and 13 June. The majority of FLN values came from 12 June, when the temperature sensor was inoperative. This gives greater credibility to the ASK pattern results measured over the farmland. Over the steppe FLN values fluctuated less than ASK, especially for CO_2. Although many more flight paths are included in the ASK results, a number of them have abnormal diagnostic statistics (variance, skewness, and kurtosis of measured raw data) that have not been fully investigated. Thus, FLN values measured over steppe command greater confidence than ASK.

Net Radiation is accurately measured in both regions.

The soil heat flux, estimated as the residual was about 50 wm^{-2} larger than the magnitude of soil heat flux measured at towers over the irrigated farmland. Strong fluctuation from path to path was noted. In part, this result occurs because fluctuations in latent heat and net radiation tend to re-enforce one another. The cause of this re-enforcement effect is unknown.

The measured mean winds were averaged by component over each path length. These averages were plotted against time and fit with low-order polynomials, which were then subtracted to remove any time trends. A cubic polynomial was used for the steppe ASK's of 4 June: a quadratic polynomial was used for the irrigated farmland ASK: and a simple removal of the mean was performed on the steppe ASK of 10 June. Plotted against mean airplane heading, the u-component (positive from west) revealed a significant dependence, as evident in Figure 7. The fit of the sine curve explains 42% of the variance and has an amplitude of 1.3 ms^{-1}, maximum for a mean airplane heading of 162°. The sine wave fit to the v-component explains only 10% of the variance and is not considered significant.

Nodes of the sine wave describing the bias in the u-component correspond approximately to the directions of the primary flux transect. Several compass and airspeed correction parameters were adjusted to minimize interpath variance for the primary flux runs. Therefore, it is not surprising to find near zero bias along these directions. More detailed compass calibrations are planned to minimize these biases. For this set of data, a correction to the u-component could be determined from the sine curve of Figure 7. We chose not to do this for the present report.

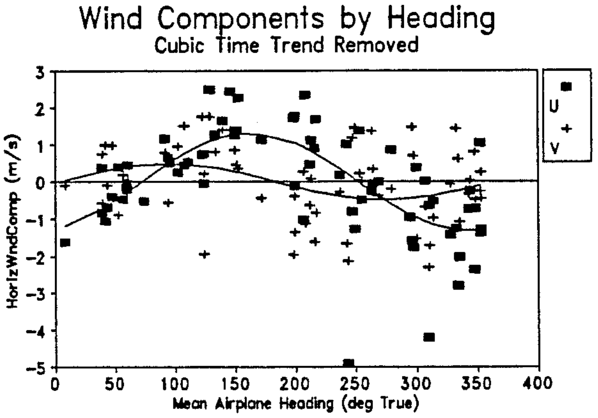


Figure 7. Dependence of measured wind components on mean airplane heading. Data from all ASK runs appear, both irrigated farmland and steppe. Sine waves were fit by least squares.

6.1.3 Homogeneity tests

The search for spatial patterns used the ASK flights because of the limited number of FLN runs unaffected by sensor troubles. Variability over the experimental region can be separated into two categories: atmospheric and surface. Since all ASK patterns were flown during periods of daytime heating, the measured atmospheric variations have spatial scales of about 1 km and temporal scales of around 100 s. They include thermal updrafts and downdrafts, moisture plumes, clouds, *etc.* Surface variations over the steppe have scales of multiple kilometers (including vegetation communities, terrain slopes, *etc.*). Over the irrigated farmland, surface variations have scales of 800 m, although several adjacent fields may be planted in similar crops. This was particularly true of alfalfa. Occasionally the flight path passed over an active irrigator, with its associated moisture plume and high surface moisture.

Fluxes computed over 4.5 km were a more representative sample of atmospheric variations, but were unable to distinguish small-scale surface variation over the irrigated farmland. The shorter fluxes, on the other hand, inadequately sampled atmospheric fluctuations, causing considerable scatter. In flux runs along the long transect (FLXs), the sample size for shorter integration lengths is increased by averaging over several passes at the same point. Such is impractical for the ASK patterns, especially over the irrigated farmland, where the surface may change significantly from one field to another. One means of treating this problem is to record, along with the 1 Hz position information, the nature of the underlying surface. This procedure has not yet been applied to the data, but existing information makes it possible.

Patterns of sensible and latent heat flux over the steppe from 20 s covariances are displayed in Figures 8a and 8b. The sensible heat flux increased with time in these forenoon measurements and is presented here with its mean time trend removed. The division into quartiles provides a pattern robust to outliers, common with such short averages. No pattern is visually evident. Each location in the figures has representatives of all four quartiles nearby. A similar result was obtained with 90 s covariances. Since no pattern is visually evident, the nul hypothesis cannot be rejected. Consequently, the steppe should be treated as being homogeneous for purposes of these measurements.

In contrast, fluxes over the irrigated farmland show evidence of spatial patterns. Sensible heat flux over the farm tends to have high values southeast from the center of the ASK and low values toward the northwest, as shown in Figure 9a. A higher sensible heat flux is consistent with drying alfalfa; the lower fluxes are expected over the mixed crops, many of which had fully closed canopies. The same conclusion may be drawn from either 20-s or 90-s covariances.

The latent heat flux pattern had an axis of minima (first quartile) and an axis of maxima (third and fourth quartiles), as indicated in Figure 9b. The minima correspond to a line of alfalfa fields, recently mowed and relatively dry. The maxima pass over a mixture of potatoes, wheat, corn and other crops. The frequent appearence of third-quartile fluxes to the southeast of the ASK's center is puzzling. This area is primarily alfalfa, and the same general patterns are evident in both 20 s and 90 s covariances.

Spatial patterns from the ASK flights evident over the irrigated farmland cannot be studied in great detail until each measurement is paired with its associated surface type. Such is beyond the scope of this report; however, further evidence of spatial heterogeneity over irrigated farmland appears in the analysis of the long transects (FLX, see Section 6.2).

6.2 Long-Transect Flux (FLX) Runs

FLX flights make up the major potion of the data set. They were flown as closely as feasible to the surface along the instrumented transect in Figure 1. Covariances and mean quantities were identifiable by location along this transect, permitting superposition. Two averaging distances, 4.5 km (90 s) and 1 km (20 s), were used in the computations; these are discussed separately below. A set of these averages and covariances was centered at each 0.5 km along the transect, with BRR chosen as the zero point. Positions are positive over the Eastern Oregon Farming Co., and negative over the steppe.

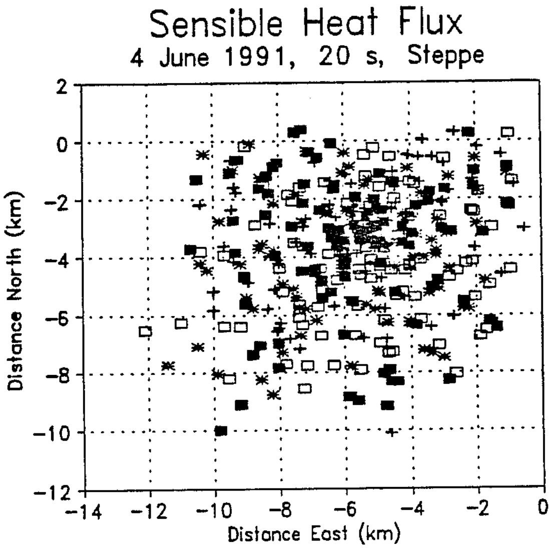


Figure 8a. Sensible heat flux over steppe with time trend removed. Symbols: ■, 1st; +, 2nd; ★, 3rd; and □, 4th quartiles.

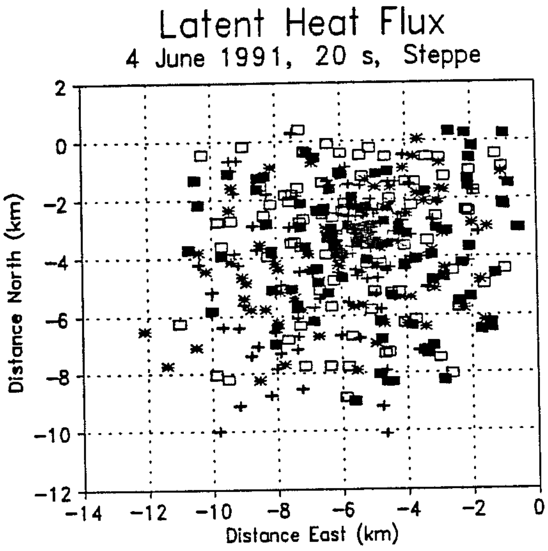


Figure 8b. Same as Fig. 8a, except for latent heat flux. Time trend has not been removed.

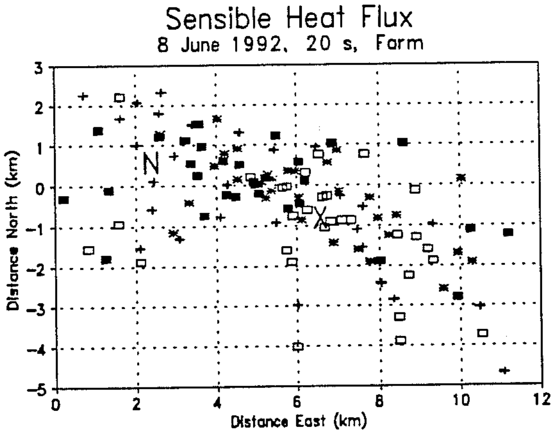


Figure 9a. Spatial distribution of sensible heat flux over irrigated farmland. Region of minimum flux is marked N, maximum X. Time trend has been removed. Symbols are as in Fig. 8.

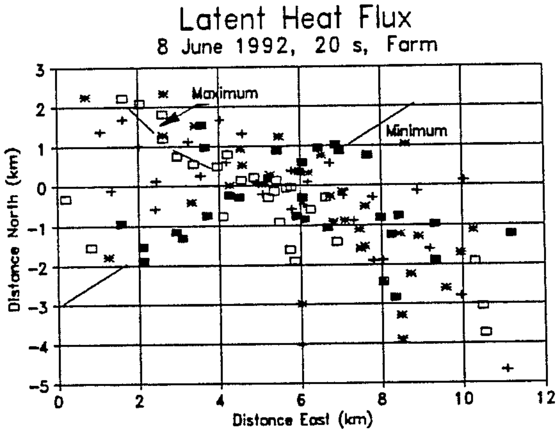


Figure 9b. Same as Fig. 9a, except for latent heat flux.

6.2.1 Path average results

The 4.5 km covariances and mean quantities were themselves averaged in three blocks along individual flux passes. The first block covered the entire flight path (-10 to +10 km with respect to BRR). The other two covered the irrigated farmland and steppe portions, from +1 to +10 km for the irrigated farmland, and from -10 to -1 km for the irrigated farmland, excluding the segment within 1 km of BRR. The average over the whole transect contains thirty 4.5 km covariance computations. Irrigated farmland and steppe averages contain about eight computations each. The length over which these covariances were computed was nine times the interval over which they are reported. Such overlap introduces a strong bias toward conditions at the center of their respective regions, a desirable feature considering the limited extent of these regions. Note that maximum weighting in the whole-transect average extends 8 km to either side of BRR. Also, this procedure eliminates any contribution from scales greater than 4.5 km.

Appendix A presents the complete set of 4.5 km covariances for the FLX and FDV transects. The first line of each three-line group gives the date and time (UTC) at the start of each transect. Blank cells indicate lost records from missing instrumentation, instrument failure, and/or other conditions rendering data missing or unacceptable. In addition to Appendix A, Table 6 lists some general operational and instrumentation problems. Since data editing has been limited, the data should be carefully checked before drawing firm conclusions. Some instruments have specific operational characteristics. For example, the radar altimeter (Ral) was designed for a minimum altitude of 12 m. Flight below this altitude was frequent and confused the device. The "H_2O Dew" columns were derived from the LICORE and EG&G chilled mirror sensors. In general, these sensors should agree. The wind data columns "WS WD U_*" are derived from multiple sensors. However, position information from the navigation receivers (GPS and LORAN) has a strong influence on the wind sensors. Small, hard to detect errors from these receivers may have caused large wind errors. In general, data robustness can be increased by averaging several transects together. Errors in temperature (T SfcT) and radiation (Py Net) data are unlikely to be significant. Flux values, however, should be used carefully.

Overall, path averages in Appendix A clearly show the difference between irrigated farmland and steppe. Fluxes at night are very small, although one should recall the 100 m flight altitude, required for safety. Farm-steppe contrasts dissappear at night. It is intended that Appendix A's use include the characterizing of time variation of overall fluxes and mean quantities over irrigated farmland, steppe, and the region in general. Appendix A also provides an efficient way to screen individual flux passes for bad data.

6.2.2 Variations along the transect

Covariances of 1 km (20 s) length were used to examine the spatial structure of air/surface exchange along the instrumented transect. Since the short average length is comparable to the size of an individual farm field, data are affected by secondary surface heterogeneities. Superposition of multiple passes, about 10 minutes apart was required because the dominant turbulence scale in the convective mixed layer is also 1 km. Each average is derived from approximately seven passes over a 1 hr period. Hours having fewer than four transects to average were rejected. Figure 10 shows a typical average of seven superimposed transects. These transects are individually displayed in Figures 11a through 11g.

Immediately apparent from Figure 10 is the sharp change at BRR for nearly all parameters, and the high correlation of various parameters with location. At BRR, the magnitudes of sensible (H) and latent (LE) heat fluxes interchange. Over the steppe, LE is small and steady. Crossing BRR, LE increases by a factor of five with an increase in variance as well. Many features recur from hour to hour at the same position, such as an LE increase near the wheat tower (Z1) at 9.0 km and a decrease over alfalfa fields at about 8.0 km. This feature is also apparent from a review of Figures 11. The shape of H is nearly a mirror image of LE about BRR. The panel of wind variables in Appendix A illustrates the difficulty of generating robust 20 s wind averages. Winds over the irrigated farmland tended to be lower with greater direction variance. Shear stress has large variance but decreases over the farm. Appendix A's third panel, showing CO_2 and O_3 fluxes, reveals that both variables are near zero over steppe but increase dramatically over irrigated farmland. Strong fluxes over wheat at 9 km and weak fluxes over alfalfa at 8 km also occur as indicated. The second to last panel in Appendix A displays temperature. The large (20°C) difference between surface temperatures over irrigated farmland and steppe is typical. Air temperature gradient is also important and frequently observed. As previously indicated, this type of situation causes horizontal energy transport. The altitude trace in the last panel of Appendix A shows the flight altitude and terrain.

Figure 10 Sample transect average for several ARM variables

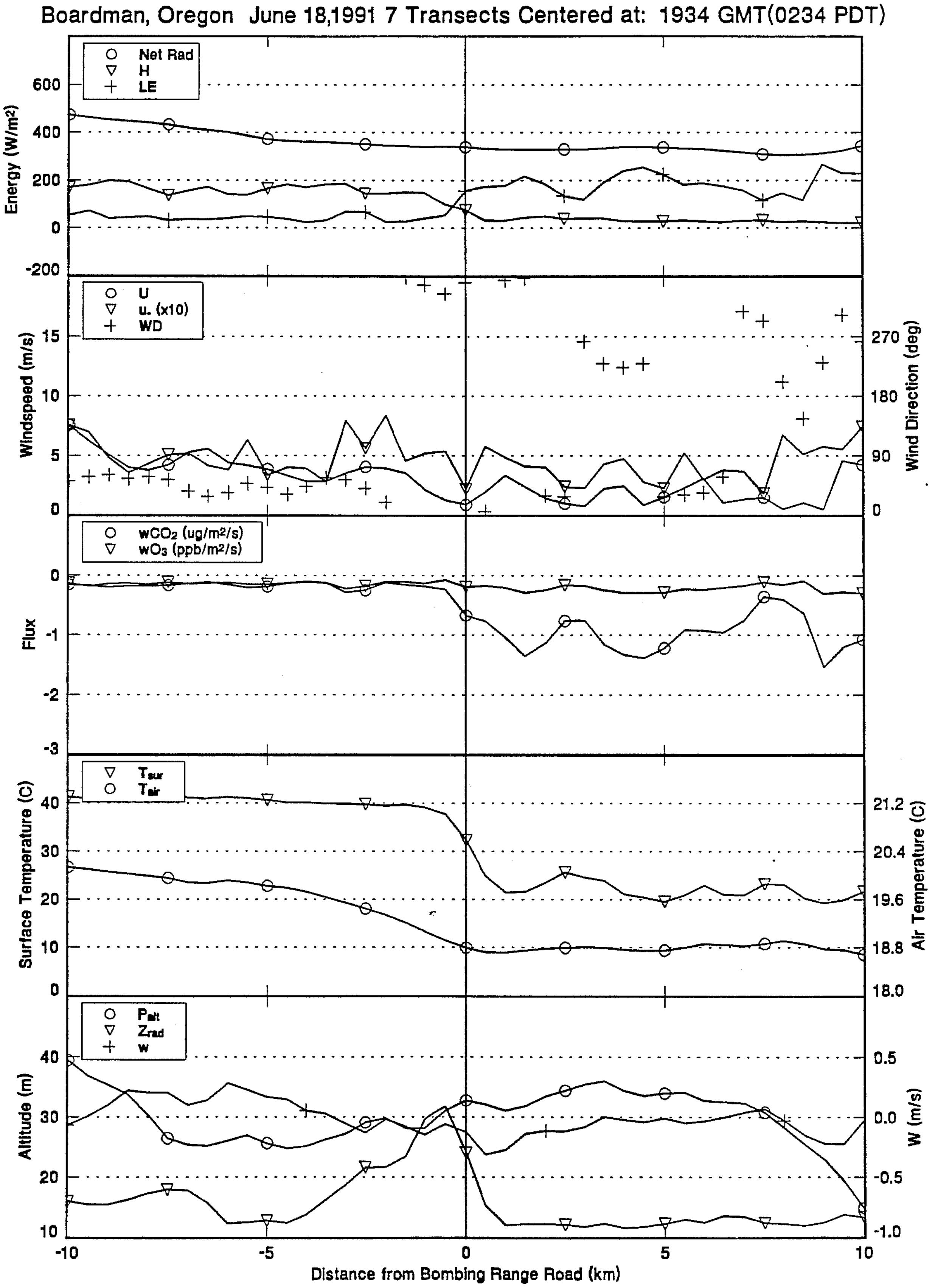


Figure 11a. 1st of 7 transects used for Figure 10 composite

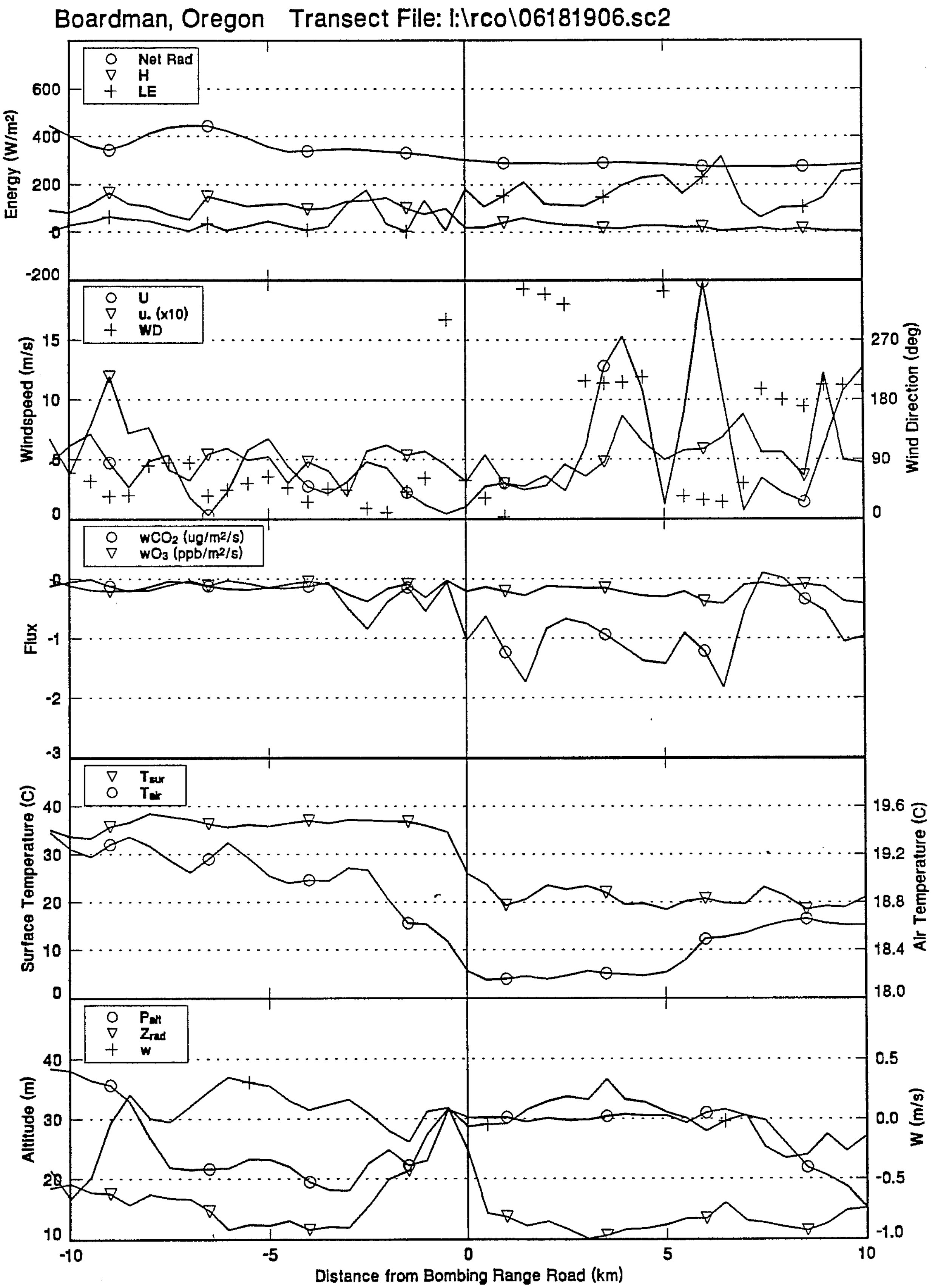


Figure 11 b. 2nd of 7 transects used for Figure 10 composite

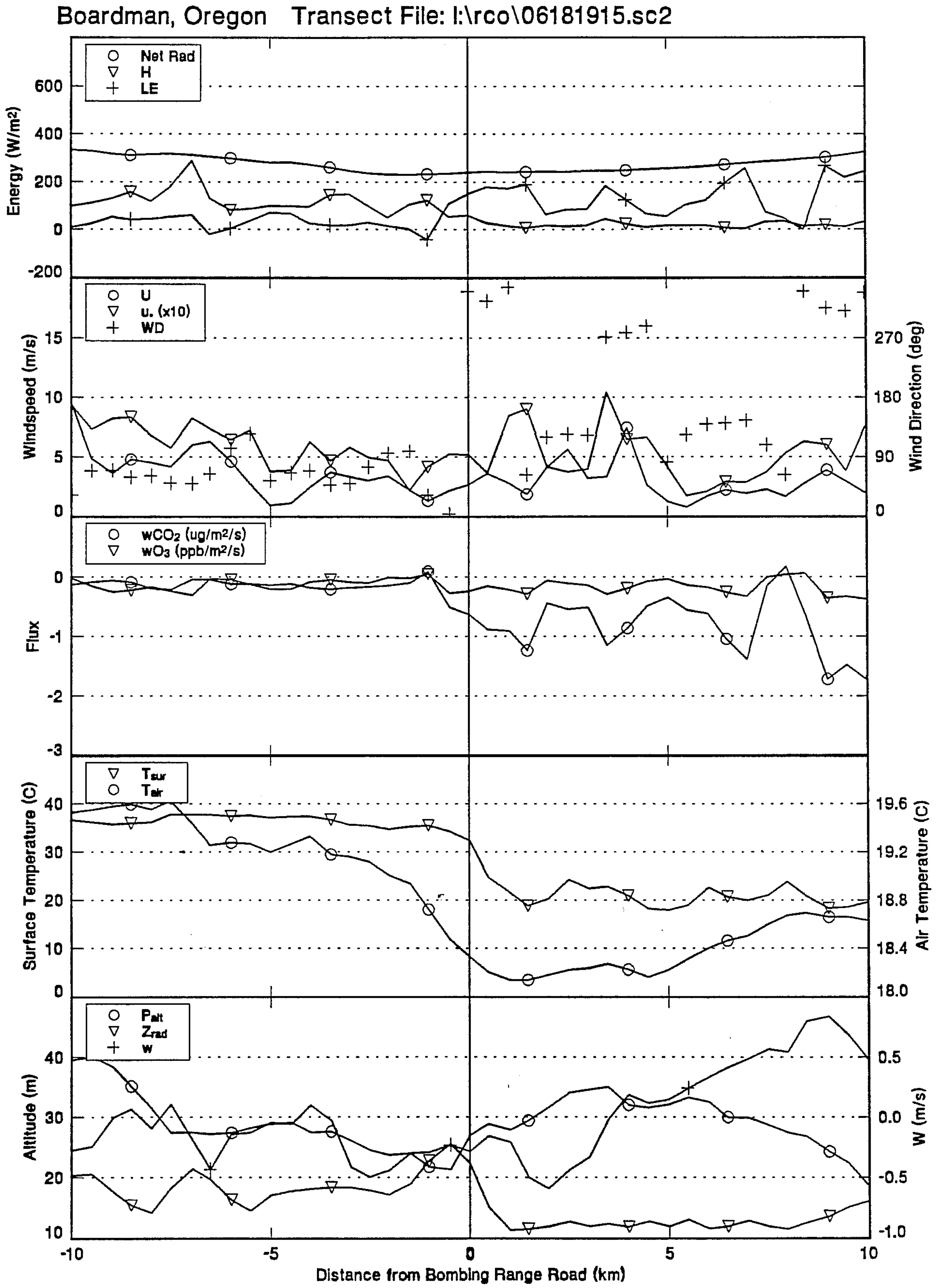


Figure 11c. 3rd of 7 transects used for Figure 10 composite

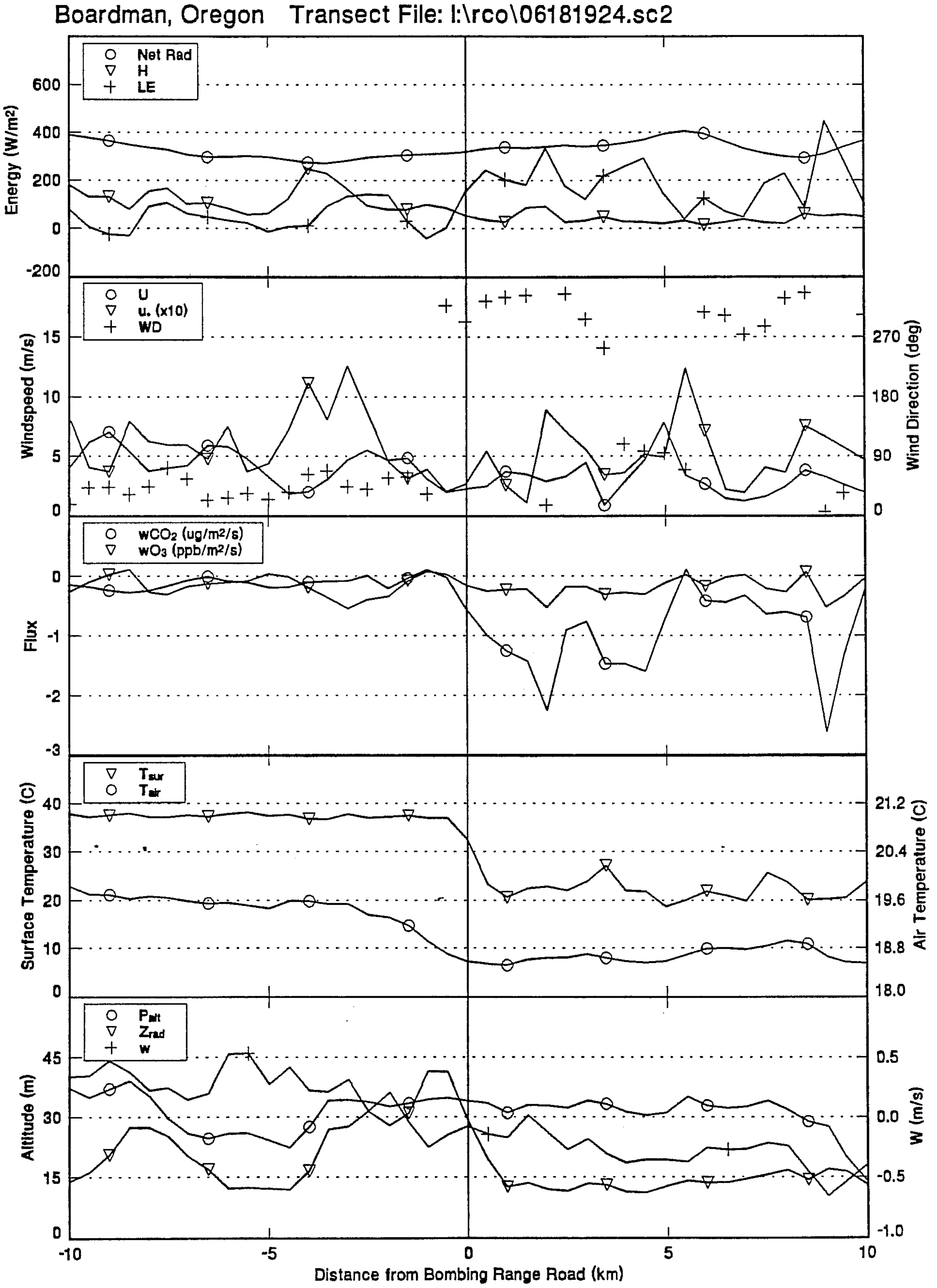


Figure 11d. 4th of 7 transects used for Figure 10 composite

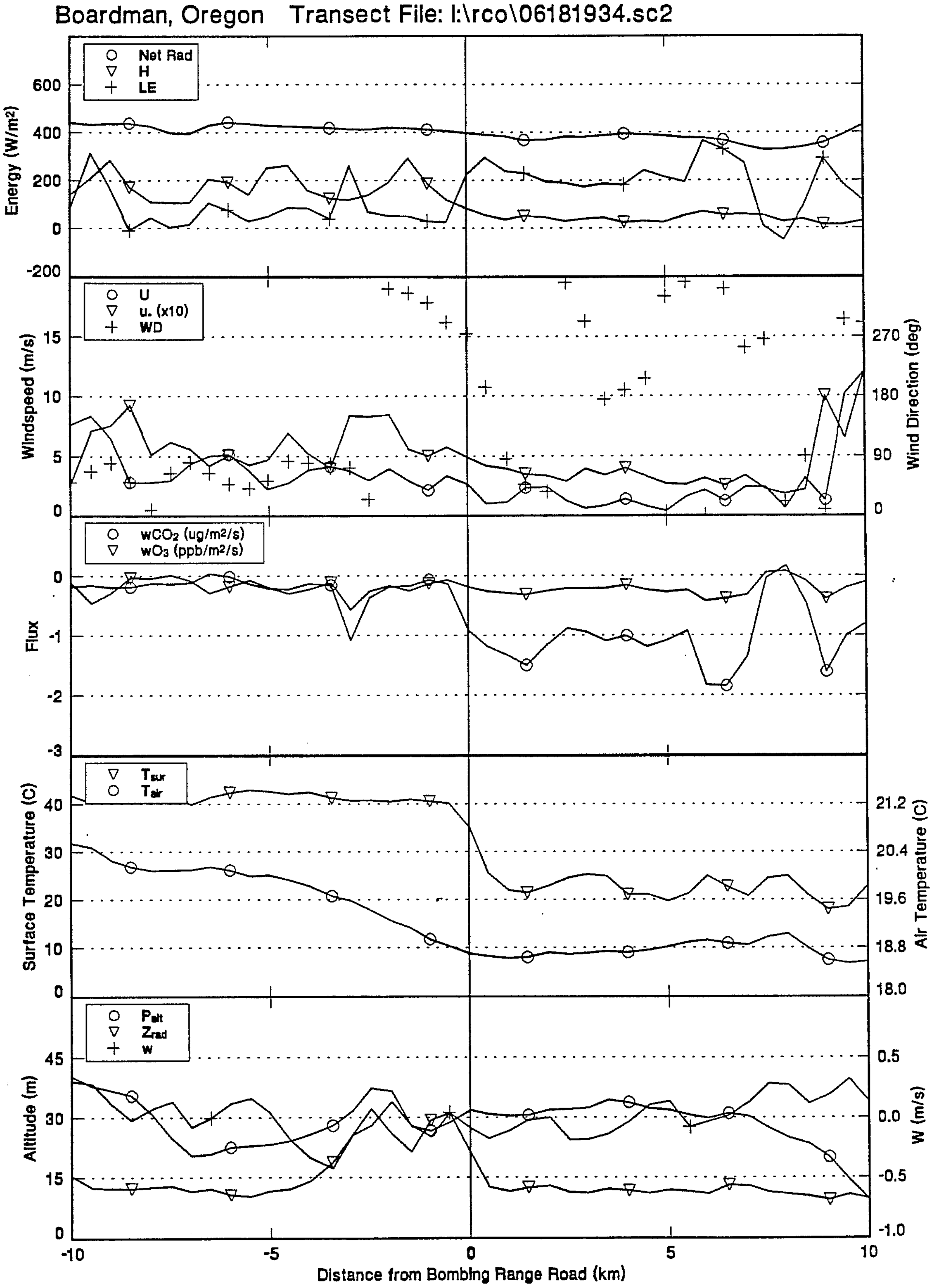


Figure 11e. 5th of 7 transects used for Figure 10 composite

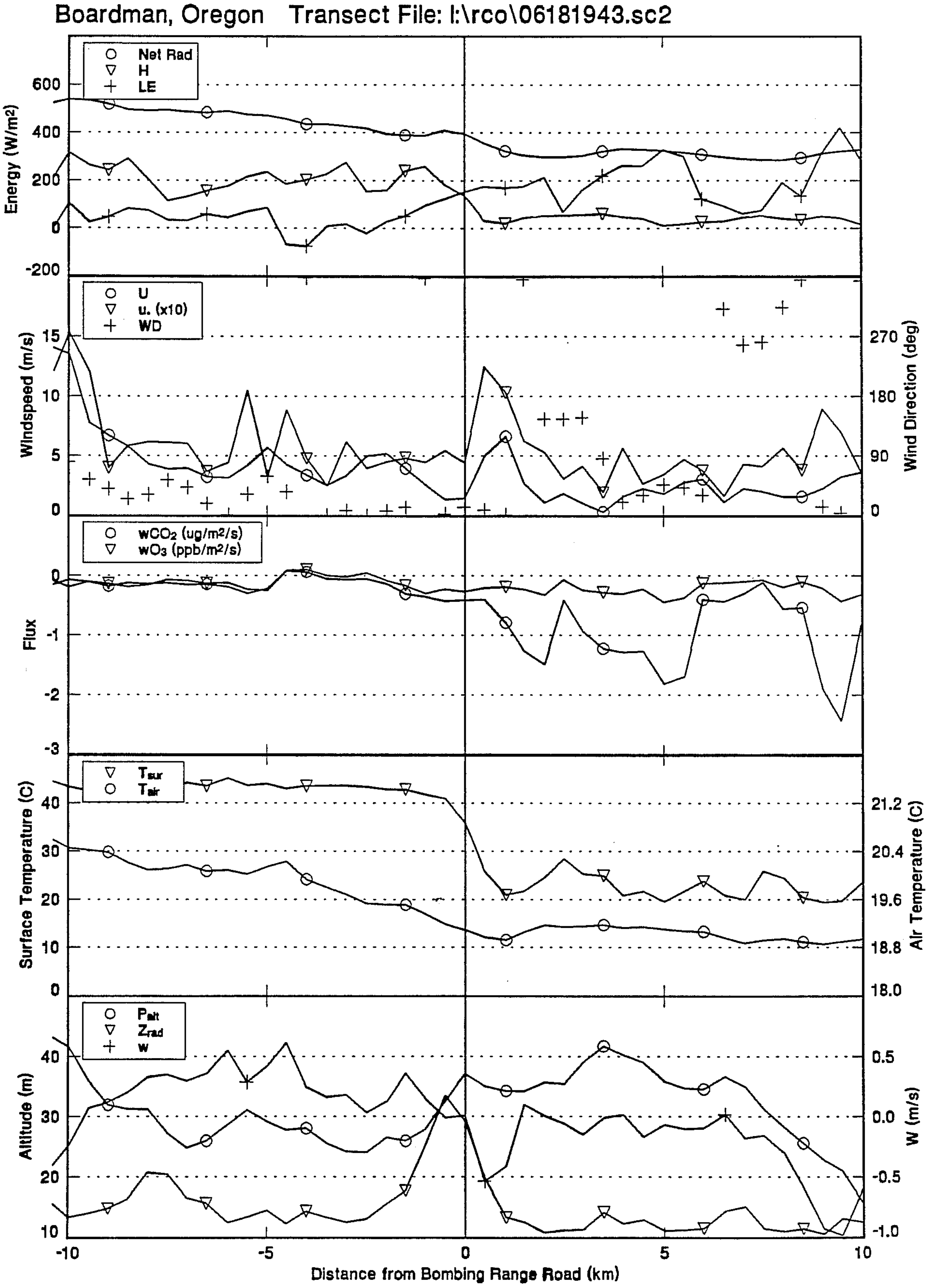


Figure 11 f. 6th of 7 transects used for Figure 10 composite

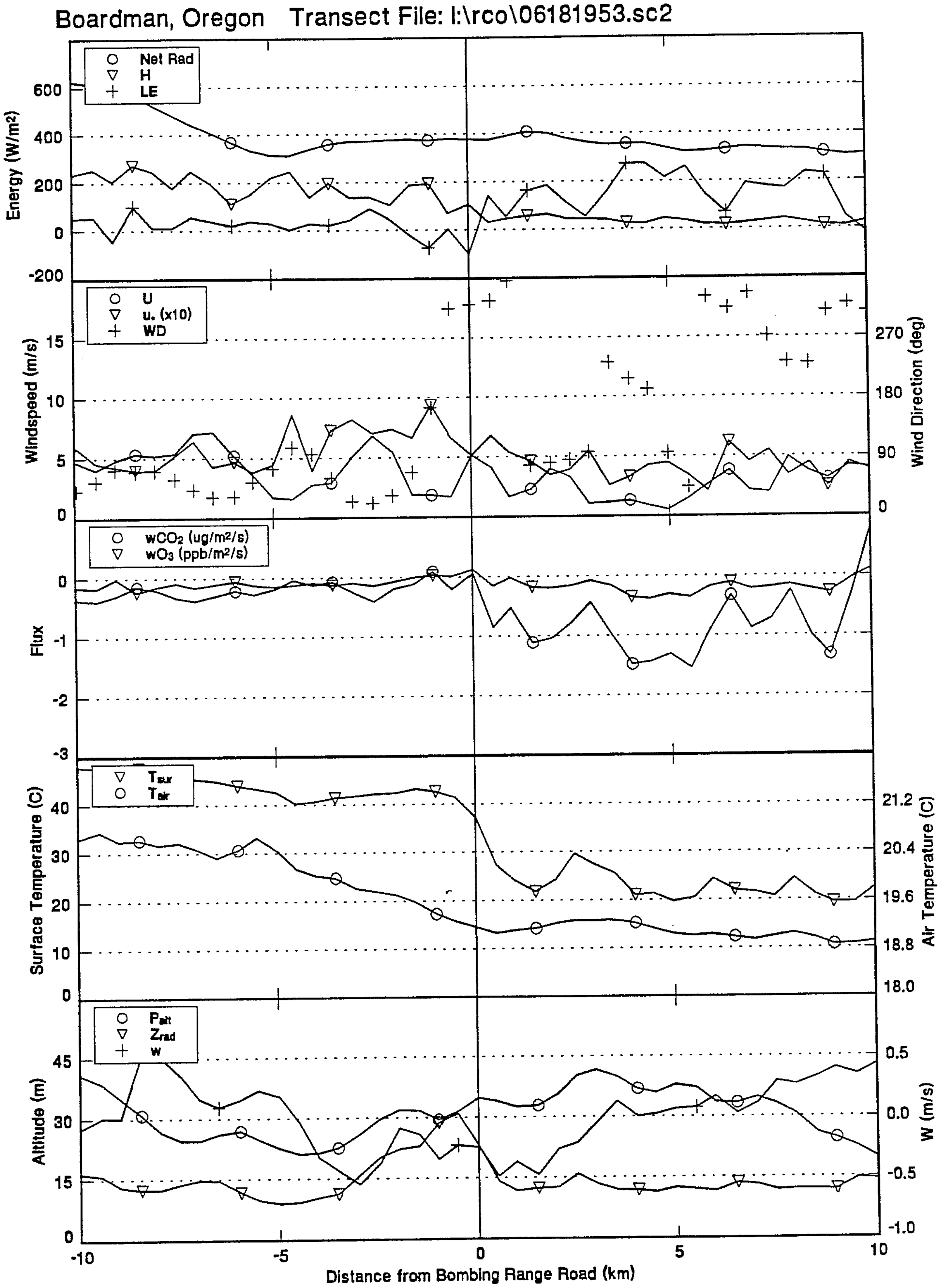
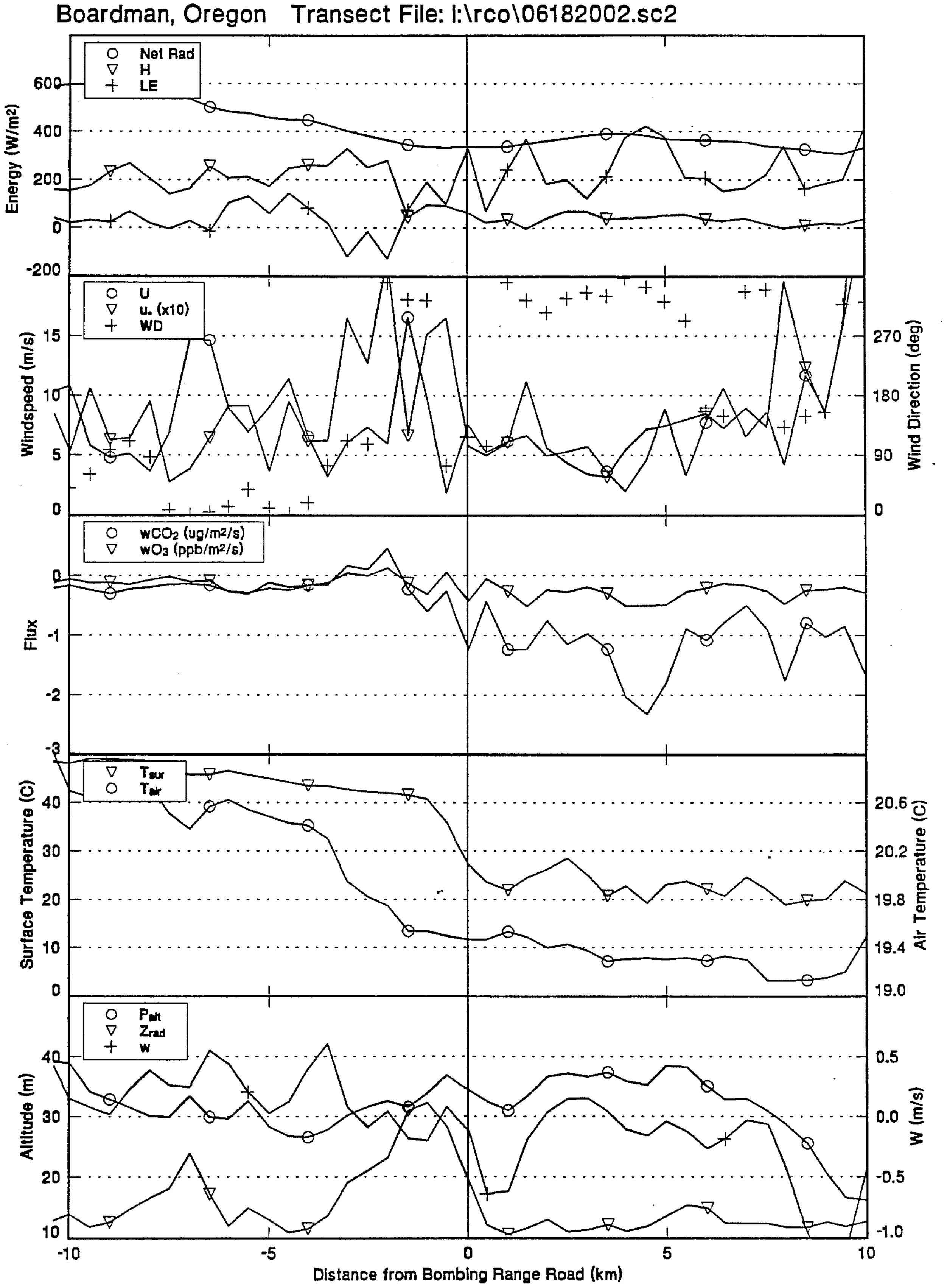


Figure 11 g. 7th of 7 transects used for Figure 10 composite



6.3 Flux divergence (FDV)

Ten FDV runs were flown from June 9-17, 1991 to assess the flux divergence in the vertical. Of these, seven were during the day, one in the evening, and two at night. Appendix C displays the plotted results. Measured flux variables include sensible and latent heat, carbon dioxide, and ozone. In general, FDV flights followed a stair-step pattern. A pair of passes was flown at one altitude in opposite directions along the main transect line, then the airplane moved to a higher level and repeated the pattern. From the highest level (300 to 500 m above ground), the stair-step pattern was usually retraced downward to the original flight altitude to counteract time trends. Each FDV pass encompassed both irrigated farmland and steppe, so that FDV profiles could be extracted for each landcover type.

As a result of the limited number of passes, FDV data contain a great deal of data noise. Daytime measurements for latent heat, carbon dioxide, and sensible heat over the steppe seem to have the highest noise levels. Noise levels for sensible heat over the irrigated farmland proved to be somewhat lower. The most precise flux divergence profiles were obtained for ozone. Flux profiles of the sort reported here were also flown over Kansas in the International Satellite Land-Surface Climatology Program's (ISLSCP) First Field Experiment (FIFE). These had much less scatter than the present patterns. It is likely that the horizontal heterogeneities, secondary circulations, and other complexities, for which the Boardman site was chosen have contributed to the scatter. Analysis of currently available data should allow a more detailed examination of this problem.

6.3.1 Sensible heat fluxes

Daytime sensible heat flux measurements indicated increasing atmospheric heat content in the layer sampled. Not suprisingly, flux runs measured later in the day usually showed larger heat flux divergence than morning profiles, particularly over irrigated farmland. The pair of daytime flux runs on June 15, 1991 is interesting. Although separated by only 2.5 hr (measured at 0909-1017 PDT and 1114-1321 PDT), the measurements show a significant slope change from negative to vertical. Weather charts for June 15, 1991 indicate that a cold front may have passed between these two flux runs. However, it is not certain whether the change in the flux trend can be attributed to synopic or local effects since flux runs over the steppe for the same time periods have more scattered results. Most of these steppe fluxes show at least slight warming, but regression slopes vary widely.

The nighttime sensible heat flux run plotted in Appendix C has nearly vertical regression and near zero data values.

6.3.2 Latent heat fluxes

Most of the daytime latent heat fluxes over irrigated farmland have negatively sloped regression lines implying a moisture buildup in the measured layer. The daytime pair of measurements on 15 June, previously discussed is even more dramatic for latent than for sensible heat. The flux line slope changes from decidedly negative to positive. Unfortunately, corresponding latent heat measurements over steppe do not show a similar change in flux slope. Daytime latent heat fluxes over the steppe were generally positive and had weakly positive regression line slopes. Given the character of the steppe, the weak upward moisture flux and net drying of the air seem plausible.

Nighttime latent heat flux measurements over both irrigated farmland and steppe suggest stable conditons. The resulting regressions exhibit nearly vertical lines and little departure from zero flux values.

6.3.3 Carbon dioxide fluxes

The majority of daytime CO_2 flux runs over irrigated farmland exhibit the expected downward flux. Slopes vary widely and show no apparent correlation to weather patterns.

Over the steppe, the daytime CO_2 flux measurements have widely varying regression slopes. However, as would be anticipated, there are no steep negative flux gradients. The air layer was generally losing CO_2, though to a lesser degree than over the farmland.

Nighttime CO_2 fluxes over irrigated farmland are slightly noisier than other night fluxes. Also, the data appear to have a discernable negative slope (implying slight CO_2 increase in the sampled layer). Over the steppe, night CO_2 fluxes appear to be more nearly zero with a near-vertical slope.

6.3.4 Ozone fluxes

The daytime ozone fluxes, except for 13 June over farmland, tend to indicate slight downward movement and a slight slope, having either sign. No obvious correlation of the ozone fluxes with other factors is apparent. However, the relative precision of the ozone flux divergence values suggests that they are accurately measured.

Both of the night ozone FDV runs over irrigated farmland have slight positive slopes. However, those measured over the desert have positive and negative slopes with fluxes close to zero.

The daytime flux run over irrigated farmland for June 13, 1991 strongly resembles the ozone night flux runs over irrigated farmland. June 13, 1991 was mostly cloudy with intermittent light rain. However, the June 13 flux run should be interpreted with caution since it contains no flux measurements above 80 m.

6.4 Mean quantity profiles

Twenty atmospheric profiles were obtained to describe the vertical structure of temperature, pressure and several trace gases. Appendix D displays plots of each profile for potential temperature, specific humidity, saturation mixing ratio, ozone concentration, and carbon dioxide concentration.

During the collection of profile data, a number of differing technical factors were incorporated into various profiles. Method of aircraft flight, landscape surface overflown, and depth of profile measurement are the primary factors. Such methods of data collection allow investigation into how these factors affect measured meteorological variables and gas concentrations.

In most cases, profiles were measured as the airplane ascended and/or descended in a spiral, although an ascending straight line flight path was sometimes used. Each profile is the result of either one or two passes. Two-pass profiles generally include one ascending and one descending pass. Single-pass profiles primarily use ascending passes. Major types of landscape overflown include steppe, irrigated farmland, and airport areas. The maximum measurement depth for each profile varied from 500 to 2900 m. For all profiles, the average vertical distance between observations is approximately 25 m.

Profiles were collected on June 2-8, 10, 12-15, & 17, 1991. Table 8 describes sensors and methods used to derive each plotted variable from the raw profile data.

Table 8. Plotted profile quantities displayed in Appendix D.

Item	Sensors Used	Sensor Character	Remarks
Potential Temperature (°C)	Hy-Cal BA-507-B Setra System	Slow (mean temp.) Slow (mean pres.)	
Specific Humidity (g-kg^{-1})	Hy-Cal BA-507-B EG & G Chilled Mirror Setra System	Slow (mean temp.) Slow (mean dew pt.) Slow (mean pres.)	
Saturation Mixing Ratio (g-kg^{-1})	Hy-Cal BA-507-B Setra System	Slow (mean temp.) Slow (mean pres.)	
Ozone Concentration (ppb)	ATDD O_3 Sensor DASIBI 1003AH Hy-Cal BA-507-B Setra System	Fast (O_3 flutuations) Slow (mean O_3) Slow (mean temp.) Slow (mean pres.)	Measurements were derived using two O_3 sensors. Values from both O_3 sensors were corrected for temperature and pressure. Corrected data from the fast (ATDD) sensor were further adjusted by subtracting out the mean and time trend of that sensor. Finally, the slow (DASIBI) sensor's mean and time trend were added to the fast (ATDD) sensor values (producing more stable and responsive data over time) to obtain O_3 concentrations.
Carbon Dioxide Concentration (ppm)	LI-COR Li-6262 Setra System	Slow (mean CO_2) Slow (mean pres.)	CO_2 measurements pressure-adjusted to obtain mean CO_2 concentrations.

6.5 Airplane-Tower flux comparisons

6.5.1 Concepts

The quality of the airplane data was assessed by comparison with tower data. In general, agreement between the two measurement systems is good, especially considering the complexity of the site and the many differences between the temporal averages at the towers and the linear averages from the airplane. Fluxes and scalars at the towers were computed as half-hour averages and covariances, equally weighted. Towers, like the airplane, had full three-dimensional flux measurement systems. Data from the wheat (Tower A1, Figure 2), corn (Tower D) and steppe towers were available for this comparison.

Fluxes were computed from the airborne data as equally-weighted covariances over 4.5-km segments centered on the tower (90 s at 50 ms^{-1}). Scalar variables were averaged over the same effective interval, but with a triangular weight distribution, also centered on the tower. During each half-hour averaging period, the airplane made four passes over the tower. Fluxes and mean values from the resulting four segments were averaged to obtain the final values for comparison with the tower. Averages having fewer than four transects, flight altitudes greater than 40 m, and periods for which there were no tower data were rejected. A few wind averages were rejected due to positioning errors (a result of poor satellite geometry or signal strength). The resulting data set contained approximately 21 data point pairs for each tower. The typical minimum flight altitude was 10 m, while the average altitude was 12 m over wheat, 20 m over corn, and 25 m over steppe. Power lines near the corn and steppe towers accounted for the higher altitudes. At the wheat and corn flux towers, energy balance closure (H+LE+Rn-G) was not significantly different from zero at a 5% confidence level. At the time of the comparison, only heat flux and mean wind measurements were available from the steppe tower. Steppe flux tower instrumentation did not allow assessment of energy balance closure.

Since ATDD's corn tower ("D" in Figure 2) was 2.5 km north of the instrumented flight path, Corn Field 21 (Figure 2) was chosen to anchor the airplane flux measurements. This was justified since most corn fields were at the same immature stage of development. A significant amount of bare soil was exposed in these fields. Typical corn leaf area indices were about 1.7. Neighboring fields east and west of Field 21, along the instrumented flight path, contained potatoes. Potato fields had a closed canopy with no bare soil visible from the air. The ATDD wheat tower (Z1) was bordered by a cut alfalfa field to the west and a wheat field to the east. Typical wheat leaf area indices were 2.8. Since the wheat field contained mature plants, there was large contrast between the cut alfalfa and wheat. The steppe tower was located 6.5 km west of BRR, with a large fetch of steppe in all directions.

The airplane-tower flux comparison ignores flux divergence and inconsistencies between the airplane and tower footprints (a footprint is the land surface area affecting the airplane or tower measurements). Ignoring these factors degrades the comparison and adds variance. However, flux divergence at 20 m altitude should be small (only 10 to 20 Wm^{-2} for sensible heat flux), and the footprints of airplane and tower would be difficult to match. For the fluxes as computed here, the 4 m towers had a small upwind footprint while the airplane had a 4.5-km linear footprint. Each tower was carefully sited to have good up-wind fetch. However, the airplane's footprint includes a number of developing boundary layers. Thus, the towers sample equilibrium boundary layer fluxes, away from the transition zones that are included in the airplane's fluxes. Furthermore, the airplane's 4.5 km footprint also includes fields adjacent to that being sampled by the tower.

Table 9 illustrates sensitivity to the airplane's footprint length. The mean instrument difference (airplane minus tower) and its standard deviation are presented, by eddy-covariance integration distance, for the three towers. In general, the distance over which the covariance was computed, from 0.5 km to 4.5 km, influences the results. Over large distances (*i.e.* 4.5 km), more data are integrated into the covariance (or scalar average), improving the statistical robustness. However, the larger distance incorporates more spatial variability and therefore becomes less representative of a tower measurement. At short distances (*i.e.* 500 m) the airborne data are more representative of a tower measurement (the irrigation circles are 800 m across). But with such short averages, the natural turbulent variability and the poor representation of large scale spatial features degrades both the mean quantity and its variance. Generally, Table 9 supports this description; however, several exceptions are discussed in following pages.

Table 9. Airplane-tower flux data comparison summary: mean flux difference (airplane minus tower) statistics. Mean and standard deviation were calculated using covariance integration distance.

DIST (km)	U (ms^{-1})	u* (ms^{-1})	AIR T (°C)	Sfc. T (°C)	Py (Wm^{-2})	NET (Wm^{-2})	H (Wm^{-2})	LE (Wm^{-2})	F_{CO^2} ($mg\text{-}m^{-2}s^{-1}$)
ATDD'S WHEAT TOWER (Z1)									
4.5	0.5/2.1	-.03/.21	-0.6/0.9	3.4/3.3	-17/46	-23/26	19/33	-73/55	0.40/0.33
3.5	1.2/1.1	-0.01/0.20	-0.6/0.9	3.1/3.5	-21/43	-25/26	18/34	-66/57	0.27/0.35
2.5	1.3/1.2	-0.03/0.19	-0.6/0.9	3.3/3.8	-23/42	-26/26	18/30	-76/69	0.30/0.42
1.5	1.2/2.3	-0.05/0.23	-0.6/0.9	3.3/4.1	-18/42	-25/26	19/30	-94/88	0.45/0.47
1.0	1.7/1.3	-0.09/0.19	-0.6/0.9	3.2/4.9	-23/46	-26/27	24/30	-115/80	0.57/0.50
0.5	1.9/1.5	-0.12/0.16	-0.6/0.9	1.7/5.1	-18/52	-26/26	17/34	-117/99	0.62/0.60
ATDD'S CORN TOWER (D)									
4.5	2.1/1.3	-0.05/0.22	-0.3/1.8	-2.6/4.0	-4/73	-17/54	-1/27	-13/69	0.0/0.3
3.5	2.0/1.3	-0.05/0.22	-0.3/1.8	-2.6/4.2	-2/75	-16/54	-6/29	2/68	-0.03/0.32
2.5	1.9/1.3	-0.02/0.19	-0.3/1.8	-3.7/2.7	-0/77	-16/54	-8/26	18/80	-0.03/0.28
1.5	1.9/1.5	-0.04/0.24	-0.4/1.8	-3.6/3.0	5/80	-15/54	-12/26	22/71	-0.08/34*
1.0	2.0/1.7	-0.00/0.43	-0.4/1.8	-2.5/5.0	8/82	-15/54	-7/27	23/94	-0.12/0.31
0.5	2.1/1.9	-0.01/0.28	-0.4/1.8	2.8/4.8	3/88	-17/53	-15/31	-0/65	-0.08/0.34
PNL'S Steppe TOWER									
4.5	1.3/1.2		-3.0/0.7				-76/45		
3.5	1.1/1.1		-3.0/0.7				-84/50		
2.5	1.1/1.3		-3.0/0.7				-84/53		
1.5	1.2/1.7		-3.0/0.7				-95/59		
1.0	1.2/1.8		-3.0/0.7				-107/59		
0.5	1.3/2.0		-3.0/0.7				-111/57		

6.5.2 Comparisons by quantity

The wind speed comparison presented in Figure 12 shows that the airplane-observed 12 m to 25 m winds are 30% higher than the 4 m tower winds. This difference would be expected for a logarithmic wind profile with a surface roughness between 1 and 10 cm -- the range required to give U_{12}/U_4 or $U_{25}/U_4 = 1.3$. This is a reasonable z_0 range for the irrigated farmland and steppe. It should be noted that tower data were measured with both sonic and propeller anemometers. Also, airplane position errors generally increase the airplane's estimated winds. Future improvements in the satellite constellation and the addition of a five channel GPS receiver (a single channel was used for this experiment) may further reduce position errors in the future. Finally, review of Table 9 indicates no important sensitivity of mean wind speed to averaging length except at the wheat tower (Z1).

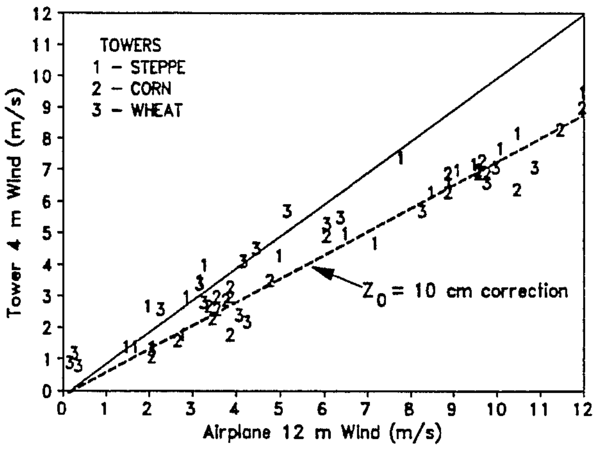


Figure 12. Comparison of 12 m airplane winds to 4 m tower winds.

The shear stress comparison (Figure 13) indicates no important difference between the mean of the aircraft and of the corn (D) or wheat (Z1) towers, although a large variance is noted (see Table 9). The near zero difference in mean implies that the shear stress was correctly measured and that, at the 12 m to 25 m flight altitude, the airplane was within the constant flux layer. Shear stress is difficult to measure from moving platforms and has a large natural variance. However, installation of a 5 channel differential GPS system, more precise heading calibrations, and improved data processing procedures are expected to reduce the variance of future measurements. Table 9 indicates that airplane minus tower differences and standard deviations are independent of covariance length for the range explored. Neither the mean difference nor the standard deviation is a very robust statistic. Although major position errors were removed, smaller ones were

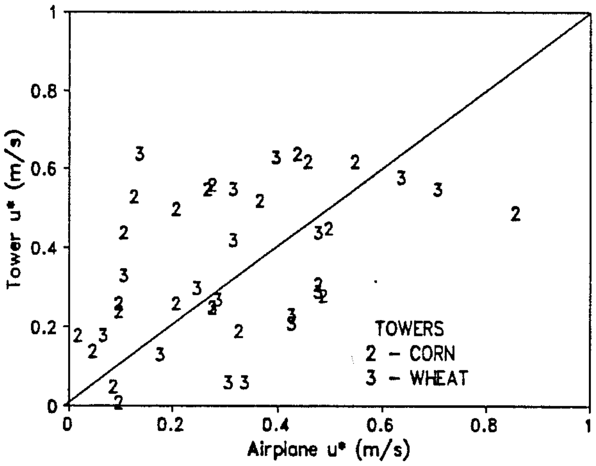


Figure 13. Comparison of 12 m airplane to 4 m tower u*'s.

not; thus, small position inconsistencies may have influenced the results shown in Table 9, especially at short covariance lengths.

Both pyranometer (Figure 14) and net radiation (Figure 15) measurements provided excellent comparisons. The pyranometer difference is approximately -10 Wm^{-2} ($\approx$1%) with a standard deviation of about ±60 Wm^{-2}. Similarly, the net radiation difference is about -25 Wm^{-2} ($\approx$8%) with a standard deviation of approximately ±35 Wm^{-2}. As expected, there is no important sensitivity to changes in averaging length. In general, both sensors show a small negative bias regardless of path length. This bias is small enough to be a result of calibration differences. The pyranometer measurements show this trend to be small for the corn tower (D) and more pronounced for the wheat tower (Z1). Similar results were observed for net radiation. However, direct net radiation is more difficult to measure on an airplane due to the potential for shading of the sensor by the fuselage. Both physical and operational differences could account for the observed differences.

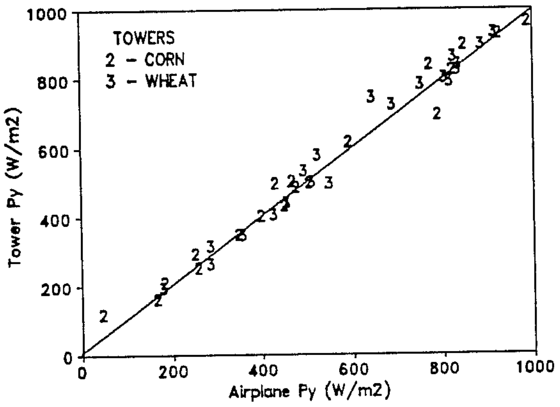


Figure 14. Comparison of airplane and tower pyranometer sensors.

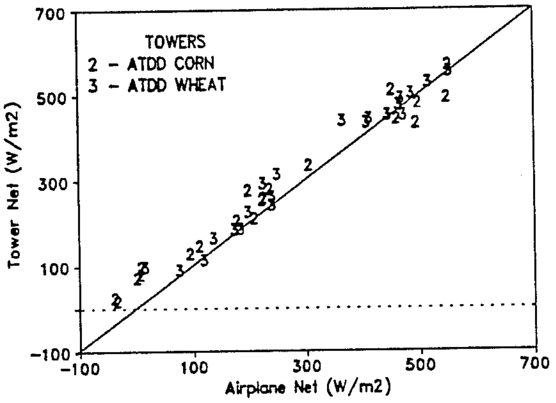


Figure 15. Comparison of the airplane and tower net radiation sensors.

Physically, a lower path average net radiation for the airplane would be expected as a result of footprint differences. The tower radiometers were fitted to "see" a specific crop with a small spot footprint. In contrast, airplane sensors provided line integral averages. Since 10% of the irrigated farmland area was composed of roads and islands, and an even larger percentage of the irrigated farmland was made up of hot, harvested alfalfa fields, line and spot foot-prints yield different results. For example, near the wheat tower (Z1), the presence of alfalfa fields increases the percentage of hot land surface. Hot land surfaces emit stronger outgoing longwave radiation, reducing the net radiation. A typical farm-to-steppe net difference was around 30 Wm^{-2}. Operationally, the airplane net radiometer and pyranometer sensors were mounted vertically for nominal flight speed and fuel load. Variance from this nominal condition was about 1°. For some sun angles, a small departure from the vertical along with fuselage shading causes a small directional dependence in observed net radiation. Fortunately, the effect of shading was small as a result of the small Long-EZ fuselage. However, turbulence induced motion of the airplane relative to the mean vertical angle tends to cause larger angular differences, typically around ±1.5° for pitch and ±5° for roll. Since these motions are fast with respect to the sensor time constant, it is assumed that the effect would be to reduce response independently of platform motions. Future processing enhancements are under development to correct for this motion but they are not expected to significantly change observed variance, except perhaps for low sun angle. At low sun angles, time matching of data becomes important. For these comparisons, the time mismatches of data pairs should not exceed 15 to 20 min.

A comparison between observations of surface infrared temperature from the airplane and from the two ATDD flux towers is given in Figure 16. Unit emissivity has been assumed for both systems. The higher surface temperature observed by the airplane compared to the wheat tower (Z1) is expected, considering the difference in the airplane's 4.5 km line average and the tower's spot observation. In particular, the percentage of the farm that was not irrigated or was of similar character to the steppe (typically 20 °C hotter than irrigated farmland) should be considered. Areas such as these surround the 800 m wheat field adjacent to the wheat tower (Z1).

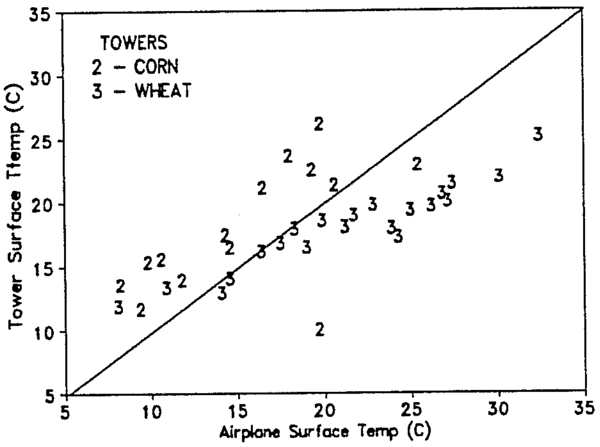


Figure 16. Comparison of airplane and tower surface infrared temperature observations.

By the argument just given the surface temperature measured at the corn tower should correspond more closely to that from the airplane due to the exposed soil in the immature crop. In fact, the tower measured significantly higher temperatures than the airplane, except for the shortest averaging length (Table 9). Since the Everest infrared sensor calibration was checked before and after each flight, the differences in these data probably have a physical cause. For the longer averaging lengths, the neighboring fields may have had cooler surface temperatures, especially the potatoes. At the shortest averaging length, entirely contained within the corn field, the airplane measured higher surface temperature than the tower. The difference in viewing angle could account for this. Tower sensors were oriented 45° from vertical, while the airplane sensor had a nadir orientation. The airborne sensor thus "saw" more of the hot, bare soil than did the tower sensor. Kimes *et al.* (1980) show that view angle effects in radiometric measurements of a wheat canopy can be as extreme as 13 °C.

A comparison of aircraft and tower air temperature is presented in Figure 17. A negative bias in the aircraft air temperature (25 m minus tower 4 m) was expected. Such bias should increase as insolation increases. However, the large -3 °C bias observed (which occurred even at low air temperatures) may indicate a calibration offset in the steppe tower's temperature sensor. Both the difference and variance observed were independent of the chosen flight path length.

Figure 18 presents a sensible heat flux comparison. The measurements for the corn and wheat fields compared with the aircraft show a small difference in the mean and an acceptable variance (considering the differences between the two measurement systems). Additionally, Table 9 indicates the robustness of the corn and wheat field heat flux measurements (i.e. low bias and variance). This was true regardless of covariance length. In contrast, the comparison with the steppe tower reveals bias of -75 Wm^{-2} as well as a large variance. Furthermore, the covariance length sensitivity analysis shown in Table 9 indicates a significant large-scale covariance contribution. There is no indication that this influence has been fully accounted, even at the 4.5 km length.

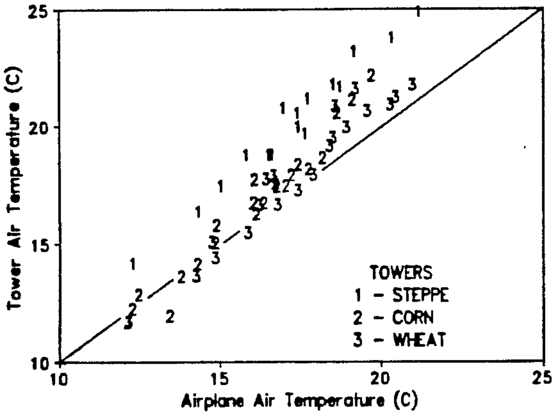


Figure 17. Comparison of air temperature measured by the aircraft and steppe tower.

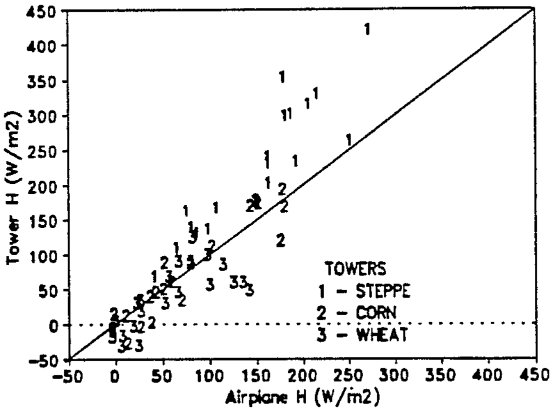


Figure 18. A comparison of sensible heat flux measurements for the aircraft vs. corn and wheat towers (D and Z1 respectively).

Considering the relatively central location of the desert flux tower, the observed heat flux difference was contrary to inital expectations. It should be noted that the airborne MFP agrees well with ATDD towers. Since measurements at these towers were not found to violate energy-balance closure they may be taken as reliable. Therefore, the observed measurement discrepancy is likely to be found between the aircraft and the steppe tower or in some unaccounted physical process that has introduced flux divergence between the towers' elevation and flight altitude. Relevent physical processes occuring between tower and average flight altitude (4 and 25 m respectively) can be described by the integrated heat budget equation

$$\rho C_p \int_{z_{twr}}^{z_{AP}} \left[\frac{\partial\overline{\theta}}{\partial t} + \overline{U}\frac{\partial\overline{\theta}}{\partial x} + \overline{W}\frac{\partial\overline{\theta}}{\partial z} \right] dz = H\,\big|_{z_{twr}} - H\,\big|_{z_{AP}} . \qquad (3)$$

The right side of Eq. (3) represents the difference between sensible heat flux at tower height Z_{twr} and that at airplane height Z_{AP}. The heat content of the layer between tower and airplane is expressed in terms of potential temperature θ, air density ρ, and specific heat of air at constant pressure C_p. The overbar indicates a half-hour time average at the tower, or an average of four 4.5 km airplane passes, centered on the tower, during the same half-hour. Three components of the heat budget are expressed by terms on the left side. These are: storage, horizontal mean transport, and vertical mean transport. No significant heat source existed within the measured layer, nor were horizontal turbulent fluxes considered important. Normally, terms on the equation's left side are assumed to be zero in eddy-correlation measurements of boundary-layer fluxes. When such assumptions are invalid, an eddy-flux measurement is still possible, although the additional terms in the equation must be considered. The aircraft measurements provide the information necessary for assessing these terms. The size of these terms is minimized by the low flight altitude of the measurements.

The first term on the left side of Eq. (3) represents the heat flux divergence due to energy storage (resulting in warming in the 21 m depth between the flight altitude and the tower height). For typical warming rates of 1-3°C-hr^{-1}, this term explains only 5 to 20 Wm^{-2} of the total flux.

The second term on the left side of Eq. (3) describes horizontal advection of energy. Review of mean temperature variation along the transects (Appendix B) shows that dΘ/dx was frequently nonzero (primarily over steppe). Gradients up to 1.5 x 10^{-4} °Cm^{-1} were common. In combination with an 8 ms^{-1} mean wind, this mechanism accounts for a flux transport of about 30 Wm^{-2}.

The third term on the left side of (3) describes mean vertical motion. This term contributes to the heat budget through the secondary circulations caused by daytime surface temperature contrasts (Segal *et al.* 1988, 1989, and Avissar and Pielke 1991). The steppe was frequently 25°C hotter than the cool, moist farmland bordering it on the east and west. Also, the surface slopes toward the cool river to the north. During light winds, the pilot could discern flow organization about BRR, an observation substantiated by the airplane's wind velocity measurements under light winds. The measured winds showed a marked contrast between irrigated farmland and steppe. Though more evident under light winds, the divergence pattern will be present any time there are strong surface temperature contrasts. The horizontal divergence forces a mean vertical velocity that strengthens with increasing height. In contrast, the vertical temperature gradient tends to decrease with increasing height. Over the steppe, the vertical motion is upward, giving warm advection. This has opposite sign to the first two terms on the lefthand side of (3).

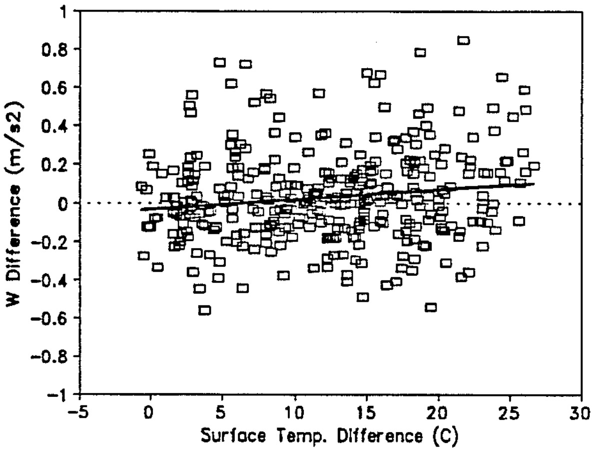


Figure 19. Average difference of vertical velocity vs. surface temperature as observed from the airplane.

Figure 19 helps to assess the strength of typical vertical advection. The graph shows average differences in vertical velocity vs. surface temperature difference between the irrigated farmland and steppe as observed from the airplane. Measurement of a small mean vertical velocity is difficult in general, and particularly so for aircraft wind systems. Near-surface flow organization should be more apparent from an analysis of horizontal winds. Nevertheless, the data are statistically incriminating. The regression line in Figure 19 (wind differences against surface temperature) passes nearly through the origin and has a slope of 0.005 $ms^{-1}(°C)^{-1}$. With a standard error estimate of 0.002 $ms^{-1}(°C)^{-1}$, the slope is significantly different from zero at the 95% confidence level. For a typical surface temperature difference of 20°C between farm and steppe, the estimated mean difference in w is 10 $cm\text{-}s^{-1}$. A gradient of -0.02 $°Cm^{-1}$ is possible over the steppe at the flight altitude. Combined with a 5 $cm\text{-}s^{-1}$ upward velocity, a flux difference, tower minus airplane, of -15 Wm^{-2} would result from vertical advection, partially offsetting the other two terms.

The combined effect of the terms described above explains a major portion of the differences between the measurement systems, although a more precise conclusion about what portion of the data is explainable awaits more detailed analysis. More importantly, the initial analysis illustrates some of the considerations necessary for measuring fluxes under heterogeneous conditions. How to define proper averaging length, or more generally, proper separation between mean and turbulent flows for flux computation, is not readily apparent. More detailed examination of the organized flow structures, the cospectra of vertical motion, and the given measured flux quantities is necessary. The value of measurement at low altitudes is evident; at the 25 m flight altitude, a significant fraction of total heat flux can be attributed to transport and storage of heat in the layer below the measurement height. For the steppe, this suggests a need to consider the full atmospheric budget equations for mass, momentum, and energy.

Flux divergence measurements (FDV flights shown in Appendix C) proved unable to display the differences between flux tower and airplane readings. Given the scatter in these FDV profiles, a linear extrapolation to the surface from a 25 m measurement elevation is unlikely to provide reliable results.

For the corn tower (D), the LE comparison with airplane measurements shows very good results. There is a mean difference of only -12 Wm^{-2} and a variance of ±69 Wm^{-2}. The large variance should be expected considering the corn tower's displacement of 2.5 km from the flight transect. The small difference in average values could be a result of the corn field's being more representative of farmland use. Aircraft measurement comparisons to the wheat tower (Z1) were not as promising as those for the corn tower (D). The mean difference is -73 Wm^{-2} and with a mean variance of ±55 Wm^{-2}. However, the difference is consistant with atypical wheat land use (which is not well represented by a 4.5 km covariance). For wheat, Table 9 indicates a serious sensitivity to covariance distance, indicating a large-scale data contribution beyond 4.5 km. Considering the flight altitude of about 12 m, such a large-scale contribution is unlikely. A more likely effect is that of intermittently flying through irrigation plumes (along with the resulting patches of moist-ground footprints). In a 4.5 km (90 s) covariance, turbulent quantities are generally intermittant; however, effects resulting from the irrigation plumes and resulting foot prints would have to be even more intermittent for their effects to be well represented. Unlike the corn fields, wheat fields were under maximum irrigation. The LE comparison is plotted in Figure 20.

The comparison between CO_2 flux measurements from towers and airplane is given in Figure 21. As in previous comparisons, the difference between tower and airplane values was small over corn and large over wheat. The explanation follows that of the LE comparison. However, the CO_2 comparison reveals no large-scale contribution to the data, which supports the speculation that the patchiness of irrigation affected LE measurements.

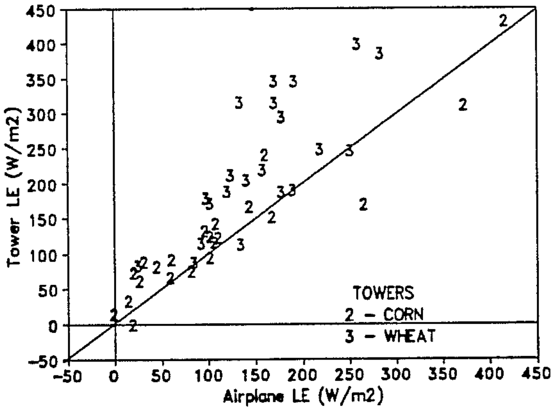


Figure 20. Comparison of latent heat measurements from tower and airplane.

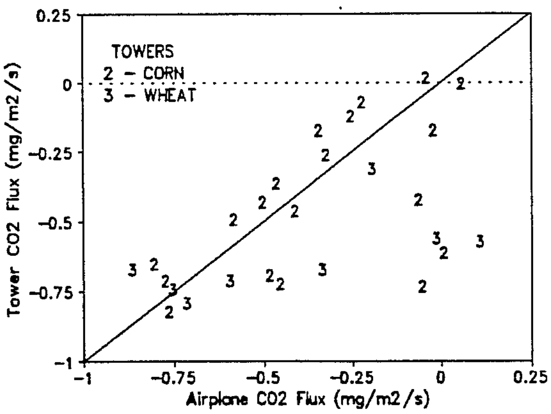


Figure 21. Comparison of airborne and flux tower CO_2 flux measurements.

7. DATA SUMMARIES

7.1 Asterisk (ASK) and Flux Normal (FLN)

For this preliminary report, no quantitative statistical tests were made of heterogeneity in measured patterns or of dependence on path direction. However, these features were identified visually in the spatial distribution of some measured quantities.

Path-average fluxes from adjacent paths, generally in opposite directions, differed strongly for fluxes of water vapor (latent heat) and CO_2. Fluxes of O_3 had almost no path direction dependence. The mean-wind u-component (but not the v-component) was dependent on mean heading, varying ±1.3 ms^{-1} around the compass, with extrema at 162° and 342°. The nodes of this u-component fluctuation are approximately in the direction of the long flux transects (FLX's), indicating that mean winds were correct for those headings. The causes of such heading-dependent variation are under investigation. At this time, recommended practice is to average pairs of fluxes from paths of opposite direction.

Fluxes of sensible and latent heat were visually homogeneous over the steppe. Over the irrigated farmland, there are detectable heterogeneities related to the distribution of crops. In this setting, the ASK measurements were inadequate for a detailed analysis. Daytime atmospheric variations have scales comparable with the 800 m field sizes, thus requiring multiple passes over the same field for adequate sampling of spatial and temporal distributions. A figure-eight pattern, more directly related to field configuration and involving repeated passes over the same path, was used in June 1992. The results of this will be reported later.

7.2 Long-Transect Flux (FLX)

The long-transect flux runs constitute the majority of the data (over 400 passes along the transect line shown in Figure 1. The contrast between irrigated farmland and steppe is readily identifiable in these measurements. Likewise, when fluxes averaged over 1 km were superimposed by position and averaged (for proper sampling of the atmospheric scales), secondary heterogeneities produced by the farm fields were identifiable. Flux transects measured during the daytime appear to have the greatest potential. The nighttime measurements were apparently above much of the near-surface flux activity (safety constraints forced flight altitudes to above 50 m AGL at night). A test for intermittent turbulence has not yet been conducted for the nocturnal data. Such events have been identified in other experiments in which the airplane has participated.

7.3 Flux Divergence (FDV)

Except for ozone and nighttime fluxes, vertical flux profiles revealed a great deal of scatter. This was not surprising in view of the deliberate selection of a heterogeneous study site. A need for more detailed investigation is obvious. Some of the more apparent flux patterns observed should serve as a starting place for further study. Examples include a reversal of latent heat flux divergence over the farmland on June 15, 1991 and the notable precision of many of the O_3 flux profiles relative to other fluxes.

7.4 Profiles of Mean Quantities (PRO)

Samples of the vertical structure of atmospheric stability and other mean scalar parameters were measured primarily in spiral-form profiles flown approximately three hours apart on most days. Appendix D displays the plotted results.

7.5 Airplane-Tower flux comparisons

Validation of the flux measurements from the airplane was provided by comparison of observed fluxes with those determined from several towers. "Footprints" (regions of the surface where the measured exchange actually took place) of tower and airborne measurements differ significantly in configuration. Also, vertical divergence of flux between the tower level and airplane level can be significant. However, the results from these data support the feasibility of the airborne technique while demonstrating the importance of flying at low altitude and of including the entire heat budget equation in the interpretation of these measurements (especially over heterogeneous surfaces).

The measured mean radiation, winds, temperatures, and fluxes of latent heat, sensible heat, CO_2, and O_3 over the irrigated farmland compared well with the surface towers, when properly adjusted to account for different elevations and footprints. This result is strengthened by the ability to close the surface heat budget from tower measurements, which provides independent support for their accuracy.

The sensible heat flux measured over steppe from the airplane was 75 Wm^{-2} less than that measured at steppe tower. Although a full surface heat budget was not measured at that tower, additional flux measurements from different parts of the steppe support its findings. Several mechanisms for rectifying the differences in flux values are proposed based on the atmospheric heat budget equation. Taken together, they appear to explain most of the discrepancy. A more firm conclusion should be possible upon further data analysis. Particular attention should be paid to all physical processes represented by the heat budget equation when making airborne flux measurements over heterogeneous surfaces. Also, such measurements must be made as close to the ground as safety permits.

8. RECOMMENDATIONS

This experiment demonstrated the benefit of multiple passes over the same path at short intervals. Heterogeneous surfaces influence fluxes and other quantities on scales comparable with the heterogeneities themselves. Often, atmospheric turbulence also influences measurements on a comparable scale. Superposition of multiple passes, each short enough to resolve surface features of interest, appears to be the most suitable method for sampling by airplane. Accurate positioning using the Global Positioning System insures confidence in the superpositions.

This experiment demonstrated the importance of measurement at low altitude and computation using the complete budget equation when air-surface exchange is being determined under heterogeneous conditions. Towers are generally short enough to be embedded in flow that is in equilibrium with the underlying surface. Thus, there is little relative change in flux between the ground surface and the tower's measurement height. However, at 10 to 20 m above ground (the lower end of the airplane's altitude), organized patterns of larger scale begin to be significant. These include secondary circulations, mean horizontal gradients, significant capacity for storage of the measured quantity, and sources or sinks, such as from chemical reactions. Fortunately, the normal suite of measurements (including spatial distribution) appears to be adequate for estimating the required budget terms.

Flux measurements at night have revealed little so far. It is likely that turbulence at the 50-100 m minimum safe flight level is out of equilibrium with the surface and generally so weak that it is almost impossible to measure from an airplane moving at 50 ms^{-1}. However, profiles (PRO) of mean quantities may be of interest at night since these seem to persist with little change until mixing occurs during the next day.

Design of the airplane's participation in the 1992 Boardman Experiment included the following features, derived from the 1991 results. Since homogeneity over the steppe has been established, only one futher ASK was flown there. Over irrigated farmland, a figure-eight pattern was flown, replacing the ASK and passing repeatedly over the same parts of the same fields, as defined by ground references. The tendency of some measurements for a dependency on path orientation suggest that at a minimum the fluxes should be averaged in pairs of oppositely directed passes. In any case, such averaging is desirable, as indicated in the first paragraph of this section.

Preliminary analysis of the data obtained by airplane from the 1991 Boardman ARM Regional Flux Experiment indicates good promise of identifying atmospheric structures produced by surface heterogeneities. Given adequate analysis, the airplane, tower, and biological data should reveal a clear pattern to guide composition of the more obscurely defined heterogeneities of the ARM Cloud and Radiation Testbeds (CART) into a bulk boundary-layer source term for cloud formation over the 100 km scales needed for cloud parameterization in global circulation modeling.

ACKNOWLEDGEMENTS

This research was supported by the Department of Energy's Atmospheric Radiation Measurement program. The authors thank Dr. Chris Doran for his important overall program management and coordination efforts which made the BARFEX experiment possible. Within ATDD, Dr. Rayford Hosker, the director, provided for strong in-house logistic and administrative support. Without the efforts of these two, this experiment would not have been possible. Special recognition goes to Robert McMillen, Dennis Baldocchi, Tilden Meyers, and Richard Eckman for their remarks and criticism.

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APPENDIX A
ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS
90 s COVARIANCE

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6021747	71		5.5	10.0	257	0.63	22.4	36.6	759	468	142	152		-0.81		
FARM	62		5.6	8.0	260	0.51	22.5	30.6	842	469	121	340		-0.69		
DESERT	72		5.4	11.2	258	0.71	22.4	39.8	689	470	144	44		-1.12		
6021757	38		5.6	10.6	243	0.78	22.9	35.9	925	516	153	299		-0.66		
FARM	44		5.8	8.9	242	0.57	22.8	28.7	921	527	78	443		-0.63		
DESERT	34		5.5	11.2	244	0.93	22.9	37.6	928	512	178	302		-0.64		
6021816	34		5.3	10.9	252	0.55	23.1	36.9	858	492	168	531		2.08		
FARM	23		5.6	9.1	251	0.69	23.5	31.8	860	516	92	334		-0.76		
DESERT	36		5.3	11.3	254	0.63	23	37.5	865	489	182	620		2.58		
6021828	38		5.4	10.7	241	0.72	23.4	37.8	956	535	176	364		-0.82		
FARM	27		5.8	9.9	240	1.92	23.4	29.1	944	539	77	608		-1.15		
DESERT	39		5.3	10.9	243	0.61	23.4	39	959	533	172	353		-0.96		
6021846	36		5.3	11.1	254	0.4	23.7	37.6	755	522	144	510		-0.54		
FARM	28		5.3	10.4	231	0.55	23.8	33	692	514	114	104		-3.24		
DESERT	36		5.3	11.5	257	0.6	23.6	37.8	720	520	142	406		-0.58		
6021859	103		5.2	9.7	238	1.09	24	37.9	977	553	217	307		-0.5		
FARM	97		5.6	8.9	236	0.64	24	31.2	970	568	106	340		-0.24		
DESERT	122		5.1	9.8	239	1.22	24	39.6	979	546	263	309		-0.79		
6021918	44		5.4	12.5	256	0.51	23.9	37.8	797	541	145	469		1.27		
FARM	41		5.4	12.0	258	0.22	24.1	32.9	961	564	89	-349		-0.45		
DESERT	44		5.4	12.7	256	0.78	23.8	38.5	782	536	171	731		2.14		
6031848	47		3.4	6.8	237	0.56	14.7	35.3	989	557	230	146		-1.09		
FARM	55		3.5	5.9	239	0.58	14.5	31.2	984	560	174	197		-1.51		
DESERT	33		3.4	7.4	250	0.56	15	40.1	990	545	299	148		-0.38		
6031900	32		3.5	7.0	244	0.44	15.1	36.2	835	536	258	277		0.2		
FARM	27		3.7	6.3	231	0.39	15	27.8	818	539	208	571		0.72		
DESERT	28		3.5	7.6	239	0.54	15.3	40.2	771	523	301	424		0.59		

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6031911	78		3.5	6.2	237	0.35	15.5	37.3	1001	561	230	196		-0.38		
FARM	175		3.8	6.3	237	0.55	15.3	28.5	1005	576	145	352		-0.95		
DESERT	30		3.3	6.8	231	0.6	15.7	43.3	1001	546	256	77		0.03		
6031922	35		3.3	4.6	256	0.43	15.6	37.5	844	543	239	297		0.14		
FARM	39		3.4	4.6	271	0.5	15.5	29.5	974	569	160	117		-2.91		
DESERT	36		3.3	5.2	260	0.49	15.7	43.6	859	533	267	334		0.73		
6031931	28		3.4	5.5	246	0.42	16	38.2	1002	564	225	313		-0.4		
FARM	27		3.5	5.2	266	0.5	15.7	27.8	996	580	133	585		-0.77		
DESERT	27		3.3	6.1	254	0.52	16.1	44.6	1001	544	286	105		-0.32		
6031942	35		3.4	5.4	246	0.12	16.1	39.6	885	544	211	163		-0.89		
FARM	25		3.4	5.4	219	0.16	16	33.6	866	544	169	446		0.94		
DESERT	39		3.4	6.6	262	0.37	16.1	43.6	905	536	232	65		-1.18		
6031952	41		3.5	4.9	242	0.49	16.3	38.7	1004	559	207	192		-0.57		
FARM	24		3.5	4.8	229	0.71	16.2	30.6	1007	576	216	456		-0.86		
DESERT	60		3.4	5.3	240	0.43	16.4	44.2	1000	545	230	45		-0.48		
6032003	35		3.4	5.1	258	0.28	16.4	40.2	964	546	215	19		-2.18		
FARM	31		3.5	2.9	229	0.21	16.3	30.9	1010	567	125	290		-1.32		
DESERT	37		3.4	7.4	263	0.68	16.4	45.4	930	542	280	-217		-4		
6032013	32		3.4	5.4	243	0.24	16.8	39.3	994	554	192	221		-0.57		
FARM	26		3.6	4.3	246	0.28	16.6	30.4	1000	572	127	429		-0.77		
DESERT	33		3.3	7.1	237	0.36	17	45.3	994	539	254	95		-0.34		
6032023	32		3.4	5.0	249	0.12	16.9	39.5	982	547	223	143		-0.23		
FARM	26		3.6	4.5	293	0.31	16.9	30.8	1007	564	169	227		0.2		
DESERT	36		3.3	6.4	242	0.21	16.9	45.1	988	543	298	111		-0.25		
6032033	30		3.4	6.5	238	0.76	17.3	38.8	980	544	257	335		-0.68		
FARM	25		3.8	4.1	241	0.57	17.2	30	983	561	209	691		-0.99		
DESERT	32		3.2	8.9	239	1.19	17.3	44.4	978	527	312	133		-0.58		

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6032043	32		3.3	6.0	240	0.11	17.3	39.4	978	540	237	201		-1.37		
FARM	29		3.5	3.8	217	0.3	17.1	32	979	545	137	307		-2.34		
DESERT	31		3.2	8.0	245	0.04	17.4	44.3	963	529	293	138		-0.54		
6040100	30		3.7	11.4	251	0.55	17.7	22.3	355	123	107	171		-0.32		-0.12
FARM	28		3.9	10.0	249	0.77	17.8	18.9	357	134	78	389		-0.41		-0.21
DESERT	31		3.7	12.1	252	0.44	17.7	25	349	105	128	43		-0.29		-0.06
6040113	40		3.7	12.3	258	0.79	17.4	21.7	402	130	95	115		-0.43		-0.12
FARM	31		3.8	10.1	244	0.38	17.4	18.3	384	125	43	216		-0.37		-0.13
DESERT	43		3.7	13.6	255	1.17	17.4	23.9	429	144	123	55		-0.46		-0.11
6040121	27		3.8	11.6	248	0.71	17.5	20.7	290	22	112	121		-0.26		-0.12
FARM	27		3.9				17.7	18.4	296	26	119	244		-0.29		-0.22
DESERT	27		3.8	12.6	253	0.71	17.4	22.5	283	-2	120	46		-0.26		-0.09
6040133	35		3.8	11.7	247	0.54	17.2	20.8	331	51	57	37		-0.34		-0.06
FARM	29		3.9	11.2	245	0.69	17.1	16.4	336	104	12	143		-0.41		-0.08
DESERT	35		3.8	11.9	247	0.49	17.2	22.3	321	22	80	27		-0.37		-0.08
6040141	28		3.8	11.4	251	0.69	17.3	19.4	230	-41	69	79		-0.17		-0.07
FARM	24		3.9	10.7	243	0.91	17.3	16.4	237	10	25	188		-0.17		-0.09
DESERT	29		3.8	11.9	252	0.5	17.2	21	222	-70	87	24		-0.18		-0.05
6040152	34		3.8	11.9	251	0.37	16.9	18.5	225	-86	26	92		-0.32		-0.07
FARM	27		4	10.2	250	0.38	16.9	15.8	194	-81	2	164		-0.34		-0.08
DESERT	36		3.8	12.7	251	0.57	16.9	20.4	238	-92	49	30		-0.32		-0.06
6040201	27		3.9	11.6	250	0.5	16.9	17.5	171	-4	51	102		-0.17		-0.09
FARM	24		4.1	10.5	248	0.69	17	15.2	175	9	17	223		-0.18		-0.13
DESERT	27		3.9	11.0	251	0.54	16.7	19	164	-13	77	43		-0.21		-0.09
6040213	38		3.9	13.5	254	1.47	16.6	17.1	125	-72	23	68		-0.38		-0.06
FARM	28		4	13.1	253	1.12	16.5	15.3	108	-67	-4	142		-0.43		-0.07
DESERT	44		3.9	12.9	262	1.39	16.6	18.8	113	-71	38	28		-0.37		-0.06

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6040221	32		3.9	11.9	248	0.71	16.4	16.3	113	-18	38	74		-0.16		-0.08
FARM	26		4.1	9.9	243	0.8	16.5	14.7	116	-14	18	134		-0.12		-0.09
DESERT	34		3.9	12.3	252	0.58	16.3	17.4	109	-24	51	43		-0.16		-0.09
6060103	26	6.1	5.5	3.6	342	0.22	16.9	21.9	227	89	37	115	354.5	-0.25	45	-0.05
FARM	18	6	5.4				16.8	20.3	229	79	42	151	355.7	-0.35	46	-0.06
DESERT	32	6.1	5.5	4.6	346	0.3	16.9	23.9	184	78	17	112	354.8	-0.16	45	-0.06
6060113	70	6.1	5.5	5.1	312	0.17	16.6	21	190	60	22	16	355.8	-0.11	47	-0.03
FARM	75	6	5.4	3.7	322	0.28	16.6	19.9	318	124	18	43	354.9	-0.07	48	-0.03
DESERT	50	6.2	5.6	3.3	347	0.35	16.7	23	115	22	37	-2	356.1	-0.13	46	-0.05
6060125	46	6.5	5.9	5.2	339	0.1	16.5	20.2	163	48	28	59	353.3	-0.31	43	-0.06
FARM	48	6.2	5.5	4.4	338	0.18	16.8	18.4	209	79	27	85	353.6	-0.49	45	-0.04
DESERT	43	7	6.4	6.7	340	0.03	16.2	21.3	142	34	30	43	353.2	-0.16	41	-0.08
6060135	33	6.8	6.3	5.4	348	0.21	16.4	19.9	161	46	37	39	353.6	-0.2	41	0
FARM	32	6.3	5.7	3.4	355	0.15	16.6	17	168	57	21	75	353.4	-0.24	45	0
DESERT	32	7.1	6.5	6.9	348	0.22	16.2	21.6	160	49	48	17	353.5	-0.17	40	0
6060145	30	6.9	6.4	5.8	344	0.38	16.2	19.2	128	43	21	40	355.2	-0.21	40	-0.01
FARM	22	6.4	5.8	4.8	347	0.36	16.6	17	130	46	12	81	353.1	-0.29	44	-0.05
DESERT	32	7.2	6.7	7.7	346	0.41	16	20.5	125	39	30	15	355.7	-0.13	38	-0.02
6060156	33	7.2	6.7	6.5	346	0.38	15.9	18.3	82	14	22	10	356.4	-0.08	37	0
FARM	26	7.1	6.5	4.0	330	0.19	16.2	16.1	72	11	9	16	354.8	-0.1	37	0.02
DESERT	33	7.2	6.7	7.4	354	0.59	15.8	19.8	91	17	33	7	357.1	-0.08	39	-0.03
6060206	33	7.3	6.7	6.2	343	0.46	15.7	17.1	57	2	18	24	355.1	-0.1	37	-0.02
FARM	26	7.1	6.5	5.3	320	0.24	16.1	15.1	65	10	19	44	356.1	-0.02	38	-0.06
DESERT	32	7.4	6.8	8.3	181	0.61	15.5	18.3	49	-6	16	10	354.1	-0.13	38	0
6060216	23	7.5	6.9	6.9	341	0.52	15.4	16.6	39	-10	16	18	354.4	-0.03	37	-0.01
FARM	22	7.7	7.1	6.2	325	0.26	15.5	14.8	48	-1	12	25	354.6	0.04	35	0.02
DESERT	23	7.4	6.8	6.8	353	0.72	15.4	17.8	34	-14	16	13	354.1	-0.08	38	-0.02

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6060226	31	7.6	7	6.3	332	0.26	15.3	16.2	43	-3	17	2	354.3	-0.07	35	0.04
FARM	17	7.7	7.1	4.6	299	0.23	15.6	14.4	43	-1	20	-10	355.4	0	32	0.15
DESERT	41	7.4	6.8	6.8	345	0.27	15.2	17.4	43	-6	15	5	353.4	-0.12	39	-0.01
6060237	27	7.6	7	6.0	183	0.38	15.1	15.8	19	-19	10	13	355.5	0.05	35	-0.05
FARM	23	7.8	7.2	5.3	204	0.29	15.3	14.3	16	-18	7	26	356.8	0.16	30	-0.06
DESERT	25	7.4	6.8	6.0	359	0.36	15.1	16.8	23	-18	11	2	354.7	-0.06	39	0
6060248	30	7.7	7.1	6.2	354	0.18	15	15.3	14	-20	7	7	355.5	-0.05	35	-0.01
FARM	26	7.7	7.1	4.8	197	0.04	15.2	14	15	-17	4	5	357.1	-0.01	29	-0.01
DESERT	31	7.6	6.9	7.4	351	0.32	14.8	16.1	13	-23	8	4	354.7	-0.09	39	0
6060258	36	7.7	7.1	6.2	184	0.23	14.8	14.8	13	-22	7	5	355	0.03	35	0
FARM	30	7.9	7.3	5.4	194	0.21	14.9	13.3	13	-18	6	0	356.3	0.1	29	0
DESERT	39	7.6	6.9	7.0	358	0.28	14.7	15.9	13	-23	9	8	354.2	-0.01	39	-0.02
6060309	36	7.9	7.2	6.2	352	0.3	14.6	14.4	1	-26	2	9	355.8	0.01	34	0.02
FARM	30	8	7.3	4.7	180	0.58	14.8	13.2	1	-23	-3	20	357.5	0.07	29	0.01
DESERT	39	7.7	7.1	7.2	350	0.14	14.4	15.3	1	-28	6	8	354.5	-0.01	38	-0.02
6060320	36	7.9	7.3	6.0	360	0.18	14.4	14.2	-1	-28	2	10	355.8	0.06	35	-0.08
FARM	29	8.1	7.5	4.1	197	0.14	14.5	13.3	-2	-27	-6	24	357.8	0.13	30	-0.12
DESERT	30	7.7	7.1	5.9	184	0.35	14.4	14.9	-1	-29	5	-4	354.4	-0.05	39	-0.03
6060331	36	7.9	7.3	5.7	355	0.12	14.3	13.9	-4	-28	0	1	354.7	-0.08	33	0.01
FARM	30	8	7.4	6.3	353	0.08	14.4	12.8	-4	-25	1	2	356	-0.05	29	0.01
DESERT	38	7.8	7.2	5.7	355	0.14	14.2	14.6	-5	-30	1	3	353.5	-0.1	38	0.02
6061906	34	7.3	6.9	3.8	200	0.32	16.5	28.6	455	268	117	78	347.6	-0.53	54	-0.08
FARM	40	7.4	7	3.7	193	0.2	16.5	22.8	490	256	86	115	347.9	-0.72	53	-0.1
DESERT	30	7.1	6.7	3.8	208	0.62	16.5	31.4	448	267	131	59	347.1	-0.36	56	-0.07
6061916	36	7.5	6.9	2.9	196	0.2	16.6	29.2	590	342	127	81	348.2	-0.76	55	-0.1
FARM	31	7.5	7	2.9	187	0.08	16.7	24.8	763	444	125	146	346.9	-1.36	54	-0.09
DESERT	36	7.4	6.8	2.9	202	0.2	16.6	32.1	509	295	126	45	349.6	-0.33	55	-0.1

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6061926	51	7.4	6.8	4.3	199	0.29	16.8	33.1	694	429	147	105	348.3	-0.73	56	-0.09
FARM	43	7.4	6.8	4.3	194	0.59	17	27.1	618	419	131	152	347.5	-1.38	55	-0.12
DESERT	52	7.3	6.8	4.7	199	0.42	16.7	32.8	588	323	147	83	348.3	-0.36	56	-0.1
6061936	28	7.4	6.7	3.2	201	0.35	17	30.8	572	317	110	73	349.6	-0.63	55	-0.05
FARM	24	7.4	6.8	4.4	207	0.27	17	24.8	626	357	66	108	348.6	-0.93	54	-0.03
DESERT	31	7.3	6.7	2.9	197	0.46	17	34.1	572	314	162	54	349.7	-0.42	55	-0.06
6062022	30	7.1	6.4	4.2	189	0.29	17.4	32.1	584	323	126	61	348.7	-0.55	54	-0.04
FARM	23	7.3	6.6	4.3	181	0.34	17.5	26.1	581	320	93	125	349	-1.04	54	-0.01
DESERT	33	7	6.3	4.5	189	0.26	17.4	34.5	612	322	144	27	348.4	-0.31	54	-0.06
6062032	35	7.1	6.4	3.8	356	0.38	17.6	31.5	599	329	123	86	349	-0.61	54	-0.06
FARM	21	7.3	6.6	3.1	352	0.17	17.6	23.3	493	263	63	140	349.3	-0.81	53	-0.06
DESERT	44	6.9	6.2	3.8	358	0.63	17.7	38.3	756	430	172	49	349.2	-0.38	55	-0.07
6062042	34	7.1	6.4	4.3	195	0.36	17.6	32.7	666	376	129	67	349.5	-0.5	54	-0.03
FARM	22	7.4	6.8	4.4	348	0.25	17.6	24.7	516	297	74	90	347.2	-0.6	52	-0.01
DESERT	43	6.8	6.1	4.1	217	0.4	17.7	39.4	846	478	193	82	351.1	-0.44	55	-0.05
6062052	33	7.2	6.5	2.8	248	0.42	17.8	32.8	612	326	119	80	349.3	-0.63	55	-0.03
FARM	24	7.5	6.8	2.8	354	0.39	17.7	25	555	286	69	94	348.4	-0.82	54	-0.02
DESERT	41	6.8	6.1	6.3	283	1.07	17.9	37.6	669	354	163	62	350.4	-0.43	56	-0.01
6062101	28	7.1	6.4	7.2	345	0.63	18	32.8	637	341	148	87	349	-0.69	55	-0.02
FARM	23	7.5	6.9	3.6	213	0.25	17.8	25.4	660	355	80	124	346.7	-0.92	53	-0.01
DESERT	30	6.8	6.1	11.9	334	1.7	18.1	36.8	599	321	193	61	350	-0.43	56	-0.03
6062111	24	7.3	6.7	3.3	352	0.33	18	32.7	666	375	141	94	347.6	-0.7	55	0.01
FARM	14	7.6	7	2.5	336	0.69	18	25.6	737	422	109	144	347.5	-1	53	0.04
DESERT	28	7.1	6.5	3.8	357	0.13	18.1	36.4	611	333	173	71	348.1	-0.43	56	0.01
6062120	23	7.2	6.6	3.9	181	0.54	18.2	34.2	740	412	157	86	349.5	-0.6	54	-0.01
FARM	15	7.4	6.8	4.1	350	0.5	18.2	26.5	763	453	160	200	347.6	-1.21	52	0.01
DESERT	29	7.1	6.5	3.9	190	0.67	18.1	37.7	678	379	173	38	350.5	-0.31	56	-0.02

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6062130	23	7.2	6.5	3.1	347	0.66	18.2	33.3	733	413	149	117	348.4	-0.84	54	-0.01
FARM	22	7.3	6.7	4.6	340	1.19	18.1	24.4	690	353	87	187	346.8	-1.2	53	-0.02
DESERT	21	7.1	6.5	2.7	358	0.49	18.3	38.3	664	380	167	40	349.9	-0.41	55	0
6062140	21	7.1	6.5	3.9	180	0.31	18.4	35.4	792	431	175	116	349.4	-0.84	54	-0.06
FARM	21	7.3	6.7	4.7	354	0.41	18.4	25.2	698	405	105	227	347.9	-1.66	53	-0.11
DESERT	21	7.1	6.5	4.0	188	0.35	18.4	39.2	727	372	216	50	350.5	-0.41	55	-0.03
6062150	26	7.1	6.5	3.3	337	0.03	18.5	36.2	773	441	185	110	349.3	-0.74	54	-0.06
FARM	23	7.2	6.6	4.4	341	0.34	18.4	25	665	374	108	183	348.7	-0.89	53	-0.04
DESERT	26	7.1	6.4	2.9	331	0.35	18.6	40.7	730	420	200	59	349.3	-0.74	54	-0.07
6062159	22	7.1	6.5	4.2	354	0.18	18.7	36.6	821	431	218	127	348.3	-0.88	54	-0.04
FARM	17	7.2	6.5	3.9	347	0.12	18.6	25.7	697	366	115	178	348.2	-1.21	53	-0.05
DESERT	22	7.1	6.5	4.3	354	0.25	18.6	41.1	838	427	248	53	348.5	-0.5	54	-0.02
6062208	21	7.1	6.5	3.0	342	0.17	18.8	35.5	732	404	134	88	349	-0.55	54	0.01
FARM	18	7.1	6.5	4.5	341	0.24	18.7	26.5	758	424	95	160	349	-1.01	52	0.02
DESERT	22	7.2	6.5	2.4	345	0.14	18.8	40.8	773	431	141	46	349.3	-0.29	55	-0.01
6062218	27	7.1	6.4	3.5	344	0.33	18.9	34.9	728	376	169	92	348.2	-0.61	54	-0.03
FARM	30	7	6.4	3.4	335	0.37	18.9	25.4	605	319	132	141	347.9	-0.84	54	-0.07
DESERT	23	7.2	6.5	3.5	345	0.16	18.9	41.3	865	440	201	42	348.3	-0.4	54	-0.03
6071732	17	7.5	7.3	10.4	232	0.67	18.5	31.2	842	473	175	101	351.5	-0.73	42	-0.03
FARM	11	7.7	7.6	9.4	227	0.62	18.4	23.3	779	454	109	223	350.2	-1.2	40	0
DESERT	20	7.4	7.2	11.0	238	0.71	18.5	36	867	481	188	32	352.4	-0.41	44	-0.03
6071743	24	7.4	7.2	9.7	236	0.44	18.5	32.4	785	453	143	44	350	-0.86	46	-0.03
FARM	20	7.5	7.3	9.1	234	0.33	18.5	26.1	825	489	105	148	349.1	-0.9	42	-0.06
DESERT	24	7.3	7.2	10.0	241	0.57	18.5	36.1	739	420	151	-6	350.5	-0.75	47	-0.03
6071752	19	7.4	7.2	10.2	230	0.75	18.8	32.6	840	474	177	118	352	-0.73	43	-0.04
FARM	15	7.5	7.3	10.5	222	0.53	18.6	25.1	900	524	102	234	350.8	-1.27	43	-0.03
DESERT	21	7.3	7.1	9.8	234		19	38.7	893	491	259	71	353.4	-0.45	44	-0.07

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6071802	27	7.3	7.1	9.9	240	0.21	18.8	33.4	811	471	155	71	350.7	-0.9	40	-0.06
FARM	18	7.5	7.3	11.2	231	0.08	18.8	26.7	839	489	124	144	349.9	-0.99	43	0
DESERT	27	7.2	7	9.4	244	0.31	18.9	38.2	837	482	177	10	350.4	-1.01	40	-0.06
6071811	15	7.4	7.2	9.6	236	0.67	19.2	34.8	914	522	190	151	351.9	-0.61		-0.06
FARM	11	7.6	7.4	10.5	227	0.78	18.9	25.6	917	534	156	422	349.6	-1.3		-0.13
DESERT	18	7.3	7.1	9.1	240	0.79	19.4	40.4	913	512	217	36	353.2	-0.24		-0.06
6071822	21	7.4	7.2	9.3	240		19.4	34.8	836	508	175	73	354	-0.69		0
FARM	13	7.6	7.4	9.1	235	0.44	19.3	26.1	874	528	106	266	352.6	-0.81		-0.03
DESERT	28	7.2	7	9.1	249		19.4	39.9	861	500	226	-20	353.2	-0.46		-0.01
6071830	19	7.4	7.2	10.7	225	0.73	19.6	35.5	937	543	217	129	352.2	-0.72		-0.04
FARM	12	7.5	7.3	10.2	226	0.67	19.4	26.4	935	552	132	285	351	-1.21		-0.01
DESERT	25	7.3	7.1	11.2	223	1.21	19.8	41.2	941	538	305	35	353.2	-0.44		-0.07
6071841	36	7.3	7.1	10.1	229	0.29	19.6	35.5	835	528	173	136	351.1	-0.91		-0.02
FARM	18	7.4	7.2	9.0	231	0.45	19.6	27.1	903	544	142	339	348.7	-1.45		-0.02
DESERT	43	7.2	7	11.0	225	0.52	19.6	40.9	813	515	213	7	351.7	-0.58		0
6071850	16	7.3	7.1	10.1	227	0.72	20	37.1	935	548	201	116	350.1	-0.61		-0.02
FARM	10	7.6	7.3	8.9	222	1	19.9	28.5	950	573	143	259	350	-0.92		-0.01
DESERT	20	7.2	7	11.0	227	0.97	20.2	41.9	911	529	254	36	349.8	-0.48		-0.01
6071901	19	7.2	7				19.8	37.4	828	512	181	82	350.3	-0.73		-0.01
FARM	13	7.3	7.1	8.8	228	0.4	19.8	27.3	902	562	112	237	349.7	-1.16		-0.02
DESERT	20	7.2	7				19.8	41.8	787	471	190	-3	350.3	-0.71		0.01
6071909	13	7.2	6.9	10.0	220	0.48	20.2	37	914	538	198	131	348.8	-0.42		-0.02
FARM	10	7.4	7.1	10.3	216	0.29	20	27.2	968	582	141	306	348.2	-0.79		-0.03
DESERT	15	7	6.8	10.0	222	0.66	20.2	42.4	831	479	264	27	349.4	-0.31		-0.01
6072305	21	6.7	6.8	12.6	260	0.39	21.1	29.5	440	222	56	117	335.8	-0.59	44	-0.25
FARM	13	7.1	7.2	10.3	262	0.18	21.1	21.7	376	192	-21	272	336	-0.96	43	-0.43
DESERT	25	6.5	6.7	15.6	260	0.98	20.9	33.4	482	243	107	41	335.3	-0.4	44	-0.16

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6072325	18	7.2	7.3	9.7	254	0.39	21.2	28.6	394	191	39	77	338.2	-0.48	42	-0.14
FARM	13	7.5	7.5	7.8	258	0.4	21.2	22.6	349	169	3	147	337	-0.61	42	-0.15
DESERT	18	7.1	7.2	11.4	251	0.73	21.1	32.3	421	196	60	13	338.7	-0.34	41	-0.12
6072334	17	7.3	7.3	8.6	256	0.64	21.3	27.8	337	167	82	60	337.9	-0.31	41	-0.13
FARM	12	7.5	7.6	5.9	272	0.39	21.2	22.6	305	157	23	119	336.7	-0.4	42	-0.16
DESERT	18	7.1	7.2	10.9	248	1.15	21.2	31.2	358	174	116	21	338.7	-0.27	41	-0.12
6072344	19	7.4	7.4	7.8	272	0.49	21.1	27.6	375	179	61	55	337.8	-0.53	41	-0.13
FARM	11	8	8	5.4	306	0.52	21	22.5	366	184	28	145	336.5	-1.1	42	-0.36
DESERT	25	7.1	7.2	10.8	258	0.37	21	30.5	366	170	74	13	338.4	-0.32	39	-0.09
6072353	18	7.4	7.5	7.4	277	0.5	21.1	27.3	323	160	66	68	338.2	-0.32	42	-0.16
FARM	10	8	8	6.4	307	0.51	20.8	23	374	192	26	133	337.5	-0.58	47	-0.12
DESERT	21	7.1	7.1	9.6	263	0.54	21.2	29.4	257	117	79	29	338.8	-0.09	39	-0.21
6080004	29	7.4	7.5	6.0	306	0.4	20.7	26.3	291	130	47	70	338.2	-0.35	41	-0.11
FARM	21	7.7	7.7	6.8	329	0.48	20.5	22.4	383	185	30	163	338.1	-0.68	42	-0.21
DESERT	31	7.1	7.2	6.9	270	0.36	21	28.6	235	101	47	9	338.1	-0.13	39	-0.06
6080013	21	7.4	7.5	5.6	295	0.55	20.6	26	262	123	58	52	338.9	-0.3	41	-0.11
FARM	17	7.7	7.7	6.6	322	0.52	20.4	21.3	272	141	31	116	338.3	-0.46	41	-0.15
DESERT	22	7.2	7.3	7.2	263	0.83	20.8	28.8	262	118	81	6	338.9	-0.13	40	-0.11
6080023	21	7.3	7.3	4.2	302	0.47	20.6	25.7	257	111	39	72	339.2	-0.28	40	-0.12
FARM	15	7.4	7.5	5.3	330	0.59	20.4	20.5	253	118	10	133	339.4	-0.48	40	-0.17
DESERT	25	7.3	7.3	5.9	262	0.62	20.8	28.5	240	96	38	42	338.6	-0.21	40	-0.1
6080031	15	7.1	7.2	5.1	278	0.17	20.5	24.8	198	85	37	6	339.6	-0.25	40	-0.14
FARM	9	7.6	7.6	4.0	322	0.34	20.4	20.6	232	109	13	89	338.7	-0.25	39	-0.08
DESERT	16	6.8	6.8	8.4	255	0.17	20.6	26.7	161	61	58	-76	340.1	-0.25	39	-0.19
6080042	18	7	7	5.3	273	0.41	20.5	23.9	156	57	25	73	340.3	-0.21	39	-0.02
FARM	11	7.4	7.4	4.1	327	0.47	20.3	20	173	74	-2	103	340.2	-0.29	37	-0.08
DESERT	18	6.6	6.6	9.1	259	0.45	20.5	25.9	136	44	26	73	340.5	-0.22	38	-0.01

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6080050	17	7	7	6.9	252	0.36	20.2	22.9	133	49	45	-5	340.6	0	37	-0.03
FARM	10	7.5	7.5	2.8	289	0.6	20.3	19.7	150	63	21	-11	340.2	0.1	36	0
DESERT	19	6.6	6.7	11.7	243	0.47	20	24.5	132	43	63	-6	341	-0.02	37	-0.04
6080101	18	6.9	6.9	8.1	253	0.4	20	22.3	121	44	25	36	340.9	-0.17	37	-0.07
FARM	11	7.4	7.4	3.1	268	0.24	20.2	19.4	101	35	3	50	340.7	-0.05	36	-0.05
DESERT	21	6.7	6.7	11.6	251	0.46	19.8	24.1	140	51	37	20	341.1	-0.27	37	-0.1
6080110	11	7	7	8.5	241	0.59	19.8	21.6	103	34	36	14	341.2	0	37	-0.06
FARM	10	7.4	7.4	4.3	243	1.14	20.2	19.3	101	37	18	74	340.9	0.09	35	-0.09
DESERT	10	6.8	6.8	10.5	243	0.42	19.5	23.1	102	29	38	4	341.3	-0.06	38	-0.04
6080121	18	6.9	6.9	9.6	243	0.23	19.4	20.9	102	30	2	48	341.3	-0.15	38	-0.07
FARM	10	7	7	7.2	242	0.15	19.5	18.3	109	43	-14	111	341.3	-0.07	38	-0.1
DESERT	20	6.8	6.8	10.9	243	0.4	19.2	22.3	87	16	11	7	341.5	-0.2	38	-0.07
6080130	40	6.9	6.9	9.8	235	0.63	19.1	20.5	96	28	29	40	341.3	-0.06	37	-0.07
FARM	55	7.1	7.1	7.5	232	0.94	19.4	18.3	113	43	7	88	340.4	-0.01	36	-0.08
DESERT	51	6.9	6.9	10.6	235	0.55	18.8	21.7	79	15	36	14	342	-0.05	37	-0.06
6081700	35	6.4	6.4				17.4	33.8	730	402	149	78	341.2	-0.43	36	-0.11
FARM	24	6.5	6.5	3.7	293	0.15	17.3	26.6	733	404	92	131	340.9	-0.4	29	-0.11
DESERT	43	6.3	6.3				17.4	37.9	732	399	177	39	341.1	-0.44	45	-0.11
6081708	37	6.5	6.4	3.4	270	0.42	17.7	34.4	826	434	110	91	341.7	-0.48	36	-0.1
FARM	27	6.6	6.5	3.3	313	0.32	17.4	26.1	825	434	95	211	340.8	-0.82	35	-0.19
DESERT	43	6.4	6.3	4.8	239	0.29	17.8	39.4	830	430	110	23	342.5	-0.31	36	-0.05
6081716	245	6.2	6.3				17.9	31.3	683	421	79	51	332.3	-0.27	41	-0.07
FARM	245	6.4	6.5	3.5	285	0.11	17.7	24.2	747	438	47	157	331.8	-0.21	38	-0.18
DESERT	240	6.1	6.2				17.9	36.7	731	426	131	18	332.7	-0.35	41	-0.05
6081730	99	6.4	6.3	3.6	223	0.33	17.9	35.1	854	469	114	74	338.5	-0.29	37	-0.09
FARM	94	6.6	6.6	2.2	254	0.3	17.7	25.9	859	480	59	137	337.2	-0.39	36	-0.14
DESERT	101	6.3	6.2	4.8	223	0.46	18	40.5	855	459	130	30	339.3	-0.23	38	-0.05

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																	
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6081740	97	6.4	6.4				18	37.1	816	468	165	63	338.1	-1.01	36	-0.08
FARM	90	6.6	6.6				17.9	29.2	821	486	59	163	336.6	-0.59	36	-0.09
DESERT	95	6.2	6.2				18	41.5	802	456	259	31	338.7	-1.21	36	-0.1
6081749	40	6.5	6.4				18.2	37.2	902	496	116	171	340.6	-0.01	38	-0.18
FARM	30	6.8	6.6				18	28	898	499	114	278	339.3	-0.2	38	-0.29
DESERT	43	6.3	6.2				18.3	43.6	886	479	92	32	341.7	-0.28	39	-0.03
6081758	37	6.3	6.3	3.0	205	0.19	18.4	38.7	857	479	118	99	341.4	-0.17	41	-0.08
FARM	28	6.5	6.4	2.5	203	0.09	18.3	30.8	870	492	116	207	340	-0.88	42	-0.14
DESERT	42	6.2	6.2	2.7	206	0.3	18.4	43.9	846	464	134	36	341.8	-0.02	44	-0.06
6081807	100	6.3	6.2	2.8	226	0.32	18.6	38.4	897	500	128	106	338.7	-0.7	40	-0.1
FARM	92	6.4	6.4	2.2	257	0.36	18.5	28.5	917	520	87	187	337.5	-0.92	39	-0.16
DESERT	104	6.2	6.1	3.2	219	0.69	18.7	44.8	879	473	163	53	339.3	-0.71	41	-0.06
6081818	99	6.3	6.2				18.7	38	780	489	173	158	338.6	-0.94	39	-0.14
FARM	94	6.6	6.6				18.6	27.2	828	493	82	357	336.6	-1.78	37	-0.32
DESERT	104	6.1	6.1				18.8	45.3	806	477	208	28	339.4	-0.49	43	-0.07
6082256	29	6	6.3				21.8	34.8	462	197	55	131	340.6	-0.52	378	-0.08
FARM	18	6.4	6.6				21.5	27.7	464	203	25	217	339.9	-0.87	149	-0.2
DESERT	36	5.7	6	3.8	266	0.11	22	39.9	472	197	90	32	341.1	-0.28	489	-0.02
6082306	21	6.2	6.3	3.0	182		21.9	33.6	422	199	75	67	340.8	-0.39	68	-0.11
FARM	11	6.5	6.7	1.1	330		21.6	27	494	253	37	229	339.4	-0.82	105	-0.17
DESERT	25	6	6.1	5.2	189		22	37.7	398	170	96	14	341.9	-0.21	44	-0.06
6082315	22	6.3	6.3	2.4	210	0.07	22	33.5	416	178	68	91	341.2	-0.52	43	-0.14
FARM	15	6.6	6.7	3.3	352	0.59	21.7	25.8	422	185	28	212	339.4	-1.06	43	-0.22
DESERT	23	6.1	6.1	2.6	238	0.19	22.2	37.6	420	175	88	26	342.1	-0.29	42	-0.08
6082325	22	6.3	6.3	2.9	222	0.32	22.1	32.1	346	152	69	69	341.1	-0.32	43	-0.1
FARM	17	6.6	6.6	1.3	347	0.32	21.9	26.8	388	186	34	128	339.7	-0.5	44	-0.13
DESERT	25	6.1	6.2	4.0	230	0.27	22.2	35.4	308	122	90	23	341.8	-0.18	43	-0.09

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6082336	27	6.3	6.3				22.2	32	354	147	38	36	341	-0.12	42	-0.07
FARM	23	6.6	6.6				21.9	26.1	418	195	27	49	339.2	-0.13	43	-0.07
DESERT	28	6.2	6.2				22.3	34.7	315	121	45	17	341.8	-0.09	42	-0.06
6082345	26	6.4	6.4	2.0	240	0.15	22.2	31.5	373	171	50	5	340.5	0.11	42	-0.07
FARM	24	6.6	6.6	1.2	325	0.31	22	26	417	210	24	10	339.1	0.27	42	-0.11
DESERT	24	6.1	6.2	3.8	231	0.16	22.3	35	355	150	62	12	341.7	-0.12	42	-0.05
6091030	202	6.5	6.9	9.6	235	0.31	17.6	9.3	-4	-54		-58	327.3	-0.06	34	-0.1
FARM	202	6.5	6.8	9.2	243	0.89	17.7	9	-5	-52		0	327.7	-0.09	41	-0.11
DESERT	209	6.6	7	11.1	238	0.6	17.2	9.5	-3	-55		-167	327	-0.01	28	-0.2
6091042	200	6.8	7	8.3	245	0.04	17.2	9.5	1	-52		2	329.3	-0.01	34	0
FARM	198	6.7	6.8	7.8	257	0.08	17.7	9.2	-5	-51		1	328.3	-0.03	42	0.01
DESERT	199	6.9	7.1	8.6	250	0.11	16.9	9.5	5	-52		2	329.7	-0.02	31	0.01
6091058	201	7	7	7.3	243	0.08	16.8	9.4	-3	-52		1	330	-0.02	32	0.01
FARM	195	6.9	6.9	8.5	228	0.1	17.4	9.4	-3	-51		-6	329.3	0.01	36	0.01
DESERT	200	7	7.1	7.0	249	0.09	16.7	9.4	-3	-53		2	330.3	-0.03	31	0.01
6091112	113	6.9	6.8	7.6	243	0	15.9	8.8	-5	-49		-4	335.6	0	32	0
FARM	108	6.8	6.7	6.9	236	0.21	16.5	9.1	-5	-47		-6	336.1	0.24	32	-0.12
DESERT	114	7	6.9	7.5	246	0.06	15.7	8.6	-6	-49		-3	335.8	-0.07	31	0.04
6091128	112	7	6.8	6.2	234	0.04	15.6	8.3	-4	-48		-6	336.3	0.09	31	-0.07
FARM	107	6.9	6.7	6.0	212	0.09	16	8.6	-2	-48		-7	336.8	0.11	32	-0.09
DESERT	113	7.1	6.9	6.6	242	0.05	15.5	8.3	-4	-48		-1	336.1	0.04	32	-0.02
6091143	43	7	6.8	4.7	231	0.13	14.3	7.8	-5	-47		1	342.8	0.03	28	0
FARM	43	6.9	6.6				14.3	8.3	-4	-46		5	347.3	0.69	24	-0.32
DESERT	42	7.1	6.9	5.5	246	0.1	14.3	7.7	-5	-47		-7	341.2	-0.18	29	0.07
6091202	54	7.1	6.9	18.8	255	0.52	14.8	7.4	0	-45		52	342.3	0.05	28	-0.01
FARM	50	6.9	6.6	16.1	248	0.16	14.9	7.7	6	-43		0	345.4	0.16	25	-0.09
DESERT	54	7.2	7	19.5	256	0.71	14.8	7.5	-2	-47		74	341.1	0.06	29	0

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6091220	43	7	6.8	2.6	234	0.12	13.8	7.3	3	-43		0	345.5	-0.01	25	-0.01
FARM	44	6.9	6.6	2.6	357	0.26	13.8	7.7	4	-41		-1	345.6	0.1	27	-0.13
DESERT	42	7.2	7	4.4	268	0.03	13.8	7.1	3	-44		-2	344.4	-0.01	25	0.04
6091232	48	7	6.8	2.4	210	0.18	13.5	7.3	10	-40		22	345.8	-0.04	23	0.07
FARM	42	6.8	6.6	3.1	340	0.16	13.5	7.7	12	-38		-1	345.6	0.33	26	-0.14
DESERT	50	7.2	6.9	3.2	252	0.39	13.5	7.1	8	-41		2	345.9	-0.07	20	0.09
6091243	46	7	6.7	2.2	217	0.03	13.7	7.8	14	-41		6	345.7	0.02	23	0
FARM	43	6.8	6.6	1.2	188	0.06	13.7	7.7	13	-37		7	345.4	0.07	27	-0.04
DESERT	45	7.2	6.9	3.0	250	0.02	13.7	7.9	15	-44		2	345.7	0	20	0.03
6091255	51	7	6.7	2.5	194	0.04	13.5	8.6	38	-24		-6	346.4	-0.13	22	0.06
FARM	47	6.8	6.6	2.9	180	0.21	13.5	8.7	43	-20		-11	346	-0.69	27	0.24
DESERT	52	7.2	6.9	2.4	239	0.1	13.6	8.6	33	-28		-4	346.1	-0.03	19	0.05
6091307	48	7	6.7	2.0	219	0.08	13.6	9.8	24	-52		3	345.7	-0.02	24	-0.02
FARM	46	6.8	6.6	1.7	206	0.1	13.6	9.3	24	-50		-3	344.5	0.03	27	-0.01
DESERT	49	7.1	6.9	2.2	237	0.11	13.6	10.1	25	-54		9	345.4	-0.03	22	-0.06
6091318	36	7	6.7	3.8	356	0.12	13.4	10.6	95	10		3	347.2	0.09	25	-0.04
FARM	32	6.8	6.6	4.2	357	0.02	13.5	10.3	102	14		10	346.3	0.45	27	-0.16
DESERT	38	7.1	6.9	2.7	190	0.24	13.4	10.8	90	7		-6	347.2	-0.04	23	0.01
6091330	39	7	6.7	3.0	200	0.03	13.5	11.9	37	-64		-1	346.1	-0.04	26	0.01
FARM	33	6.9	6.6	2.8	192	0.1	13.5	11	34	-61		-7	344.7	-0.24	28	0.04
DESERT	42	7.1	6.8	3.1	211	0.13	13.5	12.6	41	-66		3	346.9	0.02	24	-0.01
6091341	36	7	6.7	3.0	359	0.02	13.7	13	162	48		-6	345.9	-0.02	24	0.01
FARM	31	7	6.7	2.8	348	0.06	13.8	12.3	169	55		-17	344.9	-0.18	27	0.15
DESERT	36	7.1	6.8	3.0	185	0.09	13.7	13.4	155	44		-6	346.2	0.03	22	-0.02
6091353	39	7.1	6.8	2.6	207	0.03	13.9	14.3	321	-75		-1	345.2	0.01	25	-0.06
FARM	33	7.1	6.8	1.3	204	0.06	13.9	13	306	-74		5	343.4	0.05	28	-0.03
DESERT	41	7.2	6.9	2.8	216	0.08	13.9	15.3	332	-77		-3	345.6	-0.13	23	-0.02

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6091404	38	7.3	7	3.8	185	0.08	14.3	15.2	221	91		12	344.6	-0.13	23	-0.03
FARM	33	7.4	7.1	3.7	184	0.07	14.3	13.9	230	98		30	343	-0.28	23	0.05
DESERT	38	7.2	6.9	3.7	187	0.04	14.2	16.2	215	85		1	345.2	-0.09	23	-0.03
6091415	39	7.3	7	3.1	206	0.14	14.4	16.7	375	-71		19	344.2	-0.11	24	-0.1
FARM	36	7.4	7.1	2.9	212	0.08	14.4	14.4	364	-82		53	343	-0.24	23	-0.16
DESERT	37	7.3	7	2.6	213	0.23	14.4	18.2	384	-63		1	344.7	-0.06	24	-0.06
6091456	32	7.4	7.2				15.3	20.7	365	173	52	43	342.2	-0.16	21	-0.02
FARM	29	7.6	7.3				15.6	18.1	398	198	50	45	339.7	-0.17	23	0.06
DESERT	31	7.3	7.1				15.1	22.3	332	155	56	33	343.7	-0.09	21	-0.02
6091507	34	7.4	7.2	2.2	222	0.25	15.9	22.8	527	218	64	54	341.6	-0.26	27	-0.12
FARM	33	7.6	7.3	2.4	206	0.13	16	20	576	244	54	104	339.4	-0.51	27	-0.2
DESERT	36	7.3	7.1	2.2	236	0.37	15.7	25.1	536	212	87	29	343.3	-0.13	27	-0.08
6091519	32	7.4	7.2	1.8	205	0.06	16.2	23.8	438	216	72	59	341.3	-0.27	28	-0.1
FARM	29	7.6	7.3	2.2	195	0.06	16.4	20.6	442	214	55	111	339.3	-0.46	30	-0.18
DESERT	32	7.3	7.1	1.7	222	0.14	16	25.8	444	222	85	20	342.9	-0.14	28	-0.04
6091530	36	7.5	7.3	1.2	236	0.12	16	24.5	599	271	60	61	342.5	-0.29	26	-0.1
FARM	33	7.7	7.4	3.0	210	0.2	16.6	20.7	595	268	66	110	338.8	-0.52	30	-0.13
DESERT	36	7.5	7.3	0.9	251	0.11	15.7	25.1	599	270	58	51	343.4	-0.25	25	-0.09
6091547	37	7.6	7.3	0.3	332	0.1	16.2	25.3	496	252	88	48	342.2	-0.24	27	-0.06
FARM	32	7.6	7.4	0.8	207	0.17	17	22.6	517	265	67	77	338.8	-0.27	30	-0.12
DESERT	37	7.5	7.3	0.4	341	0.12	16	25.4	497	252	95	37	343	-0.24	26	-0.03
6091606	21	7.8	7.5	1.3	275	0.12	17	27.9	667	325	109	70	342	-0.41	28	-0.05
FARM	17	7.9	7.6	0.7	264	0.14	17.1	22.5	618	306	87	111	338.9	-0.7	30	-0.02
DESERT	22	7.4	7.2	2.5	240	0.23	17.2	33.4	721	354	137	36	343.7	-0.21	29	-0.06
6091615	18	7.8	7.6	0.7	356	0.2	17	29	607	325	110	115	342.1	-0.47	29	-0.12
FARM	13	8	7.7	1.0	264	0.28	17.2	23.7	605	332	90	187	339.2	-0.66	31	-0.21
DESERT	20	7.5	7.3	0.0	242	0.04	17.2	34.3	603	312	139	36	344	-0.28	29	-0.03

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6091624	13	7.9	7.7	2.4	194	0.16	17.3	30.1	723	363	106	83	342.7	-0.39	28	-0.07
FARM	10	8.1	7.8	1.3	347	0.05	17.4	24	746	378	114	145	338.9	-0.66	31	-0.05
DESERT	15	7.6	7.4	4.4	210	0.27	17.6	35	704	345	94	26	345.1	-0.14	28	-0.05
6091633	13	8	7.7	1.1	189	0.19	17.3	30.4	625	330	129	78	342.1	-0.48	27	-0.05
FARM	9	8.3	8	0.4	307	0.11	17.3	25.1	656	354	90	184	338.1	-0.65	29	-0.2
DESERT	15	7.7	7.4	1.0	192	0.35	17.5	35.3	609	318	178	3	345	-0.48	27	0.08
6091643	12	8	7.8	1.5	238	0.15	17.7	32.1	787	404	122	68	342.4	-0.5	29	0
FARM	10	8.2	8	1.2	243	0.17	17.7	25.1	766	394	94	124	338.3	-0.65	31	0
DESERT	13	7.7	7.5	1.5	243	0.05	18.1	38.5	810	409	169	-1	345.7	-0.43	28	0.07
6091652	13	8	7.8	1.1	201	0.15	17.9	32.3	672	363	120	91	341.8	-0.49	29	-0.06
FARM	8	8.3	8	0.7	351	0.12	17.9	25.9	686	386	94	175	338.2	-0.74	29	-0.13
DESERT	15	7.7	7.4	1.1	211	0.2	18.1	38	652	343	156	7	344.9	-0.29	29	0
6091702	14	8	7.8	0.6	217	0.2	18.4	33.7	808	425	133	150	341.8	-0.54	31	-0.11
FARM	10	8.3	8.1	0.7	316	0.13	18.4	25.6	796	420	100	274	337.8	-0.93	32	-0.2
DESERT	15	7.7	7.5	1.1	252	0.46	18.8	40.5	811	416	156	47	345.1	-0.23	30	-0.04
6091711	13	8.1	7.9	1.4	231	0.09	18.3	34.3	758	417	136	103	341	-0.55	31	-0.05
FARM	8	8.5	8.3	0.7	223	0.1	18.3	26.7	757	428	94	176	336.9	-0.85	31	-0.08
DESERT	14	7.7	7.5	1.6	235	0.17	18.6	41.4	757	407	147	31	345	-0.32	31	-0.02
6091721	9	8.1	7.9	0.6	220	0.24	18.8	35.8	832	444	152	108	341	-0.48	33	-0.07
FARM	8	8.5	8.3	0.2	325	0.24	18.6	26.9	802	434	93	200	336.9	-0.76	33	-0.11
DESERT	9	7.7	7.5	1.1	204	0.26	19.2	43	854	449	172	31	345.1	-0.29	33	-0.01
6091729	15	8.2	8	1.9	224	0.17	18.9	36.3	800	440	147	100	340.3	-0.59	34	-0.05
FARM	17	8.5	8.4	1.4	202	0.06	18.8	28.1	805	458	85	185	336.4	-0.83	33	-0.07
DESERT	8	7.7	7.6	2.3	221	0.35	19.2	43.7	795	422	201	19	344.7	-0.6	33	-0.02
6091739	12	8.2	8	1.3	204	0.18	19.2	37.6	889	486	137	97	340.4	-0.37	35	-0.06
FARM	8	8.5	8.4	1.1	188	0.31	19	28.6	881	494	117	173	337.2	-0.52	34	-0.08
DESERT	14	7.7	7.6	1.6	204	0.13	19.5	45	893	478	151	29	344.5	-0.2	35	-0.04

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6091748	11	8.2	8	1.7	233	0.2	19.4	37.9	824	459	151	96	340	-0.55	37	-0.05
FARM	8	8.5	8.4	1.1	215	0.05	19.2	28.6	805	475	106	191	337.2	-0.61	37	-0.08
DESERT	12	7.7	7.6	2.2	228	0.48	19.6	45.7	827	438	192	20	343.9	-0.45	34	-0.03
6091757	9	8.2	8.1	0.9	240	0.25	19.7	39.2	925	509	189	87	339.6	-0.43	107	-0.05
FARM	7	8.6	8.4	0.5	350	0.25	19.4	29.4	926	510	110	165	337	-0.75	36	-0.07
DESERT	9	7.7	7.6	1.1	225	0.16	20.1	47.6	925	497	260	62	343.2	-0.29	219	-0.05
6091912	15	7.3	8				21.8	43.4	865	536	171	1	340	0.06	356	-0.11
FARM	10	7.8	8.3				21.7	32.7	879	562	142	0	340.2	0.24	463	-0.16
DESERT	16	6.8	7.6				22.2	53.1	848	517	213	2	339.8	-0.25	212	-0.08
6091922	9	7.5	7.9	1.5	209	0.16	21.8	43.8	976	561	134	45	341	0.31	400	-0.08
FARM	7	7.8	8.2	1.8	343	0.32	21.6	32	977	578	84	210	341.1	0.58	496	-0.12
DESERT	8	7.1	7.5	2.2	227	0.25	22.2	53.4	975	539	174	54	341	0.34	475	-0.04
6091932	56	7.4	7.8	2.7	213	0.38	21.8	44.1	905	557	135	180	338.8	-0.02	386	-0.14
FARM	51	7.6	8	2.1	192	0.62	21.8	33.3	912	576	6	185	339	0.38	260	-0.11
DESERT	60	7.1	7.5	3.1	214	1.5	22	53.2	866	541	223	126	338.1	0.19	462	-0.18
6091940	60	7.3	7.6	1.6	224	1.35	22.2	44.5	980	570	154	113	338.9	-0.12	377	-0.09
FARM	56	7.6	7.9	1.0	187	0.72	22.1	33.3	982	581	142	205	338.6	-0.2	235	-0.1
DESERT	56	6.9	7.2	2.2	248	2.07	22.4	53.8	976	553	174	3	339.3	0.06	506	-0.07
6091949	166	7.1	7.5	2.9	222	1.94	22.4	44.5	955	567	91	197	334.4	0.99	389	-0.15
FARM	153	7.2	7.6	3.5	193	0.28	22.5	33.9	971	569	17	86	334.7	0.06	401	-0.06
DESERT	173	6.7	7.1	3.2	237	1.85	22.5	52.8	977	567	154	181	334.5	2.37	504	-0.19
6092000	161	6.9	7.3	2.6	223	0.61	22.8	43.3	940	558	96	275	334.8	-0.15	381	-0.06
FARM	156	7.1	7.4	2.5	188	0.68	22.8	32.2	909	555	93	179	334.1	-0.1	423	-0.02
DESERT	159	6.5	6.9	3.5	223	2.18	23	52.7	937	549	143	395	335.5	-0.27	226	-0.08
6092010	288	6.7	7.2	3.7	223	1.3	23.1	44.6	970	561	90	217	329	0.32	397	-0.05
FARM	285	6.7	7.2	4.2	218	1.32	23.2	33.8	991	589	29	129	328.9	0.09	505	-0.04
DESERT	290	6.5	7	3.6	239	0.92	23.2	52	924	530	133	219	329.7	0.57	238	-0.04

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6092019	290	6.5	7	3.2	229	1.36	23.5	43.9	883	523	70	273	328.5	-0.49	347	-0.07
FARM	282	6.7	7.2	4.7	206		23.5	36.3	975	579	96	199	328.3	-0.5	239	-0.08
DESERT	292	6.4	6.8	3.5	231	1.54	23.6	48.5	750	417	77	204	328.7	-0.35	302	-0.06
6092029	156	6.5	6.9	3.6	208	1.17	23.2	43.3	907	511	110	309	333.5	-0.39	348	-0.06
FARM	148	6.9	7.3	3.1	194	0.57	23.3	33.4	972	556	82	249	332.6	-0.41	204	-0.07
DESERT	154	6.4	6.8	3.8	223	1.47	23.3	50.9	872	486	136	150	334	-0.29	302	-0.05
6092038	166	6.3	6.7	5.7	274	1.68	23.6	45	942	556	129	169	333.1	-0.35	378	-0.04
FARM	162	6.7	7.1	2.2	223		23.7	33.9	909	547	87	189	332.7	-0.45	203	-0.05
DESERT	166	6.2	6.5	7.7	273	2.34	23.7	53.1	947	557	197	152	333.5	-0.46	460	-0.01
6092046	51	6.5	6.8	3.4	351	0.63	23.5	46.3	964	525	136	77	337.5	-0.37	397	-0.06
FARM	46	6.9	7.2	3.8	357	0.81	23.6	34.7	981	563	93	203	336.7	-0.56	463	-0.08
DESERT	53	6.2	6.5	2.9	329	1.69	23.5	55	964	506	175	-121	338.3	-0.1	491	-0.01
6092056	53	6.4	6.8	3.0	207	0.54	23.8	44.8	922	530	129	125	337.8	0.01	375	-0.07
FARM	48	6.6	7	3.8	192	0.4	23.8	33.9	928	548	71	290	337.2	-0.47	495	-0.1
DESERT	59	6.1	6.5	2.5	236	0.61	23.9	54.3	916	504	193	-4	338.3	0.29	303	-0.04
6092104	14	6.6	7	3.3	204	0.84	23.9	45.7	945	504	168	128	338.7	-0.44	387	-0.12
FARM	7	7	7.4	3.5	189	0.42	23.9	34.9	984	551	51	283	337.2	-0.63	476	-0.11
DESERT	15	6.1	6.4	3.7	214	0.79	24	54.9	952	490	224	-28	340.3	-0.27	265	-0.14
6092113	9	6.5	7	1.8	244	0.32	24.2	45.1	896	508	147	166	338.7	-0.11	389	-0.06
FARM	8	6.9	7.3	1.8	238	0.35	24.1	33.5	905	535	90	305	337.2	0.09	501	-0.09
DESERT	10	6.1	6.5	1.2	281	0.76	24.4	53.9	855	462	189	14	340.1	-0.04	279	-0.03
6101704	13	68.3	8.4	2.1	223	0.18	21.7	36.9	712	397	118	116	99	-0.55	39	-0.25
FARM	11	68.3	9.3	1.0	347	0.19	21.4	30	716	413	72	175	99	-1.13	33	-0.24
DESERT	15	68.3	7.6	3.2	224	0.22	22.3	43	708	385	161	65	99	-0.11	44	-0.29
6101714	10	68.3	8.6	1.6	212	0.14	22.3	37.5	832	451	133	81	99	-0.55	40	-0.11
FARM	8	68.3	9.5	0.9	310	0.25	21.9	28.9	838	458	72	158	99	-0.73	34	-0.06
DESERT	10	68.3	7.7	2.8	222	0.11	23	45.2	830	438	162	23	99	-0.39	47	-0.11

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6101723	9	68.3	8.8	2.0	231	0.22	22.4	38.3	754	423	132	142	99	-0.85	42	-0.29
FARM	7	68.3	9.8	0.9	181	0.31	22.2	29.6	759	444	105	226	99	-1.28	35	-0.29
DESERT	8	68.3	7.6	3.5	226	0.13	22.8	45.7	752	410	153	32	99	-0.4	44	-0.17
6101738	9	68.3	8.9	0.9	230	0.16	22.9	39.9	871	484	136	75	99	-0.79	383	-0.06
FARM	6	68.3	9.8	0.7	288	0.15	22.7	30.6	872	493	68	172	99	-1.06	383	-0.12
DESERT	11	68.3	7.7	1.9	243	0.25	23.5	48	874	470	156	18	99	-0.52	271	-0.02
6101751	8	68.3	8.9	1.9	216	0.33	23.2	40.9	815	460	118	130	99	-0.68	405	-0.32
FARM	4	68.3	9.6	0.9	192	0.09	23	31	819	482	55	276	99	-0.92	504	-0.46
DESERT	9	68.3	7.8	3.6	226	0.39	23.6	48.8	813	445	155	4	99	-0.27	393	-0.14
6101800	6	68.3	9	16.0	254	1.44	23.7	42.4	903	505	146	121	99	-0.61	373	-0.23
FARM	4	68.3	9.7	0.9	279	0.16	23.5	32	903	514	98	186	99	-0.82	493	-0.23
DESERT	6	68.3	8.1	11.5	249	1.8	24.2	50.3	904	488	195	71	99	-0.26	378	-0.25
6101905	10	68.3	8.6	2.2	212	0.38	25.7	45.8	808	530	141	159	99	-0.64	364	-0.28
FARM	7	68.3	9.1	1.3	355	0.15	25.8	34.3	852	561	111	353	99	-1.17	204	-0.47
DESERT	9	68.3	8.1	2.6	234	0.64	25.9	55.1	779	510	168	58	99	-0.36	425	-0.19
6101915	8	68.3	8.3	1.4	215	0.2	26.1	46.2	956	551	98	107	99	-0.76	379	-0.31
FARM	6	68.3	8.9	0.5	347	0.08	26.1	34.7	957	567	67	225	99	-0.99	282	-0.39
DESERT	8	68.3	7.6	2.3	231	0.29	26.4	56.3	955	526	182	27	99	-0.27	505	-0.24
6101925	64	68.3	7.9	2.9	212	1.03	26.2	46.1	888	546	94	107	99	0.09	388	-0.4
FARM	61	68.3	7.9	2.9	193	1.88	26.3	34.8	892	570	33	299	99	0.16	411	-0.51
DESERT	63	68.3	7.6	3.2	237	1.25	26.3	56.4	868	528	121	-124	99	-0.13	503	-0.28
6101935	65	68.3	7.9	2.4	215	0.61	26.5	46.2	963	565	179	76	99	-0.35	381	-0.45
FARM	55	68.3	8	0.8	208	0.73	26.5	34.4	970	575	115	51	99	-0.47	188	-0.36
DESERT	73	68.3	7.8	3.5	222	0.34	26.6	56.5	960	547	288	98	99	-0.26	507	-0.58
6101944	187	68.3	7.6	3.0	217	0.22	26.7	44.4	930	561	52	76	99	-1.59	394	-0.29
FARM	175	68.3	7.4	2.3	195	1.12	26.9	36.4	944	575	-22	5	99	-3.68	370	-0.02
DESERT	186	68.3	7.7	4.0	228	1.53	26.7	55.6	952	549	126	74	99	0.3	506	-0.45

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6101956	187	68.3	7.5	1.7	211	1.2	27.1	45.8	960	574	63	101	99	0.14	458	-0.43
FARM	181	68.3	7.5	2.4	280	0.59	27.2	34.6	962	581	61	148	99	0.07	349	-0.28
DESERT	184	68.3	7.5	2.7	326	2.65	27.2	56.2	960	558	48	79	99	0.37	506	-0.56
6102007	317	68.3	7.5	3.7	240	2.54	27.4	46.4	941	565	73	101	99	-0.13	267	-0.14
FARM	340	68.3	7.1	3.6	256	2.1	27.5	36.2	976	584	38	5	99	0.06	131	-0.09
DESERT	318	68.3	7.5	4.4	221	3.82	27.3	55.5	889	554	116	173	99	-0.54	499	0.01
6102015	334	68.3	7.4	2.6	239	1	27.7	46.8	952	574	78	-86	99	-0.01	382	-0.17
FARM	329	68.3	7.2	2.1	272	1.4	27.9	35.5	952	585	46	-288	99	-0.37	299	-0.11
DESERT	344	68.3	7.3	3.4	226	1.92	27.7	55.6	953	560	88	-11	99	0.34	457	-0.22
6102023	177	68.3	7.5	2.4	227	1.4	27.4	47.9	968	555	97	-50	99	-0.1	505	-0.41
FARM	173	68.3	7.6	1.5	200	0.99	27.5	36.1	967	575	68	37	99	-0.2	505	-0.28
DESERT	179	68.3	7.3	2.9	244	1.8	27.4	57	968	543	142	-60	99	-0.21	505	-0.67
6102031	70	68.3	7.7	3.0	281	0.49	27.6	47.9	936	553	143	11	99	-0.22	156	-0.4
FARM	56	68.3	7.8	1.3	319	1.19	27.7	35.7	939	570	116	-47	99	-0.68	142	-0.38
DESERT	86	68.3	7.3	4.5	278	1.73	27.6	57.8	935	534	198	19	99	0.25	201	-0.49
6102040	14	68.3	7.9	2.3	346	2.03	27.6	49.1	963	532	160	160	99	-0.78	462	-0.46
FARM	8	68.3	8.4	1.1	282	0.61	27.6	37.1	963	559	62	341	99	-1.6	502	-0.63
DESERT	17	68.3	7.3	2.9	215	1.39	27.8	59.2	963	514	246	26	99	-0.41	408	-0.4
6102100	13	68.3	8	1.6	217	0.36	28.1	48.5	910	525	134	181	99	-0.07	265	-0.27
FARM	10	68.3	8.5	0.8	345	0.42	28	35.8	910	546	51	232	99	-0.11	187	-0.15
DESERT	11	68.3	7.4	3.1	213	0.23	28.5	58.9	910	498	243	38	99	-0.28	337	-0.26
6121507	18	4.8	5	7.2	250	0.66	14.1	15.5	401	171		41	338.3	-0.45	35	
FARM	12	5	5.2	7.3	261	0.93	14.2	12.6	402	175		75	338.2	-0.44	31	
DESERT	23	4.7	5	6.3	250	0.22	14.1	18.4	402	175		45	337.8	-0.76	27	
6121515	23	5	5	8.7	239	0.44	14.2	17.4	564	262		64	338.8	-0.59	35	
FARM	12	5.1	5.2	9.0	231	0.51	14.2	13.3	561	263		144	337.8	-0.84	36	
DESERT	34	5	4.9	9.1	245	0.56	14.2	20.7	572	261		10	339.9	-0.43	31	

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6121525	15	5.1	5				14.4	18.2	455	209		46	339.2	-0.63	33	
FARM	12	5.3	5.2				14.4	14.6	462	215		122	338.1	-0.98	34	
DESERT	15	5	4.9				14.4	21.2	451	206		3	339.8	-0.4	34	
6121533	35	5.2	5	9.2	242	0.5	14.6	19.5	615	297		57	339	-0.46	33	
FARM	11	5.3	5.2	8.8	239	0.51	14.6	15.2	611	298		100	337.7	-0.61	32	
DESERT	68	5.1	5	9.9	243	0.42	14.6	23.1	625	299		12	340.5	-0.29	34	
6121543	13	5.2	5	8.2	244	0.03	14.7	19.9	513	248		46	339.2	-0.74	34	
FARM	12	5.4	5.2	7.1	244	0.18	14.7	16.1	521	254		80	337.6	-0.66	34	
DESERT	14	5.1	4.9	8.7	244	0.65	14.7	23.3	512	248		17	339.8	-0.92	34	
6121745	17	5.2	5	9.9	253	1.22	15.8	28.9	827	460		88	339.8	-0.52	36	
FARM	11	5.5	5.3	8.1	250	0.67	15.8	22.5	828	466		115	339.1	-0.66	39	
DESERT	19	5	4.8	11.0	255	1.11	15.8	34.1	829	456		89	340.1	-0.98	34	
6121753	37	5.2	4.9	11.0	249	1.26	16.1	29.9	913	523		92	340	-1.13	36	
FARM	12	5.6	5.4	9.6	247	1.06	16.1	22.6	910	530		214	338.4	-1.51	34	
DESERT	70	4.9	4.7	12.1	251	1.36	16.2	35.4	921	519		-16	341.3	-1.05	37	
6121803	75	4.9	4.6	13.4	258	1.22	15.9	29.1	822	488		68	338.1	-1.4	37	
FARM	70	4.9	4.6	11.7	253	0.21	15.8	22.5	868	494		200	337.6	-1.43	37	
DESERT	75	4.9	4.7	15.9	257	3.34	15.9	34.6	744	475		-10	338.5	-1.71	38	
6121812	76	4.8	4.6	12.1	254	0.65	16.1	30.4	937	547		95	338.1	-0.85	38	
FARM	72	4.8	4.6	12.4	254	0.77	16.1	22.8	934	550		187	337.6	-0.92	38	
DESERT	80	4.8	4.6	11.7	260	1.62	16.1	37	940	544		21	338.6	-0.76	38	
6121825	185	4.7	4.5	12.9	268	1.27	16.2	30.2	758	520		13	331.7	-1.13	41	
FARM	180	4.6	4.5	12.2	260	1.01	16.2	24.2	788	528		176	331.5	-0.96	41	
DESERT	187	4.7	4.5	14.2	278	3.49	16.1	36.4	642	511		-90	331.4	-0.92	40	
6121832	177	4.8	4.6	12.0	262	1.61	16.4	31.7	961	568		18	332.6	-0.66	39	
FARM	175	4.8	4.6	11.9	257	0.5	16.3	24.1	958	573		153	331.8	-0.68	39	
DESERT	181	4.8	4.6	11.9	264	2.25	16.4	38.2	965	565		-134	332.9	-0.34	39	

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6121844	326	4.6	4.5	20.3	258	6.58	16.7	31	787	540		57	326.5	0.1	38	
FARM	348	4.6	4.5	12.3	262	3.06	16.7	23.2	793	564		36	324.9	0.81	38	
DESERT	307	4.7	4.6	38.1	258	16.57	16.7	37.6	914	536		64	327.6	-0.44	39	
6121852	340	4.8	4.5	11.4	256	3.01	16.9	32.7	995	599		32	326.3	-0.07	39	
FARM	333	4.8	4.5	11.7	252	2.18	16.9	24.6	988	597		39	326.6	-0.39	38	
DESERT	350	4.7	4.5	11.2	258	2.43	16.8	39.4	1001	600		22	325.5	-0.35	40	
6121903	525	4.6	4.5	11.2	250	3.77	17.2	32.4	823	575		94	318.2	-1.02	39	
FARM	524	4.6	4.5	11.2	255	3.71	17.2	25.4	799	583		269	317.9	-1.75	38	
DESERT	521	4.6	4.5	11.1	245	3.88	17.3	38.6	919	562		-58	318.6	-0.82	41	
6121911	492	4.7	4.5	11.2	257	1.93	17.2	31.6	905	538		104	318.8	-0.14	40	
FARM	491	4.6	4.5	11.3	258	1.61	17.2	23.1	825	499		104	318.3	0.11	39	
DESERT	488	4.8	4.5	10.4	264	3.63	17.2	38.5	923	547		88	318.9	-0.82	40	
6121922	311	4.8	4.5	12.9	257	3.08	16.9	33	799	553		63	326.4	-0.72	40	
FARM	308	4.7	4.5	11.2	259	1.55	17	25	833	539		180	326.2	-0.78	39	
DESERT	309	4.9	4.6	12.9	254	2.47	16.9	40	765	561		14	327	-0.22	40	
6121931	313	4.9	4.3	11.7	263	3.18	17.1	33.2	940	565		58	328.7	0.97	41	
FARM	311	4.9	4.5	11.9	260	0.93	17.1	23.1	821	499		12	327.1	-0.34	41	
DESERT	312	5.1	4.1	11.5	269	5.13	17.1	40.8	989	591		117	330.3	3.03	42	
6121941	167	4.7	4.2	11.2	272	0.91	16.9	34.2	943	578		204	333.2	-2.99	40	
FARM	156	4.7	4.4	11.3	270	1.86	16.9	26.1	984	593		308	332.3	0.08	40	
DESERT	175	4.7	4	10.9	275	4.32	17	42	976	570		238	334.5	-2.71	40	
6121949	179	4.5	4.2	10.5	267	1.48	17	34.5	959	572		75	332.6	-1.35	40	
FARM	168	4.5	4.2	11.4	274	1.18	16.9	25.1	912	559		200	331.8	-0.8	41	
DESERT	188	4.7	4.3	9.5	260	2.03	17.1	42.8	977	573		-23	333.8	0.38	39	
6121959	61	4.7	4.3	9.6	270	1.53	16.9	35.2	985	571		94	337.8	-0.72	40	
FARM	55	4.6	4.2	9.3	274	1.61	16.9	27.3	1010	592		218	337.4	-1.15	40	
DESERT	58	4.8	4.4	9.9	268	2.12	16.9	41.1	959	542		2	338.1	-0.66	39	

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6122007	59	4.8	4.4	10.1	259	1.32	17.1	34.6	931	547		100	337.5	-0.6	39	
FARM	43	4.7	4.3	7.9	265		17	25.9	877	530		218	337	-0.96	39	
DESERT	63	5	4.4	12.4	252	1.51	17.2	41.1	901	520		37	338.8	0.43	38	
6122017	16	5	4.5	9.1	253	1.96	17.8	34.2	874	499		101	340	-1.03	38	
FARM	12	5.4	4.8	8.8	256	1.84	18	26.1	906	514		170	339.1	-0.7	37	
DESERT	18	4.9	4.5	8.6	248	1.55	17.4	43.2	994	559		27	340.6	-1.02	37	
6131904	14	4.7	4.5	6.7	253	0.28	16.3	30.7	826	467	144	94	340.1	0.19	34	-0.14
FARM	11	5	4.8	6.5	255	0.15	16.2	23.1	843	478	70	171	338.3	-0.11	33	-0.15
DESERT	13	4.5	4.3	6.6	243	0.29	16.5	37.3	837	425	213	38	341.5	0.38	35	-0.14
6131914	15	4.6	4.4	5.5	256	0.38	16.3	29.7	612	366	109	113	340.8	-0.66	35	-0.13
FARM	12	4.8	4.6	5.6	261	0.68	16.3	24	640	366	117	249	339.5	-1.32	34	-0.27
DESERT	15	4.5	4.3	5.1	255	0.36	16.4	36.3	638	426	144	22	341.8	-0.35	36	-0.11
6131923	12	4.6	4.4	5.6	253	0.47	16.5	31.7	684	395	146	79	340.6	-0.22	35	-0.14
FARM	10	4.9	4.7	4.0	262	0.71	16.3	22.8	629	368	40	98	338.8	0.05	34	-0.11
DESERT	12	4.4	4.3	6.6	251	0.44	16.8	41.2	795	477	277	19	341.7	-0.24	37	-0.15
6131934	20	4.5	4.3	5.7	261	0.72	16.5	32.2	757	454	121	64	339.9	-0.46	36	-0.09
FARM	11	4.7	4.6	4.8	271	0.37	16.5	23.5	720	502	76	99	338.4	-0.47	34	-0.06
DESERT	27	4.5	4.3	7.7	267	0.7	16.4	37	637	345	141	-4	340.7	-0.2	36	-0.09
6131943	16	4.5	4.3	6.3	247	1.05	16.6	30.8	700	397	154	99	340.1	-0.39	36	-0.17
FARM	11	4.6	4.5	4.5	246	0.52	16.7	25.2	857	529	103	254	338.5	-0.62	35	-0.29
DESERT	17	4.5	4.3	7.5	246	0.37	16.6	36.8	634	329	130	-10	341.7	-0.13	36	-0.05
6131954	71	4.4	4.3				16.5	29.2	589	338	79	40	338.2	0.08	36	-0.06
FARM	67	4.4	4.2				16.5	21	423	227	-17	39	337.5	0.26	36	-0.02
DESERT	70	4.4	4.3				16.6	36.9	712	430	164	89	338.4	-0.07	37	-0.14
6132002	67	4.3	4.2	6.8	261	1.01	16.7	30.4	671	380	110	101	338.2	-0.16	37	-0.21
FARM	70	4.5	4.3	6.6	259	1.1	16.5	20.7	526	263	6	159	337.8	-0.22	37	-0.24
DESERT	59	4.2	4	5.9	256	0.87	16.9	37.7	651	386	181	64	338.7	-0.14	37	-0.2

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6132014	73	4.2	4.1	7.8	272	0.35	16.9	31.4	717	389	198	89	337.9	-0.72	36	-0.1
FARM	67	4.3	4.2	9.7	275	1.1	16.8	25.2	818	438	107	207	337.3	-1.06	36	-0.19
DESERT	77	4.2	4	7.5	275	0.77	16.9	36.2	642	327	171	-3	338.4	-0.33	36	-0.08
6132231	18	4.1	4.2	10.0	263	1.45	18	30.7	720	387	99	83	340	-0.58	37	-0.13
FARM	13	4.2	4.3	10.0	267	1.87	17.7	19.8	408	202	17	199	339.7	-0.88	36	-0.2
DESERT	21	4	4.1	10.3	258	1.3	18.1	39.8	940	470	167	3	340.1	-0.35	37	-0.14
6132239	12	4.3	4.3	9.5	258	1.15	17.9	30	627	314	135	98	340.1	-0.27	38	-0.1
FARM	10	4.5	4.4	8.8	255	0.79	17.6	19.9	441	210	49	201	339.4	-0.45	37	-0.16
DESERT	13	4.2	4.2	9.7	263	0.43	18.1	39.2	761	371	182	17	340.9	-0.2	38	-0.09
6132249	71	4.1	4	11.2	258	0.48	18.1	30.1	774	413	123	64	338.1	-0.08	40	-0.13
FARM	66	4	3.9	13.9	254	2.41	18	20.4	568	276	49	115	337.9	-0.26	39	-0.15
DESERT	71	4.2	4.2	9.6	261	1.76	18.2	38.4	888	465	183	28	338.1	-0.03	41	-0.15
6132257	81	4	3.9	10.4	253	0.72	18	28.1	645	333	167	149	337.4	0.08	39	-0.18
FARM	73	4	3.9	11.2	251	0.23	18	20.2	497	265	74	108	337.6	0.12	39	-0.11
DESERT	82	3.9	3.8	10.4	252	0.81	18	29.5	684	354	179	154	337.3	-0.1	40	-0.18
6132316	70	3.8	3.7	10.0	247	0.27	18.4	28.6	791	416	87	94	338.7	-0.4	40	-0.12
FARM	59	4.4	4.2	8.6	248	0.34	18.5	21.6	736	415	31	153	338.5	-0.49	40	-0.12
DESERT	72	3.7	3.5	10.3	249	0.04	18.3	29.9	789	409	100	89	338.6	-0.39	40	-0.11
6132331	11	4.1	4	8.6	247	0.75	18.6	29.5	645	311	202	122	340.2	-0.61	40	-0.2
FARM	10	4.6	4.5	7.6	244	0.54	18.4	22	643	314	59	193	338.8	-0.75	39	-0.21
DESERT	10	3.8	3.7	9.1	247	1.19	18.8	36	620	285	363	6	341.3	-0.37	40	-0.21
6140014	15	4.3	4.2	10.3	246	0.61	18.5	25.8	619	297	142	65	339.9	-0.61	40	-0.13
FARM	12	4.2	4	8.7	241	0.28	18.5	20	560	291	37	138	339.6	-0.57	39	-0.13
DESERT	15	4.5	4.4	11.5	257	1.06	18.5	30.9	634	289	245	24	339.8	-0.68	40	-0.16
6140022	75	4.6	4.4	11.7	248	0.65	18.3	24.5	477	201	144	98	339.8	-0.43	40	-0.13
FARM	10	4.5	4.3	9.2	240	0.59	18.5	20	495	212	72	191	339.3	-0.62	38	-0.17
DESERT	194	4.7	4.5	13.3	250	0.8	18.1	28.5	457	182	207	10	340.5	-0.23	40	-0.1

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6140034	17	4.8	4.6	12.2	250	0.36	18	23.8	586	263	136	69	339.4	-0.84	40	-0.18
FARM	14	4.9	4.8	11.5	248	0.77	18	19.1	605	279	64	208	338.4	-1.22	39	-0.27
DESERT	20	4.6	4.5	12.3	254	0.27	17.9	28	563	242	169	-16	340.1	-0.7	41	-0.15
6140042	12	4.7	4.6	12.2	245	0.48	17.9	23	395	152	144	80	339.8	-0.35	39	-0.12
FARM	11	5	4.9	10.8	238	0.25	18	18.5	333	126	72	188	338.7	-0.53	37	-0.19
DESERT	12	4.5	4.3	13.2	250	0.49	17.7	26.5	409	147	166	-1	340.8	-0.17	39	-0.08
6141412	20	5.3	5.1	9.4	243	0.71	11.9	3.6	244	81	44	41	338.9	-0.44	30	-0.12
FARM	14	5.4	5.2	7.5	235	0.1	11.9	2.4	247	89	31	87	337.8	-0.6	23	-0.16
DESERT	23	5.2	5.1	9.9	239	0.44	11.9	4.7	249	81	45	8	339.1	-0.35	52	-0.06
6141420	16	5.4	5.1	9.8	235	0.66	11.8	6.2	402	75	45	44	340.7	-0.33	25	-0.08
FARM	13	5.4	5.2	9.9	234	0.25	11.7	3.6	398	55	28	89	339.7	-0.5	23	-0.12
DESERT	16	5.3	5.1	9.7	236	0.75	11.9	8.7	411	114	56	5	341.6	-0.16	27	-0.04
6141431	18	5.4	5.1	9.8	235	0.37	12.2	8	286	114	72	56	340.6	-0.58	28	-0.12
FARM	14	5.5	5.2	9.4	234	0.94	12.2	6.2	295	121	61	129	339.5	-0.97	27	-0.2
DESERT	18	5.4	5.1	10.0	236	0.3	12.2	9.6	280	110	86	12	341.3	-0.41	27	-0.08
6141439	17	5.5	5.2	10.1	238	0.42	12.1	10.3	460	196	57	60	340.8	-0.38	28	-0.1
FARM	13	5.6	5.3	9.3	235	0.69	12	7.3	457	198	50	143	339.7	-0.72	27	-0.22
DESERT	17	5.4	5.1	10.5	241	0.27	12.2	13	466	195	70	7	341.6	-0.16	29	-0.04
6141451	19	5.4	5.2	10.6	243	0.37	12.5	11.9	345	151	90	50	341.2	-0.55	29	-0.09
FARM	14	5.5	5.2	14.0	245	1.4	12.5	8.9	354	162	55	118	339.9	-0.91	30	-0.14
DESERT	18	5.4	5.2	9.4	244	0.26	12.5	13.7	339	145	95	19	341.7	-0.39	29	-0.06
6141500	17	5.5	5.2	9.8	238	0.42	12.5	13.4	519	237	78	60	341	-0.44	31	-0.09
FARM	13	5.6	5.3	9.7	235	0.31	12.4	9.8	519	240	46	127	340.3	-0.79	30	-0.15
DESERT	18	5.5	5.2	9.7	239	0.45	12.5	16.6	523	234	101	12	341.7	-0.24	31	-0.06
6141541	16	5.4	5.1	8.6	246	0.37	13.3	17.1	516	258	90	75	340.4	-0.52	32	-0.07
FARM	13	5.6	5.3	7.9	245	0.24	13.2	13.4	538	267	62	117	339.4	-0.78	31	-0.08
DESERT	17	5.4	5.1	9.0	246	0.51	13.3	21.7	501	249	122	22	341.4	-0.32	29	-0.05

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6141548	15	5.4	5.1	9.0	251	0.45	13.6	19.1	641	320	104	50	340	-0.33	32	-0.05
FARM	12	5.6	5.3	8.4	250	0.39	13.4	14	637	320	45	84	338.6	-0.51	30	-0.04
DESERT	15	5.3	5	9.9	248	0.54	13.7	23.4	647	317	162	24	341	-0.2	32	-0.05
6141708	15	5	4.8	8.3	236	0.4	14.5	24.3	663	372	202	149	336.4	-0.94	36	-0.09
FARM	12	5.3	5	7.8	245	0.47	14.4	16.7	553	306	126	247	336.8	-1.37	34	-0.1
DESERT	14	4.9	4.7	8.5	229	0.27	14.6	31.1	751	414	222	38	335.9	-0.55	35	-0.06
6141716	14	5	4.9	9.5	240	0.44	14.9	25.6	819	462	140	110	340.4	-0.63	35	-0.07
FARM	13	5.3	5.1	9.4	243	0.55	14.8	18.2	851	505	85	202	338.6	-1	34	-0.09
DESERT	13	4.9	4.8	10.0	238	0.43	15.1	31.6	764	411	140	16	341.9	-0.24	36	-0.04
6141727	17	5	4.9				15.1	26.3	786	443	195	135	340.7	-0.76	35	-0.06
FARM	13	5.2	5				15	19	766	446	130	273	339.7	-1.25	35	-0.1
DESERT	17	4.8	4.7				15.1	32.1	761	411	257	29	341.7	-0.33	36	-0.05
6141736	13	5	4.9	8.9	240	0.42	15.3	27.6	878	501	190	169	341.1	-0.72	36	-0.07
FARM	13	5.2	5	8.8	235	0.51	15.1	19.4	897	518	115	291	339.6	-1.27	36	-0.11
DESERT	12	4.8	4.7	9.0	248	0.56	15.6	34.7	869	475	217	20	342.2	-0.31	37	-0.02
6141746	72	4.8	4.7	9.2	243	0.85	15.2	27.7	809	453	156	82	338.4	-0.33	37	-0.04
FARM	69	4.8	4.7	8.6	240	1.09	15.1	20.2	840	490	78	117	337.5	-0.61	36	-0.06
DESERT	72	4.8	4.7	9.4	249	0.71	15.2	33.7	748	393	233	83	339.1	0.37	42	-0.03
6141756	75	4.7	4.6	10.5	235	0.72	15.4	29.2	924	540	101	45	339	-0.18	37	-0.06
FARM	62	4.7	4.6	9.8	239	0.66	15.3	20.9	923	548	39	82	339.1	-0.27	37	-0.06
DESERT	79	4.6	4.5	11.0	229	0.59	15.5	36.1	920	527	164	47	339.2	-0.16	38	-0.07
6141806	69	4.6	4.6	9.0	236	2.16	15.4	29	867	497	87	35	339.1	-0.85	36	-0.07
FARM	67	4.7	4.7	8.6	239	1.55	15.4	20.6	871	512	107	223	338.5	-0.83	36	-0.1
DESERT	71	4.6	4.6	9.5	231	2.9	15.5	36.8	866	486	114	-30	339.2	-1.27	34	-0.08
6141816	69	4.7	4.5	9.5	243	1.05	15.6	29.9	905	528	149	69	339.3	-0.47	38	-0.05
FARM	66	4.7	4.6	9.5	242	0.37	15.4	21.3	936	560	71	184	339	-0.54	38	-0.05
DESERT	70	4.6	4.5	9.8	243	1.37	15.7	38.1	937	533	190	-2	339.8	-0.42	38	-0.06

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6141826	18	4.8	4.6	8.0	237	0.49	15.9	31.2	901	516	174	76	340.6	-0.72	34	-0.04
FARM	14	4.9	4.8	8.0	224	0.67	15.8	21.9	913	540	101	218	339.7	-0.75	33	-0.05
DESERT	22	4.7	4.6	8.5	253	0.64	16	39	896	501	254	21	341.1	-0.47	36	-0.04
6141834	14	4.8	4.7	9.0	230	0.89	16.1	31.8	955	561	126	99	340.9	-0.36	37	-0.04
FARM	11	5	4.8	8.4	218	0.78	15.9	22.3	955	577	69	192	339.7	-0.42	37	-0.03
DESERT	17	4.7	4.6	9.3	235	1.26	16.3	40	953	541	260	44	341.8	-0.29	38	-0.06
6141845	20	4.8	4.7	9.0	238	0.39	16.1	32.3	844	526	168	91	341.1	0.65	39	-0.06
FARM	15	5	4.8	7.1	256	0.38	16.1	23	817	548	132	277	339.9	0.13	38	-0.09
DESERT	20	4.6	4.6	10.5	226	0.7	16.2	39.5	914	515	196	15	341.7	-0.87	37	-0.04
6141853	14	4.8	4.7	8.9	239	0.55	16.3	32.7	965	568	179	115	340.7	-0.52	39	-0.05
FARM	12	5.1	5	7.9	243	0.43	16.2	22.5	965	587	102	233	339.3	-0.86	37	-0.06
DESERT	13	4.6	4.5	9.6	238	0.73	16.4	41.2	968	549	212	43	342	-0.2	39	-0.05
6141903	72	4.5	4.5	9.3	245	0.51	16.1	32.7	854	549	196	115	338.7	-0.98	36	-0.05
FARM	52	4.6	4.5	8.7	243	1.31	16.2	22.9	906	568	94	174	339.2	-1.29	35	-0.07
DESERT	88	4.5	4.5	9.3	249	0.8	16	41.3	897	542	239	67	338.6	-0.35	36	-0.04
6141912	74	4.5	4.5	8.4	244	1.63	16.3	33.5	976	583	200	127	338.1	-0.2	39	-0.09
FARM	59	4.6	4.6	6.9	244	1.29	16.3	24.1	977	596	105	229	338.4	-0.55	40	-0.07
DESERT	86	4.4	4.3	9.5	245	2.89	16.3	42.4	978	568	300	35	337.8	-0.03	39	-0.11
6141922	174	4.4	4.5				16.6	33.5	874	567	134	122	334.1	0.39	40	-0.05
FARM	173	4.5	4.5	8.8	239	0.94	16.5	23.3	889	582	94	210	333.6	0.23	38	-0.1
DESERT	178	4.5	4.5				16.6	42	874	560	188	71	334.5	0.7	41	0.01
6141931	172	4.4	4.4	9.6	248	0.75	16.8	34.1	979	589	142	92	333.6	1.72	39	-0.08
FARM	167	4.5	4.5	9.4	253	0.67	16.7	24.1	979	601	39	156	333.6	0.24	40	-0.04
DESERT	175	4.4	4.3	10.3	244	1.16	16.8	42.5	981	577	122	8	333.9	1.81	39	-0.12
6141941	68	4.4	4.4	8.1	244	1.18	16.8	34.5	916	568	171	92	337.8	-0.35	39	-0.08
FARM	60	4.5	4.5	7.4	236	0.1	16.7	24.2	960	585	90	251	337.7	-0.62	39	-0.09
DESERT	71	4.4	4.4	9.1	250	0.75	16.8	43.3	929	556	225	11	337.9	-0.42	40	-0.06

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6141949	69	4.4	4.4	8.8	248	1.44	16.9	35.1	977	583	126	62	337.6	-0.4	40	-0.05
FARM	62	4.6	4.6	7.9	246	1.07	16.8	24.8	980	600	37	126	337.3	-0.46	40	0
DESERT	72	4.4	4.2	9.7	248	1.28	17	43.7	975	565	152	4	337.9	-0.28	40	-0.06
6141959	17	4.6	4.5	6.9	239	0.47	17.2	35.6	960	564	213	158	339.9	-1.07	40	-0.07
FARM	12	4.9	4.8	4.7	226	0.79	17.2	24.6	973	587	107	250	338.7	-1.34	39	-0.07
DESERT	20	4.3	4.3	8.8	237	0.22	17.2	44	942	551	317	35	340.7	-0.76	40	-0.07
6142007	14	4.6	4.5	7.1	249	0.42	17.5	36.5	972	570	124	147	339.2	-0.18	40	-0.04
FARM	13	4.9	4.8	7.0	258	0.37	17.3	25	972	593	105	271	338	-0.6	40	-0.07
DESERT	12	4.4	4.3	8.1	248	0.31	17.7	45.2	971	547	114	10	340.2	0.33	39	-0.01
6151042	205	5	5.1	7.7	221	0.07	16	11.1	-2	-30	-1	-1	324.8	-0.01	34	0.01
FARM	198	5	5.1	7.9	224	0.09	16.2	9.6	-3	-27	0	3	325.1	0.01	35	0
DESERT	205	5	5.1	7.8	222	0.16	15.9	12.3	0	-32	4	-9	324.4	-0.04	33	0.05
6151052	202	5.1	5.1	8.1	239	0.05	16	11.3	-5	-30	-1	0	325.5	-0.01	36	0
FARM	199	5.1	5.1	7.9	243	0.12	16.2	9.9	-5	-28	-4	3	325.1	-0.02	36	-0.02
DESERT	202	5.1	5.1	8.7	240	0.1	15.9	12.5	-4	-33	1	-1	325.8	0	36	0.01
6151105	112	5.3	5.2	7.0	218	0.05	15.7	11.2	-4	-31	-6	2	330	0	35	-0.03
FARM	104	5.2	5.1	7.4	219	0.07	15.8	9.5	-2	-28	-3	1	330.2	0	36	-0.01
DESERT	114	5.3	5.2	6.3	218	0.14	15.5	12.4	-5	-33	-7	3	329.9	-0.04	35	-0.03
6151115	110	5.3	5.2	7.4	231	0.02	15.7	11.2	-5	-30	1	-2	330.5	0	35	0.01
FARM	106	5.2	5.1	7.7	236	0.05	15.8	9.7	-4	-28	0	1	330.5	0	36	0
DESERT	111	5.3	5.2	7.1	232	0.04	15.5	12.5	-6	-32	3	-6	330.7	-0.01	35	0.04
6151128	65	5.3	5.2	6.5	213	0.2	15.3	11.1	-2	-29	-6	-4	333.4	0.13	35	-0.04
FARM	58	5.2	5.1	7.2	213	0.36	15.3	9.5	-2	-26	-12	-13	334.9	0.33	34	-0.12
DESERT	68	5.4	5.3	6.1	210	0.06	15.2	12.6	-3	-31	-1	-1	332.7	0.02	35	0.02
6151139	58	5.3	5.2	5.9	227	0.05	15.2	10.9	-4	-28	0	1	334.2	-0.03	35	0.02
FARM	55	5.2	5.1	6.4	227	0.04	15.3	9.6	-4	-26	1	4	335.7	-0.09	34	0.03
DESERT	59	5.4	5.3	5.4	229	0.18	15.1	12.3	-5	-32	-2	1	333.5	0	35	0.03

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6151151	23	5.4	5.2	4.8	201	0.68	14.6	10.8	-3	-27	-8	0	338.1	0.13	33	-0.05
FARM	16	5.4	5.2	5.2	195	0.44	14.4	9.4	-3	-22	-12	1	342.3	0.24	31	-0.1
DESERT	27	5.5	5.3	4.6	207	1.08	14.8	12.2	-3	-32	-8	3	335	0.11	35	-0.04
6151202	18	5.5	5.3	3.1	186		14.4	10.6	-2	-26	8	5	339.6	-0.06	31	0.02
FARM	12	5.6	5.3	4.7	208	0.39	14.2	9.4	-2	-22	-4	17	344.5	0.28	29	-0.07
DESERT	18	5.5	5.3	2.7	347		14.7	12	-3	-29	4	-5	335.7	-0.12	34	-0.01
6151212	19	5.4	5.2	5.2	212	0.64	14.6	10.6	1	-24	-39	7	338.3	0.37	32	-0.2
FARM	15	5.4	5.2	5.3	195	0.21	14.5	9.1	3	-21	-25	27	341.2	0.23	31	-0.14
DESERT	20	5.5	5.3	6.9	235	1.9	14.6	12	0	-26	-26	-4	335.5	0.02	33	-0.07
6151222	23	5.4	5.2	4.2	213	0.28	14.7	10.9	6	-18	23	6	338.1	0.13	32	0.07
FARM	16	5.4	5.2	4.8	217	0.45	14.6	9.4	6	-17	-6	12	341.1	0.23	31	-0.08
DESERT	28	5.5	5.3	4.0	216	0.9	14.7	12.5	5	-21	98	-1	335.5	-0.71	33	0.57
6151231	87	5.4	5.2	5.5	219	0.16	15.4	11.2	10	-19	-4	3	332.4	0	36	-0.03
FARM	79	5.3	5.2	6.3	217	0.14	15.4	9.6	13	-14	-3	-1	332.4	0.07	35	-0.03
DESERT	91	5.4	5.3	5.0	227	0.24	15.3	12.5	8	-23	-14	8	332.5	0.01	37	-0.1
6151241	85	5.4	5.2	5.6	234	0.07	15.4	10.7	17	-20	0	0	332.5	0.05	36	0
FARM	82	5.3	5.2	5.4	233	0.15	15.5	9.5	15	-14	-5	0	332.7	0.09	36	-0.04
DESERT	86	5.4	5.3	5.5	238	0.16	15.4	12.1	21	-25	4	1	332.5	0.1	36	0.02
6151253	178	5.1	5	5.9	247	0.04	16	11	40	-13	-4	6	328	0.04	39	-0.02
FARM	172	5.1	5	6.0	240	0.05	16	9.6	38	-8	-2	1	328	0	39	-0.01
DESERT	178	5.1	5	6.0	250	0.05	16	12.4	40	-15	-6	9	328.1	0.09	39	-0.03
6151303	178	5.1	5	6.8	253	0.02	16.1	11.6	65	-1	0	2	328.1	0.01	39	0
FARM	176	5.1	5	6.9	248	0.07	16.1	10	52	0	2	3	328.1	0.01	38	0
DESERT	178	5.2	5.1	6.3	254	0.07	16	13.2	77	-3	2	-3	328.2	0.04	38	0.01
6151423	20	5.7	5.5	4.4	220	0.07	15.7	16	169	55	10	44	331.6	-0.06	39	-0.05
FARM	8	6.3	6.1	4.0	209	0.21	15.6	14	230	91	7	71	328.7	0.04	25	-0.06
DESERT	28	5.4	5.2	4.3	229	0.27	15.8	17.6	131	30	6	14	333.3	-0.12	47	-0.09

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6151431	15	5.7	5.5	4.4	219	0.54	15.9	16.3	230	73	16	38	333.2	-0.06	33	-0.05
FARM	8	6.2	6	2.4	182	0.82	15.6	13.5	220	71	7	58	330.5	-0.1	28	0.04
DESERT	19	5.4	5.2	5.5	228	0.62	15.9	18.8	244	71	31	15	334.7	0.06	36	-0.07
6151443	19	5.7	5.5	3.9	235	0.5	16.2	17.3	249	105	26	21	332.1	0.01	35	-0.06
FARM	8	6.3	6.1	3.0	234	0.66	16	14.3	252	109	11	43	328.4	0.09	32	-0.1
DESERT	22	5.4	5.2	4.9	238	0.22	16.2	19.7	251	102	31	16	334.5	-0.14	37	-0.11
6151451	19	5.8	5.6	4.9	236	0.17	16.2	18.3	352	128	34	40	331.9	-0.12	35	-0.09
FARM	9	6.3	6	4.4	227	0.23	16	14.2	237	87	-1	103	328.9	-0.34	32	-0.21
DESERT	27	5.5	5.2	6.2	236	0.25	16.2	22.4	438	170	65	10	334.2	0.01	37	-0.04
6151501	20	5.7	5.5	4.1	234	0.33	16.4	19.5	334	159	33	35	332.5	-0.14	38	-0.09
FARM	15	6.2	6	3.3	255	0.33	16.5	15.7	369	180	18	99	327.8	-0.44	36	-0.16
DESERT	21	5.5	5.4	4.5	231	0.8	16.3	21.3	316	155	36	19	334.1	-0.08	39	-0.09
6151512	13	5.8	5.6	5.0	239	0.21	16.9	20.3	462	192	50	74	332.7	-0.28	37	-0.13
FARM	9	6.2	6	4.2	247	0.22	16.8	15.9	485	202	17	166	328.9	-0.76	35	-0.23
DESERT	14	5.5	5.3	6.3	237	0.17	16.9	23.9	459	185	87	15	334.9	-0.01	39	-0.1
6151522	15	5.7	5.5	3.9	241	0.15	17.2	20.6	393	185	67	40	333.1	-0.16	38	-0.07
FARM	12	6	5.8	3.2	254	0.35	17.1	15.8	401	194	20	91	331	-0.36	37	-0.12
DESERT	14	5.5	5.3	4.9	242	0.25	17.2	24.5	399	183	106	13	334.5	-0.05	39	-0.04
6151530	12	5.8	5.6	5.0	241	0.25	17.5	22.4	565	251	72	83	333.2	-0.25	38	-0.15
FARM	10	6.1	5.9	4.6	244	0.14	17.3	16.7	564	246	26	180	330.6	-0.73	36	-0.29
DESERT	10	5.6	5.4	5.8	237	0.37	17.5	26.5	547	235	109	16	335.1	0.04	40	-0.06
6151541	13	5.8	5.6	3.7	236	0.13	17.6	21.7	384	180	62	55	333.3	-0.18	39	-0.08
FARM	9	6.2	6	2.7	244	0.08	17.5	16.7	416	194	35	83	330.7	-0.29	38	-0.13
DESERT	15	5.6	5.4	4.9	234	0.15	17.5	25.7	394	196	92	13	334.7	0.01	40	-0.01
6151550	12	5.8	5.6	4.6	242	0.18	17.9	23.2	549	255	68	80	333.9	-0.39	40	-0.13
FARM	11	6	5.8	4.2	244	0.13	17.7	17.8	620	295	19	144	332.2	-0.74	38	-0.21
DESERT	11	5.7	5.5	5.7	237	0.29	17.9	27.3	488	213	93	16	335.1	0	40	-0.05

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6151600	12	5.7	5.5	3.3	253	0.3	17.9	23.1	415	197	68	64	333.8	-0.28	40	-0.12
FARM	9	5.9	5.7	1.2	311	0.28	17.8	17.4	398	191	26	101	332.6	-0.53	40	-0.12
DESERT	12	5.7	5.5	3.2	244	0.69	17.8	27.6	435	205	87	25	334.6	-0.05	40	-0.09
6151609	12	5.8	5.6	4.2	252	0.33	18.1	25.9	647	314	78	69	333.5	-0.17	40	-0.11
FARM	10	6.1	5.9	3.8	259	0.37	18.1	18.6	634	294	13	142	331.3	-0.38	40	-0.19
DESERT	11	5.7	5.5	4.8	245	0.33	18.1	31.4	617	300	110	21	335.1	-0.02	40	-0.06
6151619	12	5.8	5.6	3.0	265	0.39	18	25	511	257	58	51	332.9	0.02	40	-0.06
FARM	10	6	5.8	3.3	289	0.58	18	18.4	509	255	29	81	331	0.31	39	-0.05
DESERT	11	5.7	5.5	2.9	243	0.27	18	30.6	537	281	57	17	334.5	-0.07	40	-0.04
6151627	31	5.8	5.6	3.8	260	0.47	18.4	28	727	367	88	-31	332.9	0.03	41	-0.1
FARM	47	6	5.9	4.0	265	0.63	18.4	19.8	740	370	56	-131	331.3	0.29	40	-0.2
DESERT	24	5.6	5.5	4.0	246	1.01	18.3	34.6	700	344	133	12	334.2	-0.02	42	-0.03
6151637	117	5.6	5.4	3.3	280	0.25	18.4	27.5	595	303	76	97	329.4	-0.44	43	-0.19
FARM	109	5.7	5.6	3.5	298	0.18	18.4	21	746	413	70	199	328.2	-1.03	44	-0.31
DESERT	123	5.5	5.4	3.2	269	0.48	18.3	31.8	444	200	71	29	330.1	-0.1	41	-0.11
6151646	256	5.4	5.4	3.7	274	0.86	18.9	27.7	702	362	69	74	322.8	-0.41	42	-0.11
FARM	255	5.5	5.5	3.7	272	1.01	18.8	21.1	741	407	17	142	322.2	-0.9	41	-0.25
DESERT	255	5.4	5.4	4.1	283	0.94	18.9	34	692	336	134	36	322.8	-0.13	42	0.01
6151657	253	5.4	5.4	3.0	280		18.8	27.7	646	363	78	36	322.8	-0.58	41	-0.05
FARM	253	5.4	5.4	2.8	279	0.13	18.8	19.7	571	322	19	69	322.8	-0.44	41	-0.12
DESERT	251	5.4	5.4	3.1	275		18.7	34.9	727	418	123	29	323	-0.73	39	-0.02
6151706	102	5.5	5.4	2.7	272	0.58	18.7	29.5	710	377	81	105	328.9	-0.21	44	-0.18
FARM	101	5.7	5.5	1.7	266	1.33	18.7	21.9	773	431	38	215	327.7	-0.35	43	-0.34
DESERT	101	5.5	5.3	3.5	266	0.68	18.7	36.3	674	348	100	6	329.9	-0.15	44	-0.05
6151716	19	5.6	5.5	3.4	312	0.32	18.5	29.8	622	322	94	96	331.5	-0.1	44	-0.14
FARM	14	5.8	5.6	3.5	315	0.25	18.4	21.9	721	387	58	221	330.3	-0.51	45	-0.23
DESERT	19	5.5	5.4	3.6	305	0.41	18.5	36.4	588	290	126	22	332.3	0.1	45	-0.09

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6151732	18	5.6	5.5	2.5	288	0.67	18.9	33.7	866	466	130	87	332	0.45	45	-0.12
FARM	12	5.9	5.7	3.3	306	0.54	18.7	22.9	858	466	53	151	330.5	0.96	44	-0.14
DESERT	20	5.5	5.4	2.4	257	0.63	19	42.6	850	447	225	38	333.3	0.01	45	-0.13
6151814	25	5.5	5.5	3.1	319		19.2	34.2	807	449	115	120	332.2	-0.39	42	-0.07
FARM	22	5.7	5.7	1.0	340	0.24	19.1	23.9	855	529	56	178	331.6	-0.62	38	-0.11
DESERT	25	5.4	5.5	2.9	317		19.3	41.6	731	367	164	35	332.4	-0.11	48	-0.02
6151825	108	5.5	5.5	2.4	298		19.4	34.7	850	486	112	170	329.1	-0.83	45	-0.18
FARM	107	5.7	5.7	1.9	305		19.3	24.7	870	517	94	363	327.7	-1.71	44	-0.37
DESERT	108	5.4	5.4	2.9	282	0.25	19.5	42.4	797	441	119	33	330.1	-0.12	46	-0.04
6151836	328	5.3	5.5				20	34.9	827	509	95	136	320.4	-0.72	46	-0.12
FARM	326	5.5	5.6				19.9	24.6	919	628	43	262	319	-1.15	48	-0.24
DESERT	326	5.3	5.4				20	42	698	362	132	24	321.3	-0.07	44	-0.05
6151844	312	5.3	5.5	2.4	281		20.1	37.1	964	567	127	141	321.4	-0.67	45	-0.1
FARM	308	5.4	5.6	1.2	312		19.9	26	982	588	60	196	320.4	-0.84	45	-0.17
DESERT	314	5.3	5.5	3.7	273		20.2	46.3	931	564	165	101	322.1	-0.53	45	-0.01
6151854	97	5.5	5.6	1.8	300	0.56	19.8	39.2	946	579	146	117	329.4	-0.64	47	-0.11
FARM	93	5.7	5.7	1.0	190	0.59	19.6	26.1	1021	635	79	213	328.5	-0.89	46	-0.18
DESERT	97	5.4	5.5	3.1	279	0.91	19.9	48.3	817	450	200	57	330.1	-0.46	47	-0.02
6151903	21	5.7	5.7	2.2	291	0.49	19.9	37.6	887	499	142	182	332.6	-0.49	47	-0.11
FARM	16	6	5.9	1.4	330	0.23	19.6	27.2	1038	609	82	229	330.6	-1.23	45	-0.18
DESERT	24	5.5	5.5	4.0	279	0.79	20	45.4	798	397	205	2	334.5	0	49	-0.07
6151912	96	5.5	5.6	3.2	312	0.81	19.9	36.1	701	417	97	117	329.5	-0.55	46	-0.1
FARM	91	5.7	5.7	2.0	357	0.55	19.7	26.9	736	438	72	203	328.3	-0.85	45	-0.17
DESERT	97	5.4	5.5	4.5	288	0.16	19.9	43.8	717	412	108	24	330.7	0.27	47	-0.05
6151921	347	5.4	5.5	3.5	301	1.28	20.5	36.1	842	483	74	-28	319.1	-0.69	46	-0.1
FARM	346	5.5	5.6	1.9	320	0.72	20.3	25.7	843	483	21	-86	317.9	-1.2	45	-0.18
DESERT	348	5.3	5.4	4.6	284	0.63	20.6	44.2	792	455	126	0	320.4	-0.31	47	-0.05

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6151931	311	5.4	5.5	4.0	309	2.45	20.4	35.7	803	464	56	123	320.2	-0.67	46	-0.12
FARM	307	5.5	5.7	4.2	330	2.14	20.3	25.8	835	500	56	207	318.3	-1.02	45	-0.2
DESERT	311	5.3	5.4	3.5	283	2.49	20.5	43.6	743	421	94	19	321.8	-0.36	47	-0.05
6151939	84	5.6	5.6	2.7	297	0.26	20.2	37.2	845	480	144	94	328.6	1.22	47	-0.06
FARM	81	5.8	5.8	1.0	192	0.7	19.9	26.6	865	505	52	118	326.8	0.94	46	-0.06
DESERT	86	5.4	5.4	4.6	284	1.26	20.4	46.9	850	461	216	59	330.5	0.85	48	-0.03
6151948	21	5.7	5.7	4.7	293	0.72	20.2	36.3	708	354	99	79	331.5	-0.28	47	-0.15
FARM	15	6.1	6.1	3.5	355	0.78	19.9	26.3	840	441	35	130	329.4	-0.35	46	-0.14
DESERT	20	5.4	5.4	9.8	273	1.93	20.3	44.6	661	305	151	20	333.5	-0.22	49	-0.12
6151956	16	5.8	5.8	2.6	303	0.33	20.3	35	697	375	110	22	332.3	0.05	47	-0.09
FARM	11	6.2	6.1	2.5	355	0.32	20	25.2	793	449	50	137	329.7	-0.33	47	-0.11
DESERT	16	5.5	5.5	3.8	279	0.2	20.5	42.5	600	299	143	7	334.9	-0.05	48	-0.1
6152005	16	5.7	5.7	2.7	306		20.4	34.2	603	299	72	100	332.6	-0.14	48	-0.12
FARM	13	6.2	6.1	3.3	204		20.1	25.1	708	386	49	147	329.9	-0.13	46	-0.13
DESERT	14	5.5	5.5	5.7	281		20.6	41.2	528	243	93	28	334.8	-0.05	50	-0.05
6152013	38	5.9	5.9	0.9	183		20.5	33.4	583	302	105	54	332.7	-0.02	49	-0.07
FARM	9	6.3	6.2	3.2	182		20.1	24.2	655	370	50	167	329.7	-0.22	46	-0.08
DESERT	58	5.5	5.6	2.2	252		20.6	40.1	525	239	146	12	335.7	0.1	50	-0.09
6171516	12	5.4	5.2	8.1	247	0.21	12.9	10.9	413	205	110	84	336.4	-0.58	35	-0.18
FARM	11	5.6	5.4	9.4	253	0.16	12.9	7.3	424	216	78	156	335.8	-1.02	33	-0.28
DESERT	11	5.3	5.1	7.3	246	0.14	12.9	13.7	407	199	144	24	336.1	-0.27	36	-0.1
6171524	133	5.5	5.3	4.2	229	0.16	13.2	13.9	586	267	62	55	339.8	-0.37	36	-0.09
FARM	68	5.6	5.5	3.5	216	0.24	13.1	8.7	589	273	44	108	337.9	-0.64	35	-0.13
DESERT	254	5.3	5.1	6.2	236	0.1	13.3	18.4	590	264	81	12	341.4	-0.16	37	-0.06
6171535	12	5.4	5.2	7.7	246	0.11	13.4	16.2	477	243	130	93	339.6	-0.63	37	-0.21
FARM	10	5.7	5.5	6.3	250	0.14	13.3	11.7	480	250	100	165	338.2	-1.12	34	-0.28
DESERT	12	5.3	5.1	9.5	247	0.28	13.4	19.6	476	239	162	40	340.6	-0.3	38	-0.21

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																	
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6171545	11	5.4	5.2	5.6	250	0.13	13.6	19	638	303	71	45	340.1	-0.31	39	-0.06
FARM	10	5.7	5.5	6.2	247	0.19	13.5	13.3	633	305	40	81	338	-0.43	37	-0.07
DESERT	11	5.3	5.1	6.2	250	0.18	13.7	23.9	648	301	84	15	341.5	-0.17	40	-0.04
6171555	11	5.4	5.2	7.6	259	0.14	13.8	20.3	532	278	133	76	340.2	-0.51	38	-0.14
FARM	11	5.6	5.4	8.2	262	0.19	13.8	15	539	288	91	148	338.6	-0.72	36	-0.2
DESERT	11	5.3	5.1	8.7	259	0.39	13.8	24.7	532	273	149	11	341	-0.33	39	-0.07
6171603	117	5.4	5.1	0.6	289	0.14	14.1	22.1	689	345	88	72	340.8	-0.49	39	-0.11
FARM	10	5.6	5.3	0.2	207	0.17	13.9	15.5	687	349	57	122	339.5	-0.67	39	-0.15
DESERT	265	5.2	4.9	0.9	335	0.09	14.3	27.6	695	340	131	25	342	-0.25	40	-0.09
6171614	18	5.4	5.1	7.4	256	0.13	14.2	22.8	588	311	164	113	340.3	-0.72	40	-0.19
FARM	20	5.6	5.3	8.0	267	0.12	14.1	16.4	597	328	116	216	338.7	-1.21	40	-0.32
DESERT	11	5.2	4.9	8.5	247	0.24	14.3	28.2	583	300	206	35	341.5	-0.41	41	-0.13
6171623	12	5.4	5.1	2.8	255	0.18	14.4	24.6	733	375	90	59	340.3	-0.39	42	-0.09
FARM	9	5.6	5.4	4.4	268	0.22	14.2	17.2	730	383	41	89	339	-0.48	41	-0.08
DESERT	12	5.2	4.9	2.4	233	0.2	14.6	30.7	740	367	131	23	341.5	-0.24	43	-0.07
6171633	11	5.3	5.1	5.8	249	0.32	14.4	25.2	639	344	131	105	340.2	-0.65	40	-0.16
FARM	10	5.6	5.3	5.1	252	0.16	14.3	17.8	646	361	95	208	338.6	-1.1	37	-0.26
DESERT	11	5.2	5	7.4	248	0.4	14.4	31.4	637	334	154	25	341.2	-0.33	43	-0.11
6171642	11	5.4	5.1	1.5	237	0.17	14.8	26.9	776	406	118	121	340.5	-0.73	40	-0.2
FARM	10	5.6	5.3	1.1	207	0.2	14.7	18.4	775	417	86	252	338.9	-1.33	39	-0.37
DESERT	10	5.3	5	2.9	251	0.17	15	33.9	782	395	152	17	341.8	-0.26	41	-0.08
6171652	11	5.3	5.1	5.8	252	0.96	14.8	27.4	686	374	132	140	340.4	-0.52	41	-0.19
FARM	10	5.5	5.2	6.5	246	0.38	14.7	19.2	692	393	104	240	339	-1.02	44	-0.28
DESERT	10	5.2	5	6.3	256	1.34	14.9	34.3	685	362	139	48	341.3	-0.16	41	-0.1
6171700	62	5.3	5	0.9	180	0.38	15.3	29	814	435	88	82	340.9	0.05	41	-0.08
FARM	10	5.5	5.2	1.5	332	0.5	15	19.6	816	449	82	240	339.7	0.65	41	-0.27
DESERT	156	5.2	4.9	2.3	229	0.33	15.6	36.8	818	419	127	-6	341.9	-0.2	42	-0.01

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6171732	13	5	4.9	1.7	294	0.31	15.4	30.7	808	440	128	157	339.3	-1.31	38	-0.27
FARM	10	5.3	5.2	1.3	308	0.52	15.2	20.9	801	462	89	262	338.1	-1.61	40	-0.33
DESERT	15	4.9	4.8	2.4	292	0.78	15.6	38.9	823	429	125	-7	339.9	-1.19	39	-0.11
6171741	81	4.9	4.8	2.2	285	0.59	15.5	32.8	876	478	149	98	335.8	-0.64	44	-0.16
FARM	77	5.1	5	3.1	315	0.66	15.2	22.4	879	486	101	208	333.9	-1.01	43	-0.23
DESERT	83	4.8	4.7	2.4	252	0.4	15.6	41.1	879	472	208	21	337.9	-0.41	43	-0.12
6171749	179	4.8	4.7	1.1	248	0.34	15.8	32.2	823	471	113	98	333.1	-1.08	43	-0.18
FARM	175	5	4.9	1.1	231	0.3	15.6	22.5	825	487	63	154	332.4	-1.31	41	-0.25
DESERT	179	4.7	4.6	1.5	282	0.34	15.9	40.8	820	460	179	-8	333.5	-0.86	43	-0.07
6171758	322	4.7	4.7	2.3	256	0.9	16.1	32.3	907	519	120	165	326.6	-0.69	43	-0.25
FARM	319	4.9	4.8	2.4	239	0.71	15.8	22	914	533	17	162	326.4	-0.58	43	-0.24
DESERT	323	4.6	4.6	2.4	249	1.61	16.3	41.1	905	509	209	63	326.7	-0.07	44	-0.14
6171808	321	4.7	4.7				16.3	33	851	499	80	37	326	-2.18	43	-0.16
FARM	319	4.9	4.9	1.0	306	0.52	16	22.5	857	512	62	79	325.2	-1.74	46	-0.17
DESERT	317	4.6	4.6				16.5	41.1	853	491	116	-32	326	-2.9	41	-0.18
6171817	169	4.8	4.7	1.2	250	0.79	16.2	35.3	930	539	81	103	333	-0.66	44	-0.11
FARM	164	5.1	4.9	1.5	298	1.12	15.8	25	929	550	57	178	331.6	-0.79	43	-0.27
DESERT	172	4.7	4.6	2.2	225	0.38	16.4	44.5	933	529	121	19	333.9	-0.37	44	-0.01
6171827	77	4.9	4.7	0.6	306	2.35	16.2	35	861	510	147	96	336.2	-0.52	45	-0.13
FARM	73	5.2	5	0.9	357	0.83	15.9	22.8	886	529	108	198	335.5	-0.74	48	-0.26
DESERT	77	4.7	4.5	1.2	254	2.81	16.5	45.2	852	498	203	-34	336.7	-0.29	45	-0.01
6171836	15	5	4.8	1.1	253	1.07	16.4	37	940	537	91	130	339	-0.64	44	-0.18
FARM	12	5.3	5.1	0.8	210	1.4	16	24.3	939	559	77	241	337.6	-1.3	43	-0.31
DESERT	15	4.7	4.6	2.1	248	1.06	16.8	47.5	940	513	63	39	340.2	-0.07	44	-0.06
6171845	24	5	4.8	0.8	331	1.36	16.6	36.8	848	517	184	94	338.5	-0.54	44	-0.16
FARM	19	5.3	5.2	1.3	355	0.44	16.2	24.1	875	545	97	253	337.2	-0.79	45	-0.27
DESERT	24	4.7	4.5	0.8	267	1.9	17	47.2	836	499	221	26	339.6	-0.52	45	-0.12

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6171854	10	5.1	4.9	1.1	273	0.18	16.9	37.9	954	550	169	42	338.9	-0.51	45	-0.14
FARM	10	5.4	5.2	1.3	300	0.99	16.3	25	955	575	91	155	337.6	-0.74	44	-0.18
DESERT	8	4.7	4.5	1.9	249	0.38	17.3	48.7	954	523	206	-14	340.6	-0.28	45	-0.08
6171903	9	5.1	4.9	1.5	304	1.77	17	38.2	838	527	144	197	338.6	-0.97	43	-0.28
FARM	9	5.5	5.3	2.5	344	1.28	16.4	24.7	842	560	94	333	337.1	-1.32	42	-0.42
DESERT	7	4.7	4.5	2.5	266	0.87	17.4	49.1	845	505	179	20	340.3	-0.54	44	-0.08
6171912	70	5	4.8	0.8	320	1.37	17	39.3	965	563	147	179	336.1	-0.78	45	-0.18
FARM	63	5.3	5.2	1.8	338	1.73	16.5	26.1	964	581	91	175	334.9	-1.28	45	-0.29
DESERT	79	4.6	4.5	1.2	211	0.65	17.5	49.2	967	545	181	190	337.3	-0.44	46	-0.08
6171921	169	4.9	4.8	1.7	337	0.17	17.3	38.7	835	553	123	121	331.3	-0.82	45	-0.18
FARM	167	5.2	5.2	2.1	350	0.67	16.9	26.8	935	578	68	137	330.7	-1.23	46	-0.22
DESERT	168	4.5	4.4	1.9	295	0.73	17.6	48.5	800	537	169	5	332.4	-0.28	43	-0.09
6171931	317	4.9	4.9	1.9	328	0.81	17.7	37.9	973	584	133	2	324.8	-0.39	44	-0.14
FARM	316	5.2	5.2	1.9	337	0.54	17.3	25.6	968	601	65	13	324	-1.07	45	-0.21
DESERT	319	4.5	4.5	2.1	267	1.46	18.1	48.5	980	569	183	-4	325.8	0.2	45	-0.06
6171940	328	4.8	4.8				17.8	38.4	930	567	73	189	324.9	0.83	44	-0.13
FARM	325	5.2	5.2				17.5	25.7	941	583	5	312	324	0.11	44	-0.2
DESERT	328	4.4	4.4				18.2	49.1	952	555	113	141	326.2	1.76	44	-0.13
6171952	207	5	4.9				17.7	40.4	969	579	97	74	329	-0.88	45	-0.11
FARM	191	5.4	5.4				17.2	25.9	970	598	43	95	327.7	-4.62	45	-0.14
DESERT	198	4.5	4.5				18.3	50.7	970	563	165	17	330.8	0.3	45	-0.09
6172000	68	5.2	5				17.6	40.2	966	554	153	160	334.5	0.54	45	-0.29
FARM	66	5.6	5.5				17.1	26.2	971	582	114	288	333.6	2.65	46	-0.36
DESERT	73	4.6	4.5				18.1	51.4	965	538	128	-5	335.8	0.24	45	-0.15
6172009	13	5.3	5.1	4.7	287	0.89	17.8	40.2	957	562	171	98	337.2	-0.67	46	-0.23
FARM	10	5.7	5.5	2.1	226	1.86	17.2	26.1	960	590	103	221	335.7	-0.84	45	-0.3
DESERT	13	4.7	4.5	7.7	308	1.39	18.4	52.2	954	533	236	-46	338.8	-0.24	47	-0.12

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6172018	13	5.4	5.2	2.8	202	0.71	17.8	40.2	970	544	148	114	337.2	-0.82	46	-0.17
FARM	8	5.9	5.7	3.4	214	0.57	17.5	26.3	971	577	138	356	335.9	-1.66	45	-0.44
DESERT	18	4.7	4.5	2.2	329	1.51	18.4	52.3	971	522	162	7	338.5	-0.45	46	-0.07
6172027	9	5.3	5.1	2.8	196	0.12	18	40.3	947	552	199	104	337.8	-0.63	47	-0.23
FARM	8	5.7	5.5	2.0	352	0.38	17.5	25.8	950	580	116	282	336.7	-1.17	47	-0.37
DESERT	8	4.7	4.6	2.5	185	0.41	18.8	52.5	945	520	269	-51	339.2	-0.15	47	-0.14
6172035	10	5.3	5.1	3.5	197	0.32	18.1	40.6	970	537	180	138	337.6	-0.65	47	-0.18
FARM	8	5.6	5.4	4.2	186	0.77	17.6	26.4	970	568	94	288	336.3	-0.87	47	-0.24
DESERT	10	4.8	4.7	2.0	194	0.2	18.7	52.5	969	515	230	40	338.9	-0.41	46	-0.11
6172044	7	5.3	5.1	4.3	194	0.32	18.2	39.7	938	543	228	93	337	-0.67	48	-0.21
FARM	6	5.5	5.4	5.0	201	0.48	17.8	26.2	941	569	103	344	336	-1.1	47	-0.34
DESERT	7	4.9	4.7	3.5	359	0.89	18.9	52.1	935	512	348	-163	338.3	-0.18	48	-0.08
6172139	12	4.9	4.9	3.5	197	0.18	19	39.2	936	492	152	202	339.4	-0.7	71	-0.19
FARM	8	5.2	5.2	3.4	356	0.19	18.7	26.3	931	518	95	344	338.5	-1.18	47	-0.3
DESERT	11	4.5	4.6	3.0	195	0.25	19.4	52	942	471	159	61	341.3	-0.02	120	-0.04
6172147	11	4.9	4.8	3.4	194	0.32	19.2	39	856	487	179	146	339.6	-0.82	49	-0.19
FARM	9	5.2	5.1	3.1	193	0.93	18.8	25.6	861	514	92	315	338.5	-1.07	48	-0.25
DESERT	14	4.5	4.5	3.9	182	0.57	20.2	50.2	850	458	230	19	340.9	-0.37	49	-0.13
6172156	46	4.7	4.6	3.6	193	0.75	19.4	39.8	916	474	143	167	340	-0.8	48	-0.21
FARM	21	4.9	4.8	3.3	187	0.56	19	26.4	913	501	82	332	338.6	-1.21	48	-0.28
DESERT	90	4.5	4.4	3.9	187	0.9	19.9	50.7	917	454	189	-11	341.4	-0.36	49	-0.16
6172205	36	4.7	4.6	3.1	358	0.61	19.6	38.3	824	463	139	180	339.5	-0.63	50	-0.16
FARM	8	5	4.8	2.6	341	0.81	19.2	25.6	827	490	80	326	338.6	-1	48	-0.22
DESERT	92	4.2	4.1	3.8	357	0.73	20.1	49.6	820	431	165	90	341	-0.19	51	-0.1
6172213	36	4.5	4.4	3.5	190	0.22	19.9	38.7	889	454	145	164	339.6	-0.64	50	-0.17
FARM	26	4.8	4.7	3.0	356	0.3	19.5	25.4	887	484	56	307	338.4	-1	49	-0.24
DESERT	66	4.1	4	4.1	186	0.5	20.4	50.1	890	431	228	91	340.6	-0.53	51	-0.15

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																	
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6172222	29	4.5	4.4	3.2	355	0.2	19.8	37.7	792	440	134	195	338.9	-0.75	50	-0.18
FARM	7	4.8	4.7	2.2	323	0.39	19.4	25	794	465	65	434	338.1	-1.24	48	-0.31
DESERT	72	4.1	4	4.7	355	0.39	20.2	48.8	787	409	188	15	340.5	-0.31	51	-0.09
6172231	10	4.4	4.3	4.0	186	0.31	20.1	38.6	861	428	153	163	339.3	-0.66	50	-0.18
FARM	9	4.7	4.6	3.4	355	0.22	19.7	25.3	855	452	45	258	337.9	-0.8	48	-0.21
DESERT	10	4.1	4	4.2	188	0.42	20.5	48.7	865	412	233	105	340.5	-0.42	50	-0.14
6172240	9	4.5	4.4	4.0	353	0.37	19.8	36.8	755	415	117	144	338.8	-0.57	50	-0.12
FARM	7	4.7	4.6	2.1	328	0.37	19.5	24.9	757	436	60	318	338.1	-0.93	49	-0.21
DESERT	8	4.2	4.1	6.2	352	0.34	20.3	47.1	752	390	167	13	339.6	-0.3	50	-0.06
6181856	17	5.9	5.9	2.5	216	0.25	18.3	26.3	470	242	44	116	332	-0.58	40	-0.2
FARM	13	6.3	6.3	0.8	182	0.56	18	20	521	292	26	154	329.1	-0.65	37	-0.15
DESERT	17	5.4	5.3	3.8	200	0.15	18.8	31.8	448	211	82	13	335.9	-0.12	44	-0.08
6181906	15	5.9	5.9	1.2	212	0.29	18.7	28.9	589	330	69	116	332.4	-0.57	41	-0.19
FARM	13	6.3	6.2	1.2	245	0.25	18.4	20.6	529	282	12	194	330.2	-1.02	38	-0.28
DESERT	15	5.4	5.3	3.6	212	0.4	19.1	36.3	662	386	116	52	336	-0.08	45	-0.12
6181915	16	6	5.9	1.9	218	0.45	18.8	28.8	535	272	85	97	331.9	-0.46	42	-0.13
FARM	13	6.3	6.2	0.2	253	0.45	18.4	20.5	508	274	39	150	330.1	-0.68	40	-0.08
DESERT	18	5.4	5.3	4.2	214	0.38	19.4	36.9	606	299	149	36	335.2	-0.11	46	-0.15
6181924	19	6	5.9	2.5	239	0.26	19.1	30.2	602	330	93	91	331.3	-0.46	43	-0.15
FARM	14	6.5	6.4	1.1	246	0.38	18.7	21.9	621	351	40	156	328.5	-0.84	40	-0.16
DESERT	19	5.4	5.3	4.1	227	0.27	19.6	37.4	588	319	131	42	335	-0.11	47	-0.15
6181934	15	6.1	6	1.5	238	0.18	19.3	32	730	398	113	144	330.9	-0.66	43	-0.21
FARM	11	6.6	6.5	1.4	323	0.23	18.8	22.1	662	370	44	208	328.9	-1.03	39	-0.21
DESERT	13	5.4	5.3	4.0	211	0.19	20	41.6	800	427	201	55	334.4	-0.19	47	-0.18
6181943	15	6.1	6	2.6	243	0.43	19.5	33.3	685	389	136	89	330.3	-0.41	44	-0.13
FARM	12	6.5	6.5	1.1	274	0.34	19	22.1	570	309	44	179	328.5	-0.88	41	-0.2
DESERT	15	5.5	5.4	4.4	227	0.69	20.1	43.5	823	480	202	33	333.5	-0.03	48	-0.07

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE																	
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6181953	14	6	6	1.9	241	0.01	19.6	33.5	732	384	121	60	330.2	-0.37	44	-0.08
FARM	12	6.6	6.5	1.5	333	0.13	19	22	622	336	30	185	328.8	-0.74	41	-0.19
DESERT	13	5.3	5.2	4.3	220	0.05	20.4	44.4	882	440	226	-37	333.5	-0.07	48	-0.02
6182002	15	6	5.9	3.9	261	0.23	19.8	34.1	739	417	139	148	330.3	-0.74	58	-0.23
FARM	12	6.5	6.4	2.5	307	0.76	19.3	22.3	634	359	50	224	329.3	-1.36	78	-0.27
DESERT	15	5.4	5.3	6.4	243	0.23	20.5	46.1	889	513	233	38	332.3	-0.14	50	-0.13
6182011	16	6	5.9	3.1	221	0.69	20	36.7	785	421	132	110	330.1	-0.41	51	-0.17
FARM	14	6.6	6.5	4.9	311	1.59	19.3	22.6	637	348	19	217	328.4	-0.68	54	-0.23
DESERT	16	5.4	5.3	5.8	226	0.46	20.7	48.2	915	492	243	16	332.4	-0.19	50	-0.09
6182021	13	6	5.9	3.1	246	0.22	20.1	35.7	755	404	139	126	330.7	-0.39	333	-0.16
FARM	13	6.5	6.4	2.0	301	0.15	19.5	22.9	630	333	46	215	329.8	-0.69	461	-0.17
DESERT	13	5.3	5.2	5.5	222	0.48	20.7	46.8	852	443	209	59	332.9	-0.2	129	-0.18
6182030	12	6.1	6	2.3	239	0.19	20.1	33.8	732	407	99	152	330.1	-0.67	195	-0.22
FARM	11	6.6	6.5	1.5	260	0.43	19.6	23.3	792	461	39	342	329.4	-1.34	446	-0.45
DESERT	11	5.4	5.3	3.8	219	0.16	20.8	42.7	651	331	124	7	332.5	-0.12	51	-0.07
6182039	15	6	5.9	3.4	241	0.27	20.3	35.3	772	409	112	71	330.6	-0.3	105	-0.09
FARM	12	6.4	6.3	2.0	266	0.35	19.9	24.3	768	424	45	144	330.4	-0.45	144	-0.08
DESERT	12	5.5	5.4	5.0	235	0.32	20.8	44.5	779	398	181	-1	331.9	-0.08	56	-0.09
6182048	12	6	6	2.6	251	0.35	20.5	35.8	785	433	130	136	331.1	-0.64	155	-0.12
FARM	12	6.4	6.4	2.3	293	0.56	20.1	24.1	750	447	79	222	330.8	-0.96	353	-0.09
DESERT	10	5.6	5.5	4.2	226	0.13	21	45.6	750	395	144	13	332.1	-0.17	56	-0.05
6190003	10	5	5.3	3.3	204	0.46	22.7	31.3	597	249	47	162	330.3	-0.47	331	-0.14
FARM	9	5.5	5.8	4.4	186	0.02	22.6	23.8	786	395	6	376	328.7	-0.56	230	-0.27
DESERT	9	4.4	4.7	3.1	223	0.35	22.8	35.5	346	94	64	30	332.3	-0.16	470	-0.08
6190012	67	4.8	5	3.7	198	0.31	22.8	29.9	464	227	50	168	329.4	-0.63	57	-0.16
FARM	60	4.9	5.1	3.6	194	0.61	22.9	23.3	662	357	23	256	330	-0.76	58	-0.22
DESERT	75	4.6	4.8	3.8	204	0.28	22.8	36.2	335	116	80	46	330	-0.24	57	-0.05

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6190022	163	4.7	4.8	4.5	200	0.68	23	28.6	319	131	41	71	325.8	-0.05	200	-0.1
FARM	161	4.7	4.8	5.1	189	0.35	23.1	21.2	276	101	8	61	325.7	0.3	291	-0.06
DESERT	161	4.6	4.7	4.1	208	1.99	23.1	35.9	386	183	95	109	325.9	-0.22	61	-0.15
6190033	331	4.6	4.8	4.2	204	0.37	23.4	25.6	220	76	-2	82	319	-0.24	230	-0.03
FARM	329	4.6	4.8	4.4	203	0.62	23.5	20.3	229	75	-14	89	319.3	-0.27	356	-0.05
DESERT	332	4.7	4.8	3.4	220	0.88	23.4	31.6	215	69	12	85	318.9	-0.22	138	0
6190043	326	4.7	4.8	4.2	214	0.32	23.4	25.1	203	65	2	54	319.1	-0.14	103	-0.06
FARM	324	4.6	4.8	4.5	207	0.54	23.5	18.6	157	39	-5	34	319.8	-0.12	119	-0.07
DESERT	326	4.7	4.8	4.2	219	0.22	23.3	31.1	250	93	13	82	318.6	-0.21	82	-0.1
6190054	175	4.8	4.9	4.2	193	0.2	23.1	25.2	195	65	12	73	324.4	-0.19	56	-0.06
FARM	171	4.8	4.8	4.8	190	0.22	23.2	18.9	167	50	-2	19	324.9	-0.02	56	-0.03
DESERT	178	4.7	4.8	3.1	203	0.2	23.1	30.4	194	66	30	149	324.5	-0.32	56	-0.1
6190103	68	5	5	3.7	206	0.24	22.8	25.1	226	67	16	25	328.8	-0.08	56	-0.09
FARM	62	5	5	4.0	198	0.18	22.9	19.5	296	107	-2	25	329.1	-0.07	56	-0.06
DESERT	71	4.8	4.8	3.9	214	0.32	22.9	29.8	174	39	30	-7	329.1	0.02	56	-0.09
6190112	15	5.2	5.2	3.0	190	0.31	22.9	26.1	298	119	24	-9	330.3	0.14	56	0.06
FARM	14	5.4	5.3	3.2	183	0.52	22.9	20.5	338	141	5	-59	330	0.34	54	0.11
DESERT	14	4.9	4.9	3.0	207	0.21	23.1	30.1	202	72	27	34	332.1	-0.04	57	-0.02
6190122	33	5.1	5.1	2.8	208	0.12	22.9	26.4	338	119	4	145	330.2	0.17	58	-0.18
FARM	27	5.2	5.2	3.2	210	0.04	23	21.5	448	191	-16	112	330	0.91	57	-0.11
DESERT	35	4.9	4.8	3.3	215	0.16	23	29.5	189	39	34	46	331.3	-0.12	58	-0.09
6190132	19	5.6	5.7				22.9	24.9	205	39	19	82	327.8	-0.45	55	-0.13
FARM	9	6.2	6.3				22.8	21.1	267	49	-21	273	324.4	-1.28	53	-0.31
DESERT	35	4.8	4.8				23.1	29.2	159	33	27	15	332.2	-0.09	59	-0.12
6190142	21	5.1	5.1	2.2	194	0.42	22.9	24.5	136	27	15	10	330.5	0.04	73	-0.03
FARM	15	5.3	5.3	2.3	325	1.02	22.9	19.3	109	19	2	21	329.8	-0.05	72	-0.02
DESERT	27	4.8	4.7	3.2	209	0.2	23	28.6	155	34	24	34	331.9	-0.04	58	-0.08

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6190151	16	5	5	2.3	189	0.5	23	23.1	94	2	8	3	330.9	-0.03	58	-0.02
FARM	12	5.2	5.2	1.7	352	1.07	22.9	19.1	102	16	13	-55	330.2	0.15	57	0.06
DESERT	18	4.6	4.6	3.6	219	0.44	23.1	26.3	82	-17	7	9	332.3	-0.02	59	-0.04
6190200	23	5.1	5.1	1.9	211	0.17	23	22.4	97	0	9	-36	331	0.03	57	0.04
FARM	17	5.4	5.4	1.7	193	0.53	22.9	18.5	105	16	25	-156	330.2	0.18	55	0.22
DESERT	26	4.7	4.6	2.6	224	0.05	23.1	25.8	88	-11	2	15	332.3	-0.02	58	-0.05
6190210	13	5.1	5.1	2.1	358	0.26	22.9	22.1	86	-4	7	-22	330.8	0.07	57	0.01
FARM	9	5.6	5.6	2.1	336	0.43	22.8	18.2	83	3	13	-93	329.7	0.28	54	0.15
DESERT	14	4.7	4.6	2.1	205	0.24	23.1	25.3	85	-14	6	1	332.2	-0.03	59	-0.05
6190219	14	5	5	2.0	204	0.13	23	21.3	76	-19	2	1	331.3	-0.04	57	-0.02
FARM	14	5.3	5.3	2.1	184	0.19	22.8	17.5	80	-9	3	-25	330.4	-0.05	56	0.07
DESERT	14	4.7	4.6	2.5	232	0.22	23.1	24.6	75	-24	5	3	332.3	-0.03	58	-0.07
6190228	14	5	5	2.4	344	0.17	23	20.3	66	-13	3	7	331.4	0.03	57	-0.02
FARM	10	5.3	5.3	2.0	326	0.34	22.8	17.1	71	0	8	4	331	0.13	56	-0.04
DESERT	17	4.7	4.6	2.8	351	0.07	23.1	23.6	66	-21	1	2	332.1	-0.01	59	0
6190237	13	4.9	4.9	2.2	197	0.11	22.9	20.8	66	-12	-1	14	331.4	-0.01	57	-0.01
FARM	10	5.2	5.1	2.7	348	0.04	22.8	17.6	68	1	-1	7	330.8	-0.02	55	-0.04
DESERT	14	4.7	4.6	2.4	219	0.28	23	23.7	65	-19	0	5	331.9	0.03	58	0.02
6190246	16	4.9	4.8	2.4	347	0.22	22.9	20.1	44	-12	0	-7	331.3	0.05	57	0.03
FARM	9	5.1	5.1	2.5	329	0.26	22.8	17.1	47	-2	-1	-19	331.2	0.12	55	0.07
DESERT	19	4.7	4.7	2.4	184	0.18	23	23.1	46	-20	0	-1	331.5	0	58	0
6190256	15	4.8	4.8	2.2	188	0.13	22.9	19.9	32	-19	0	7	331.3	0.02	57	-0.02
FARM	12	5	4.9	2.5	345	0.17	22.8	16.4	22	-14	-3	23	331.1	-0.03	56	-0.03
DESERT	13	4.7	4.7	2.0	203	0.03	23	23	41	-21	1	-1	331.6	0.01	57	0
6190305	13	5	5	2.5	208	0.66	22.9	19.2	23	-18	-13	70	332.8	0.35	56	-0.4
FARM	9	5.5	5.5	4.5	231	1.18	22.6	16.1	16	-14	-34	181	334.3	0.98	53	-1.07
DESERT	15	4.8	4.7	1.9	351	0.1	23	22.1	28	-24	-2	13	332.1	-0.01	58	-0.04

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

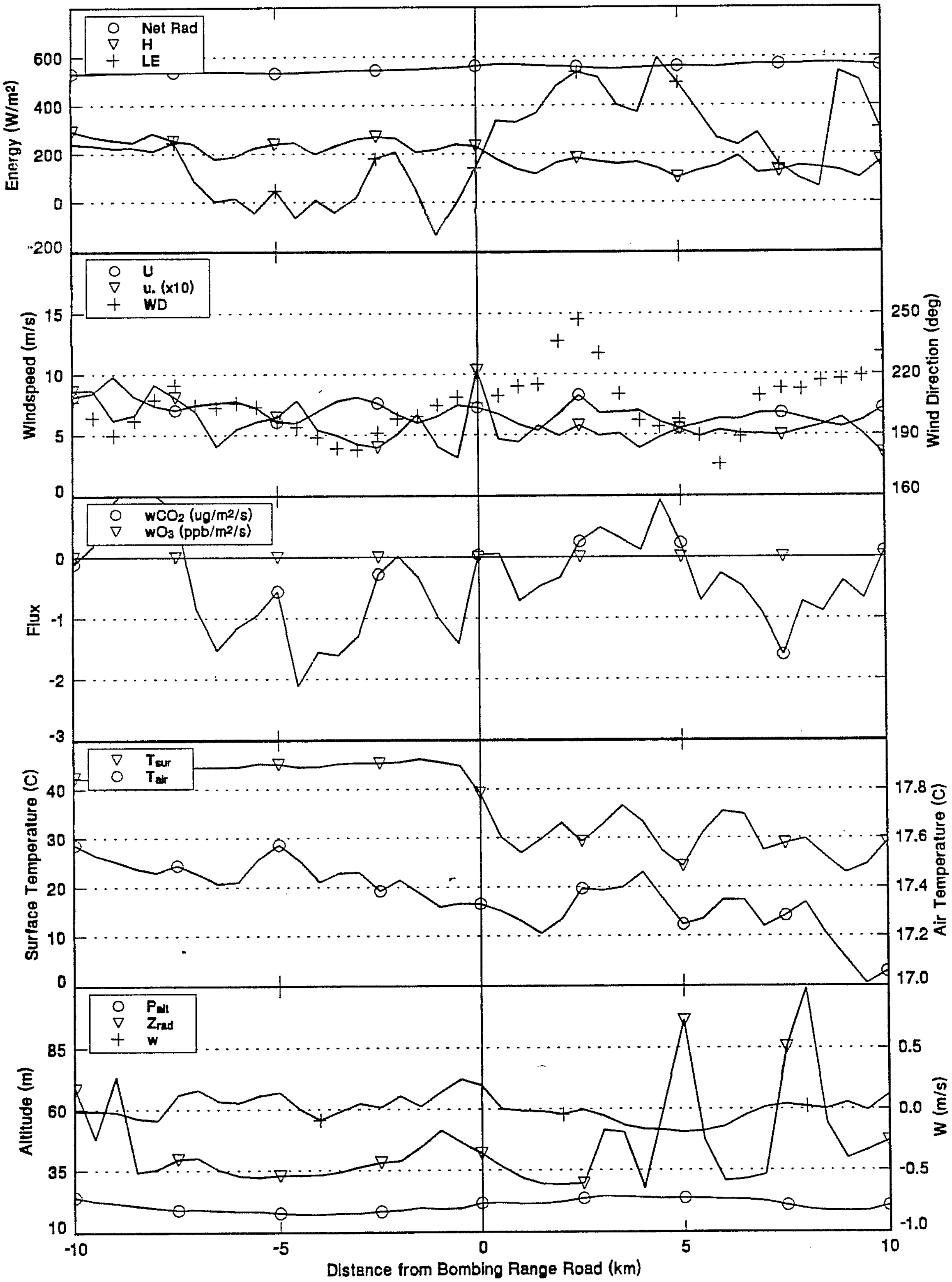
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6191833	17	6.9	7.1	3.9	189	0.26	18.7	18.4	108	46	-29	77	334.2	-0.21	32	-0.02
FARM	18	6.9	7.1	4.1	351	0.39	18.7	16.8	116	57	7	113	330.3	-0.59	30	0.03
DESERT	14	6.9	7.2	3.5	357	0.2	18.6	18.5	78	27	-71	55	337.4	0.01	34	-0.07
6191842	18	7	7.2	2.5	213	0.18	18.7	18.8	136	67	-27	141	333.8	-0.06	33	-0.18
FARM	14	7.4	7.7	3.1	203	0.48	18.6	16.4	96	42	-16	127	328.9	-0.64	30	-0.19
DESERT	22	6.8	6.9	1.9	223	0.02	18.7	19.6	169	93	-3	64	337.4	0.32	36	-0.04
6191852	20	6.9	6.9	1.2	209	0.18	18.8	19.4	177	96	-16	176	334.9	-0.47	35	-0.37
FARM	14	7	7.1	1.4	241	0.15	18.6	16.8	136	68	-34	270	332.5	-1.22	34	-0.71
DESERT	24	6.9	6.9	2.0	189	0.41	19	20.6	221	128	8	24	337	0.48	36	0.03
6191902	15	7	7.2	3.1	271	0.5	18.6	19.7	203	104	21	141	334.5	0.05	35	-0.25
FARM	11	7.4	7.6	4.1	268	0.13	18.1	16.5	156	74	-20	179	331.4	-0.11	32	-0.25
DESERT	15	7.1	7.1	2.7	277	0.17	19	22.2	252	138	37	123	336.9	0.22	36	-0.16
6192358	20	8	8.1	7.5	259	0.5	19.3	17.7	110	56	1	47	332.8	-0.14	37	-0.1
FARM	15	8.5	8.5	5.7	268	0.98	18.8	16.2	76	35	19	4	332.3	-0.1	33	-0.01
DESERT	24	7.8	7.9	8.1	261	0.35	19.6	19	137	69	-13	90	332.7	-0.22	39	-0.22
6200006	14	8.5	8.5	8.3	251	0.34	18.9	17.5	129	65	7	58	333.9	-0.03	37	-0.09
FARM	11	8.7	8.7	6.0	239	0.18	18.6	16	86	40	-15	60	332.7	-0.02	32	-0.1
DESERT	13	8.7	8.7	11.0	256	0.53	18.6	18.5	175	91	36	48	335.9	0.01	40	-0.06
6200016	19	8.6	8.6	9.9	261	0.21	18.6	17.2	127	66	-6	59	334.8	-0.36	41	-0.16
FARM	16	8.5	8.5	7.0	254	0.57	18.8	15.9	87	42	-32	68	332.2	-0.46	39	-0.18
DESERT	21	8.8	8.8	11.1	262	0.18	18.3	18.1	167	88	7	49	336.7	-0.26	42	-0.11
6200024	14	8.9	8.9	9.7	250	0.48	18.1	16.9	110	52	10	69	335.6	-0.05	39	-0.13
FARM	11	8.9	8.9	7.7	251	0.43	18.4	15.7	70	29	-14	69	333.4	-0.06	36	-0.11
DESERT	14	9	8.9	10.5	247	0.66	17.7	17.6	142	72	30	63	337.2	-0.05	42	-0.13
6200035	16	9.1	9	9.1	251	0.39	17.7	16.3	94	46	0	60	336	-0.19	40	-0.12
FARM	11	9.4	9.3	7.5	249	0.38	17.8	15.1	60	24	-18	74	335.3	-0.22	36	-0.14
DESERT	21	8.8	8.7	10.2	256	0.32	17.5	17.1	135	72	6	52	336.2	-0.24	43	-0.14

ARM/BARFEX-91 NOAA AIRPLANE FLX & FDV TRANSECTS 90 s COVARIANCE

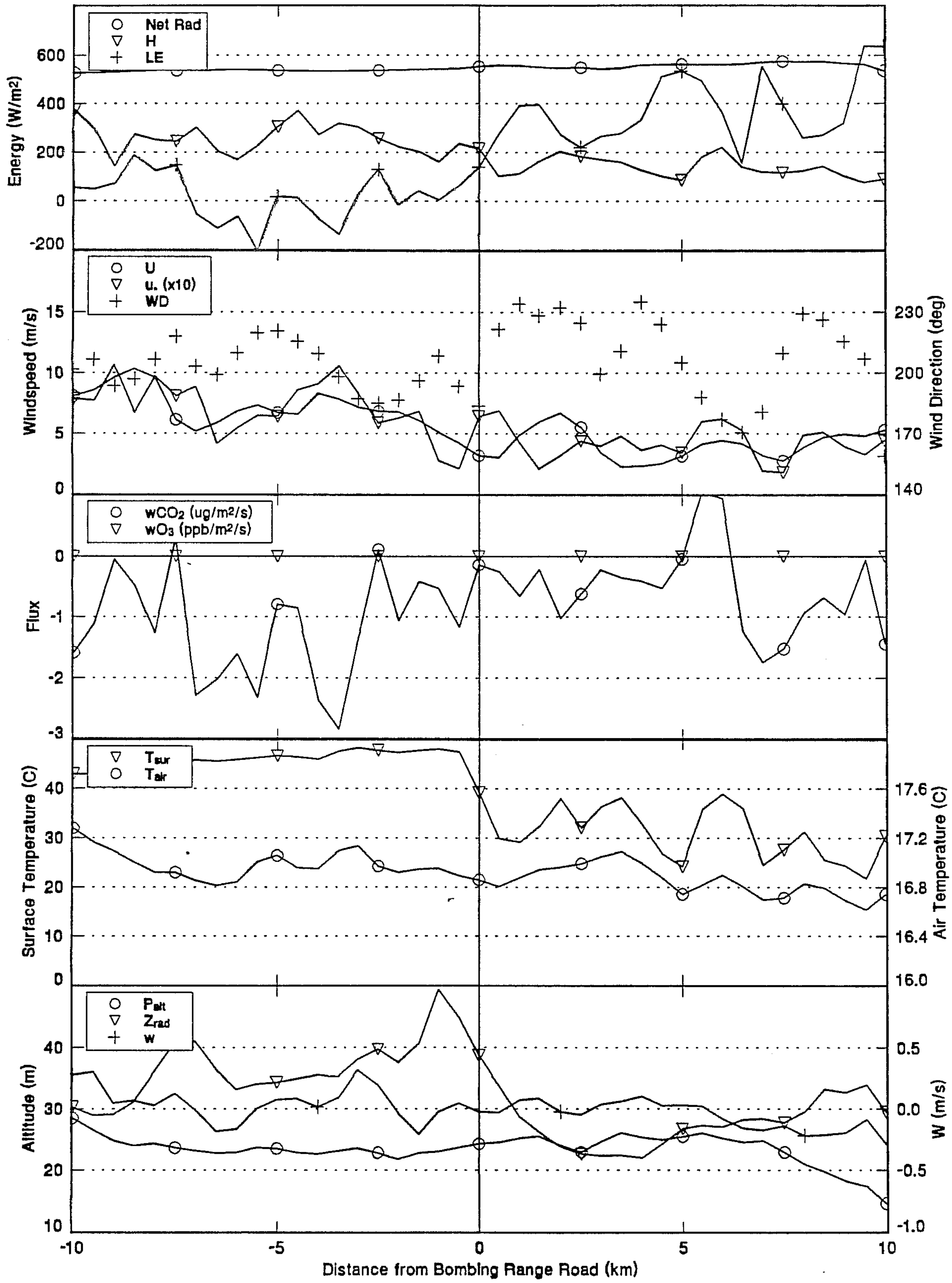
ITEM	Ralt	H2O	Dew	WS	WD	U*	T	SfcT	Py	Net	H	LE	CO2	Fco2	O3	Fo3
6200043	15	9.1	9	9.3	243	0.47	17.5	16	69	29	6	55	336.2	-0.01	40	-0.13
FARM	12	9.3	9.3	8.5	241	0.49	17.6	15.1	57	24	-19	86	335.5	0.04	36	-0.2
DESERT	14	9	8.8	9.9	243	0.54	17.2	16.7	85	38	30	43	336.9	-0.01	42	-0.09
6200053	25	9	8.9	8.6	255	0.3	17	15.8	78	34	-5	48	335.9	-0.2	41	-0.12
FARM	18	9.1	9	7.4	248	0.57	17.2	14.6	72	33	-23	63	336	-0.21	39	-0.16
DESERT	28	8.9	8.8	9.2	251	0.34	16.8	16.4	82	37	15	31	335.8	-0.2	41	-0.09
6200101	14	9.1	9				16.5	15.4	63	27	19	56	336.7	0.01	40	-0.1
FARM	11	9.2	9.2				17.6	14.4	50	22	33	88	336.8	0.08	40	-0.12
DESERT	13	9.1	9				15.7	16.1	74	33	19	29	336.7	0	40	-0.07
6200112	18	9.1	9				16.8	15.2	57	22	-3	37	336.3	-0.13	41	-0.1
FARM	12	9.2	9				16.7	13.9	40	12	-21	56	336.6	-0.06	41	-0.11
DESERT	22	9.1	9				16.7	16.1	81	34	7	33	336.1	-0.13	40	-0.08
6200120	13	9.2	9	9.1	253	0.45	16.7	14.9	47	16	1	38	337	-0.01	39	-0.09
FARM	11	9.3	9.1	8.9	250	0.34	16.6	13.9	36	10	-14	45	337.3	0.06	39	-0.08
DESERT	14	9.1	8.9	9.5	252	0.6	16.6	15.7	58	23	14	36	336.7	-0.04	39	-0.1
6200131	15	9.1	9	8.1	254	0.36	16.5	15	54	21	4	24	336.6	-0.19	39	-0.07
FARM	12	9.4	9.2	7.5	250	0.37	16.4	14	49	17	-3	10	336.9	-0.26	38	-0.03
DESERT	15	9	8.9	8.3	258	0.31	16.5	15.6	56	23	5	31	336.4	-0.15	39	-0.1
6200138	13	9.2	9.1	8.5	246	0.49	16.4	14.9	68	27	-7	48	337.4	-0.03	38	-0.11
FARM	12	9.4	9.3	8.7	244	0.5	16.4	14	59	22	-21	71	337.5	-0.02	39	-0.14
DESERT	12	9.2	9.1	8.6	247	0.45	16.5	15.6	70	30	1	27	337.8	-0.05	38	-0.09

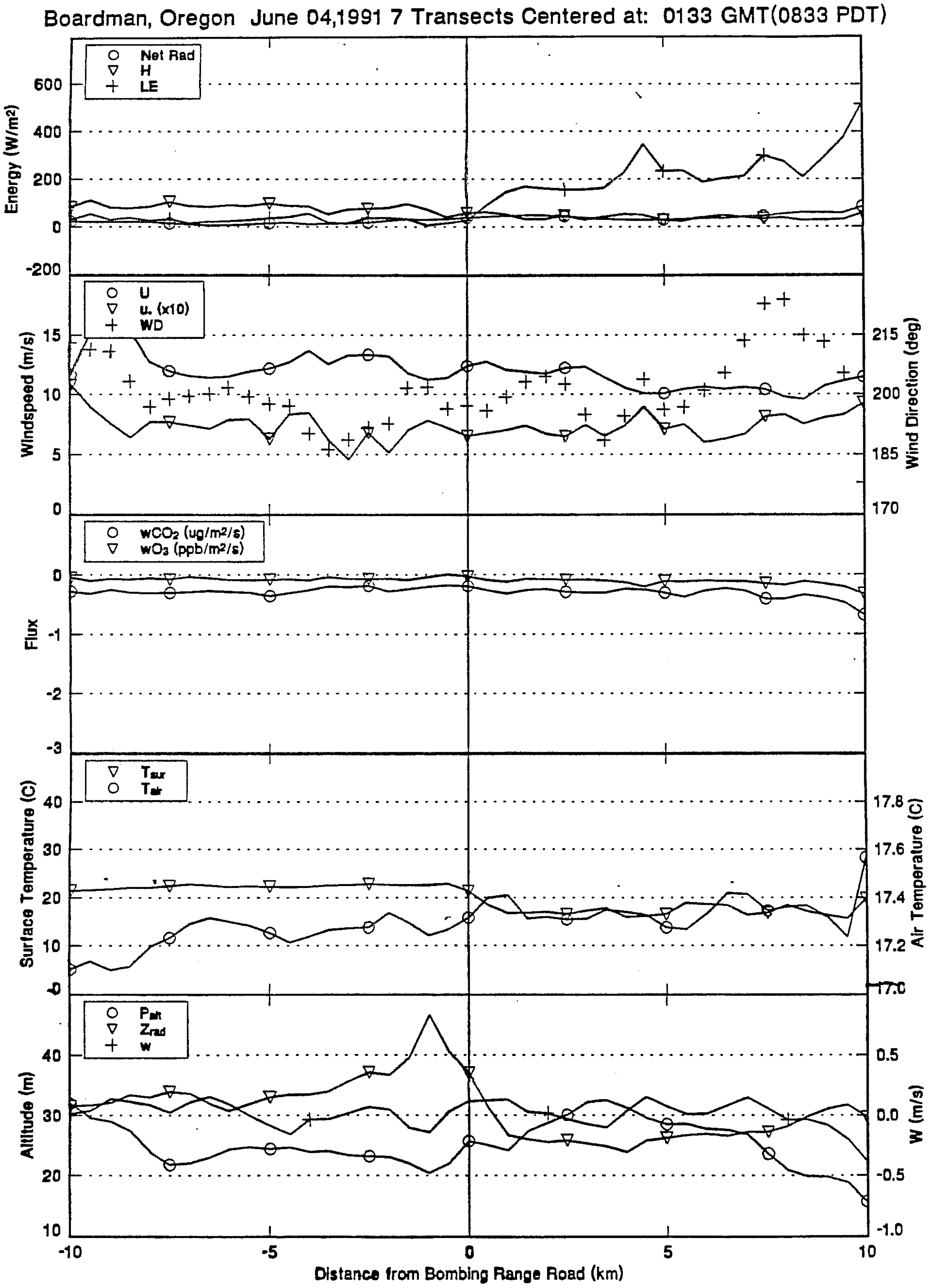
APPENDIX B
FLUX AND VARIABLE MEANS
HORIZONTAL TRANSECTS

Boardman, Oregon June 02,1991 : Transects Centered at: 1922 GMT(0222 PDT)

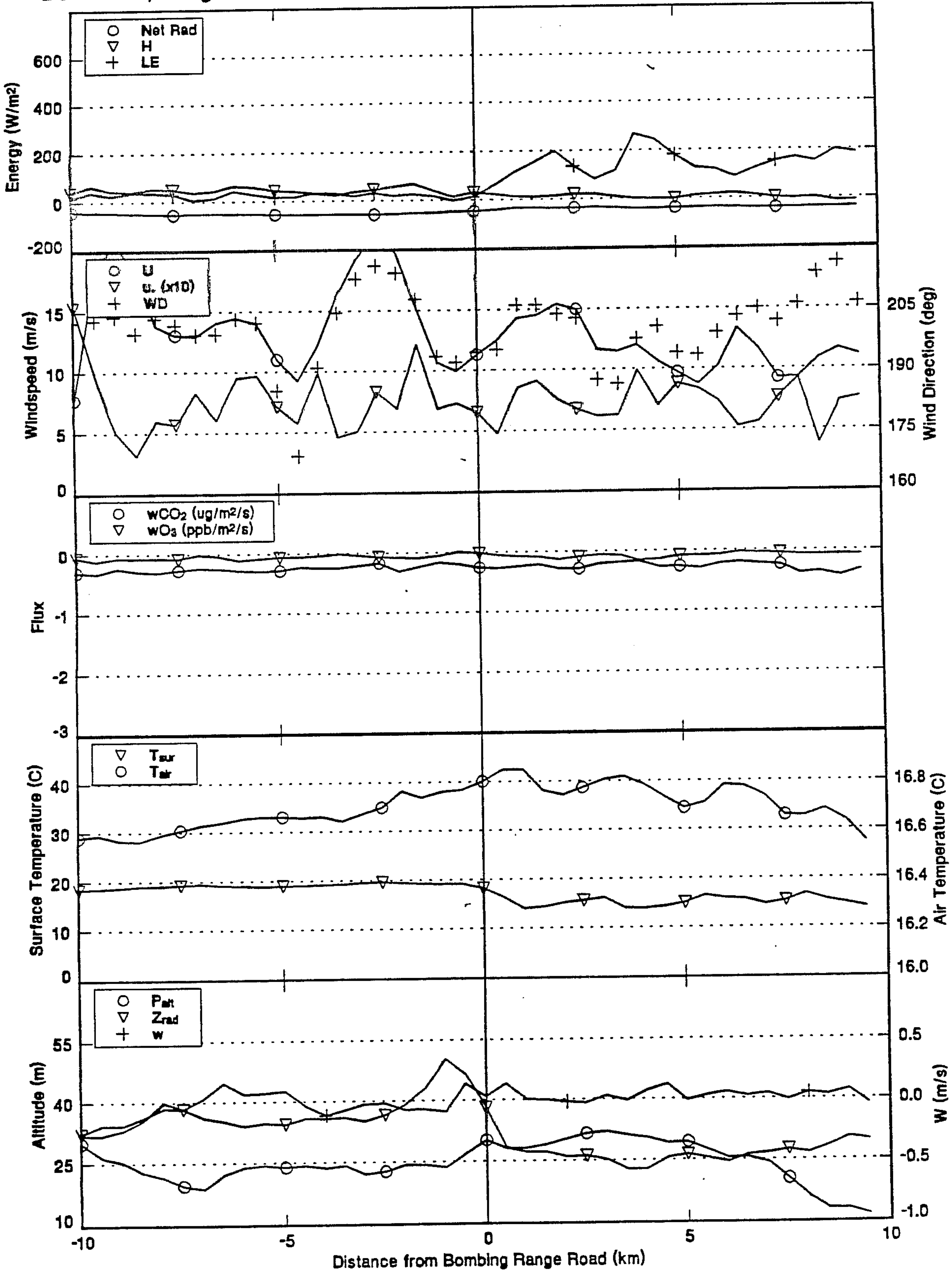


Boardman, Oregon June 03,1991 5 Transects Centered at: 2023 GMT(0323 PDT)

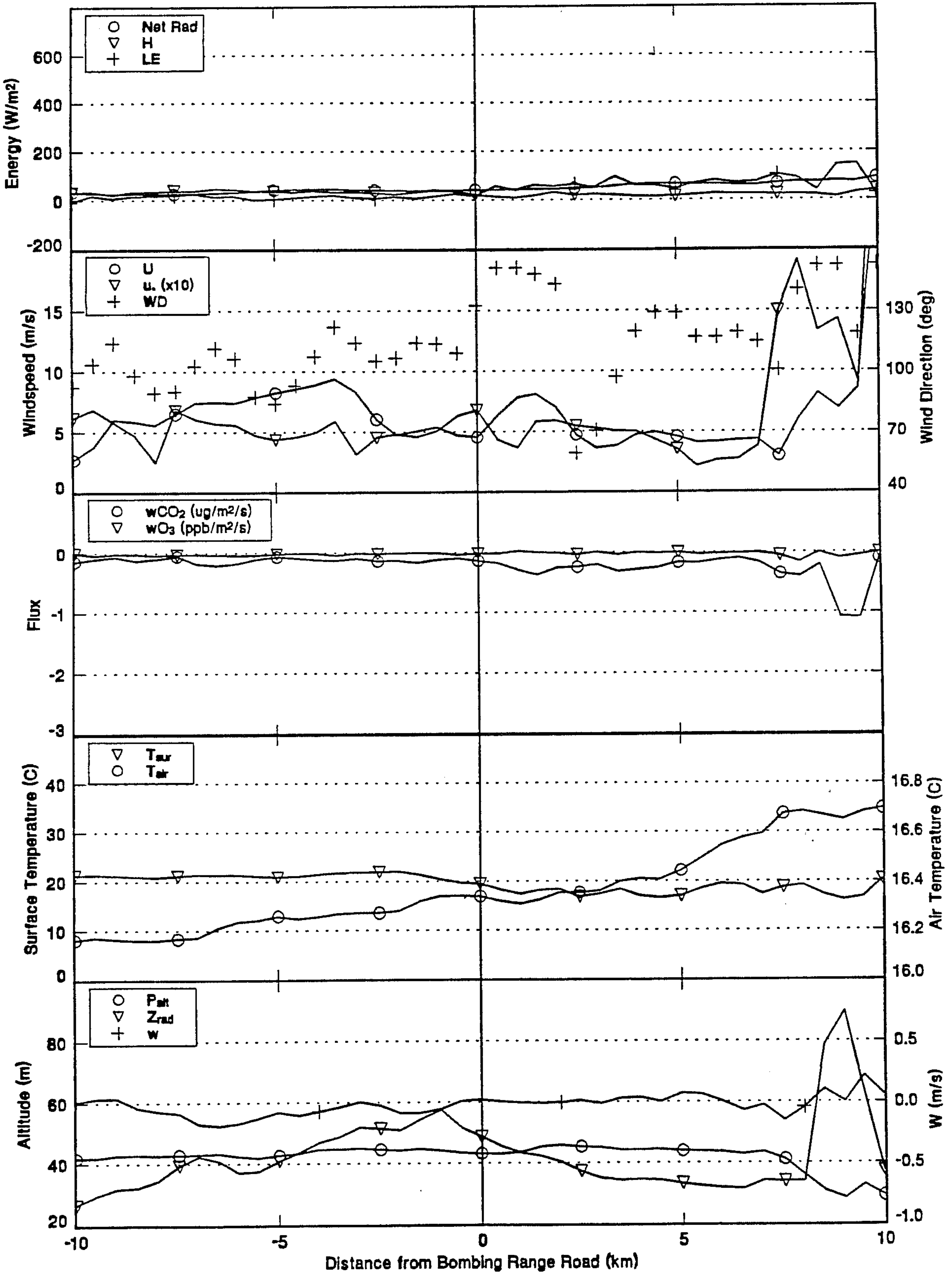


Boardman, Oregon June 04,1991 7 Transects Centered at: 0133 GMT(0833 PDT)
Net Rad
H
LE
Energy (W/m²)
600
400
200
0
-200
U
u. (x10)
WD
Windspeed (m/s)
15
10
5
0
Wind Direction (deg)
215
200
185
170
wCO₂ (ug/m²/s)
wO₃ (ppb/m²/s)
Flux
0
-1
-2
-3
Tsur
Tair
Surface Temperature (C)
40
30
20
10
0
Air Temperature (C)
17.8
17.6
17.4
17.2
17.0
Palt
Zrad
w
Altitude (m)
40
30
20
10
W (m/s)
0.5
0.0
-0.5
-1.0
-10
-5
0
5
10
Distance from Bombing Range Road (km)

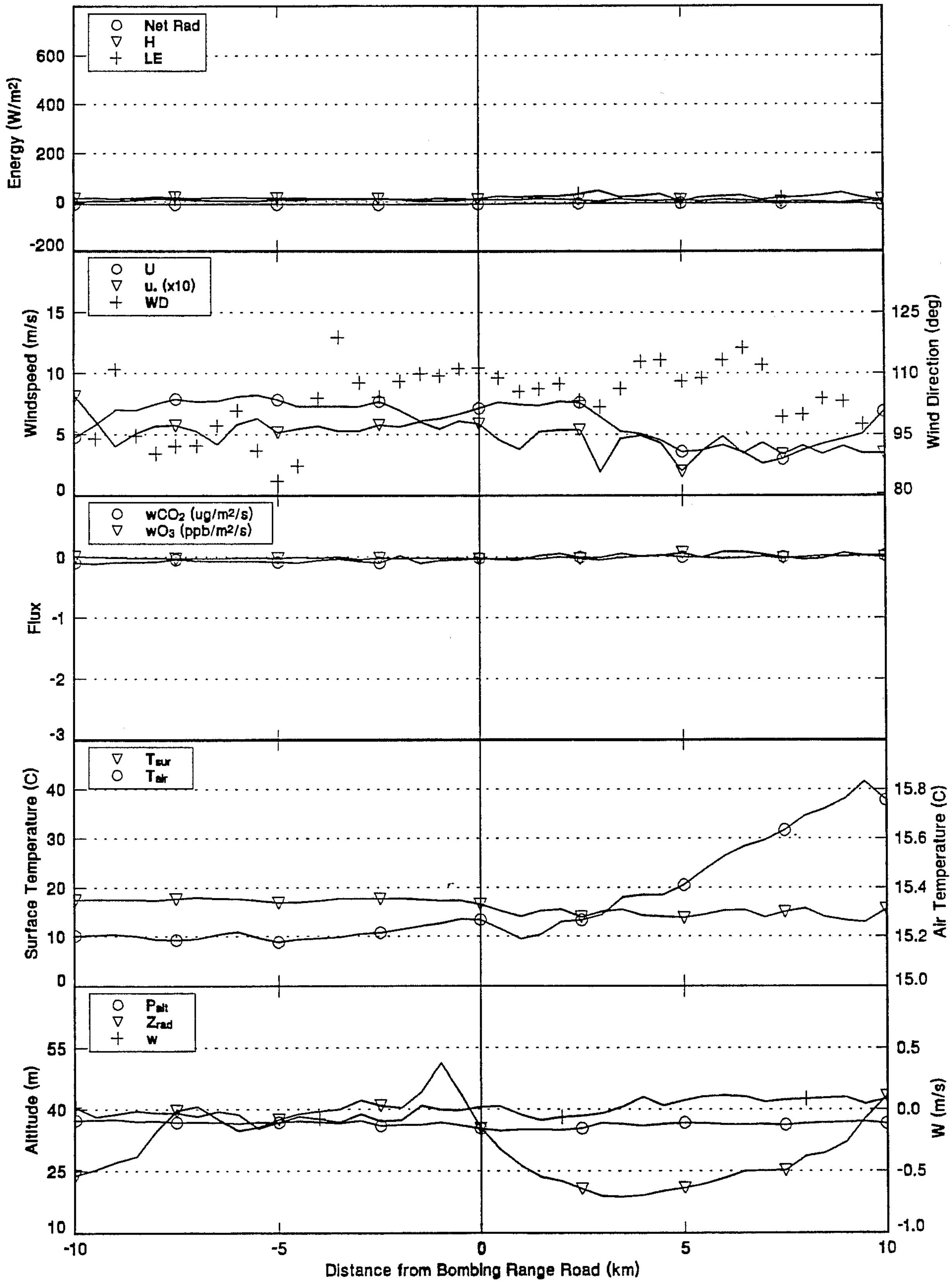
Boardman, Oregon June 04,1991 4 Transects Centered at: 0213 GMT(0913 PDT)

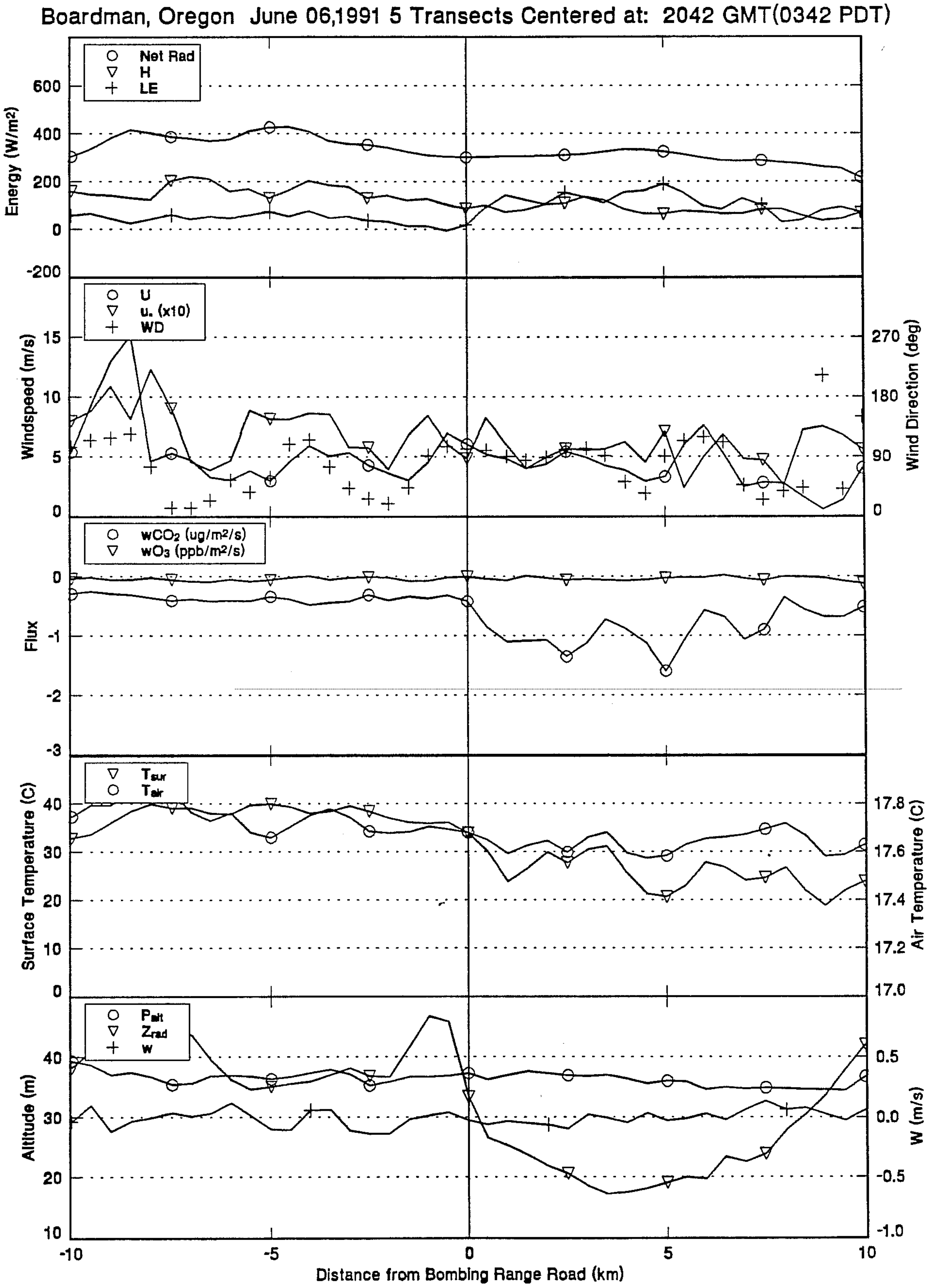


Boardman, Oregon June 06,1991 8 Transects Centered at: 0135 GMT(0835 PDT)

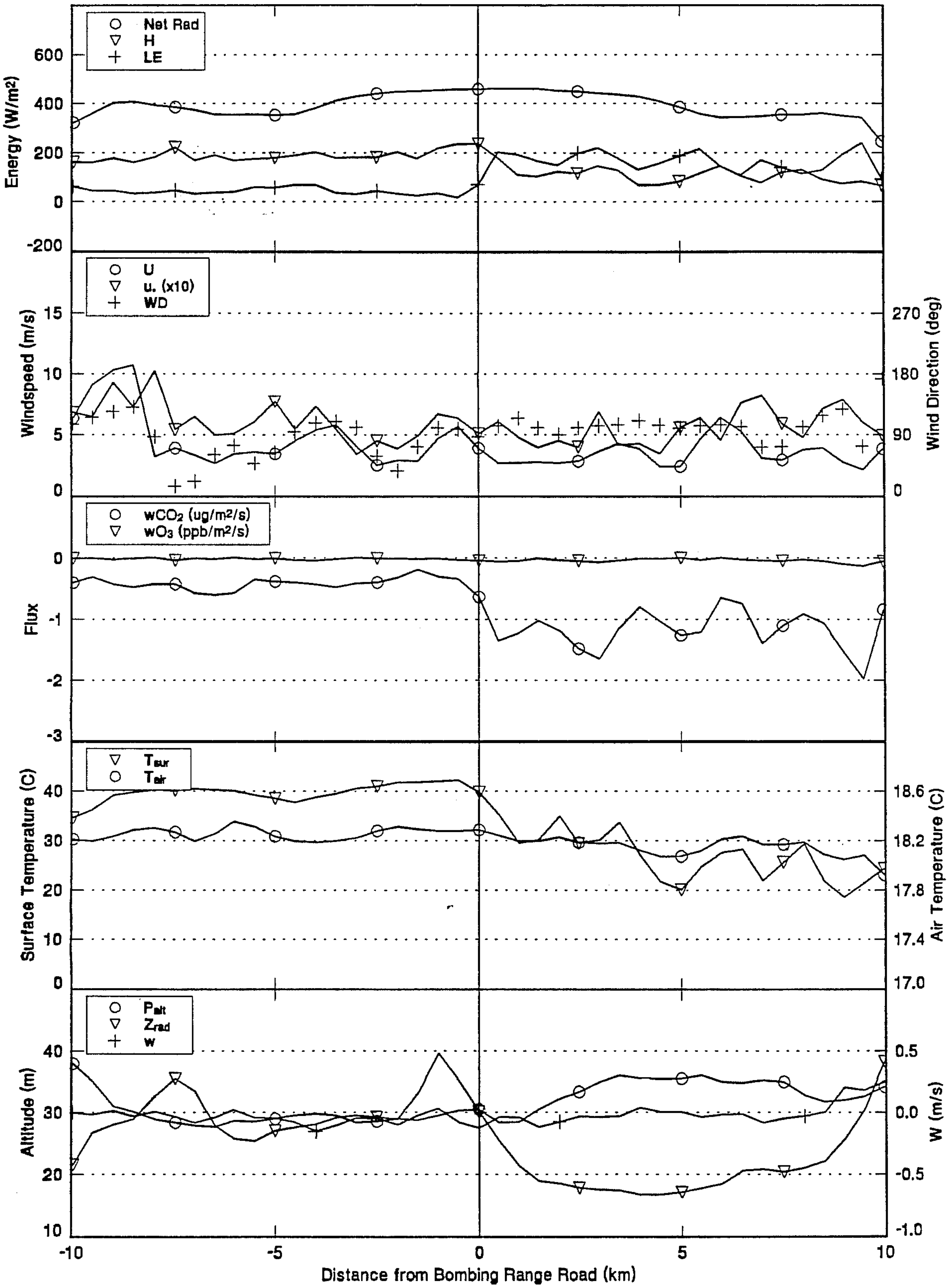


Boardman, Oregon June 06,1991 7 Transects Centered at: 0226 GMT(0926 PDT)

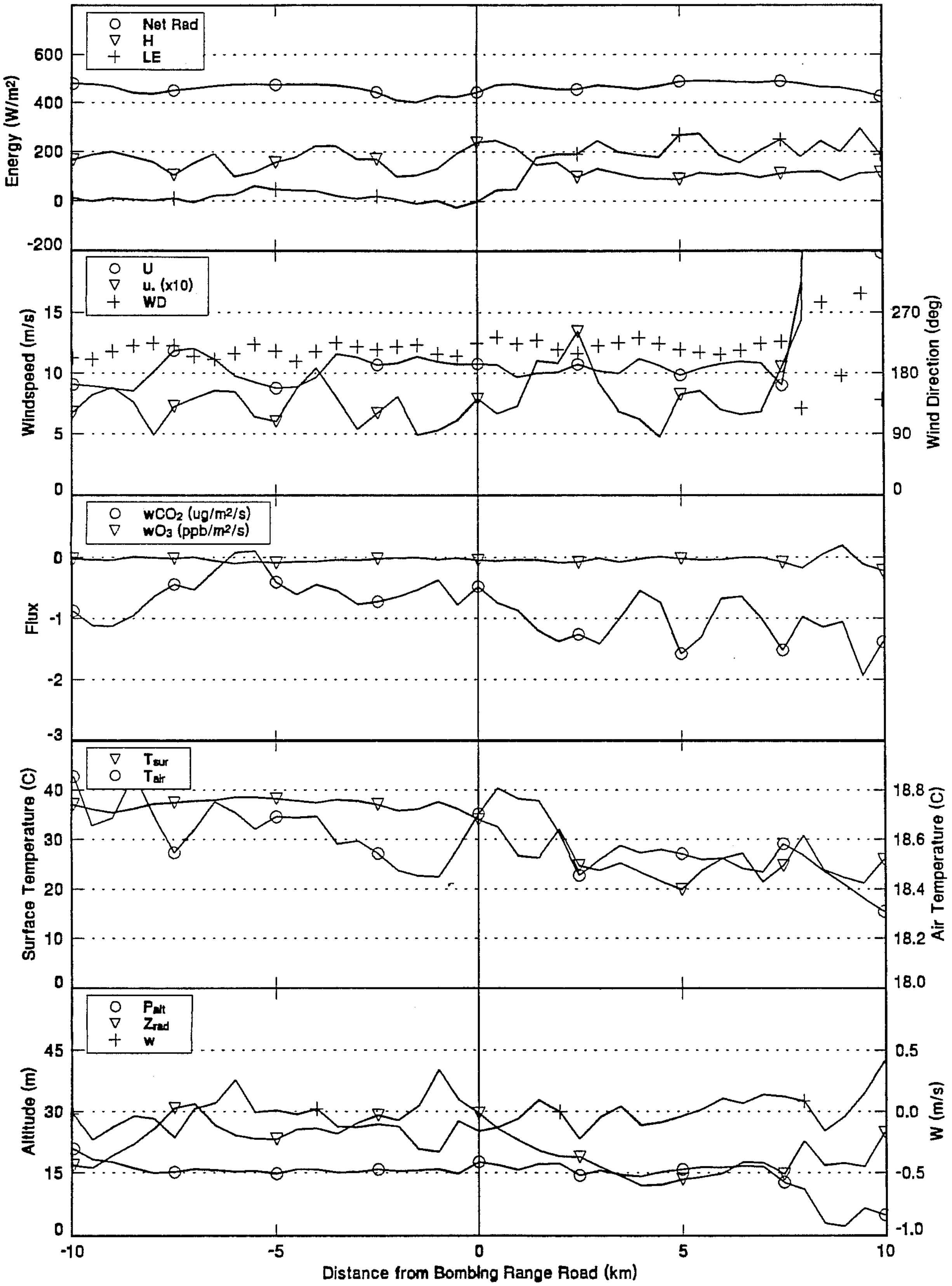



Boardman, Oregon June 06,1991 5 Transects Centered at: 2042 GMT(0342 PDT)
Net Rad
H
LE
Energy (W/m²)
600
400
200
0
-200
U
u. (x10)
WD
Windspeed (m/s)
15
10
5
0
270
180
90
0
Wind Direction (deg)
wCO₂ (ug/m²/s)
wO₃ (ppb/m²/s)
Flux
0
-1
-2
-3
T_sur
T_air
Surface Temperature (C)
40
30
20
10
0
17.8
17.6
17.4
17.2
17.0
Air Temperature (C)
P_alt
Z_rad
w
Altitude (m)
40
30
20
10
0.5
0.0
-0.5
-1.0
W (m/s)
-10
-5
0
5
10
Distance from Bombing Range Road (km)

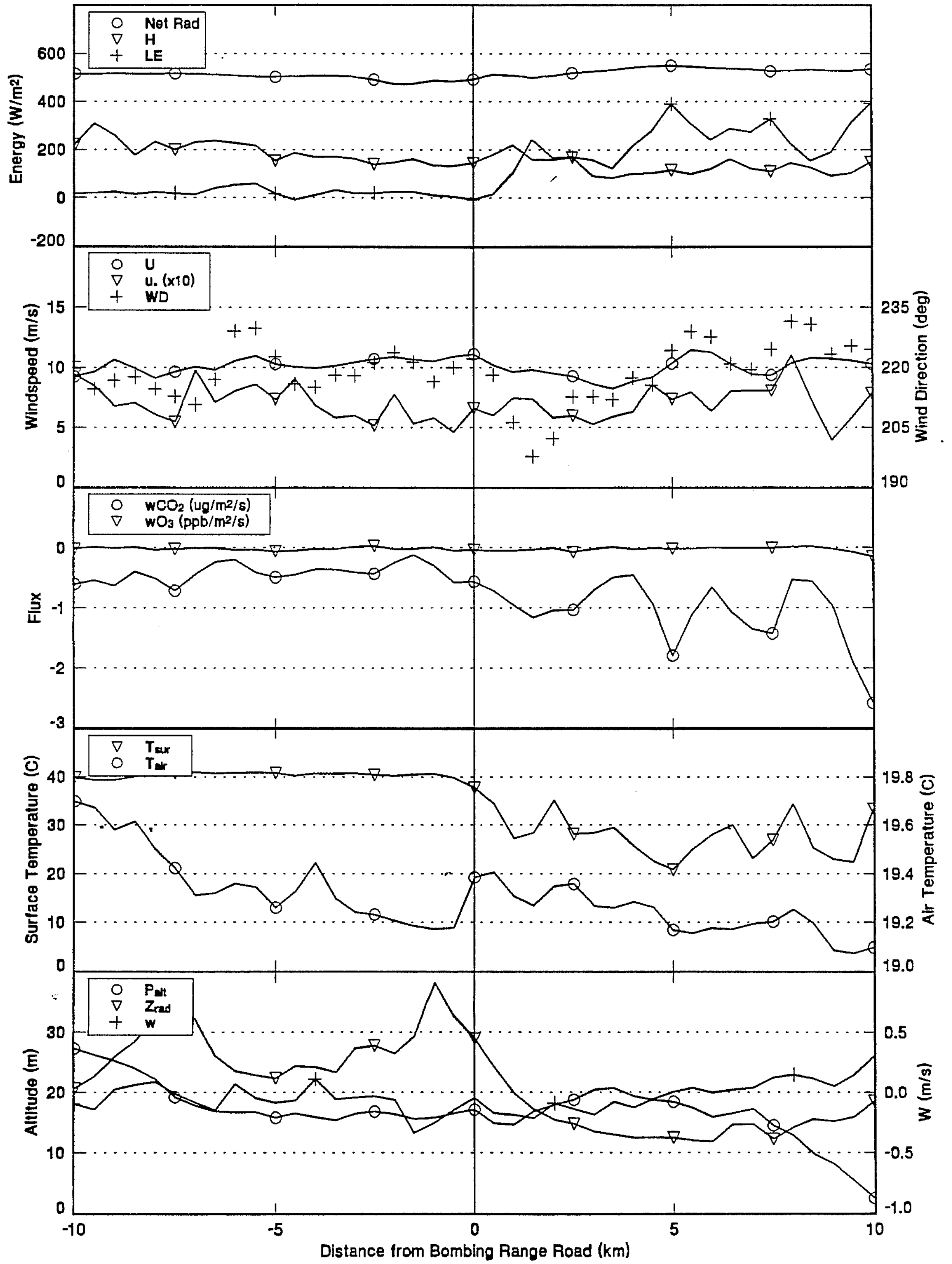
Boardman, Oregon June 06,1991 8 Transects Centered at: 2130 GMT(0430 PDT)



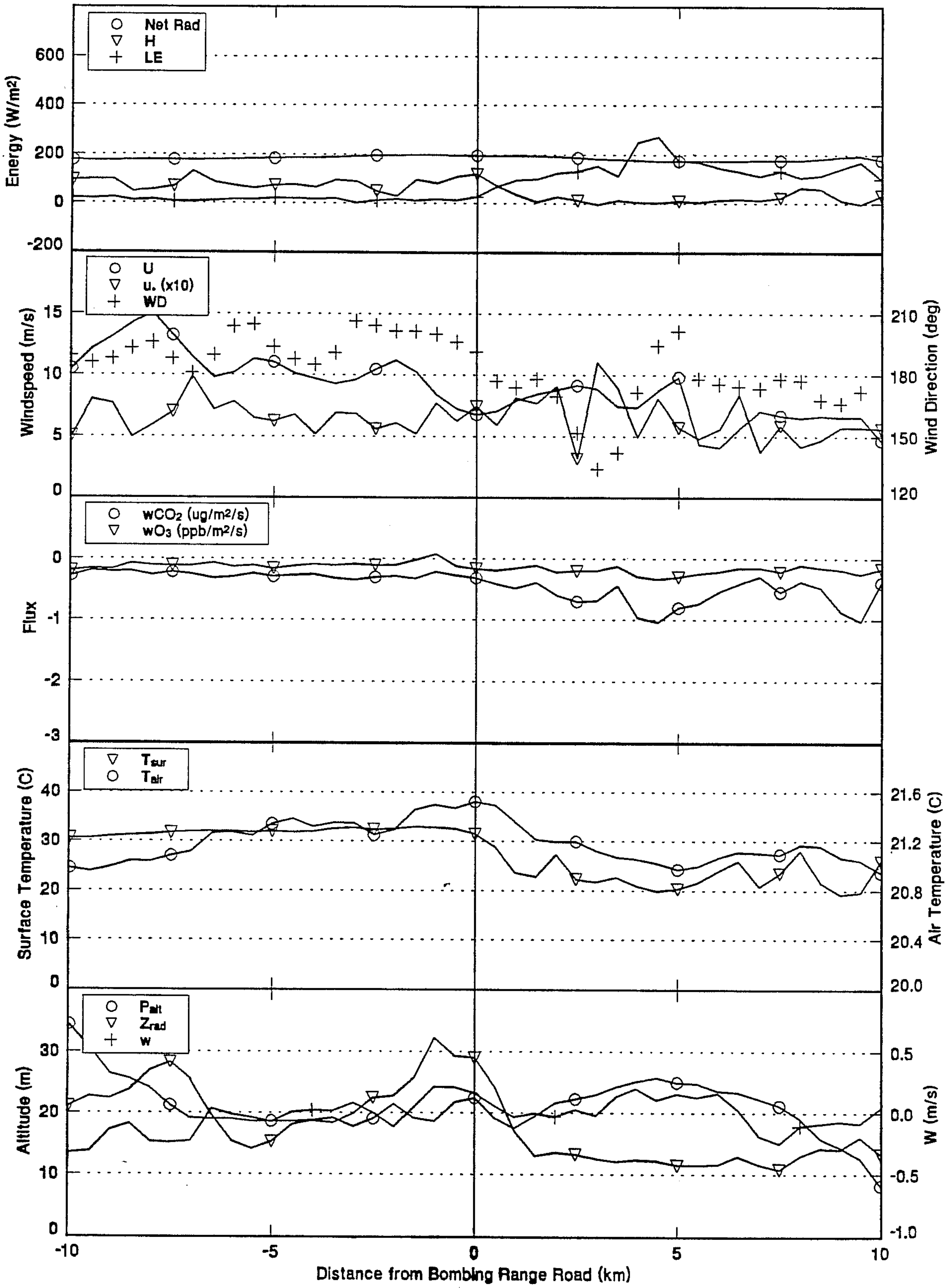
Boardman, Oregon June 07,1991 7 Transects Centered at: 1732 GMT(0032 PDT)



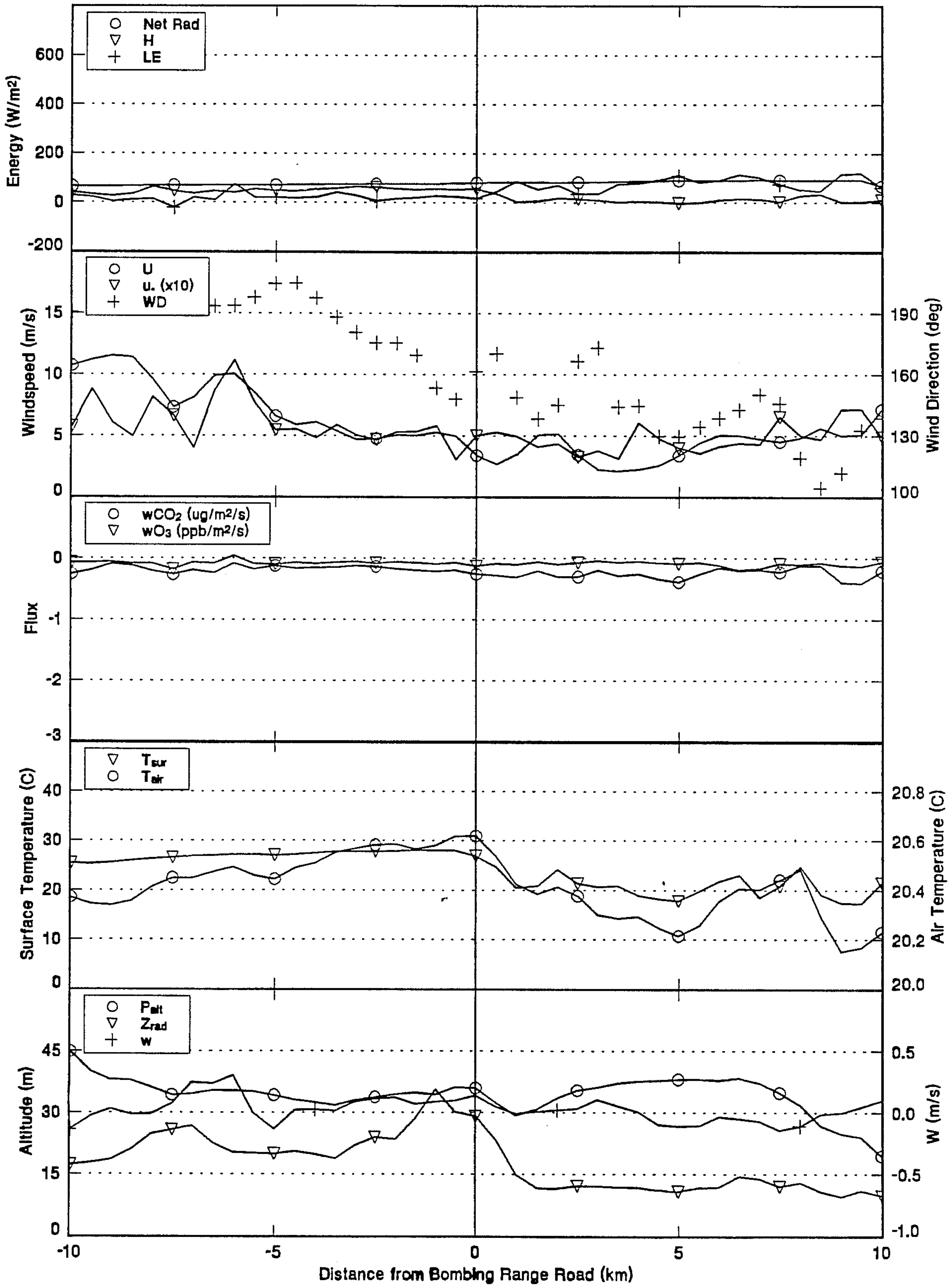
Boardman, Oregon June 07,1991 7 Transects Centered at: 1822 GMT(0122 PDT)



Boardman, Oregon June 07,1991 5 Transects Centered at: 2334 GMT(0634 PDT)



Boardman, Oregon June 08,1991 6 Transects Centered at: 0042 GMT(0742 PDT)



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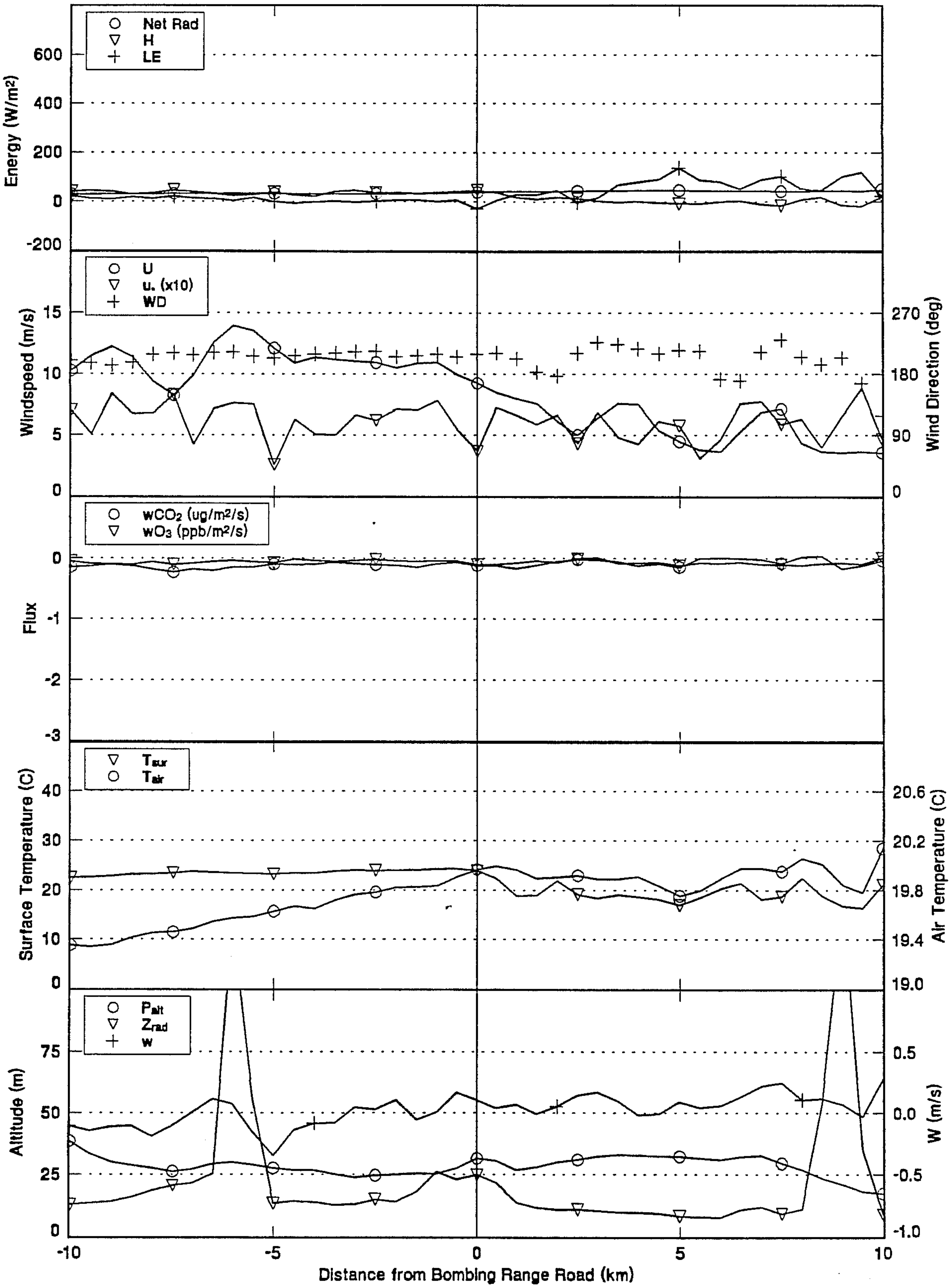

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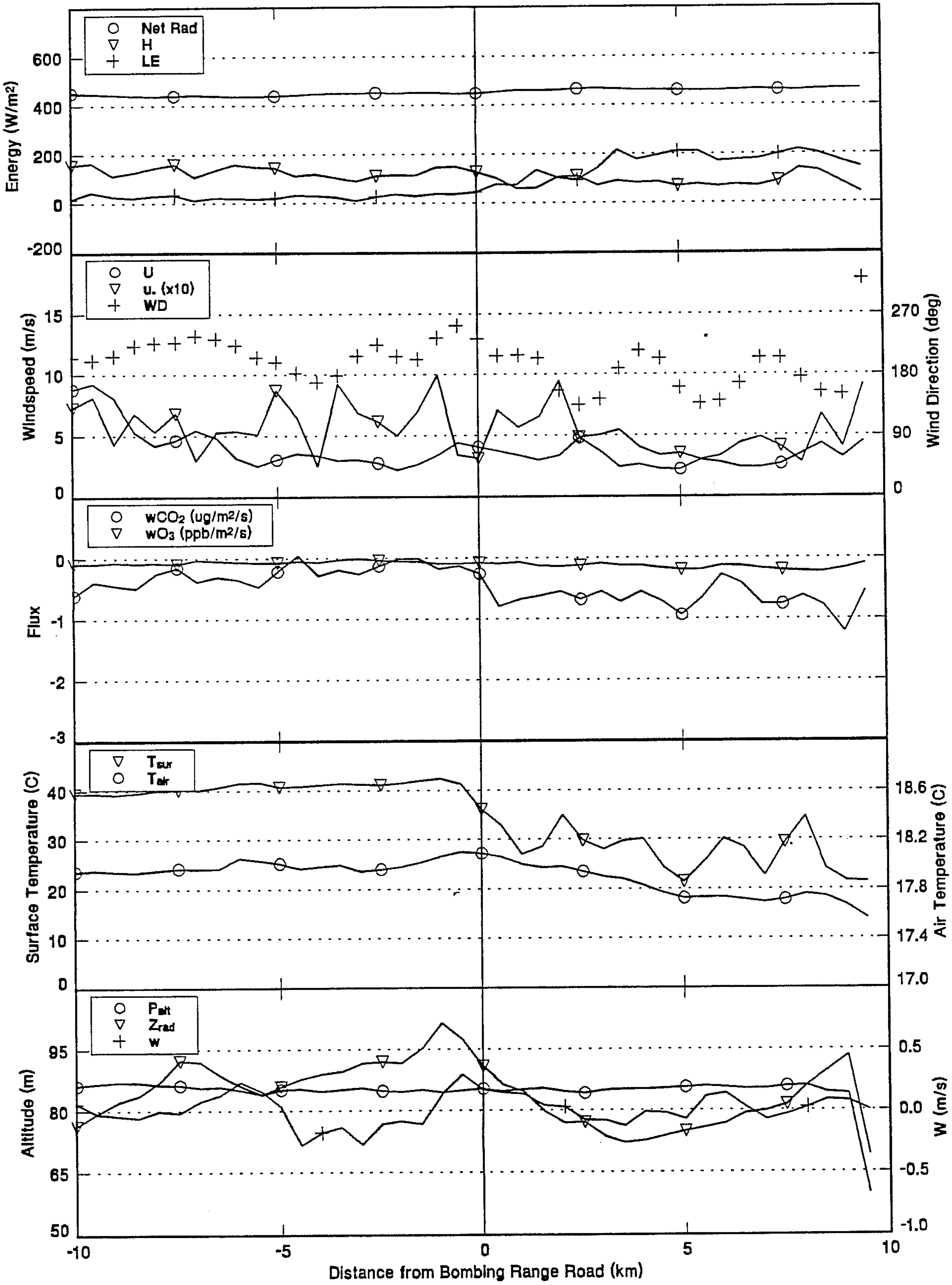
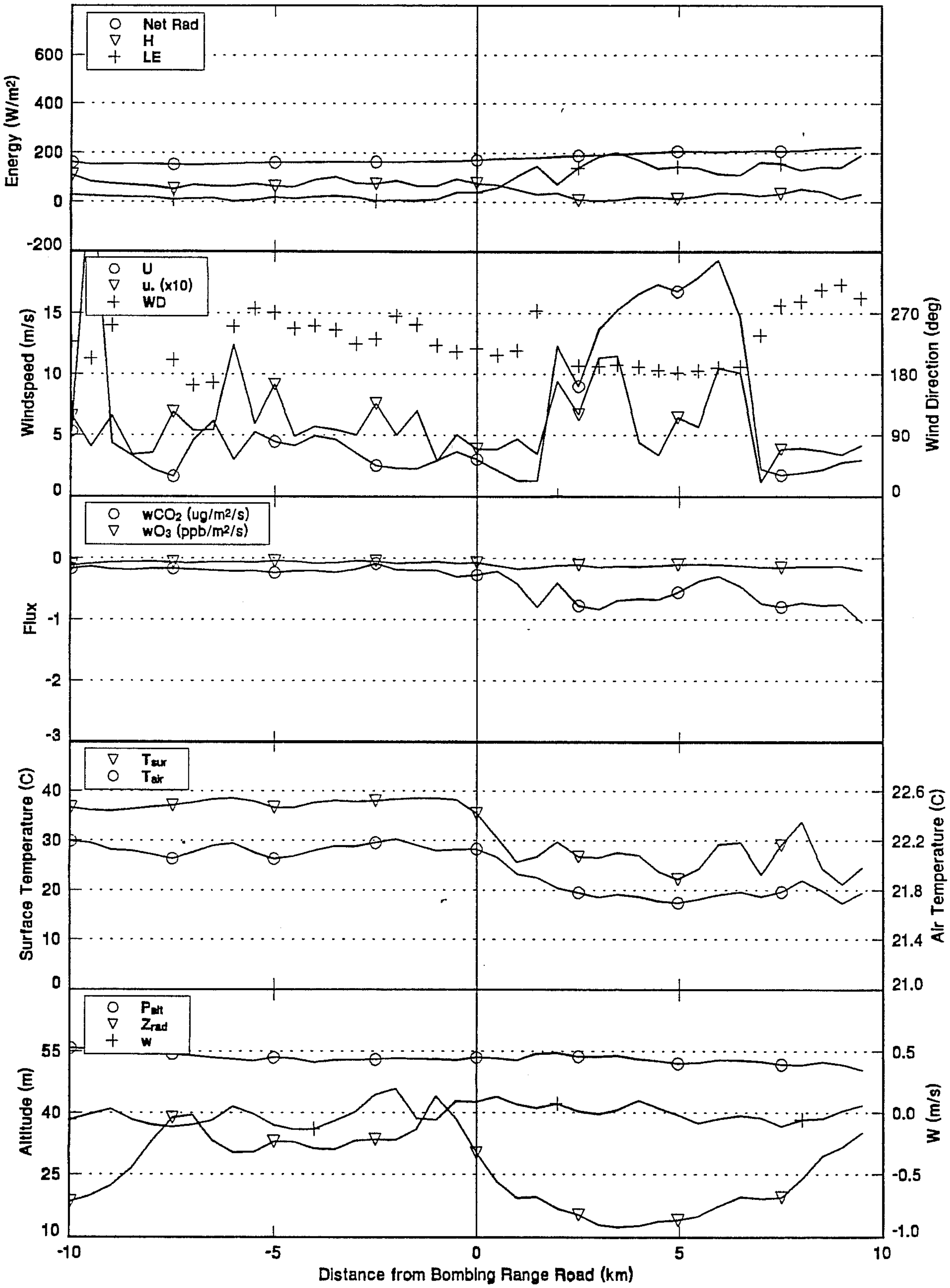
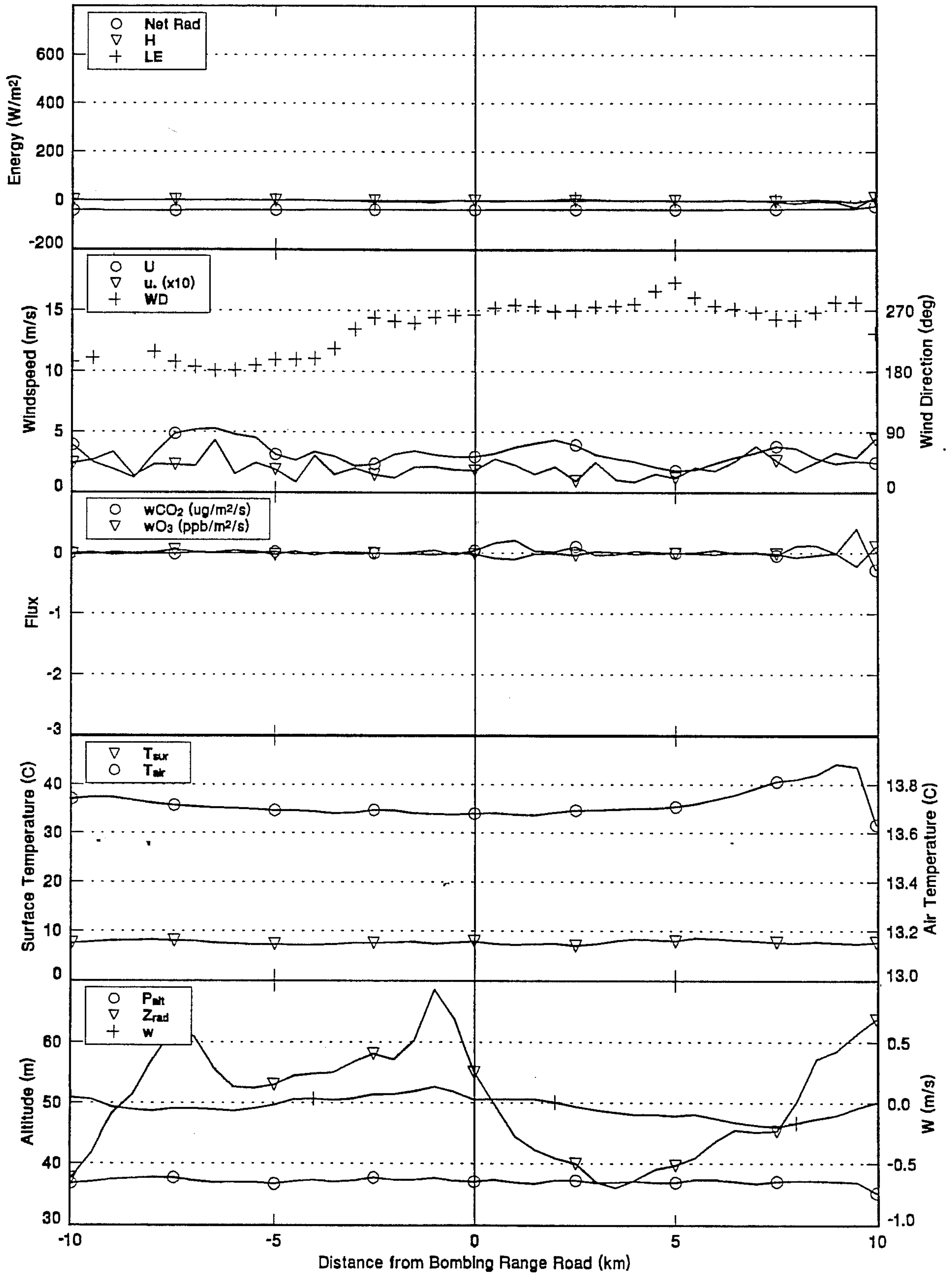


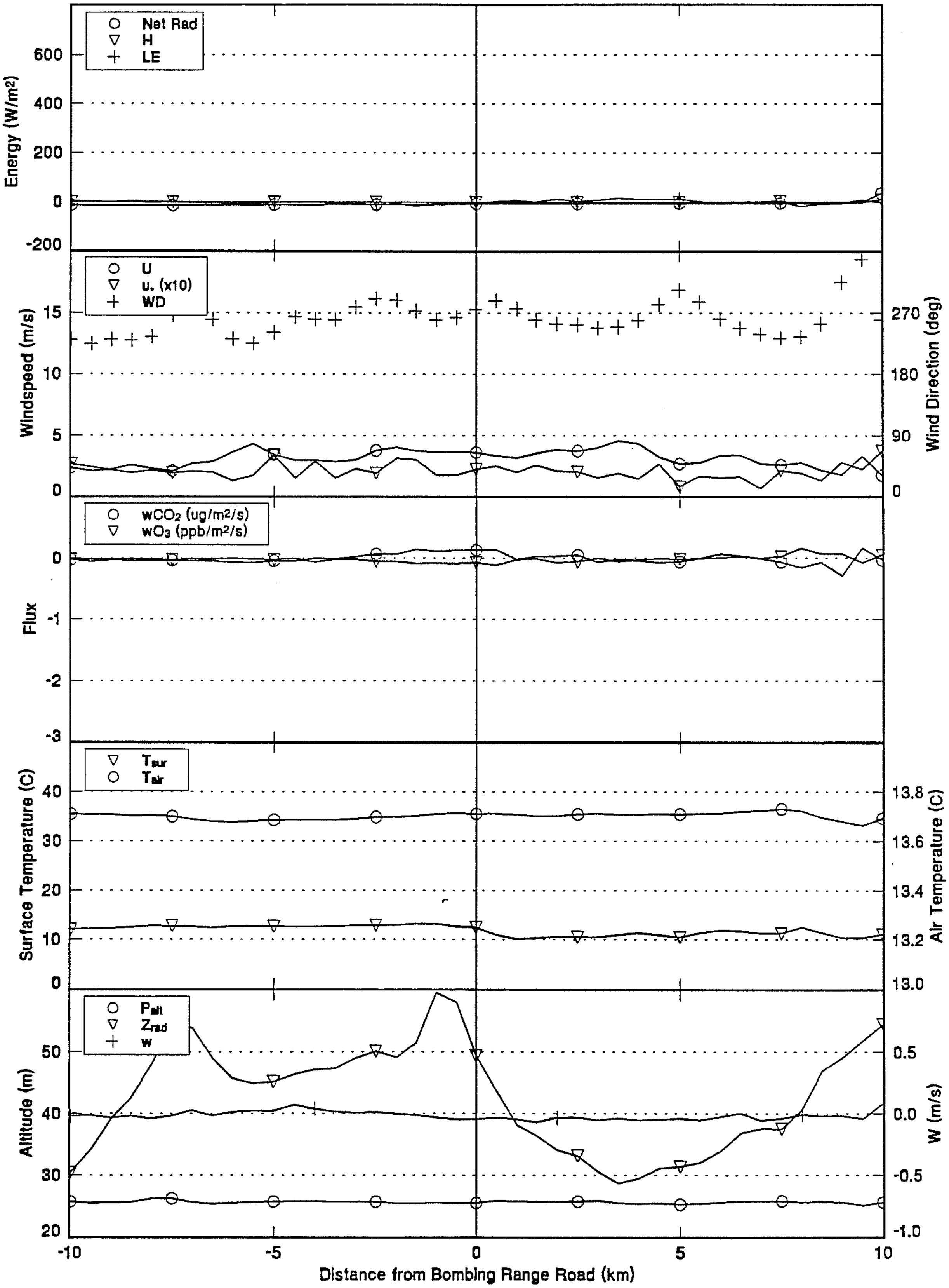
Boardman, Oregon June 08,1991 6 Transects Centered at: 2325 GMT(0625 PDT)



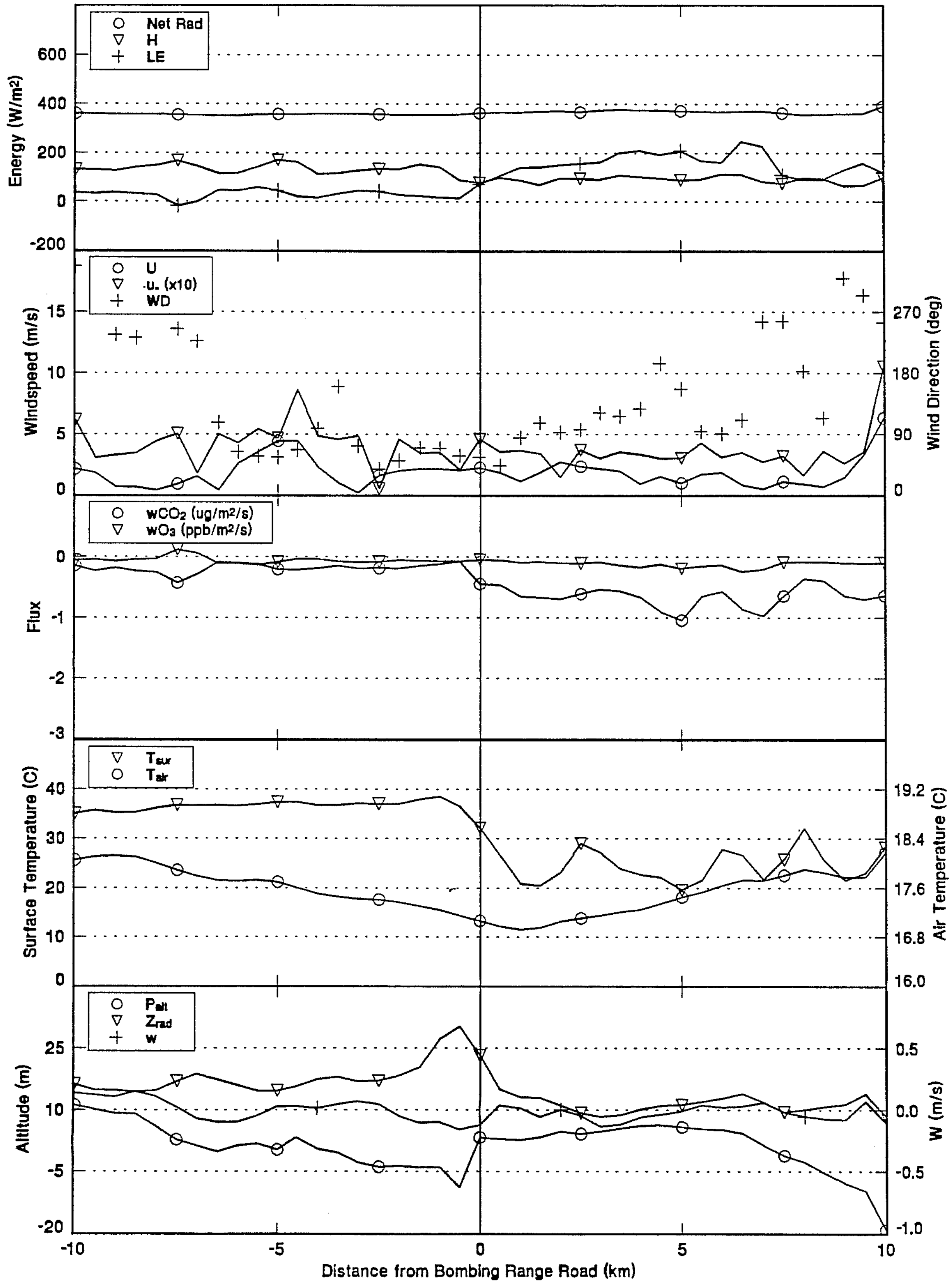
Boardman, Oregon June 09,1991 5 Transects Centered at: 1232 GMT(1932 PDT)



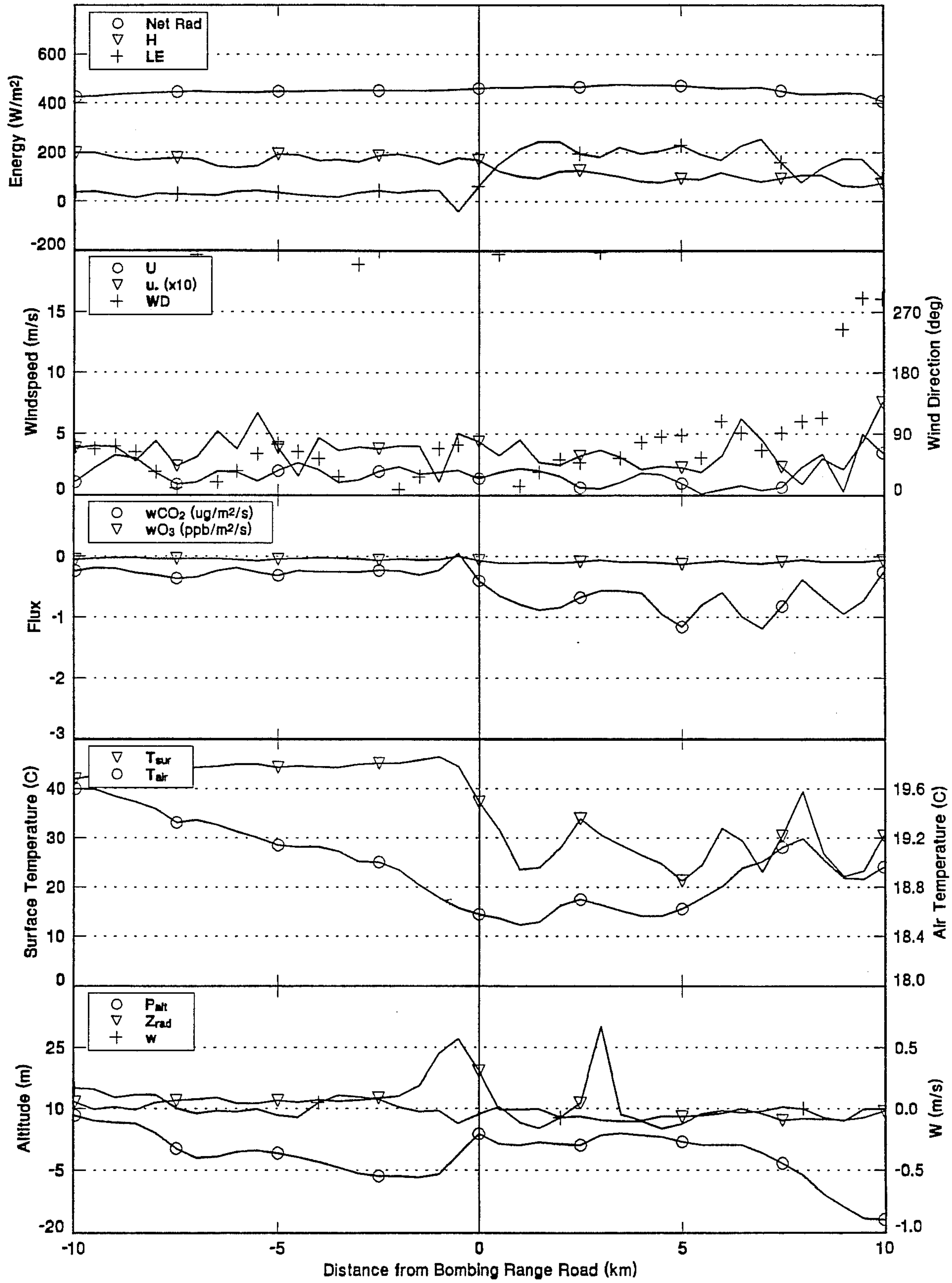
Boardman, Oregon June 09,1991 7 Transects Centered at: 1330 GMT(2030 PDT)



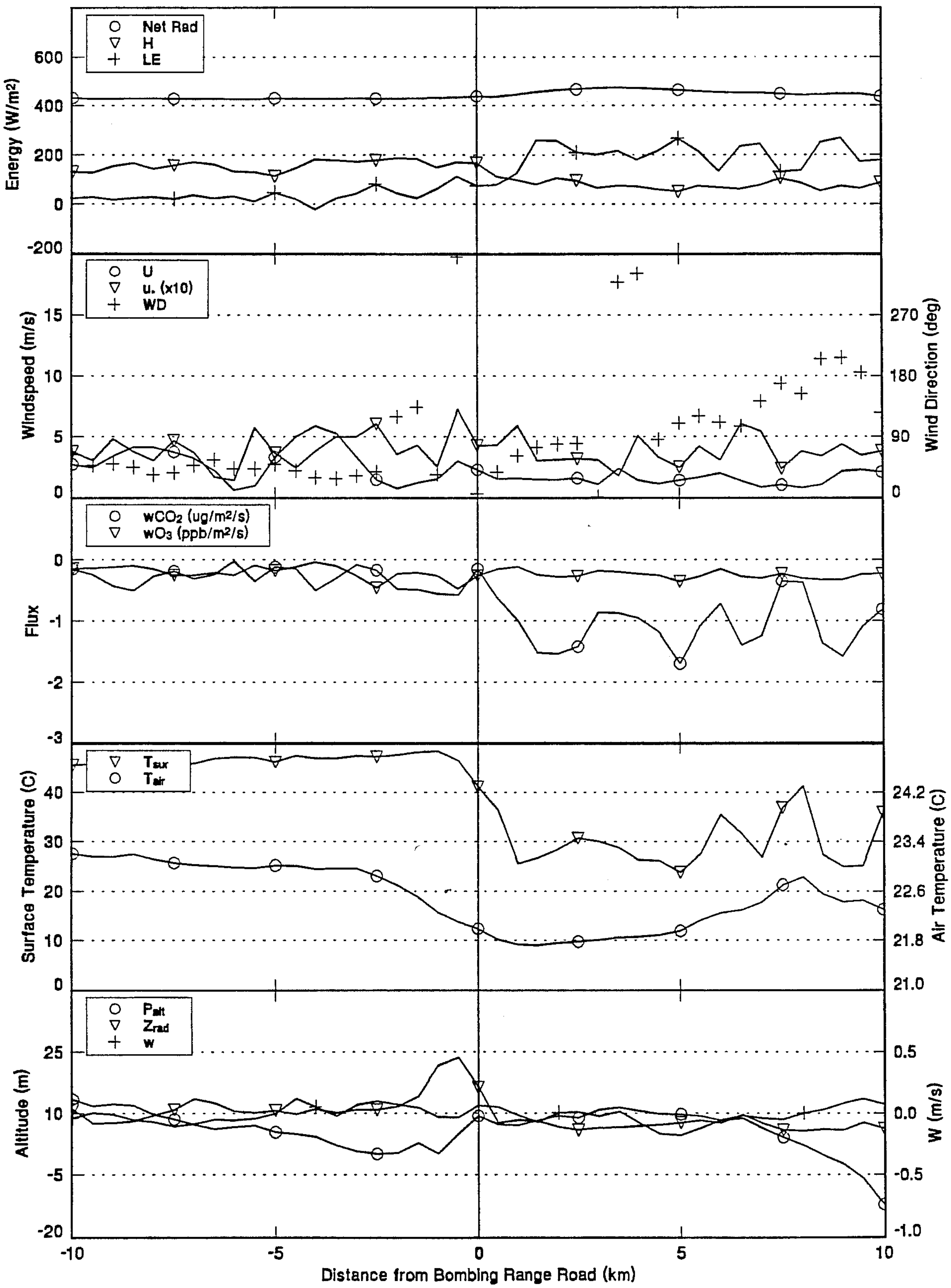
Boardman, Oregon June 09,1991 7 Transects Centered at: 1633 GMT(2333 PDT)



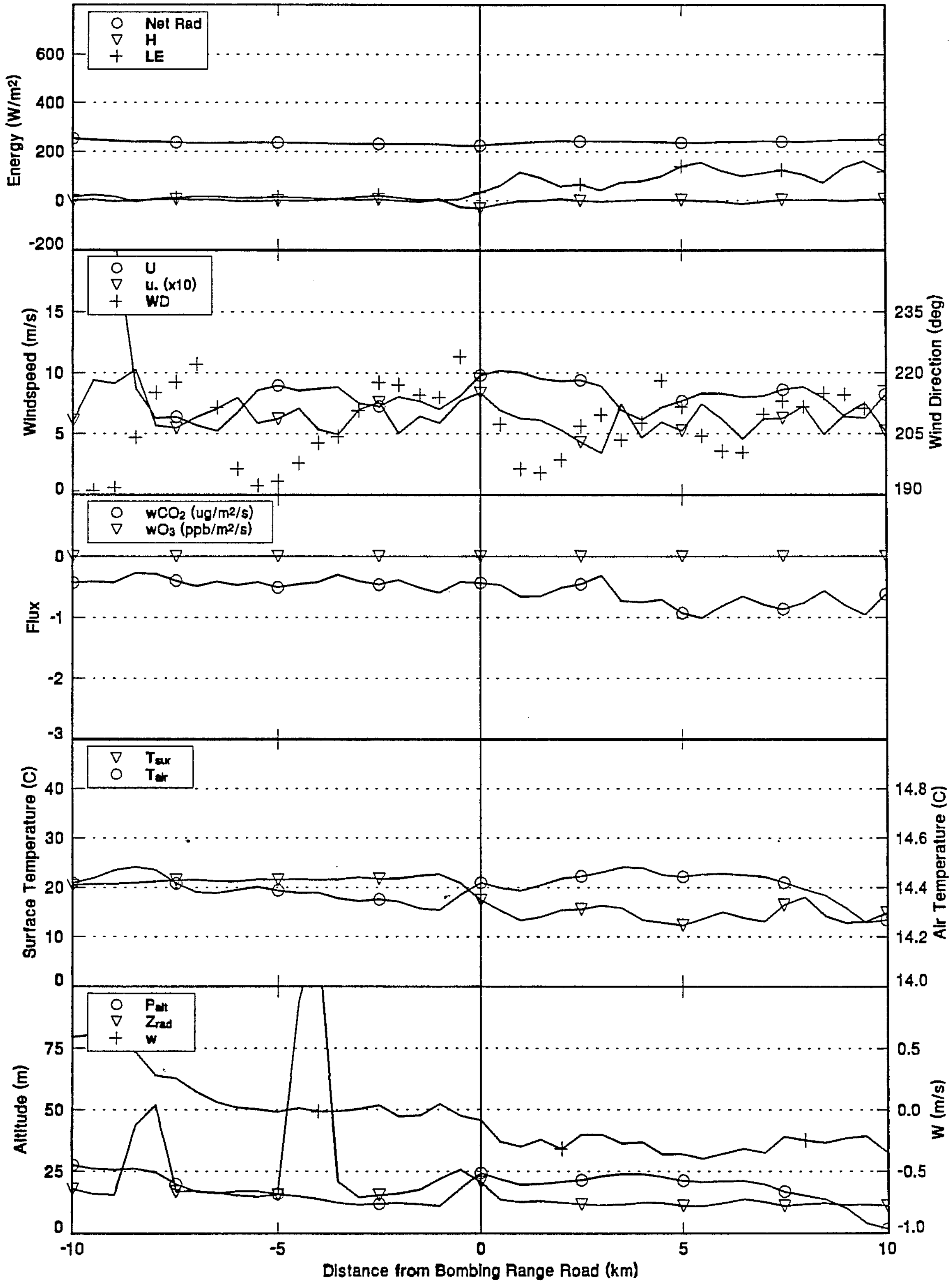
Boardman, Oregon June 09,1991 7 Transects Centered at: 1729 GMT(0029 PDT)



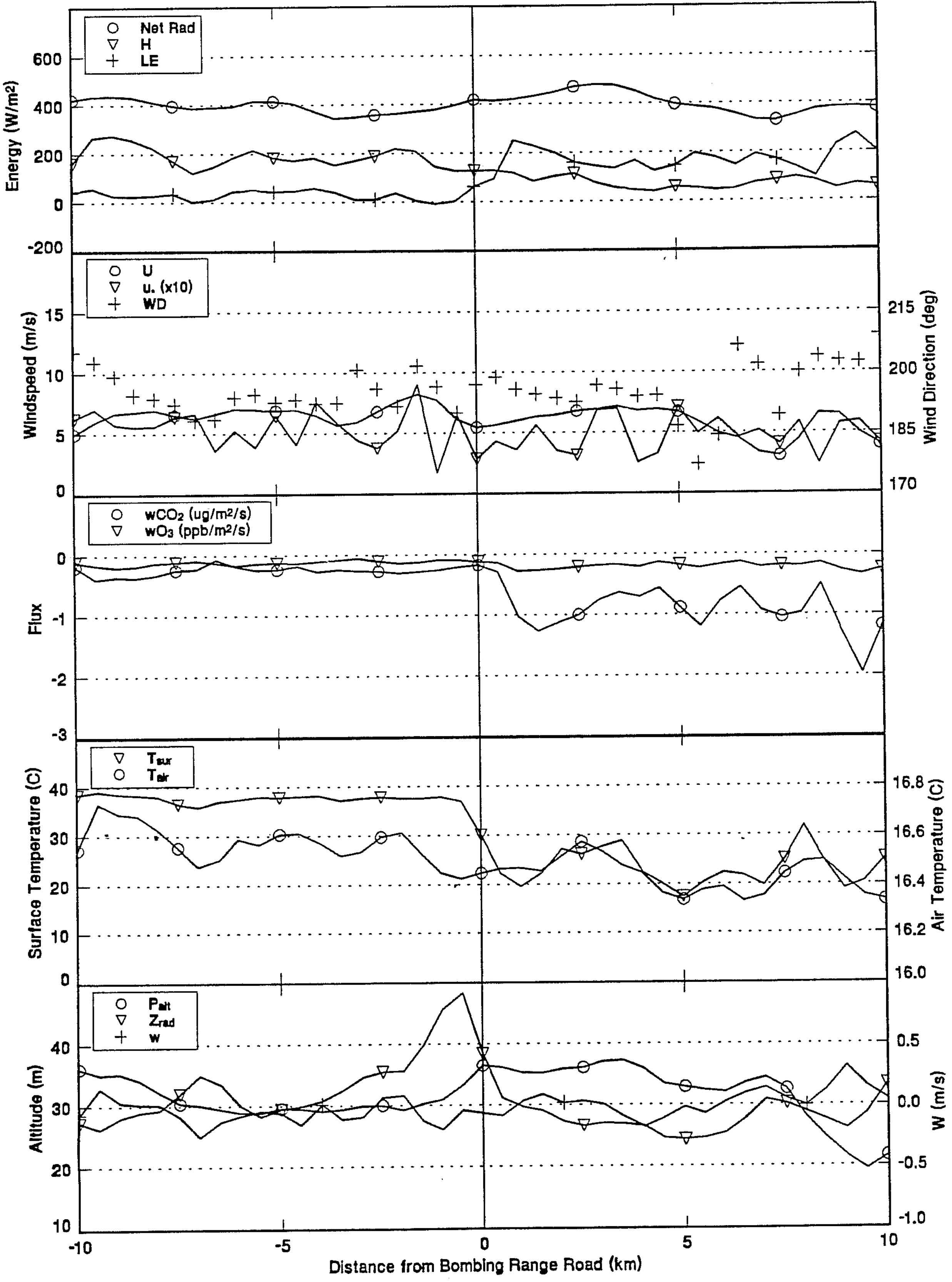
Boardman, Oregon June 10,1991 5 Transects Centered at: 1723 GMT(0023 PDT)



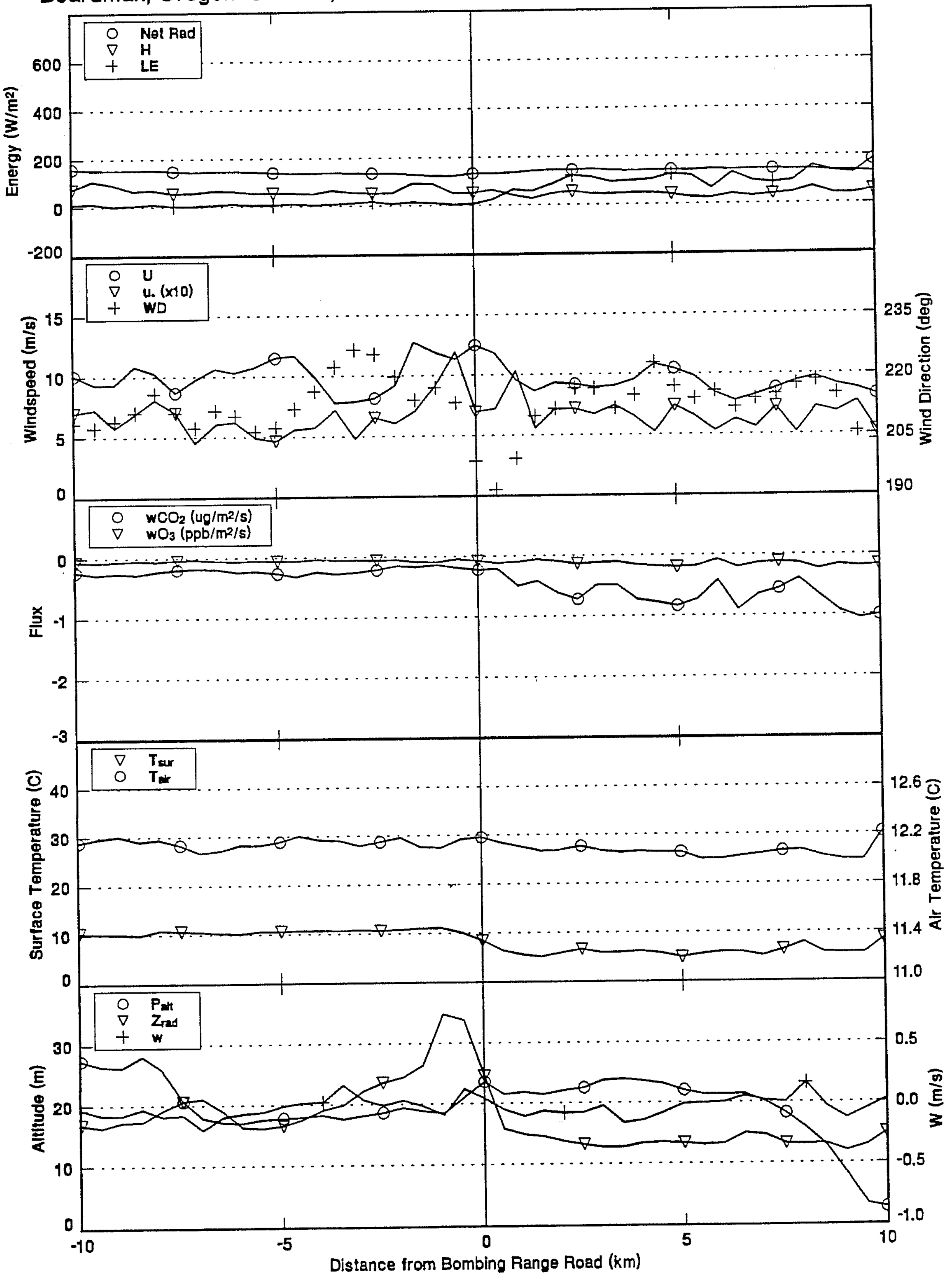
Boardman, Oregon June 12,1991 5 Transects Centered at: 1525 GMT(2225 PDT)



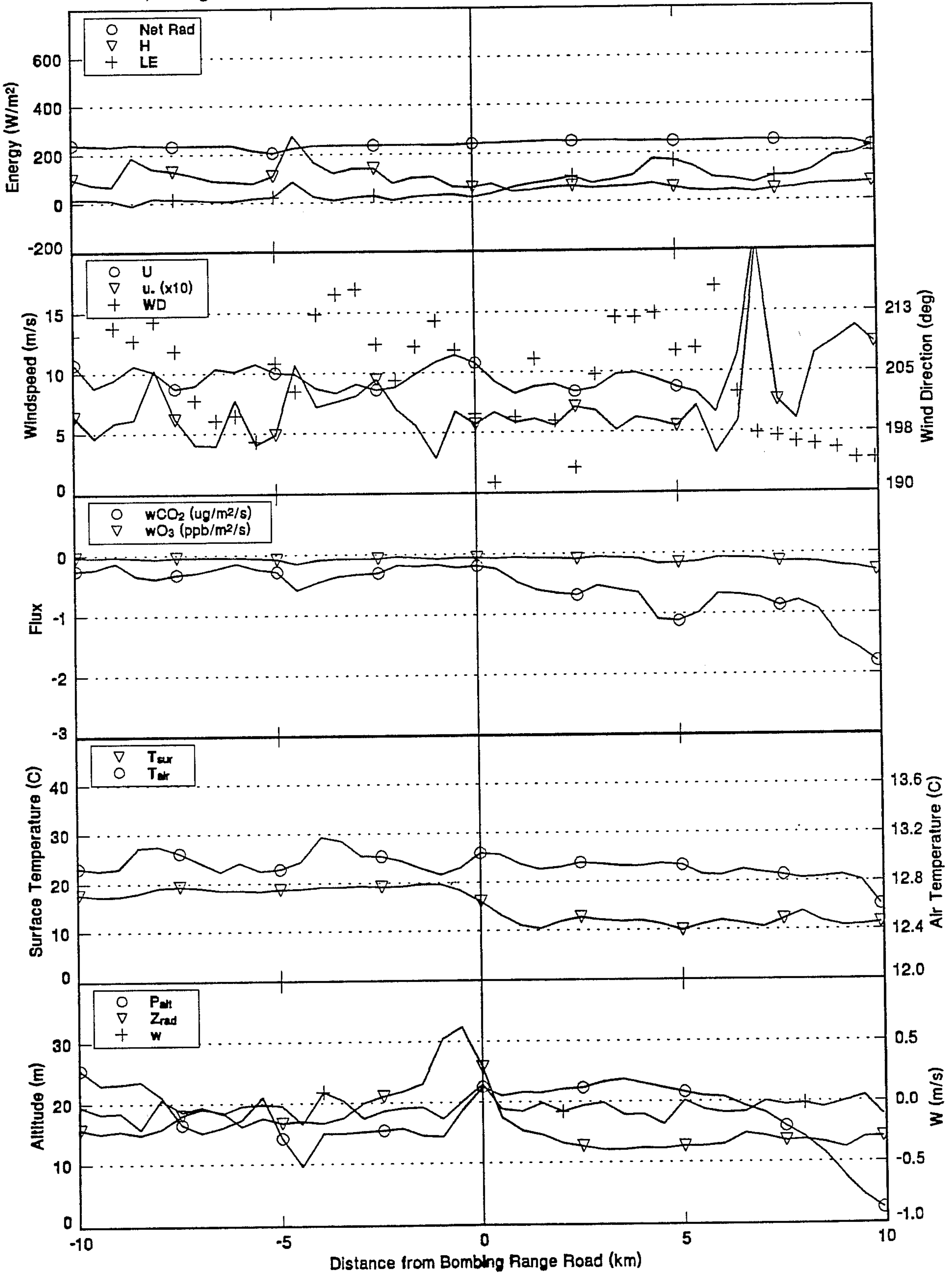
Boardman, Oregon June 13,1991 7 Transects Centered at: 1934 GMT(0234 PDT)



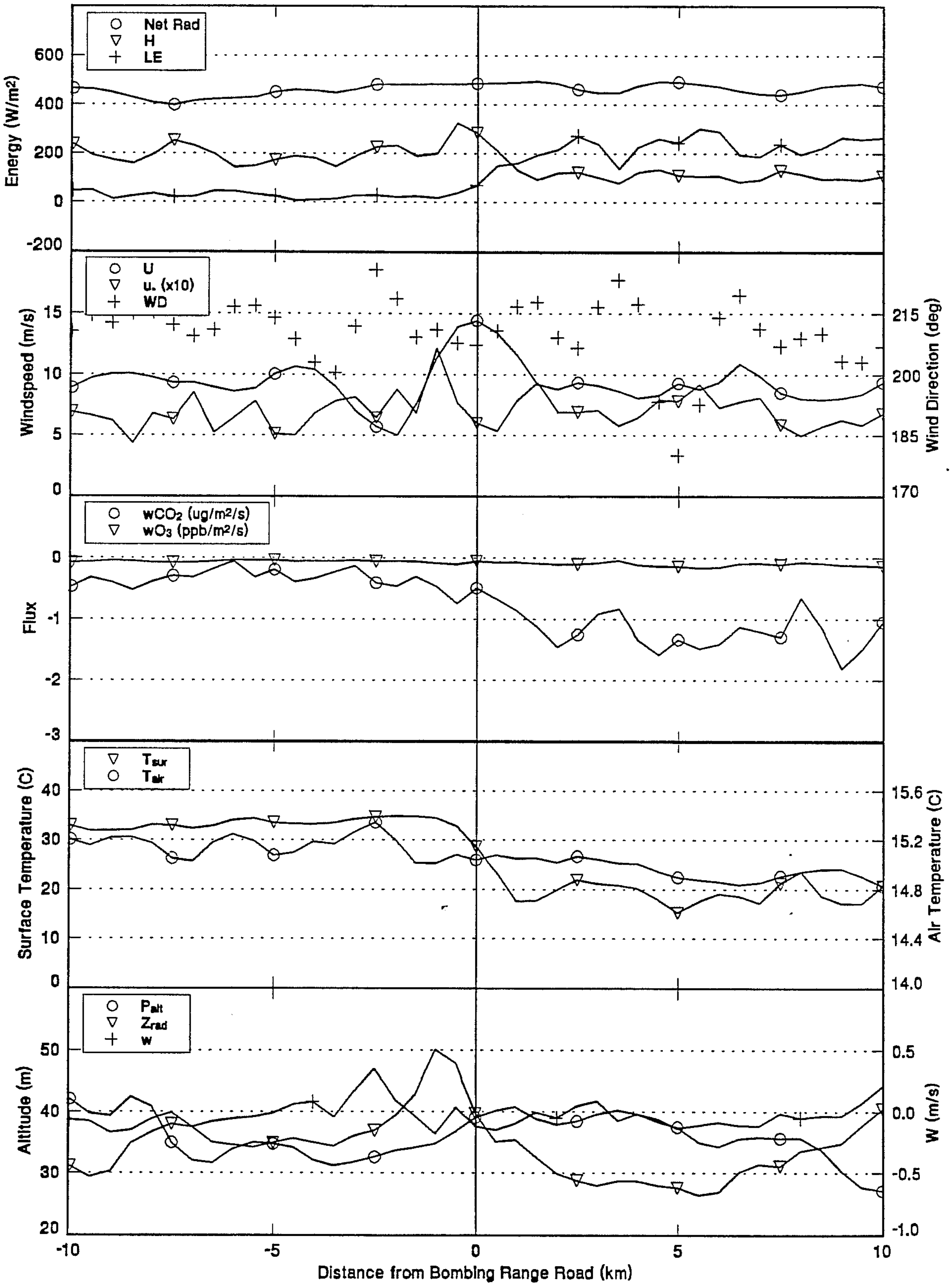
Boardman, Oregon June 14,1991 5 Transects Centered at: 1431 GMT(2131 PDT)



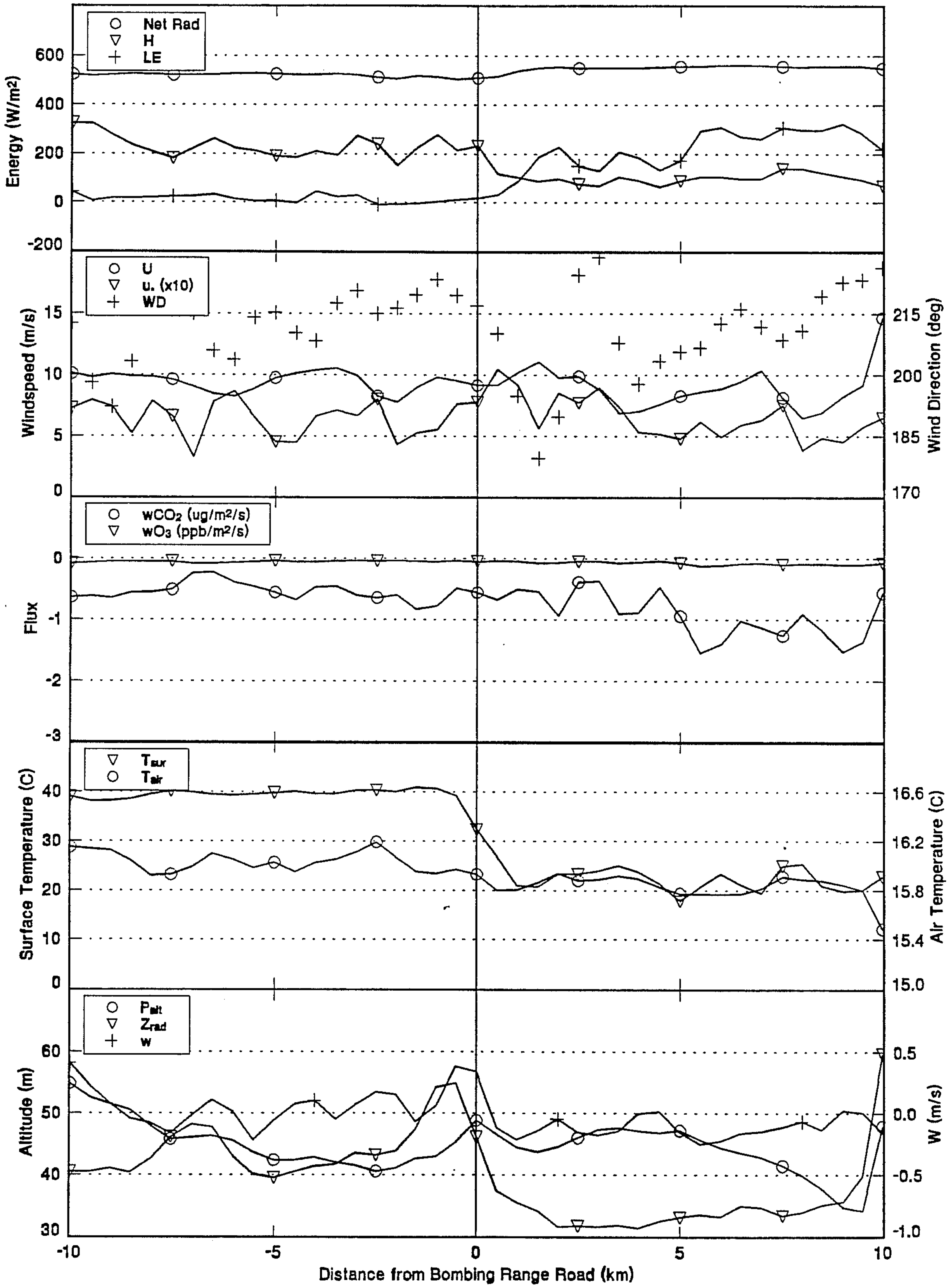
Boardman, Oregon June 14,1991 6 Transects Centered at: 1518 GMT(2218 PDT)



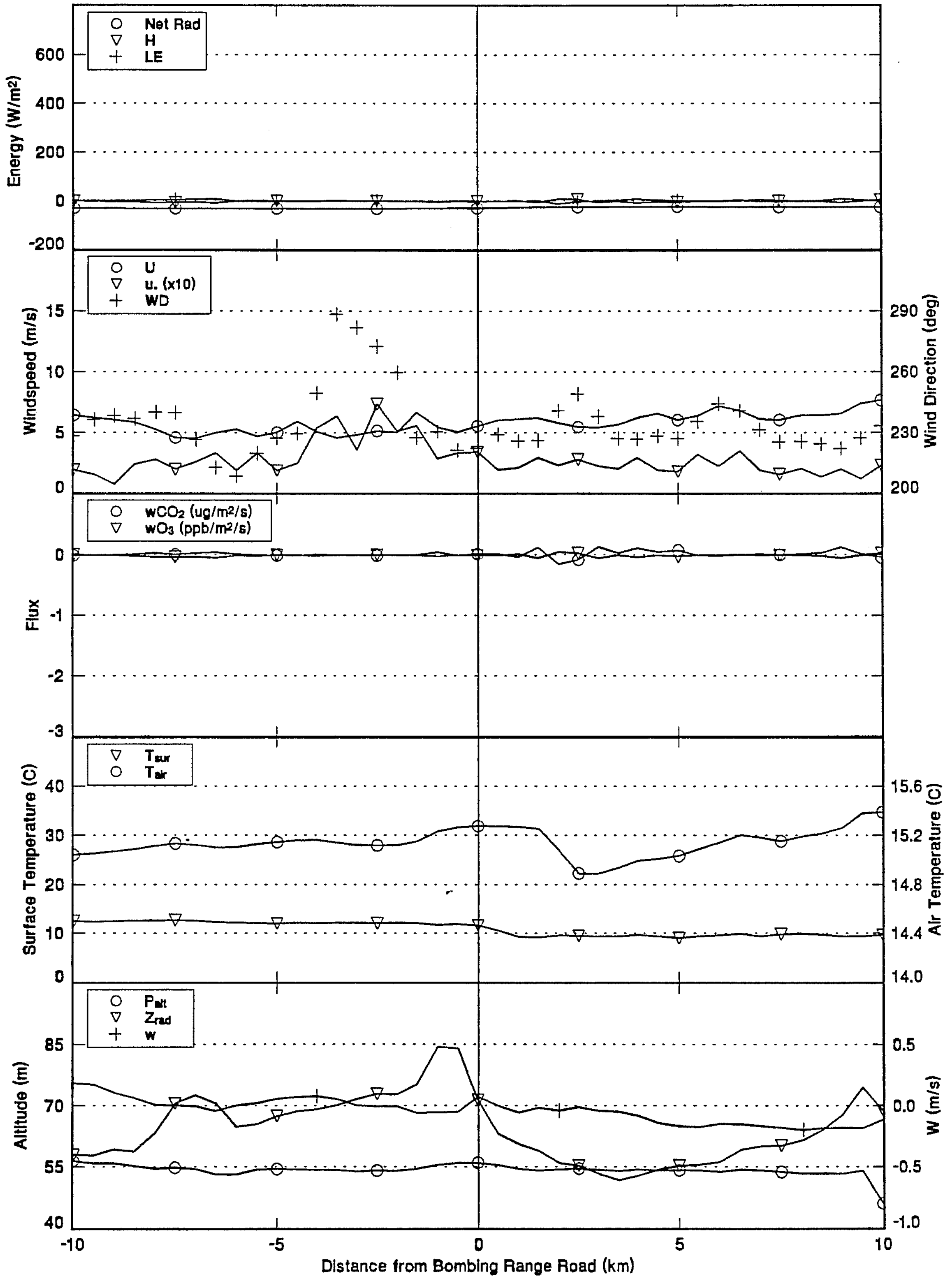
Boardman, Oregon June 14,1991 6 Transects Centered at: 1736 GMT(0036 PDT)



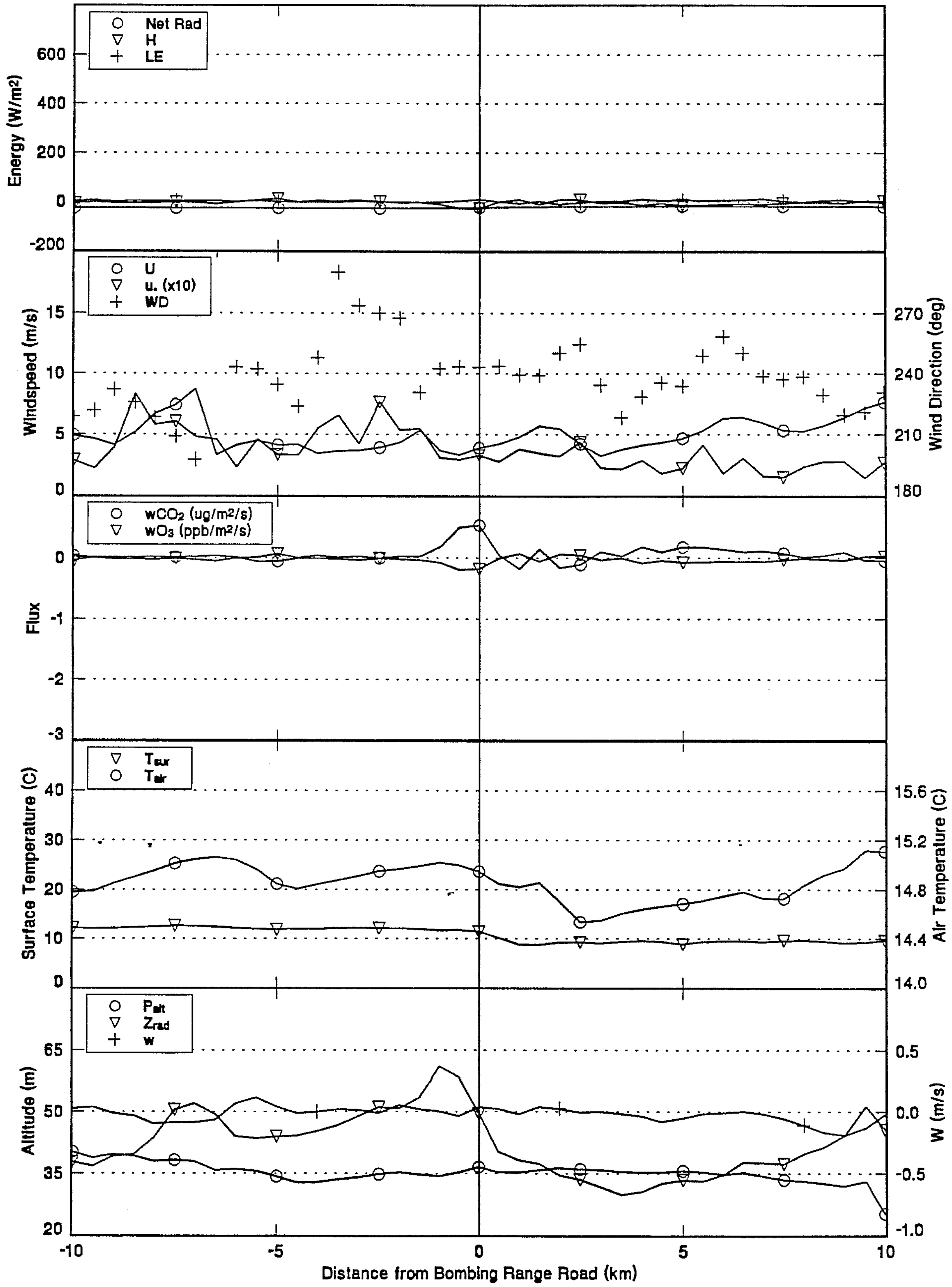
Boardman, Oregon June 14,1991 7 Transects Centered at: 1834 GMT(0134 PDT)



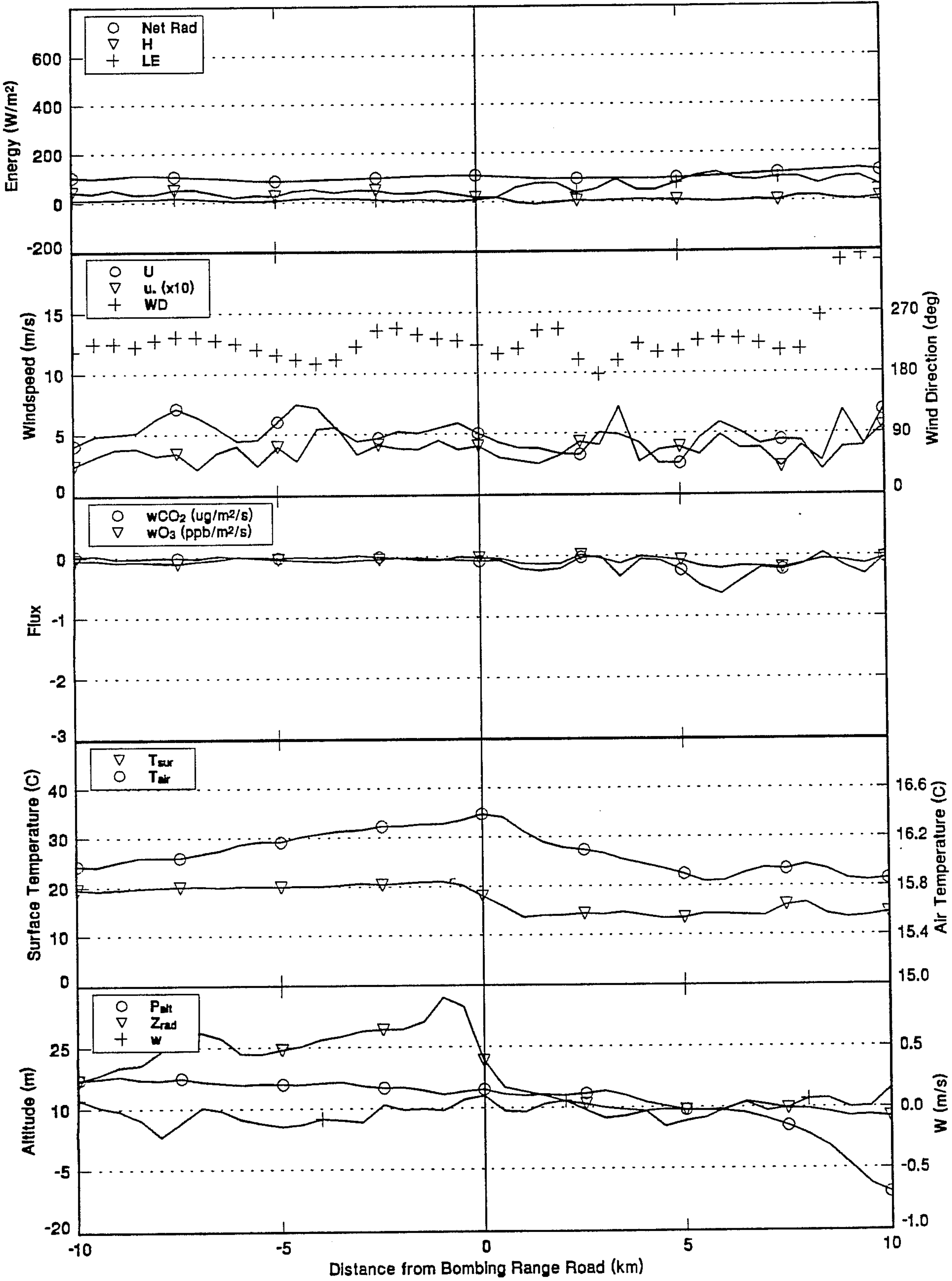
Boardman, Oregon June 15,1991 6 Transects Centered at: 1139 GMT(1839 PDT)



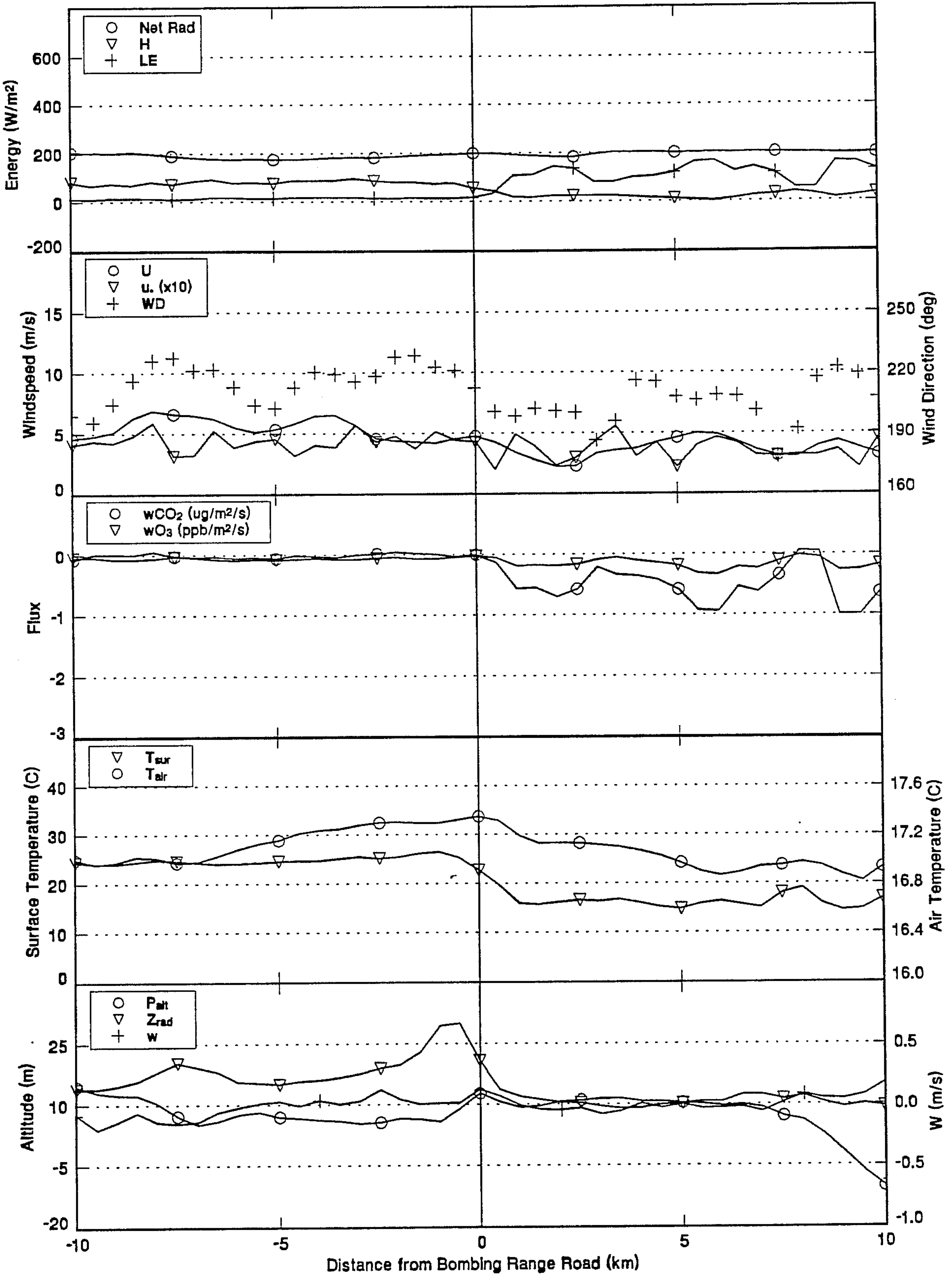
Boardman, Oregon June 15,1991 6 Transects Centered at: 1222 GMT(1922 PDT)



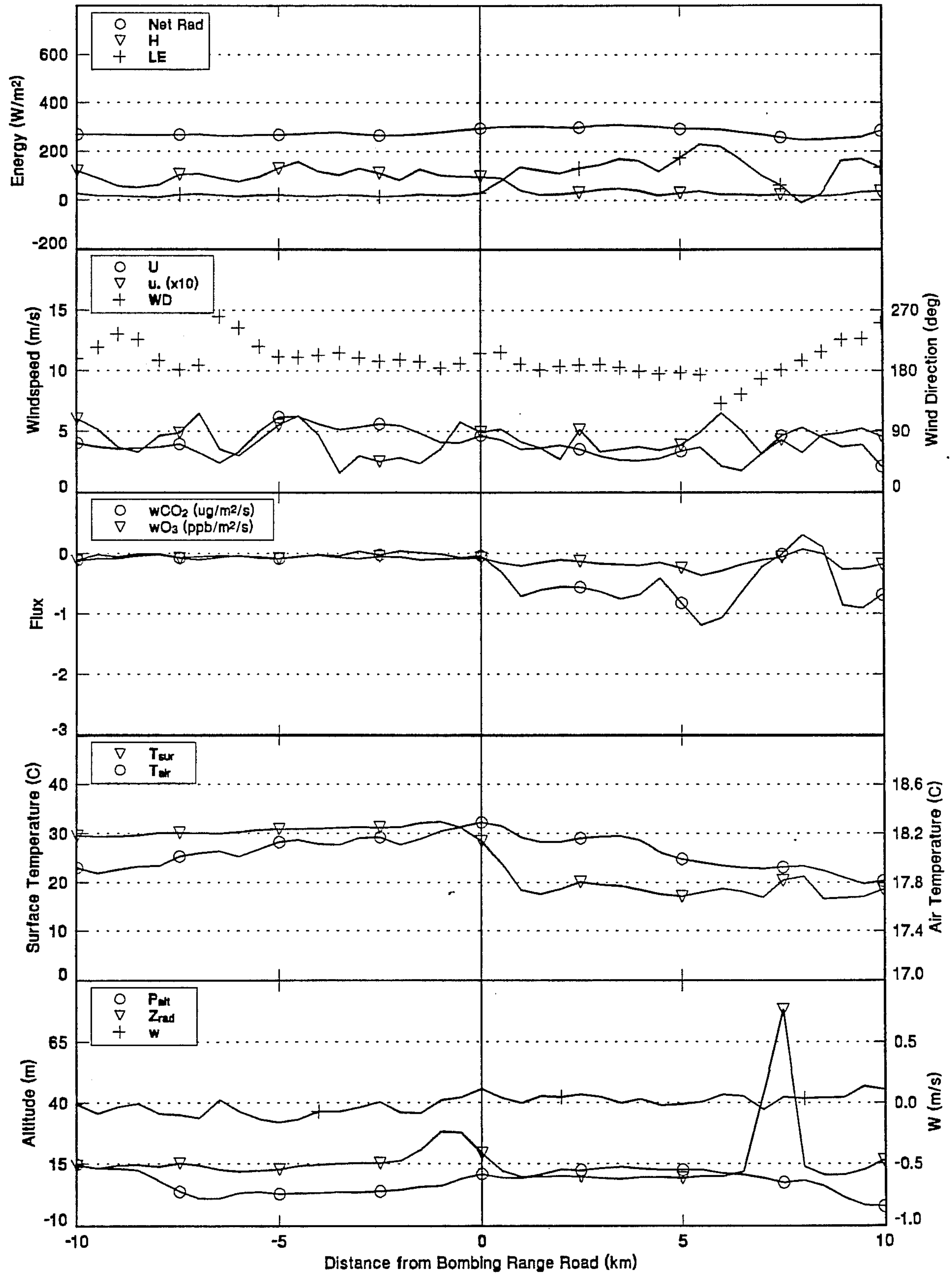
Boardman, Oregon June 15,1991 5 Transects Centered at: 1443 GMT(2143 PDT)



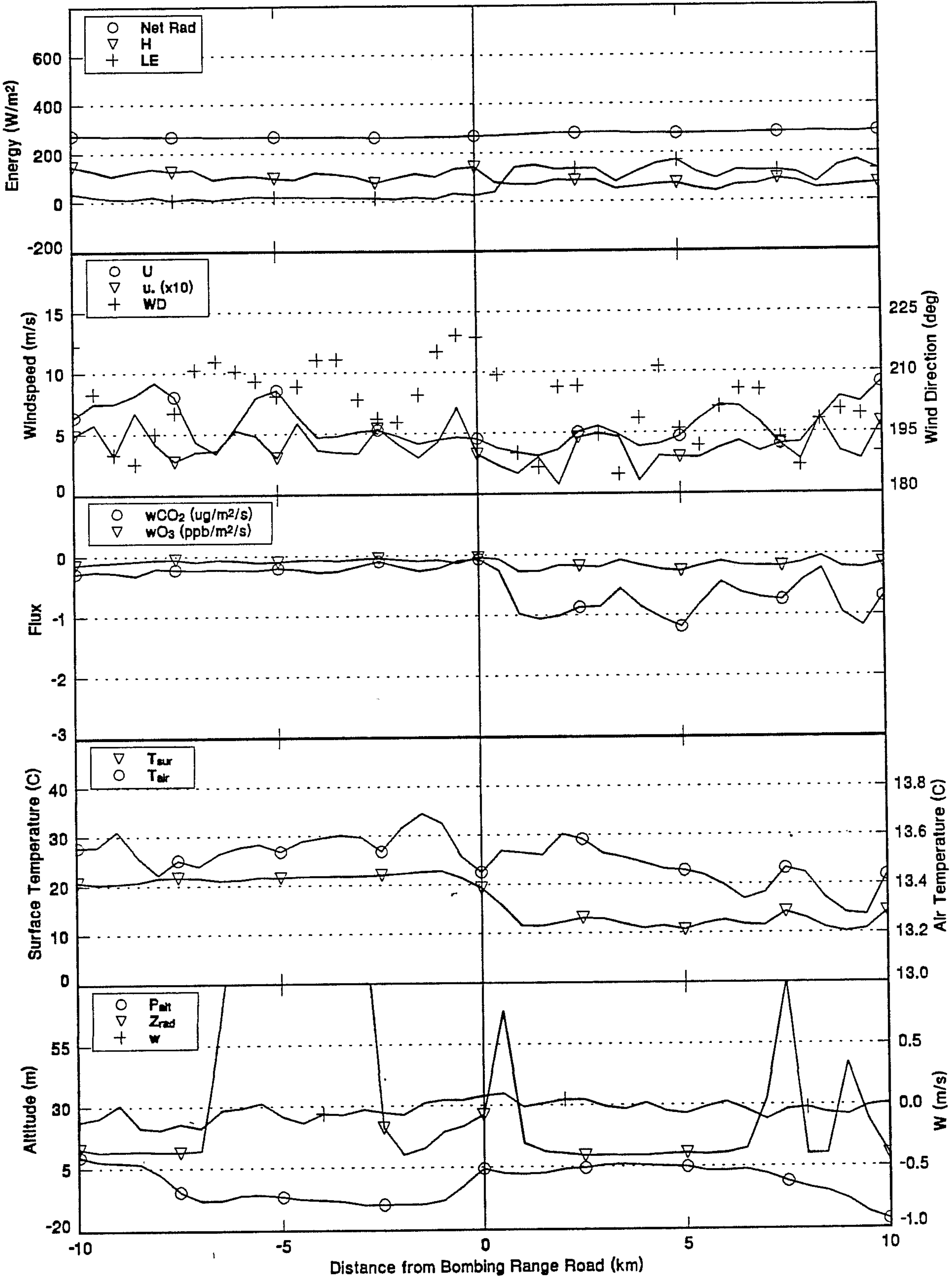
Boardman, Oregon June 15,1991 7 Transects Centered at: 1522 GMT(2222 PDT)



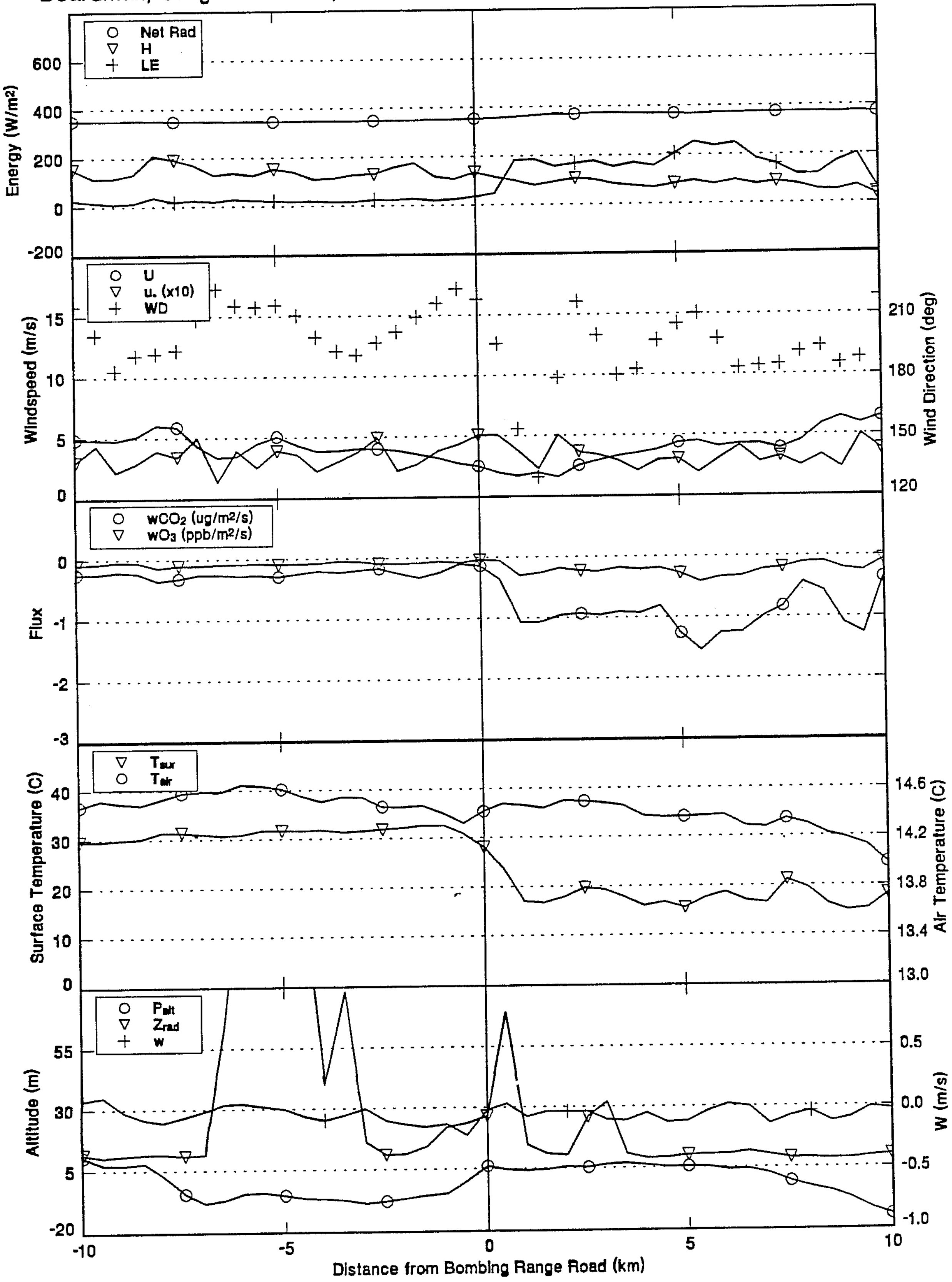
Boardman, Oregon June 15,1991 5 Transects Centered at: 1609 GMT(2309 PDT)



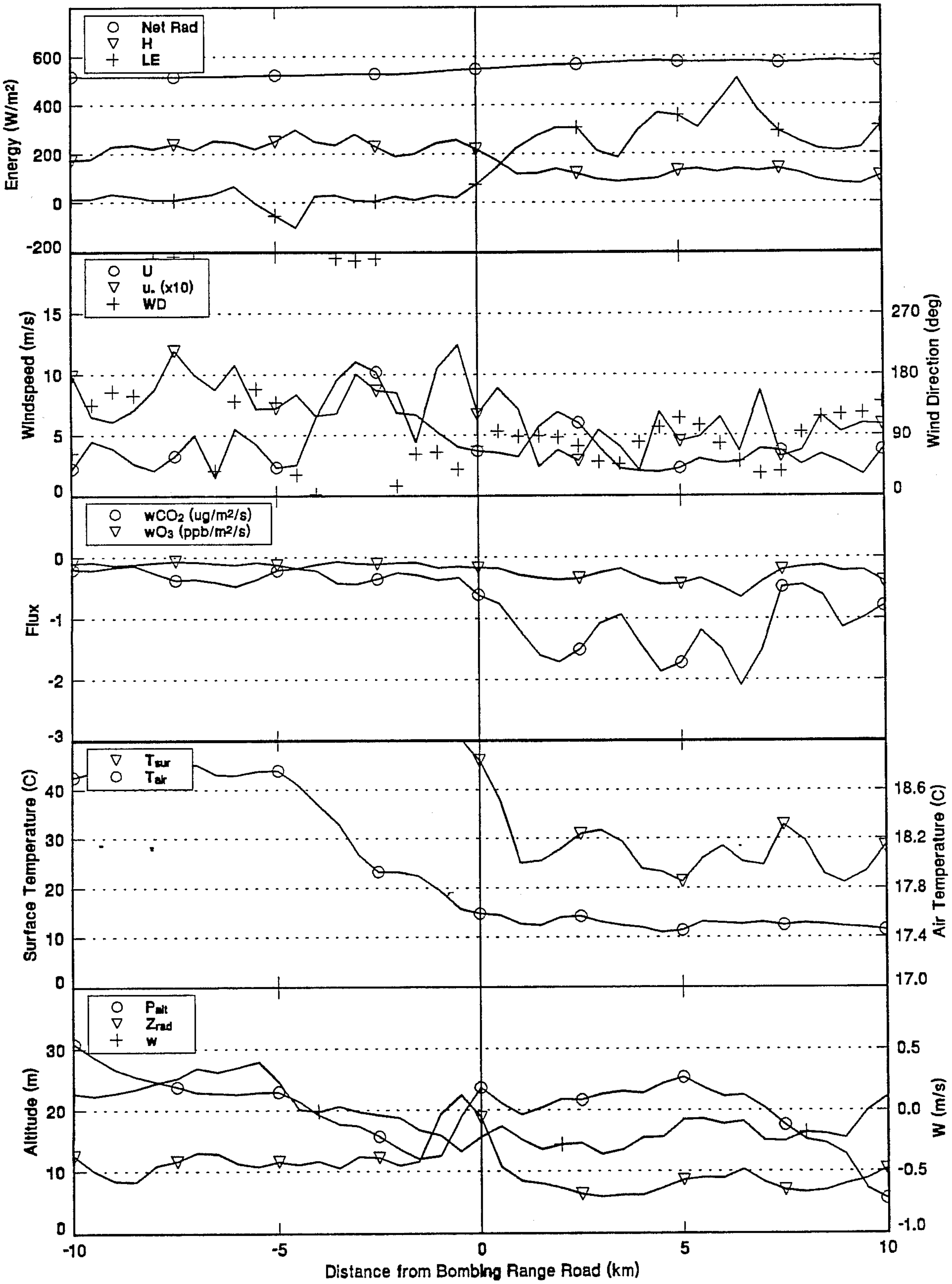
Boardman, Oregon June 17,1991 6 Transects Centered at: 1545 GMT(2245 PDT)



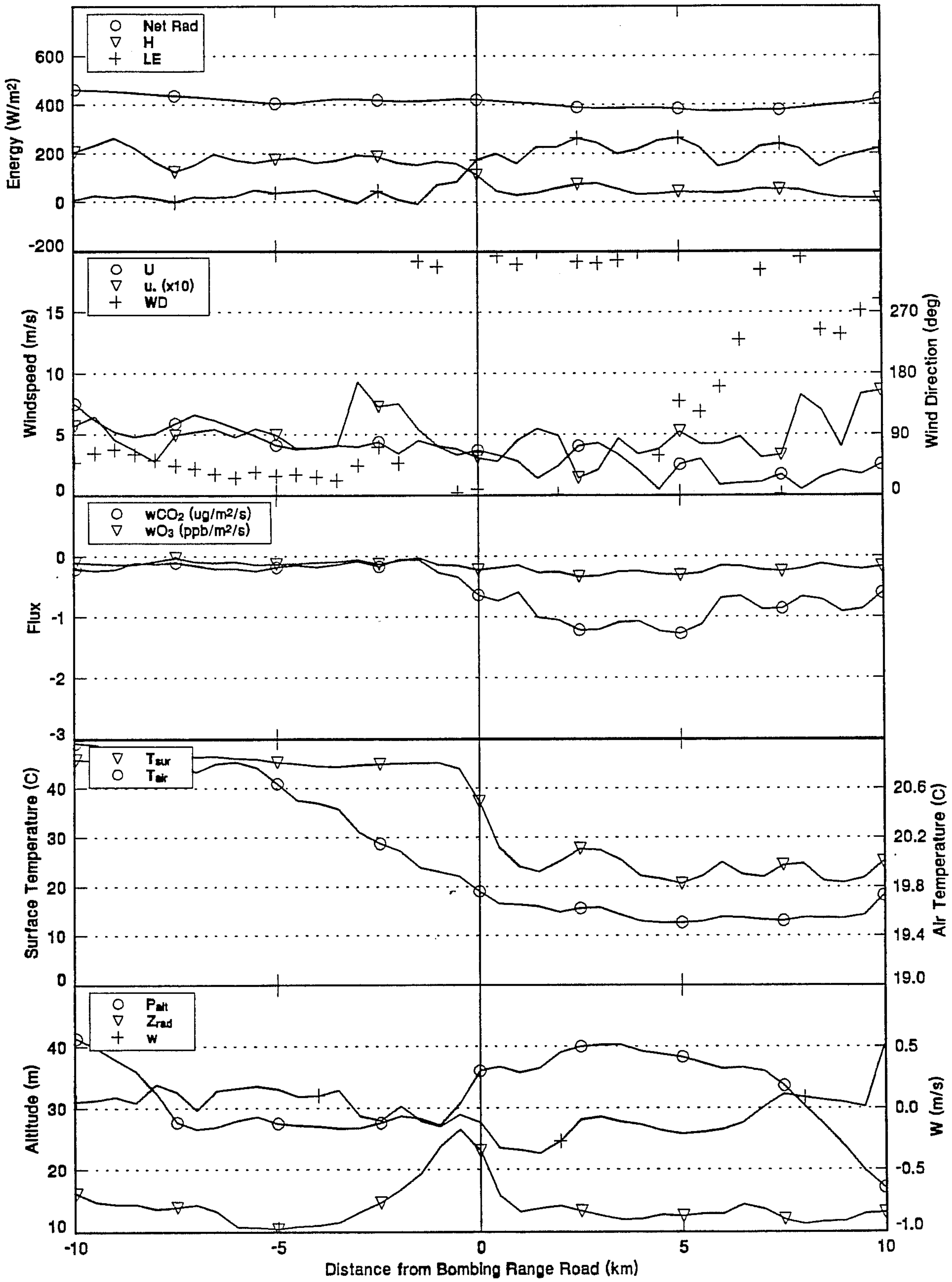
Boardman, Oregon June 17,1991 6 Transects Centered at: 1633 GMT(2333 PDT)



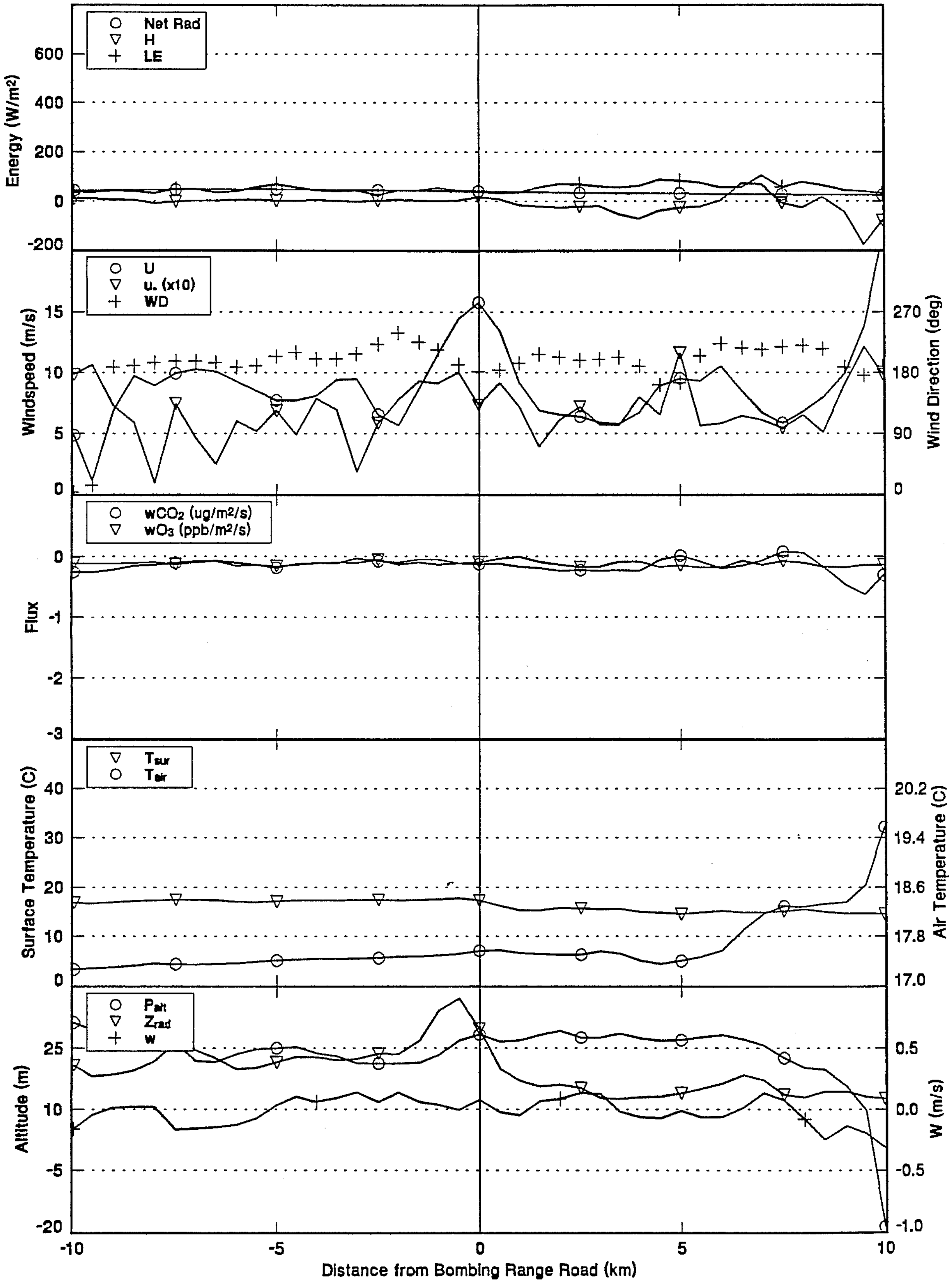
Boardman, Oregon June 17,1991 5 Transects Centered at: 2027 GMT(0327 PDT)



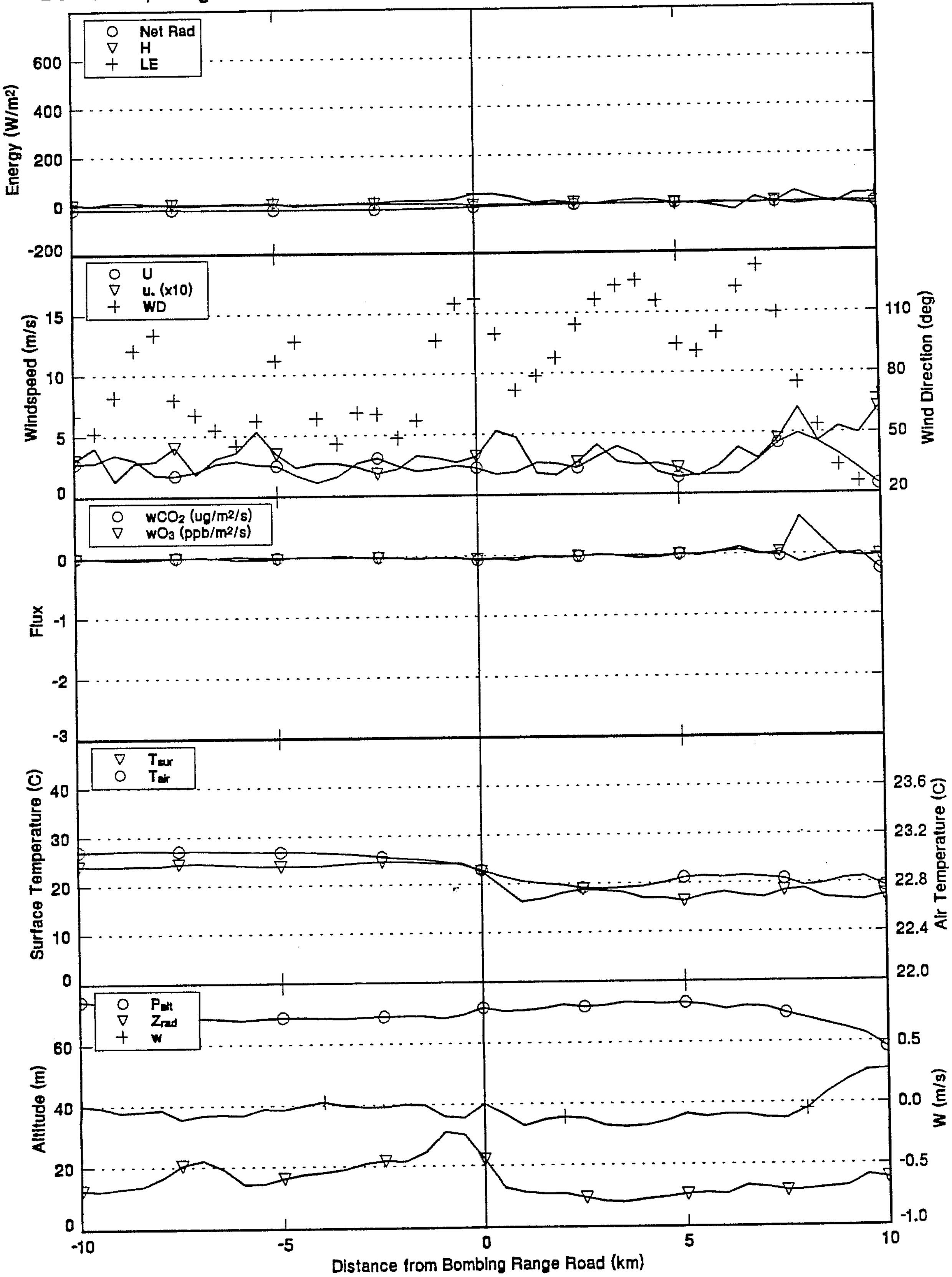
Boardman, Oregon June 18,1991 7 Transects Centered at: 2021 GMT(0321 PDT)



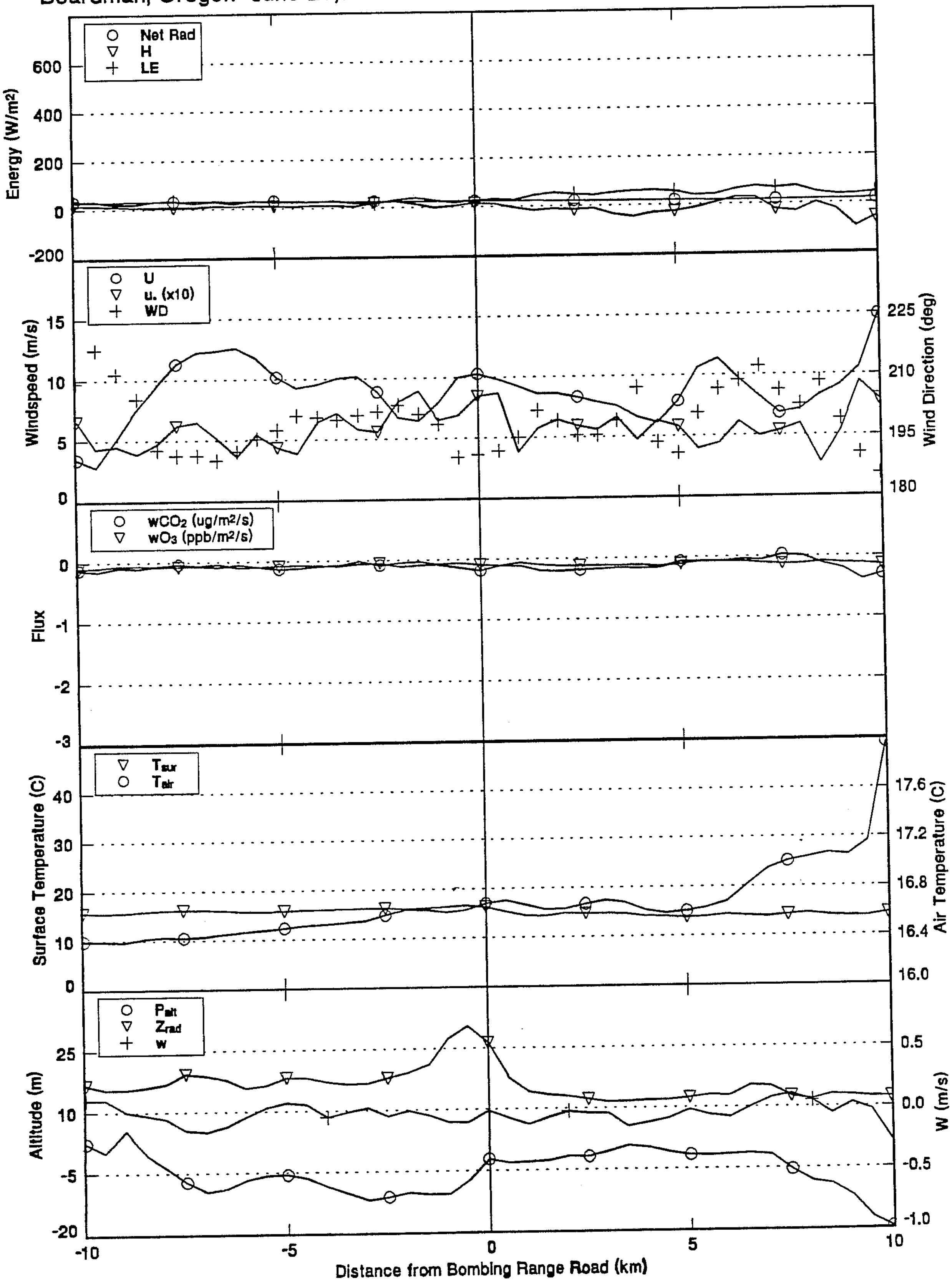
Boardman, Oregon June 19,1991 3 Transects Centered at: 0053 GMT(0753 PDT)



Boardman, Oregon June 19,1991 9 Transects Centered at: 0228 GMT(0928 PDT)



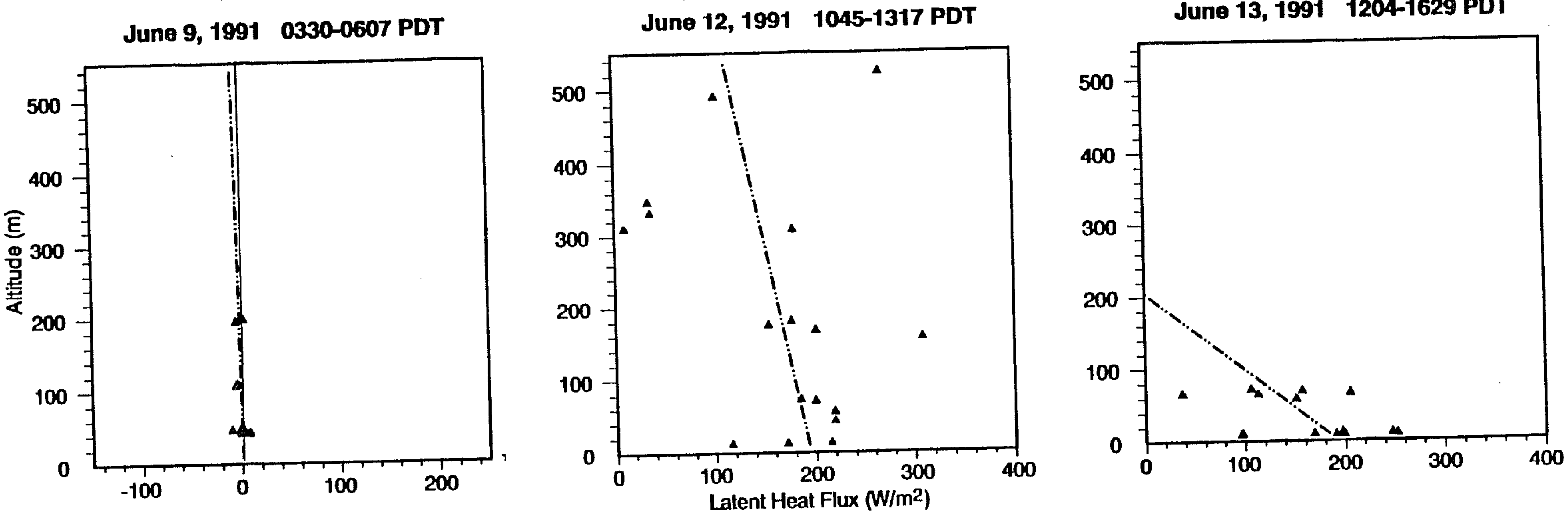
Boardman, Oregon June 20,1991 6 Transects Centered at: 0120 GMT(0820 PDT)



APPENDIX C
VERTICAL FLUX DIVERGENCE

ARM NOAA-ATDD LATENT HEAT FLUXES: Boardman, OR

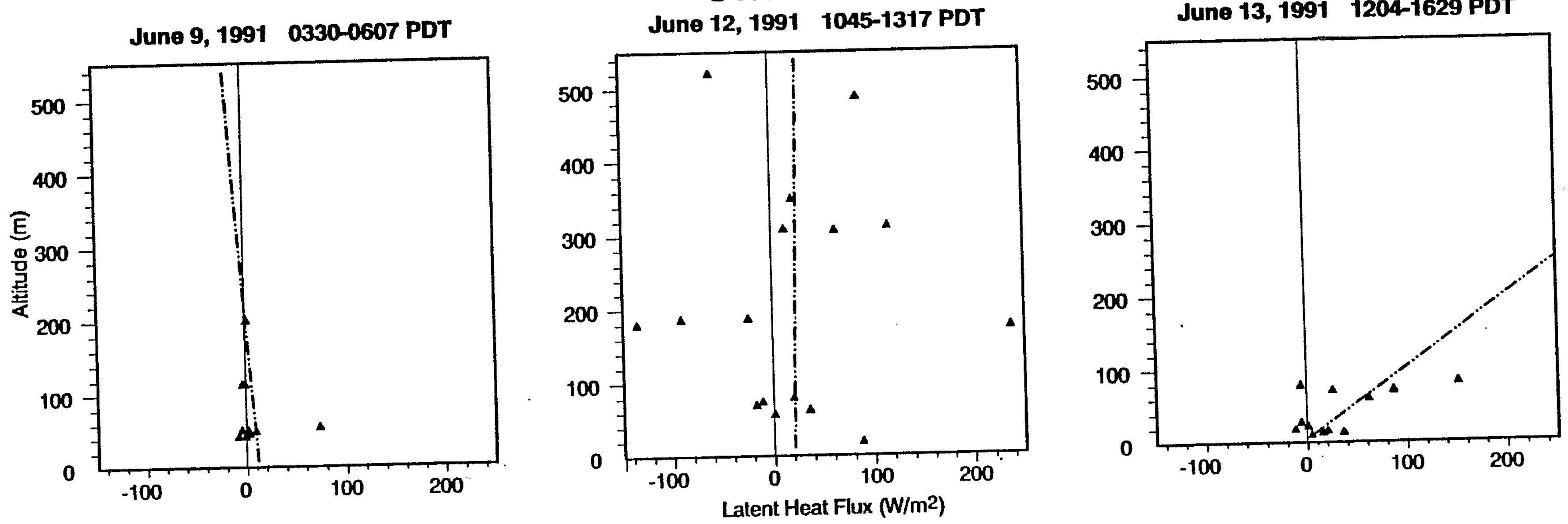
OVER FARMLAND


June 9, 1991 0330-0607 PDT

June 12, 1991 1045-1317 PDT

June 13, 1991 1204-1629 PDT

OVER DESERT

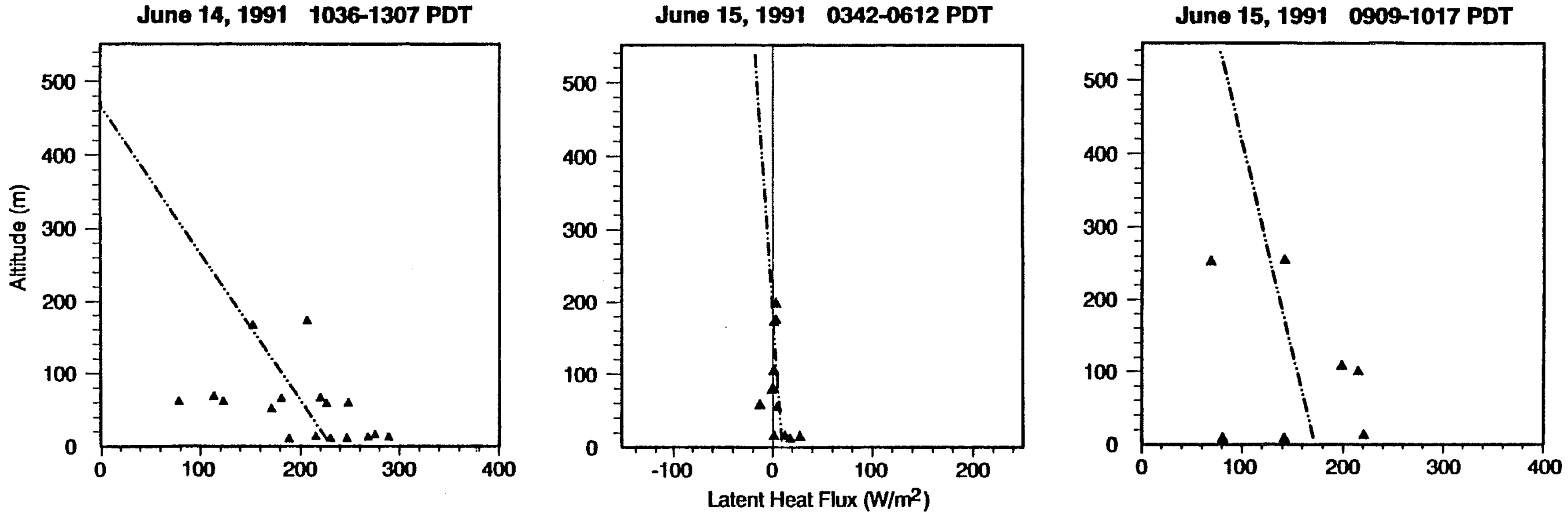

June 9, 1991 0330-0607 PDT

June 12, 1991 1045-1317 PDT

June 13, 1991 1204-1629 PDT

ARM NOAA-ATDD LATENT HEAT FLUXES: Boardman, OR

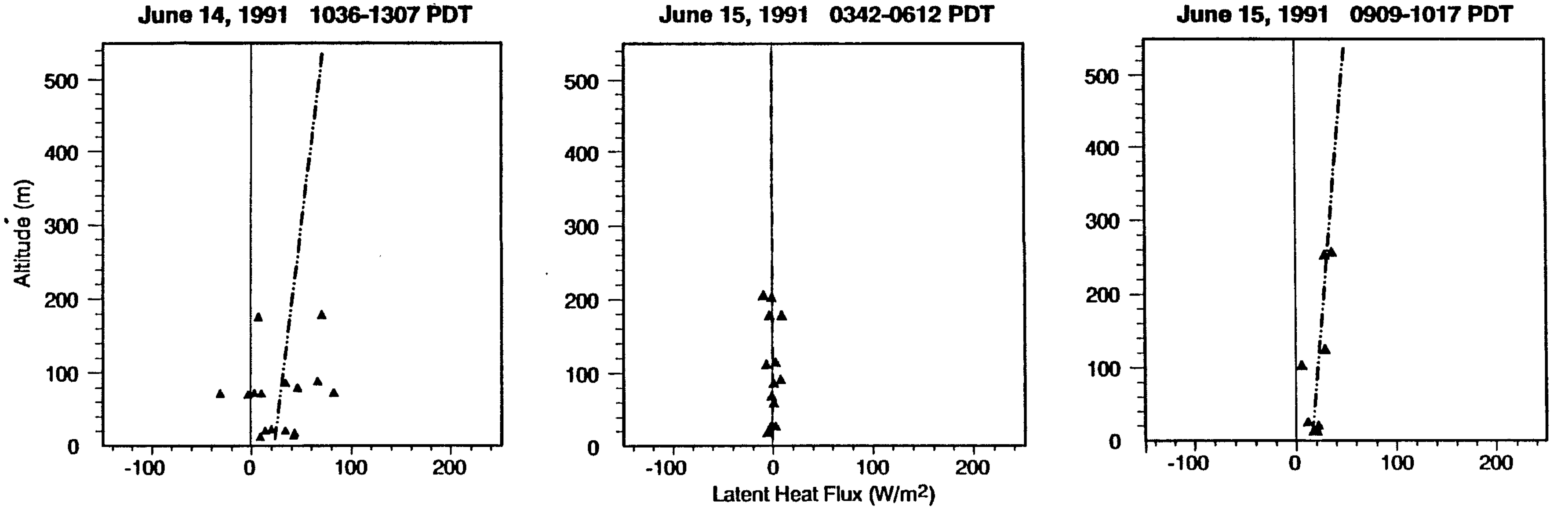
OVER FARMLAND


June 14, 1991 1036-1307 PDT

June 15, 1991 0342-0612 PDT

June 15, 1991 0909-1017 PDT

OVER DESERT

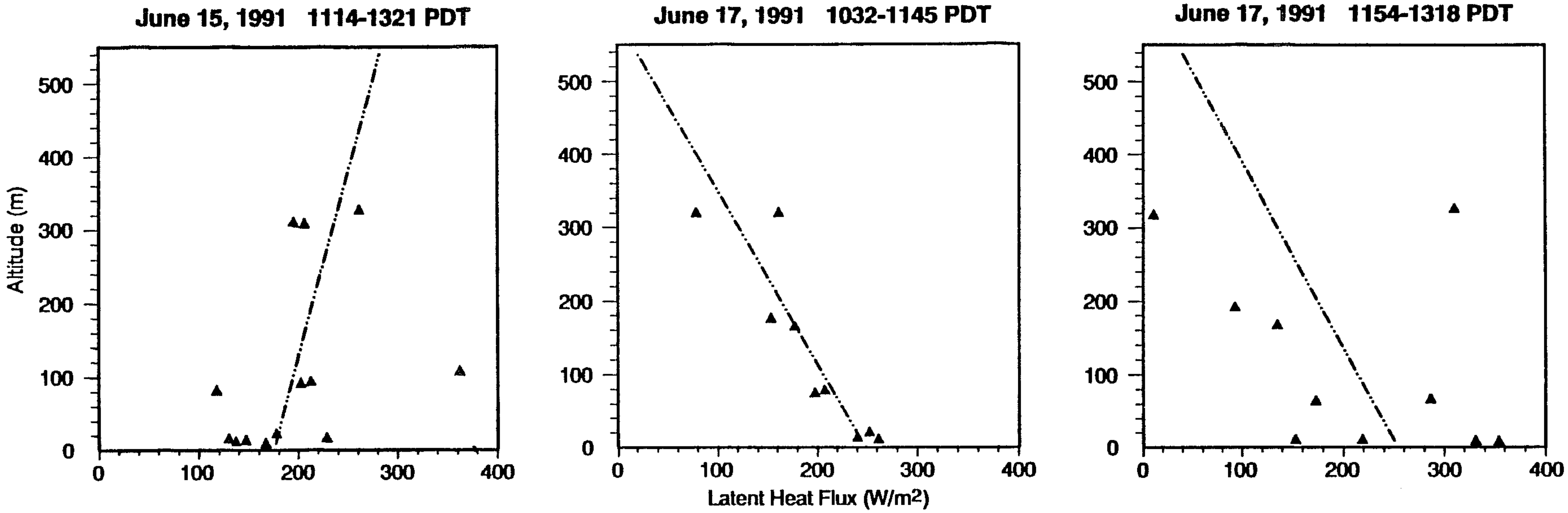

June 14, 1991 1036-1307 PDT

June 15, 1991 0342-0612 PDT

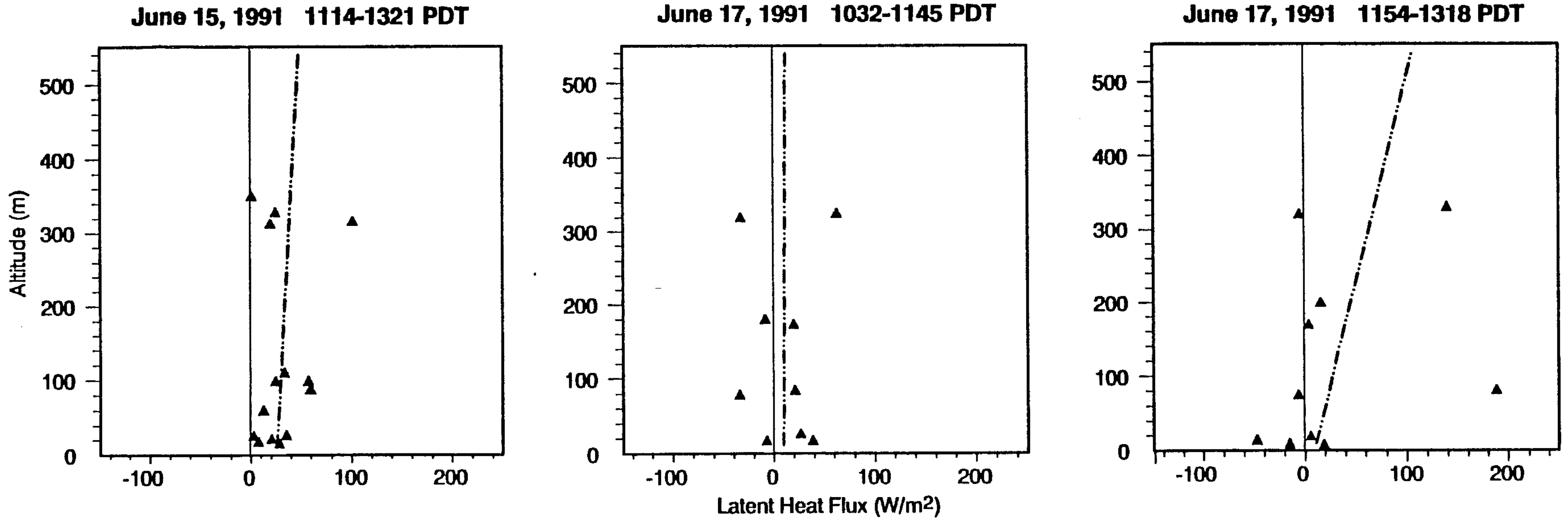
June 15, 1991 0909-1017 PDT

ARM NOAA-ATDD LATENT HEAT FLUXES: Boardman, OR

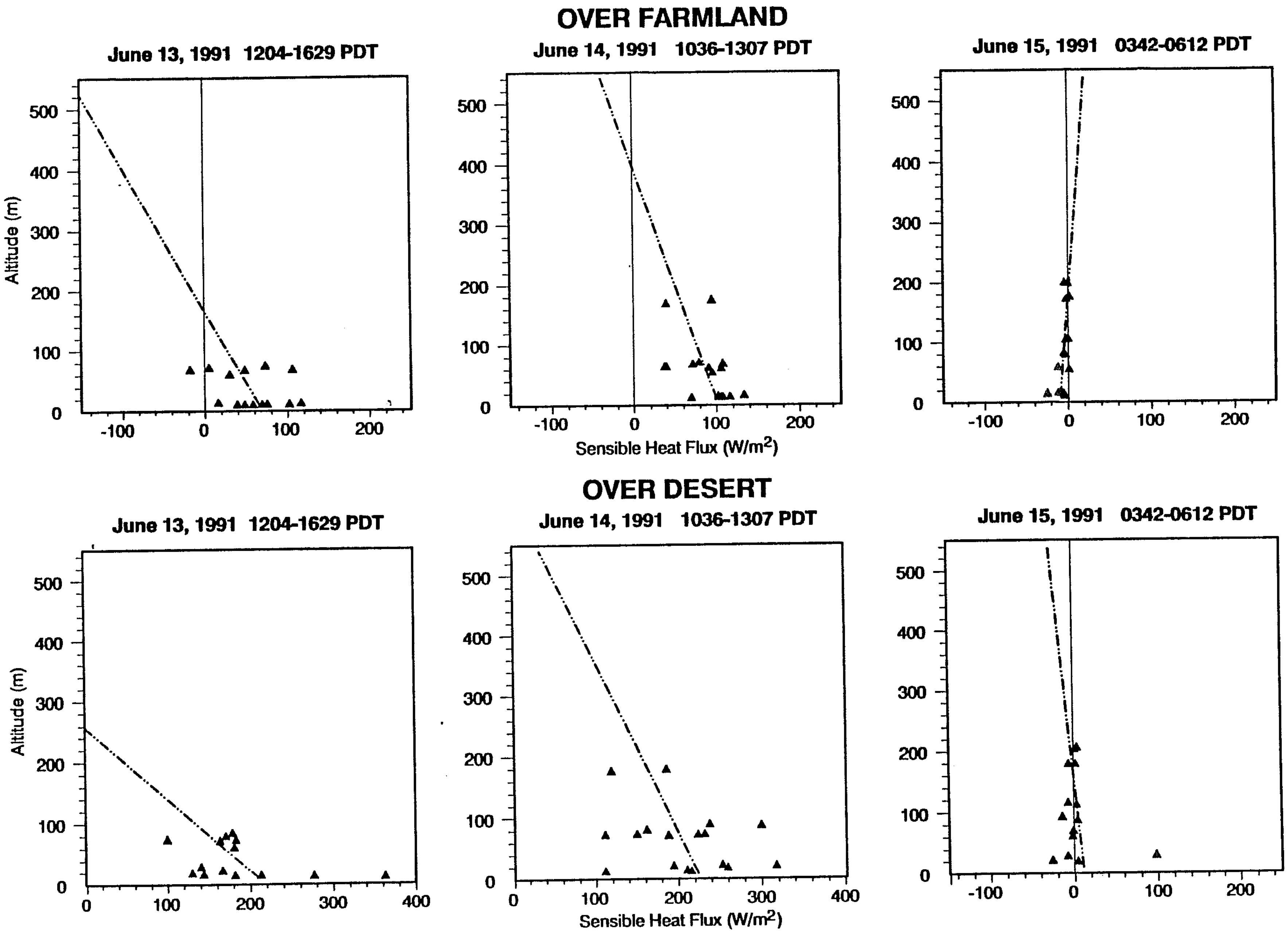
OVER FARMLAND



OVER DESERT

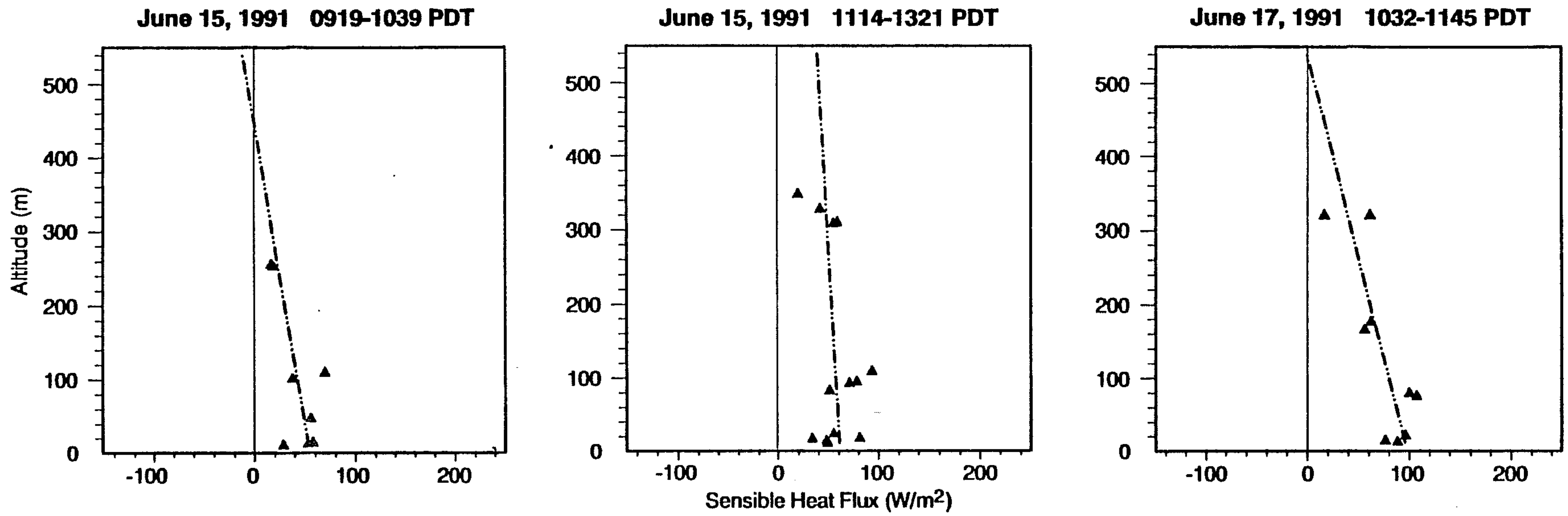


ARM NOAA-ATDD SENSIBLE HEAT FLUXES: Boardman, OR

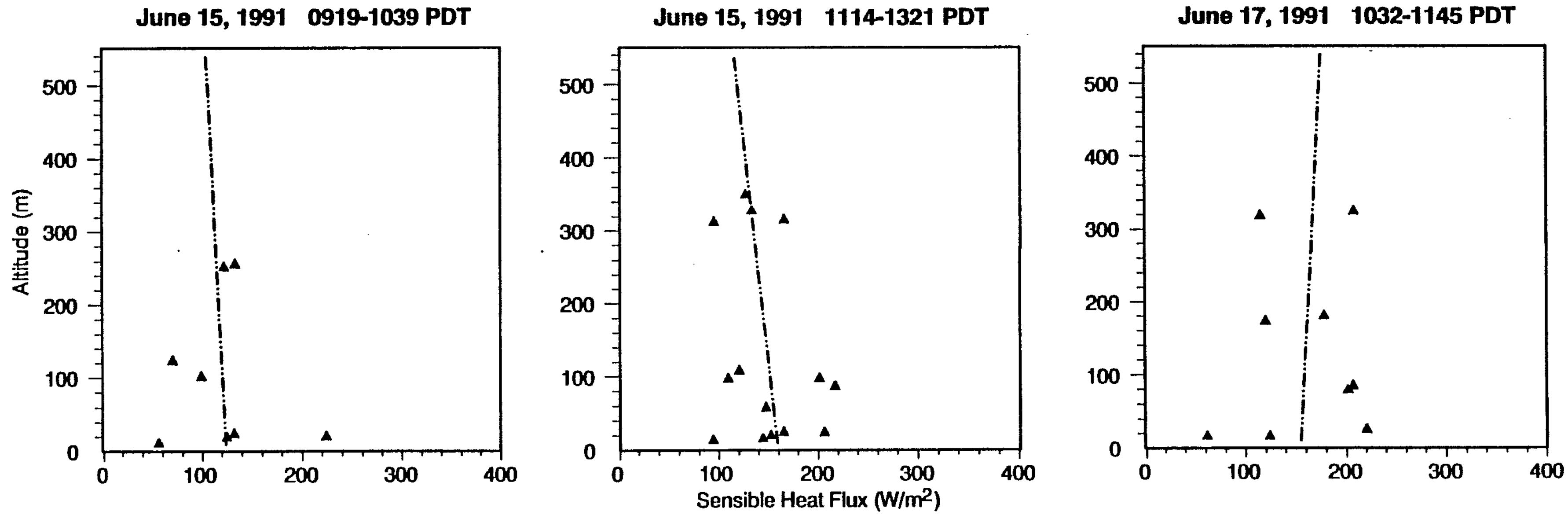


ARM NOAA-ATDD SENSIBLE HEAT FLUXES: Boardman, OR

OVER FARMLAND



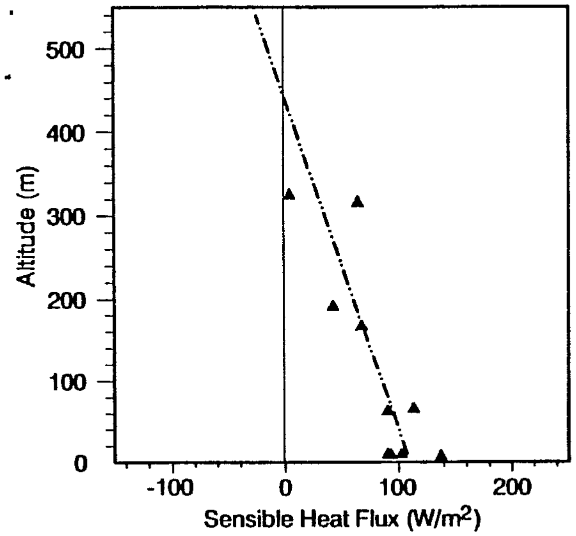
OVER DESERT



ARM NOAA-ATDD SENSIBLE HEAT FLUXES: Boardman, OR

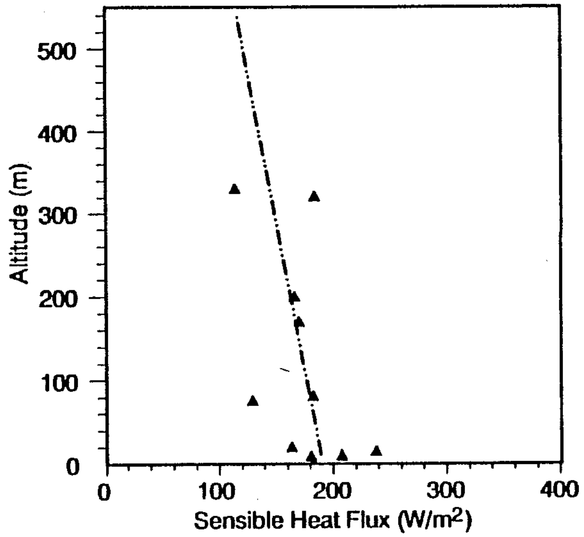
OVER FARMLAND

June 17, 1991 1154-1318 PDT



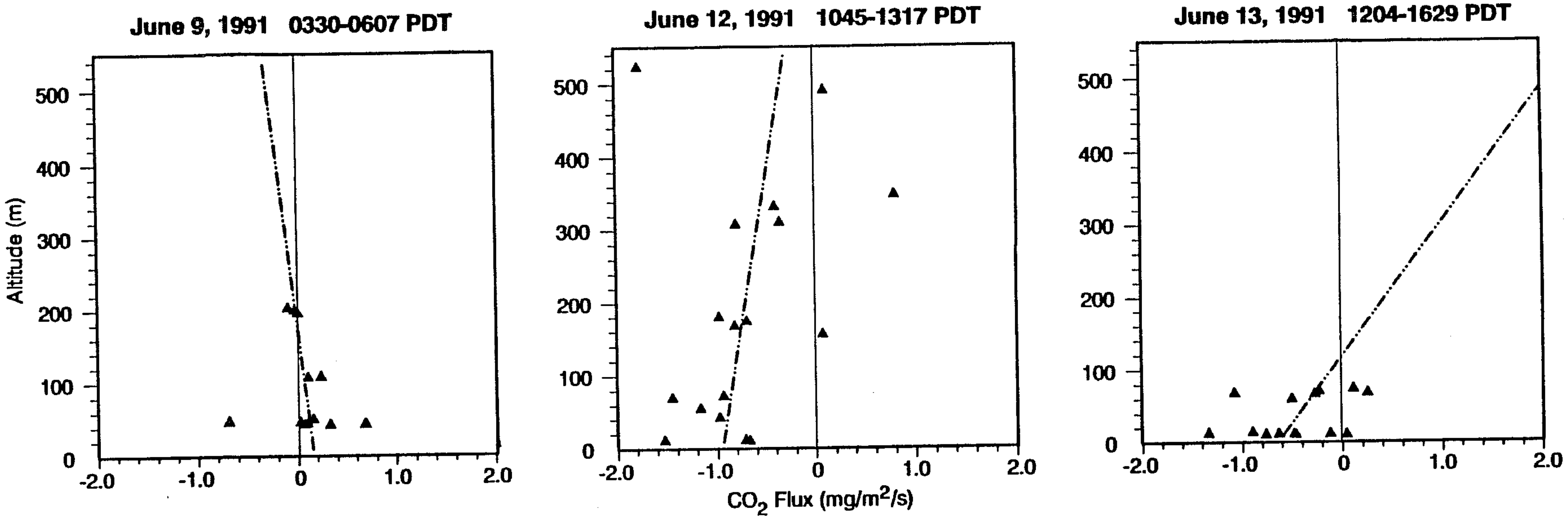
OVER DESERT

June 17, 1991 1154-1318 PDT

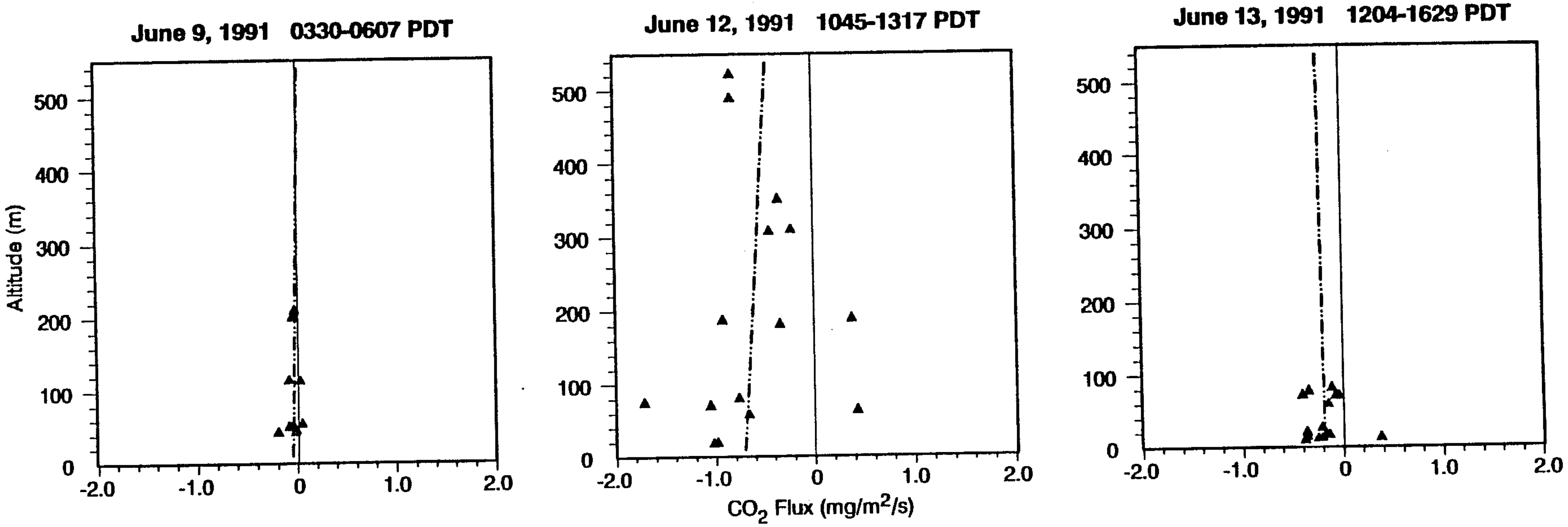


ARM NOAA-ATDD CARBON DIOXIDE FLUXES: Boardman, OR

OVER FARMLAND

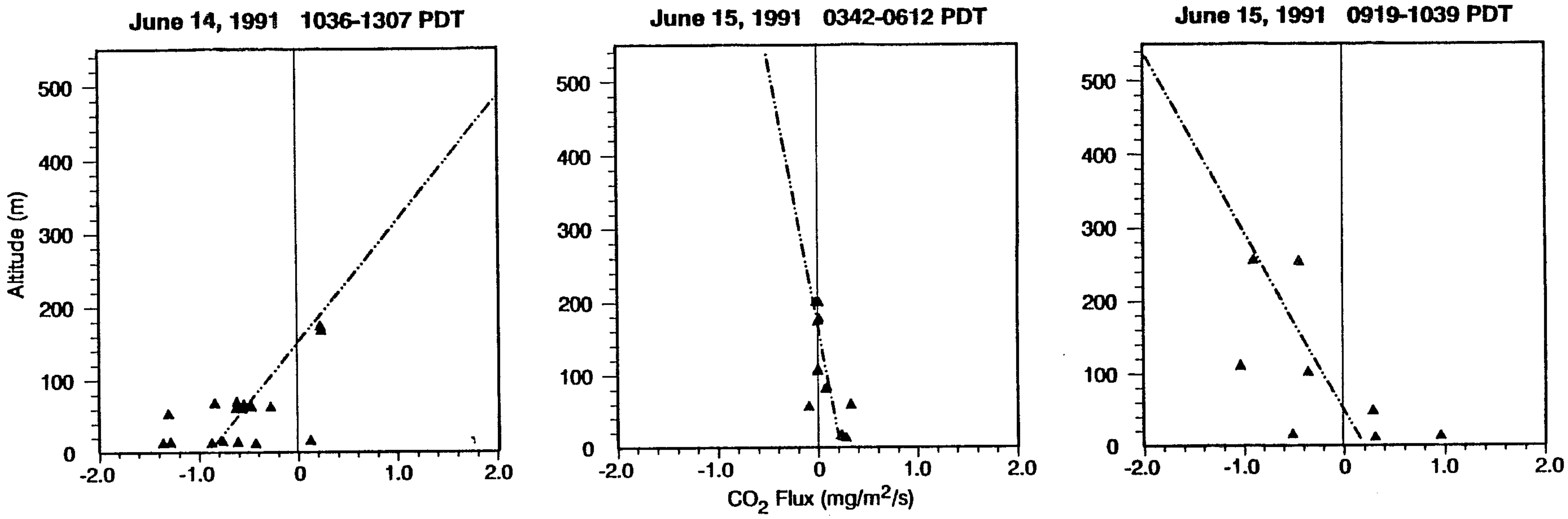


OVER DESERT

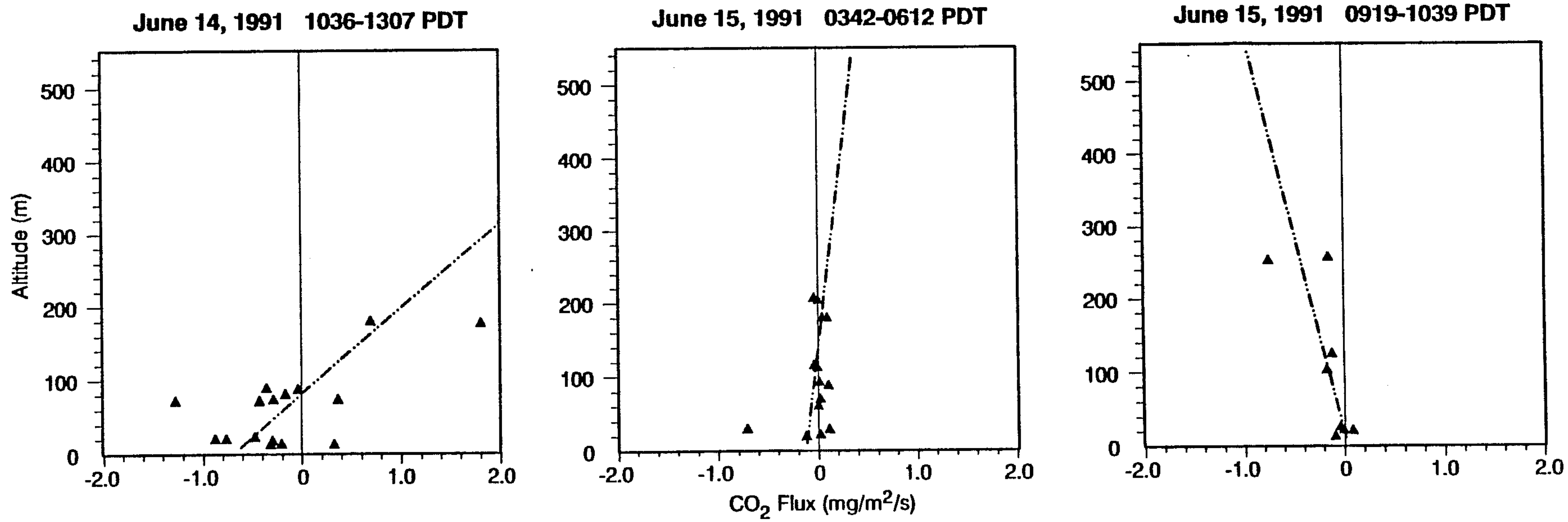


ARM NOAA-ATDD CARBON DIOXIDE FLUXES: Boardman, OR

OVER FARMLAND

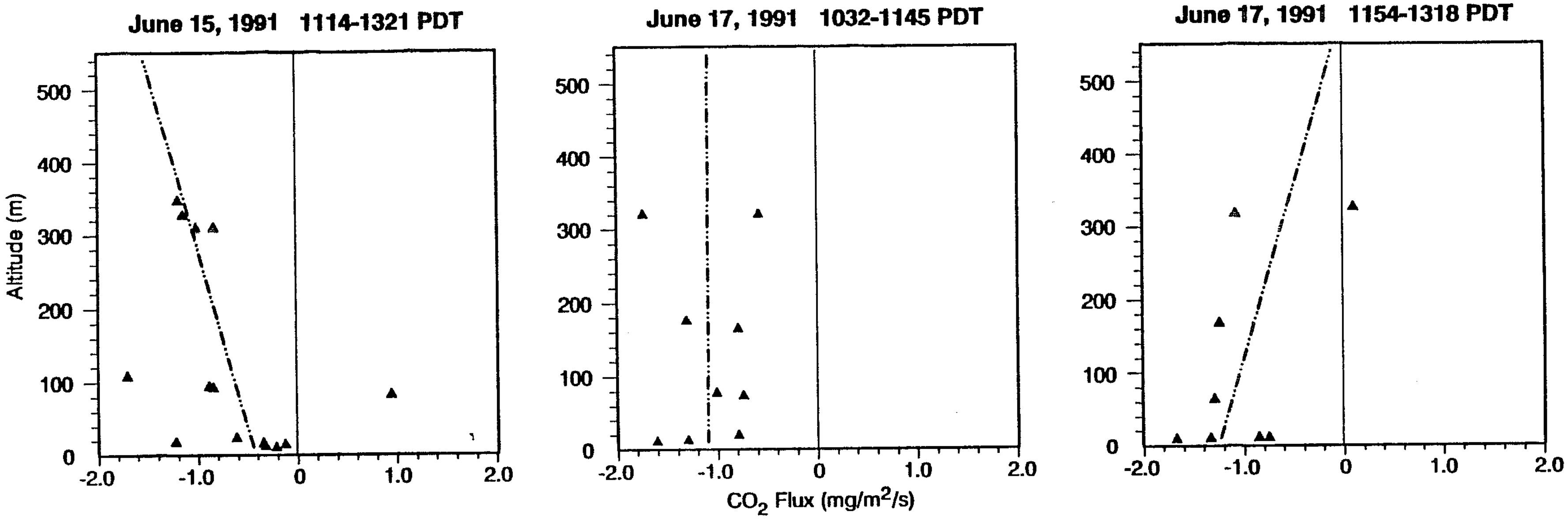


OVER DESERT

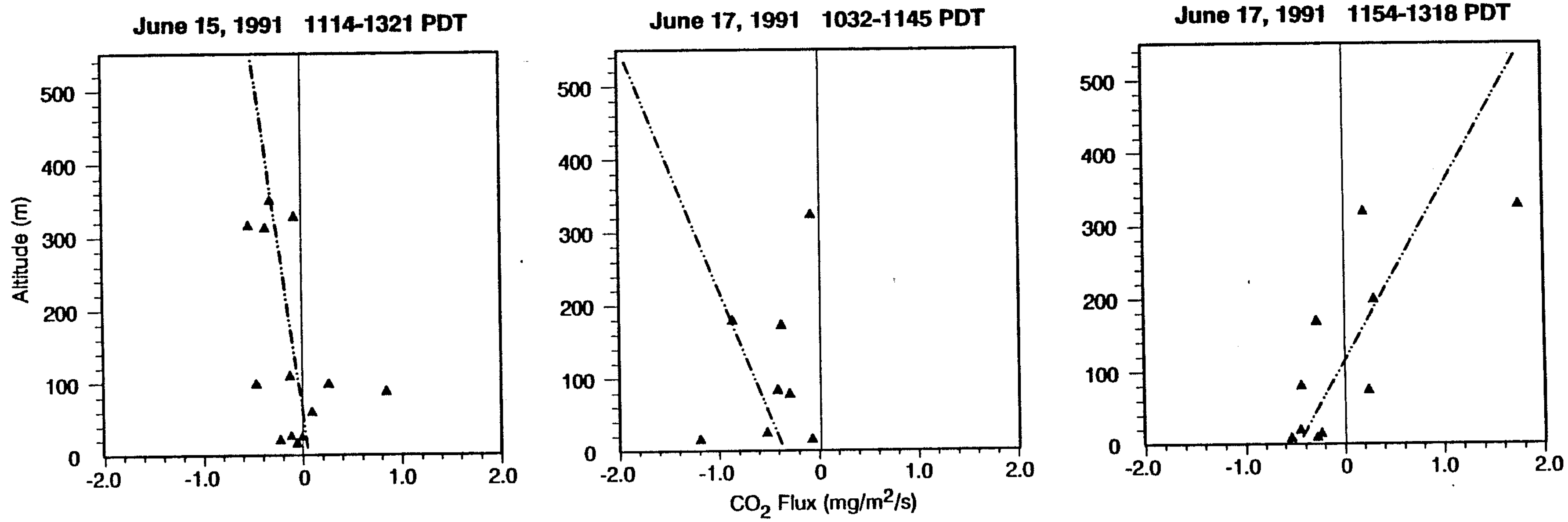


ARM NOAA-ATDD CARBON DIOXIDE FLUXES: Boardman, OR

OVER FARMLAND

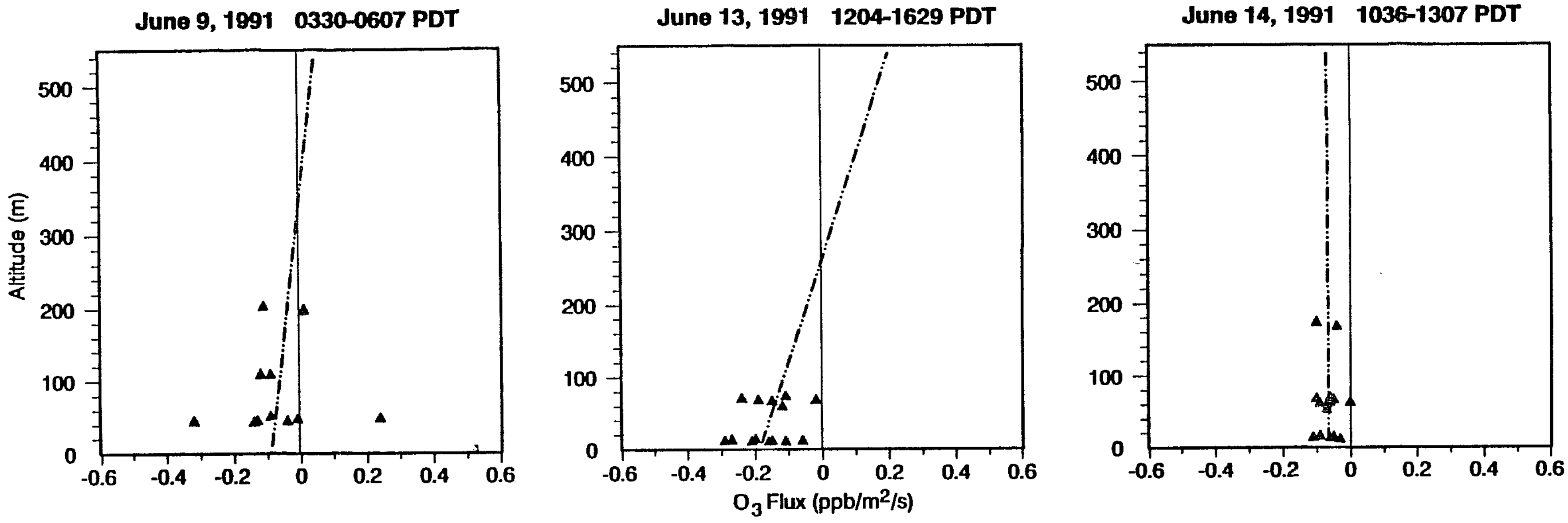


OVER DESERT



ARM NOAA-ATDD OZONE FLUXES: Boardman, OR

OVER FARMLAND

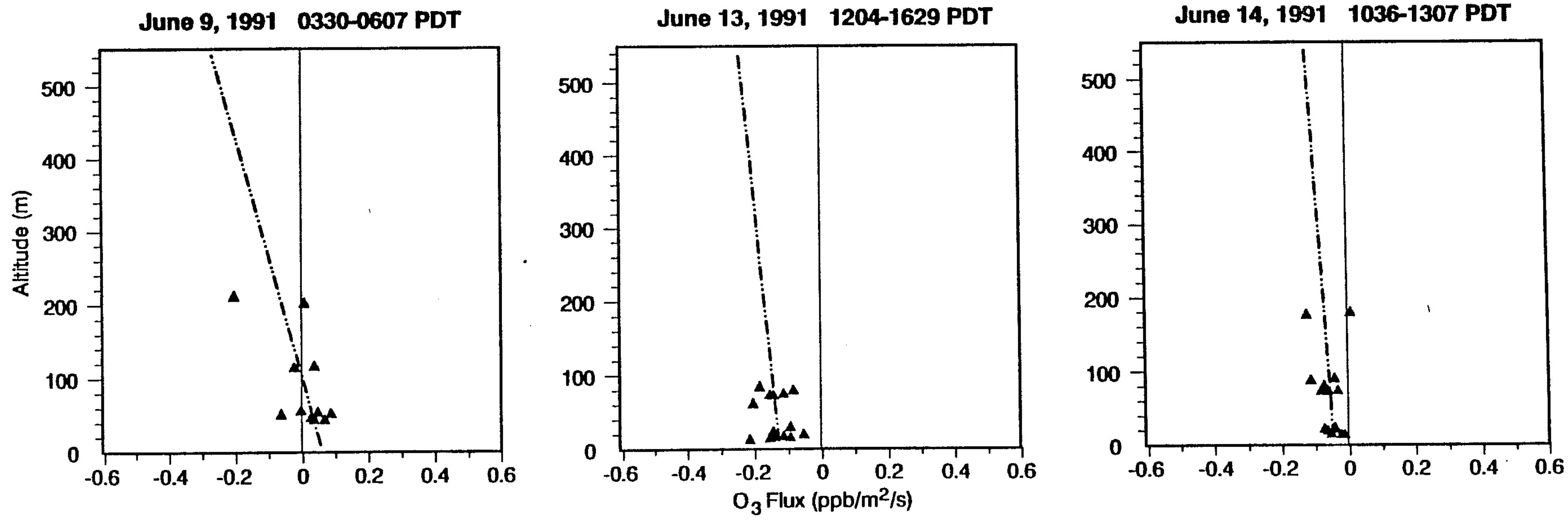


June 9, 1991 0330-0607 PDT

June 13, 1991 1204-1629 PDT

June 14, 1991 1036-1307 PDT

OVER DESERT



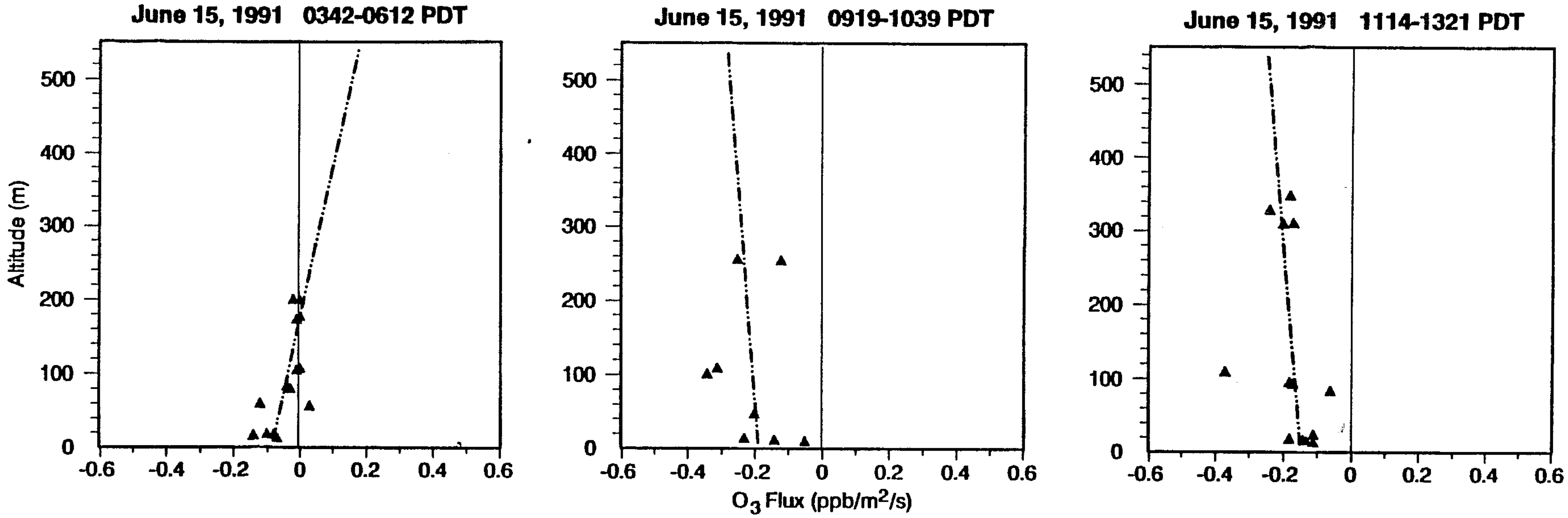
June 9, 1991 0330-0607 PDT

June 13, 1991 1204-1629 PDT

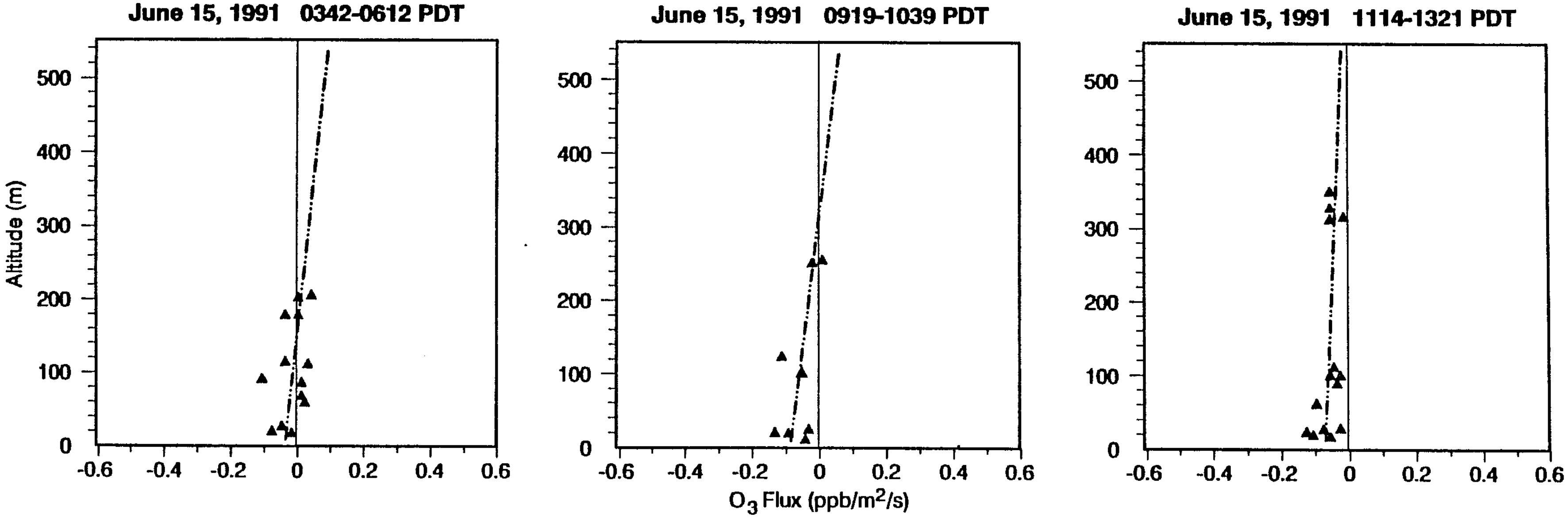
June 14, 1991 1036-1307 PDT

ARM NOAA-ATDD OZONE FLUXES: Boardman, OR

OVER FARMLAND

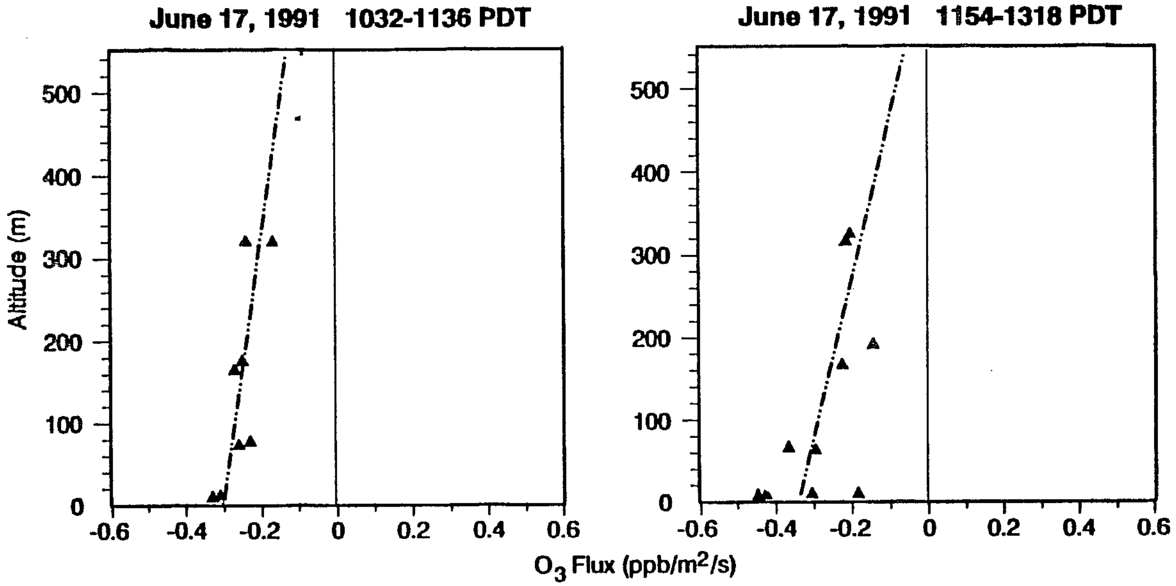


OVER DESERT



ARM NOAA-ATDD OZONE FLUXES: Boardman, OR

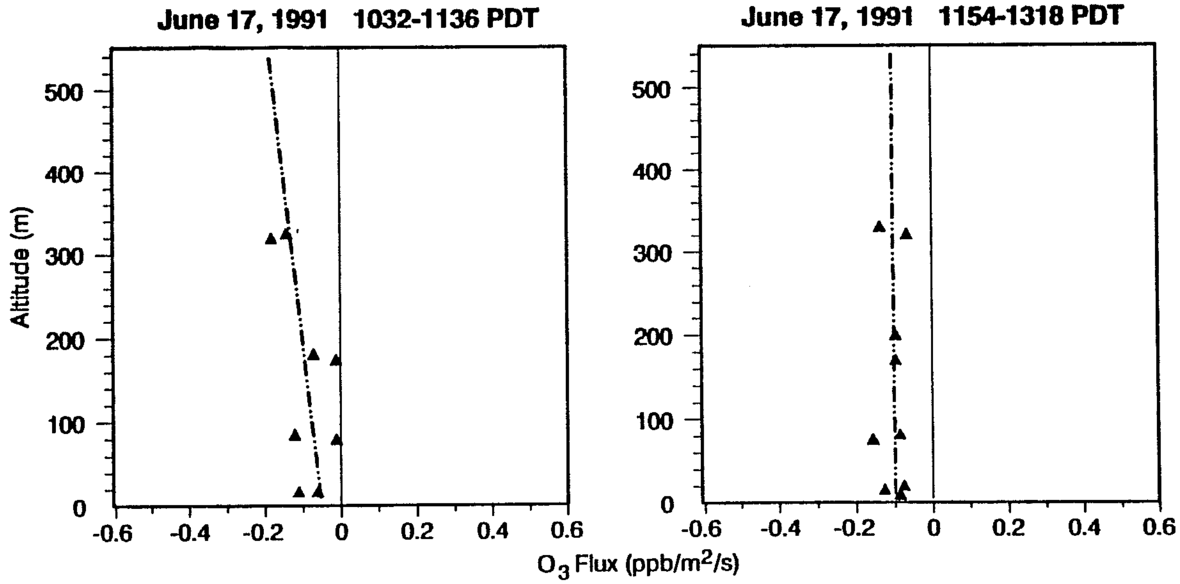
OVER FARMLAND



June 17, 1991 1032-1136 PDT

June 17, 1991 1154-1318 PDT

OVER DESERT



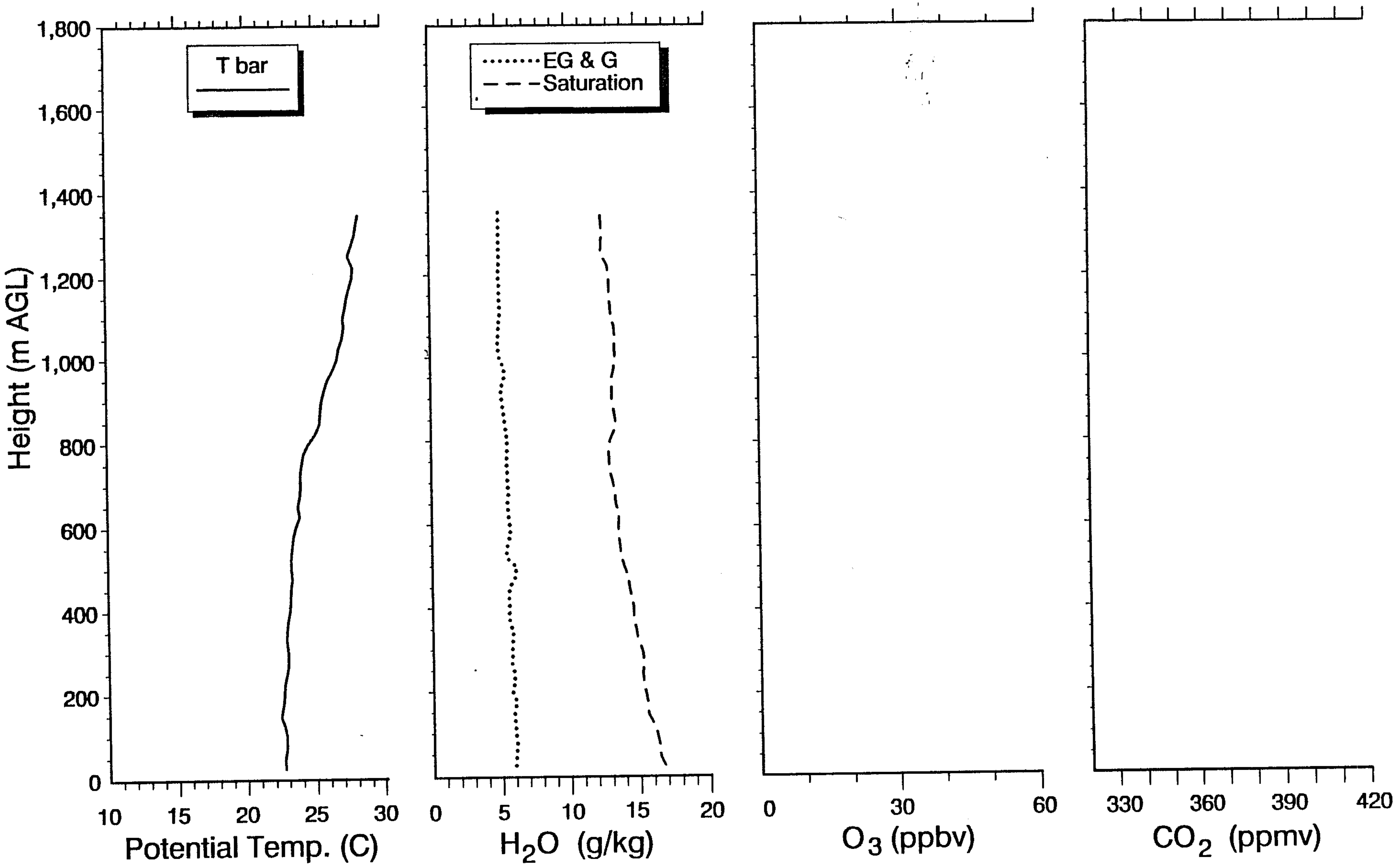
June 17, 1991 1032-1136 PDT

June 17, 1991 1154-1318 PDT

APPENDIX D
ATMOSPHERIC PROFILES

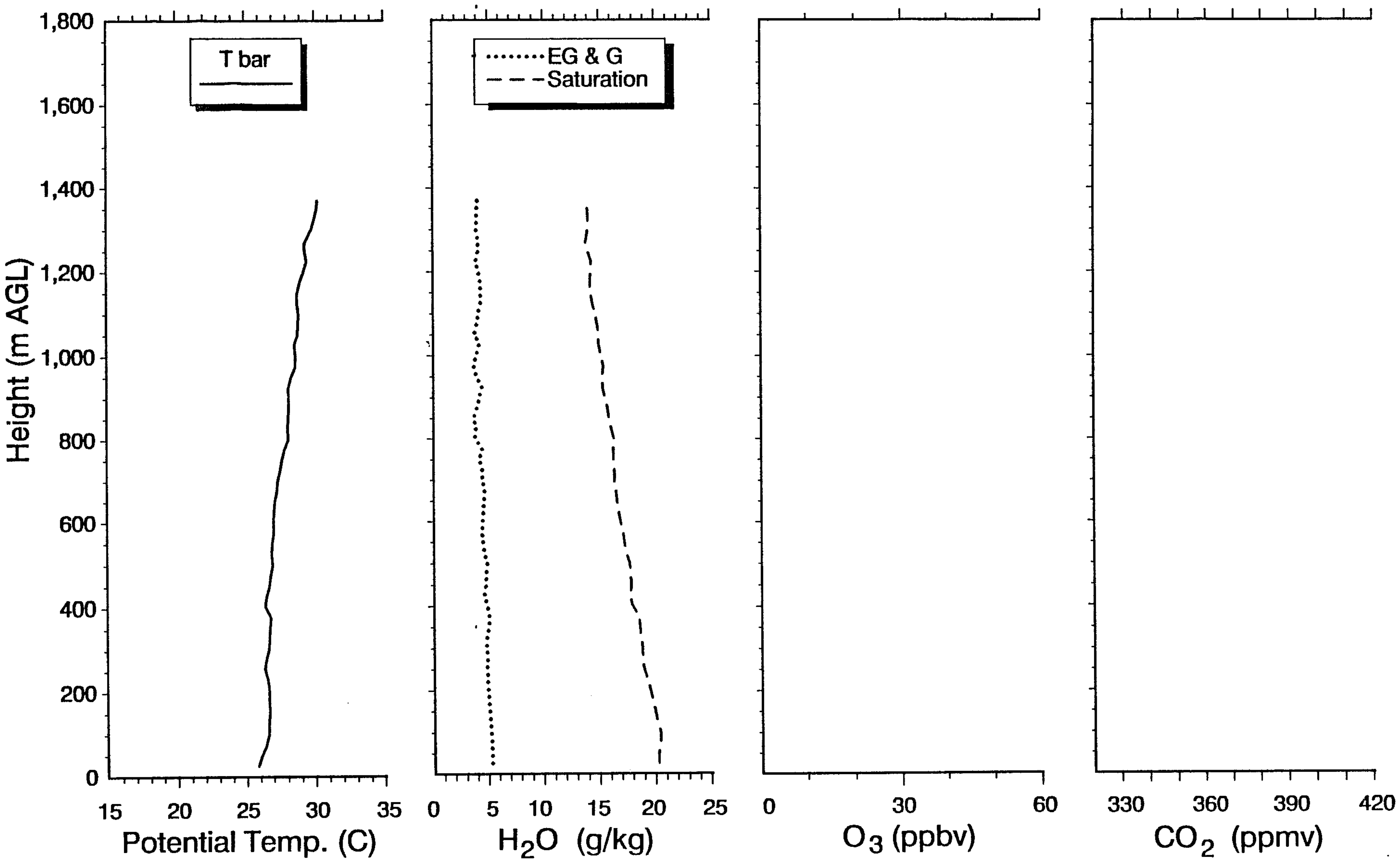
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 2, 1991 Start = 1014 PDT, End = 1030 PDT



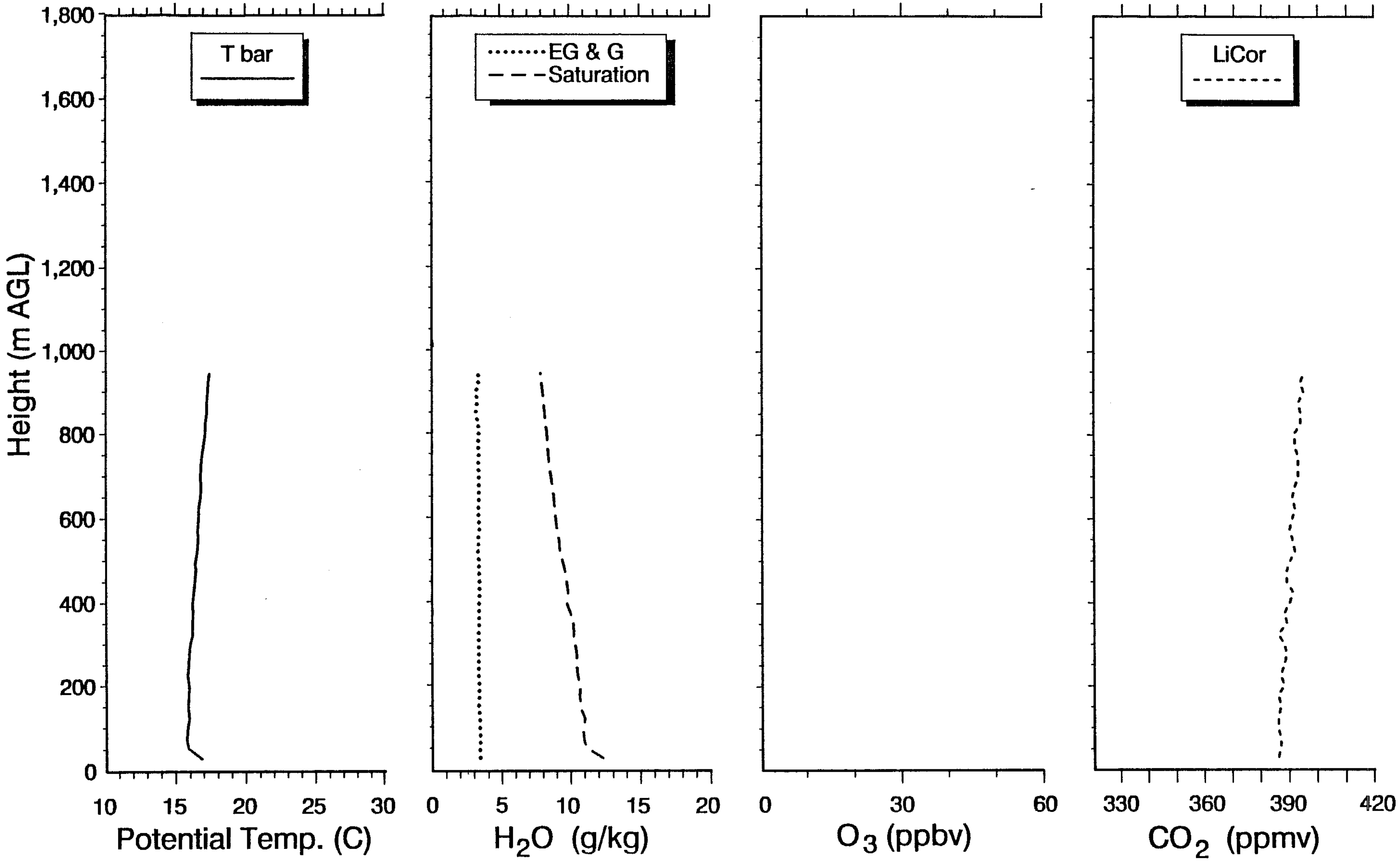
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 2, 1991 Start = 1320 PDT, End = 1332 PDT



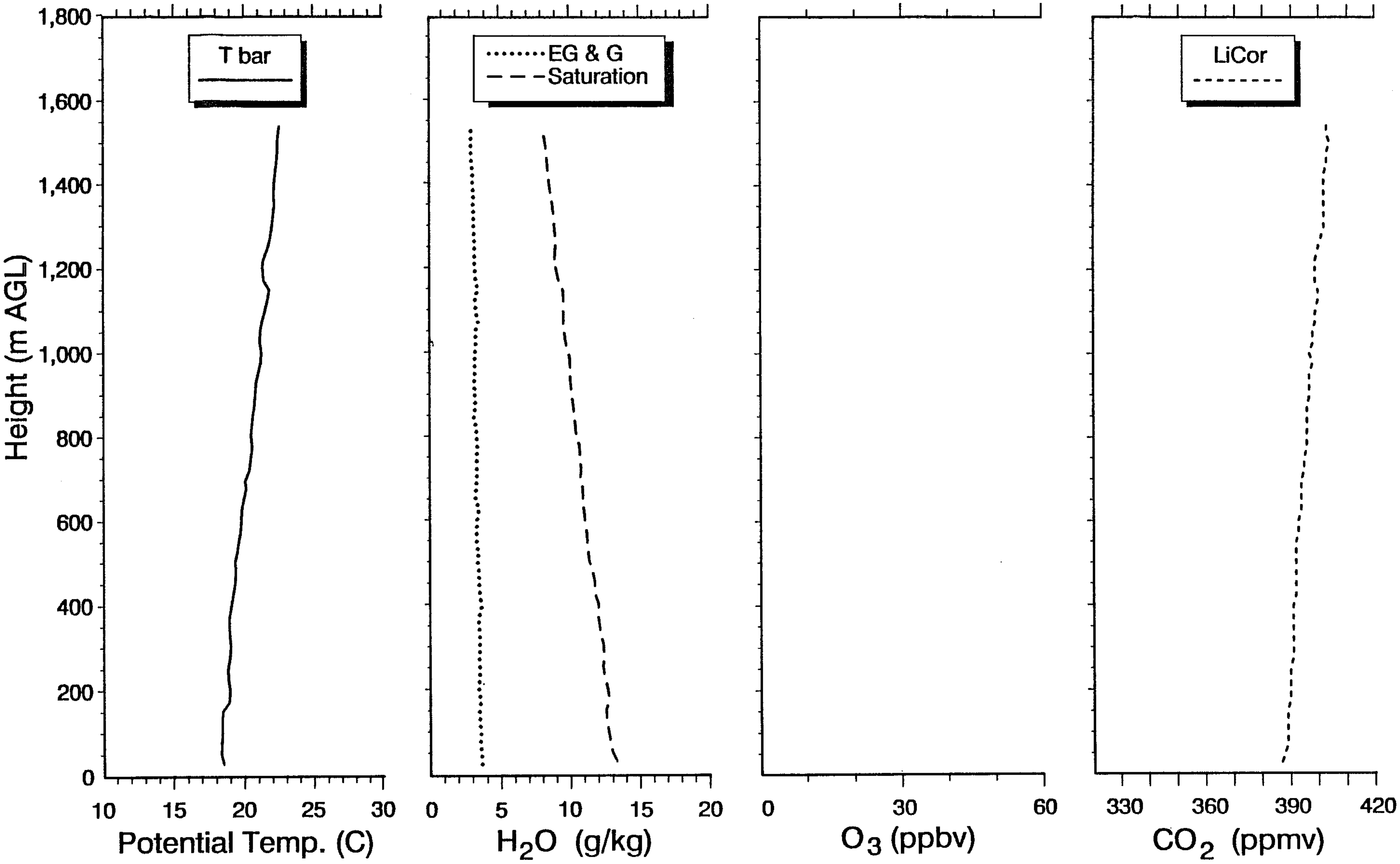
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 3, 1991 Start = 1133 PDT, END = 1147 PDT



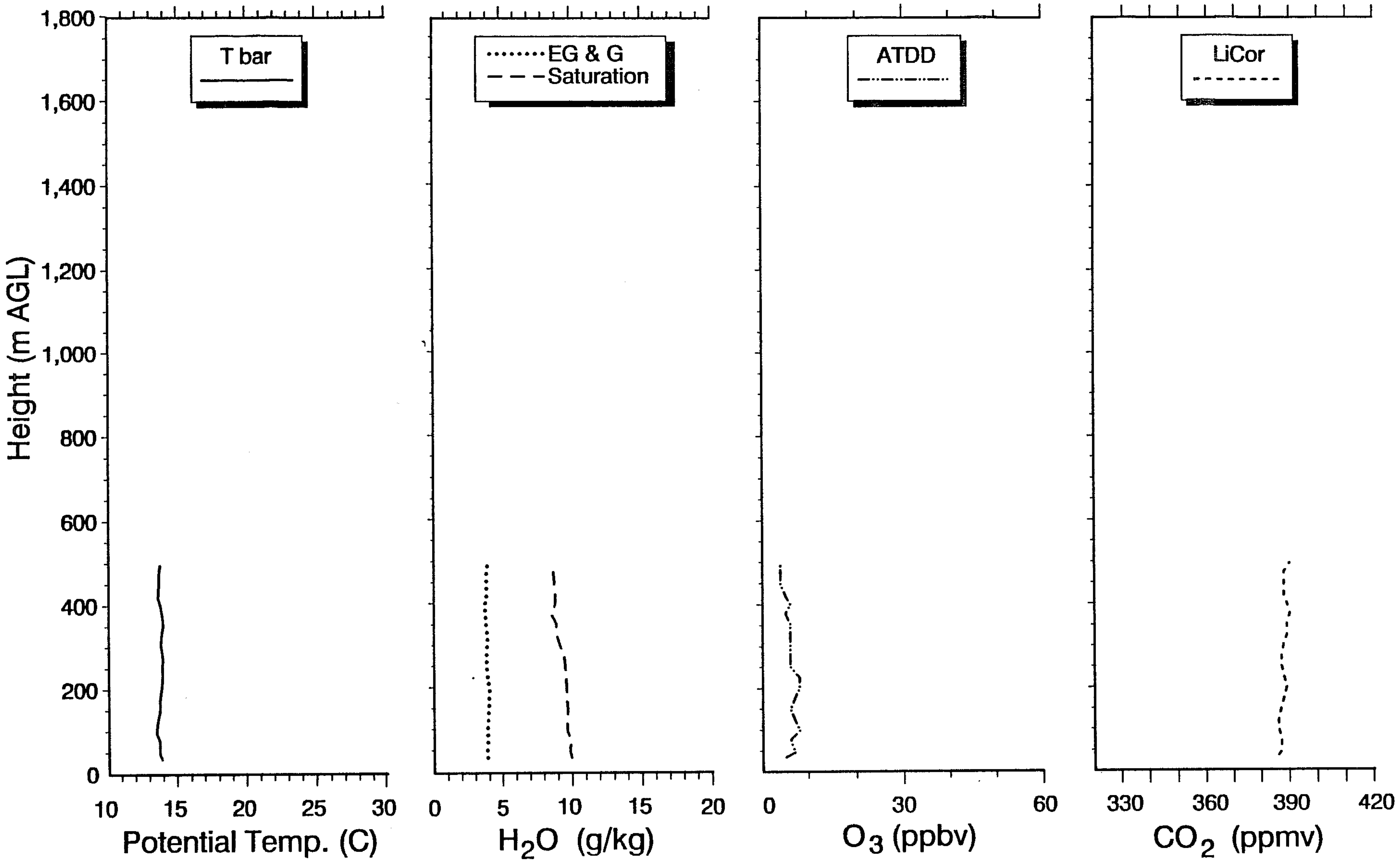
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 3, 1991 Start = 1352 PDT, End = 1411 PDT



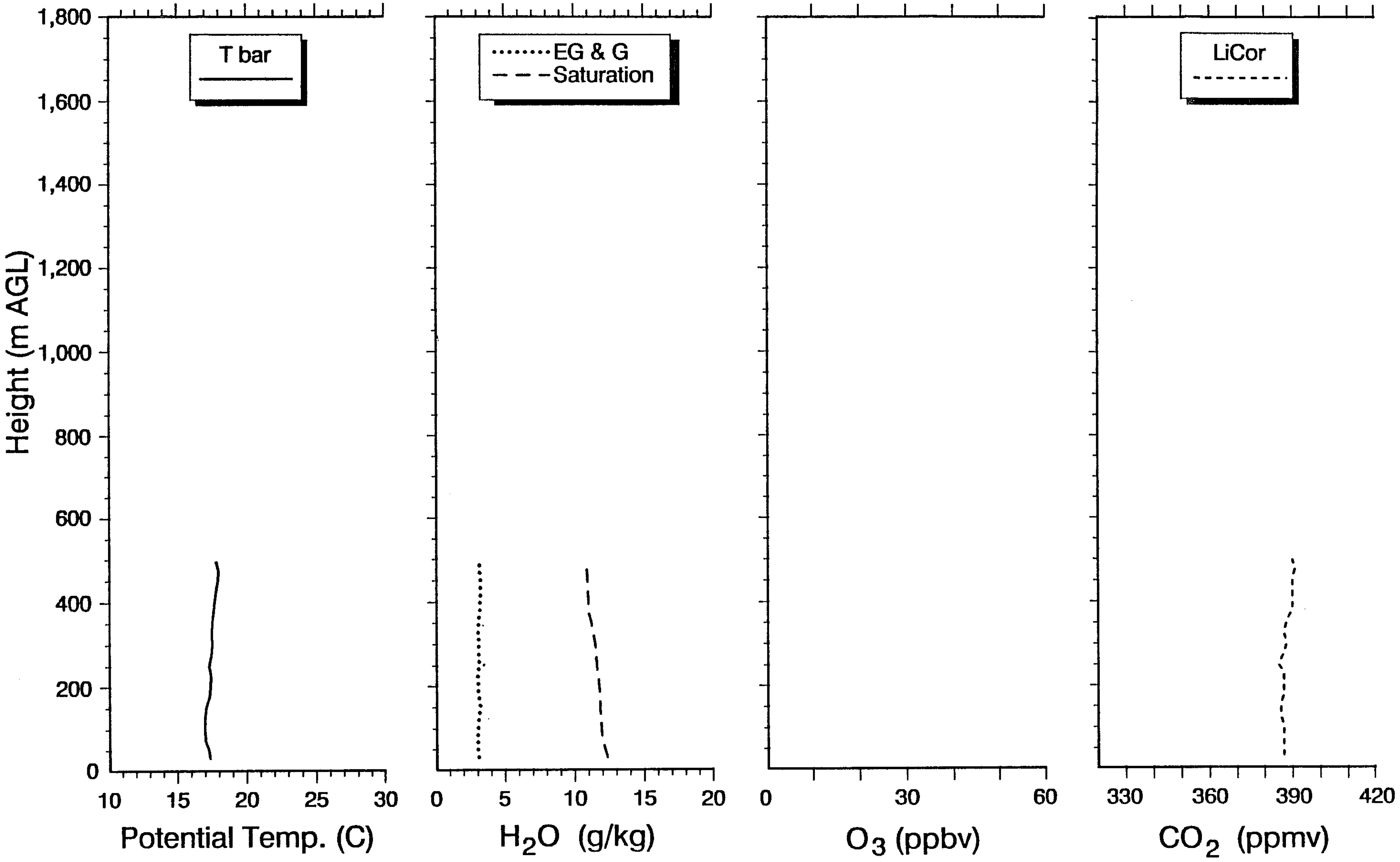
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 4, 1991 Start = 0914 PDT, End = 0922 PDT



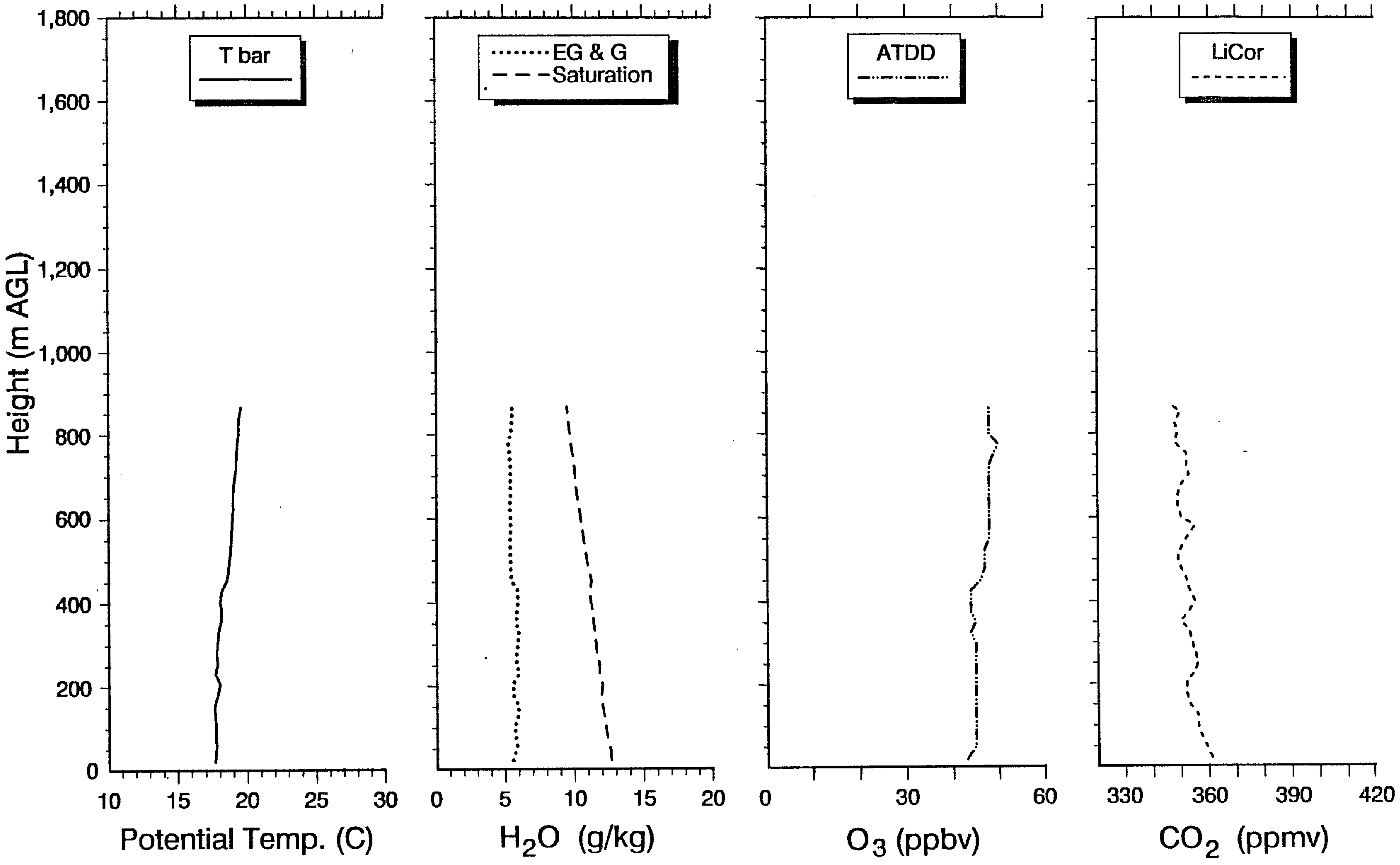
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 4, 1991 Start = 1258 PDT, End = 1304 PDT



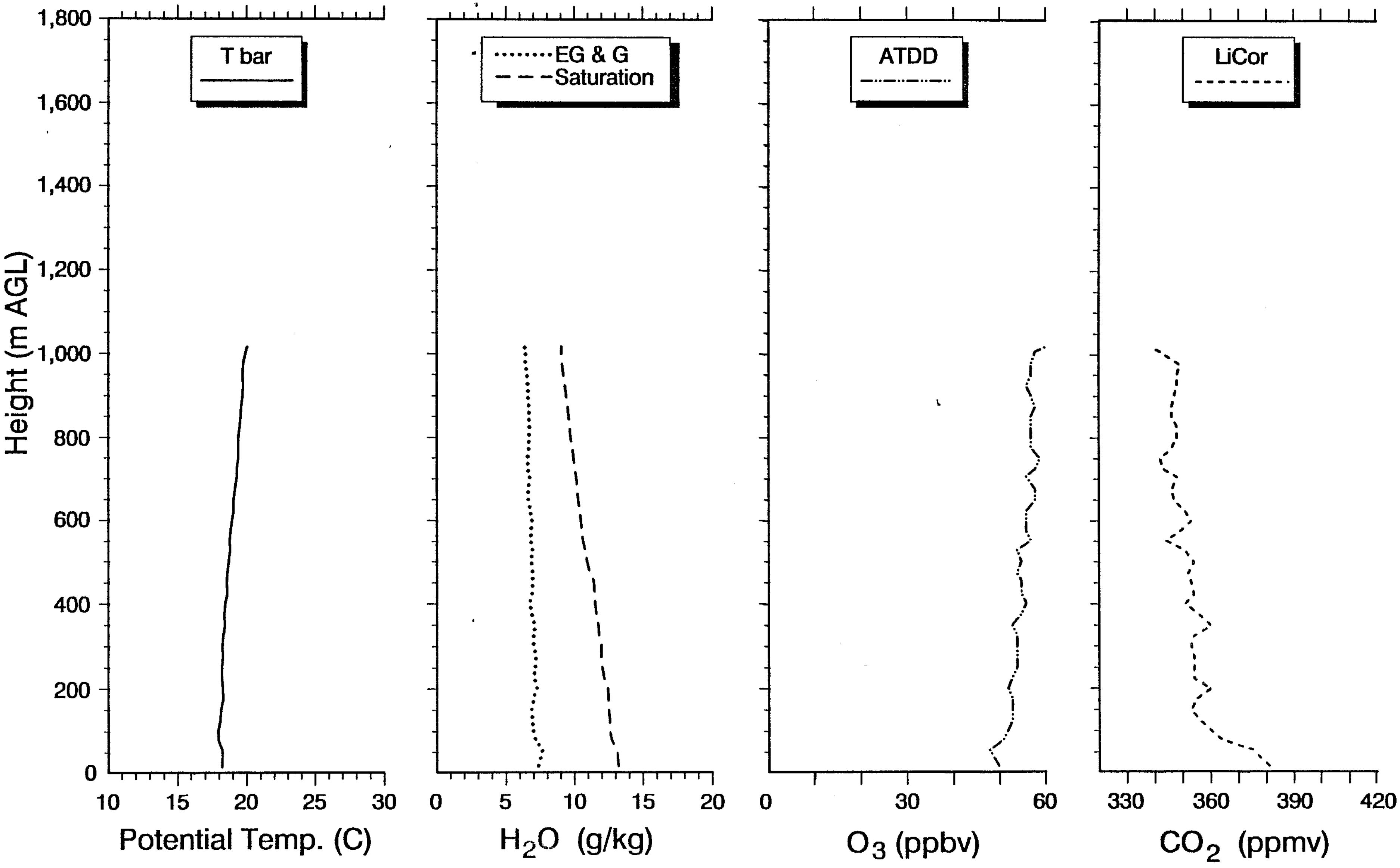
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 5, 1991 Start = 1743 PDT, End = 1755 PDT



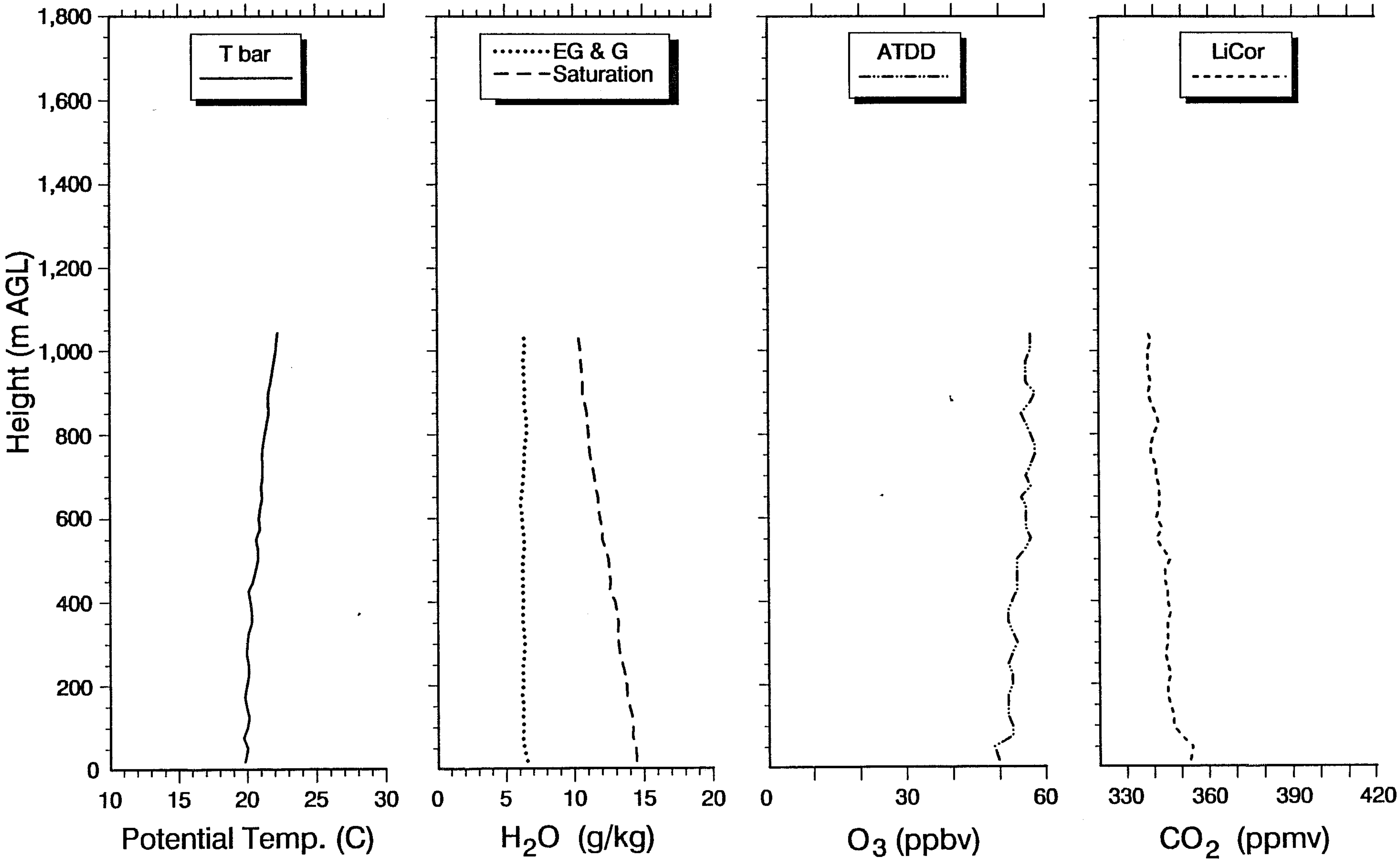
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 6, 1991 Start = 1154 PDT, End = 1204 PDT



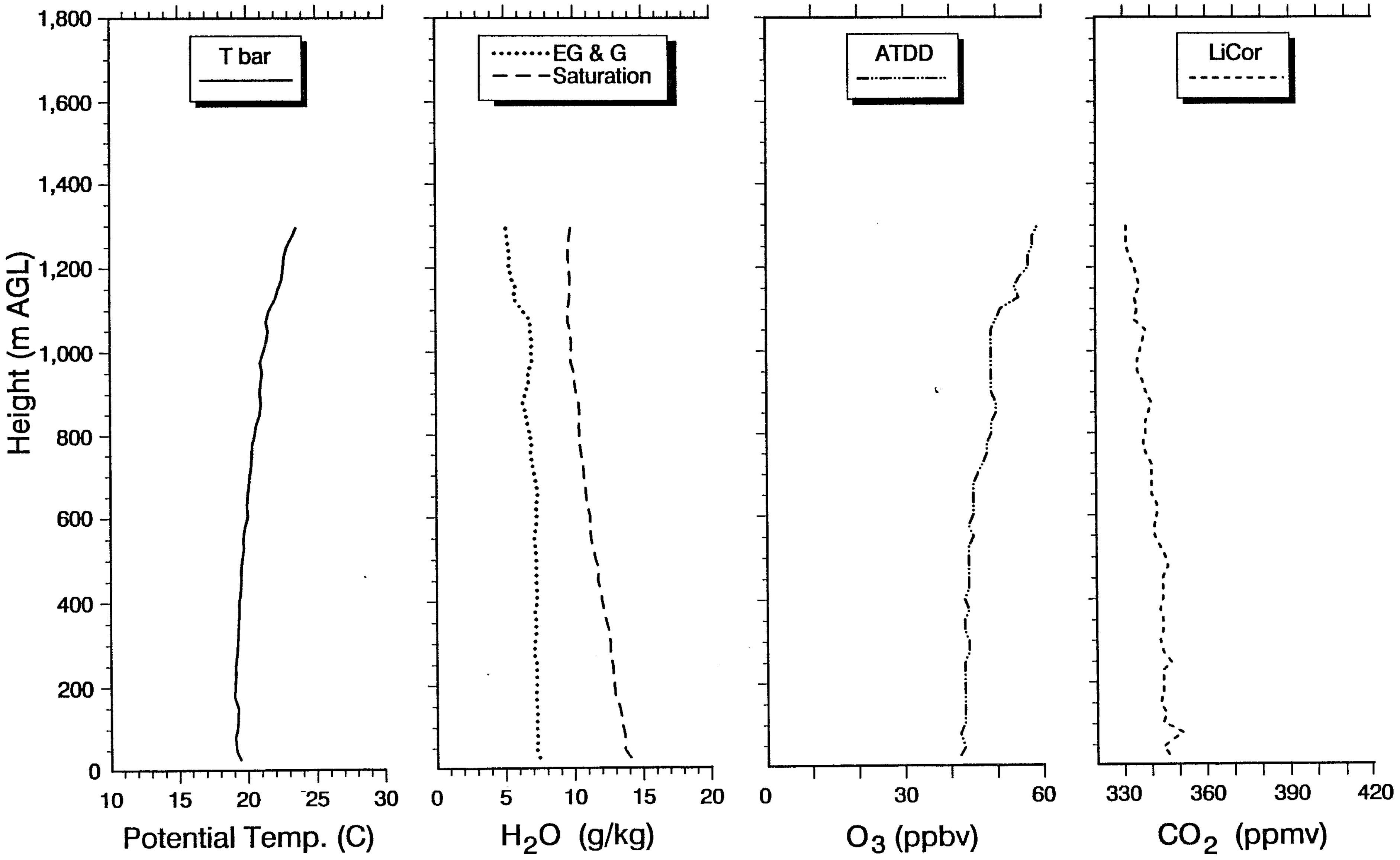
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 6, 1991 Start = 1527 PDT, End = 1540 PDT



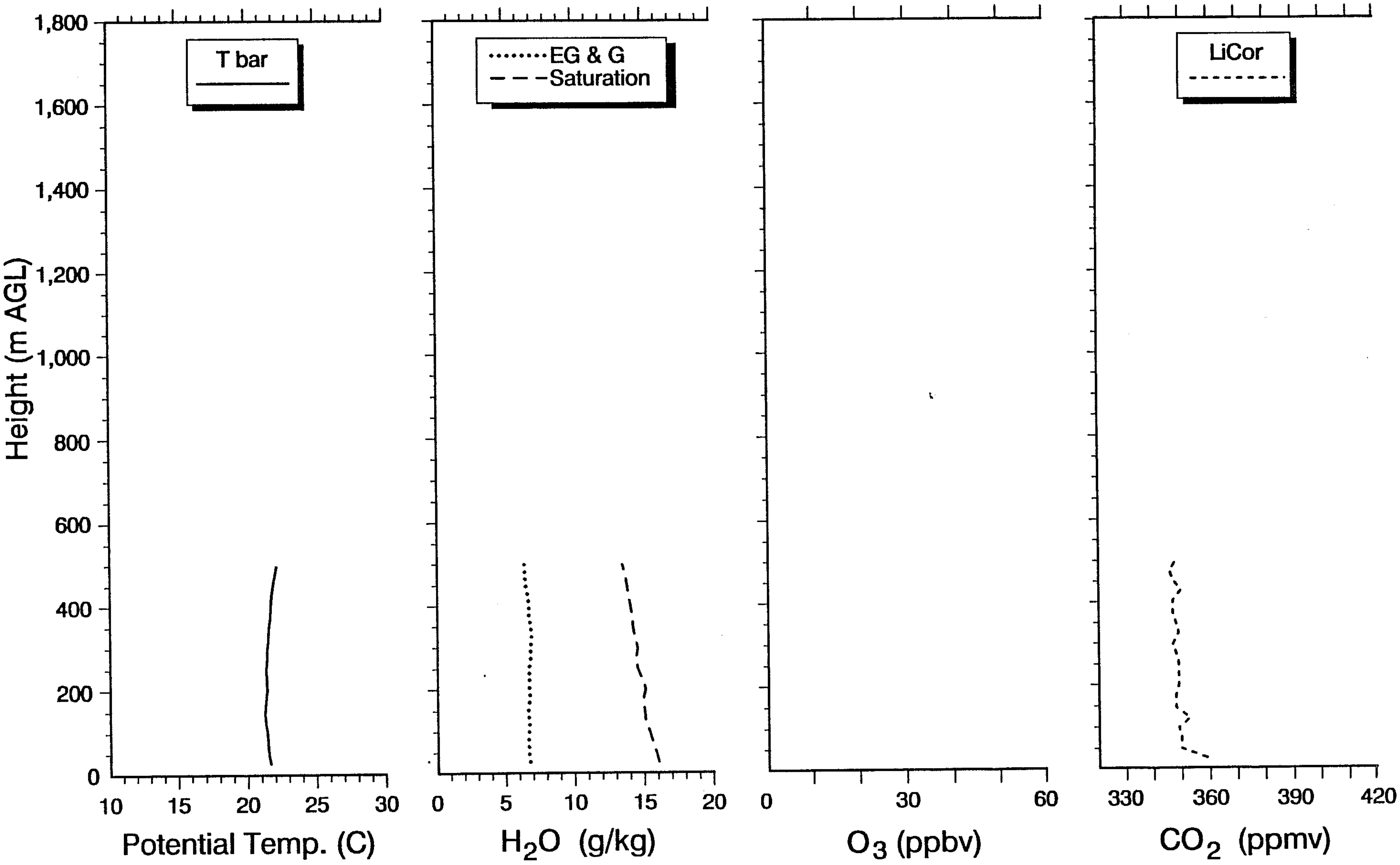
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 7, 1991 Start = 0949 PDT, End = 1007 PDT



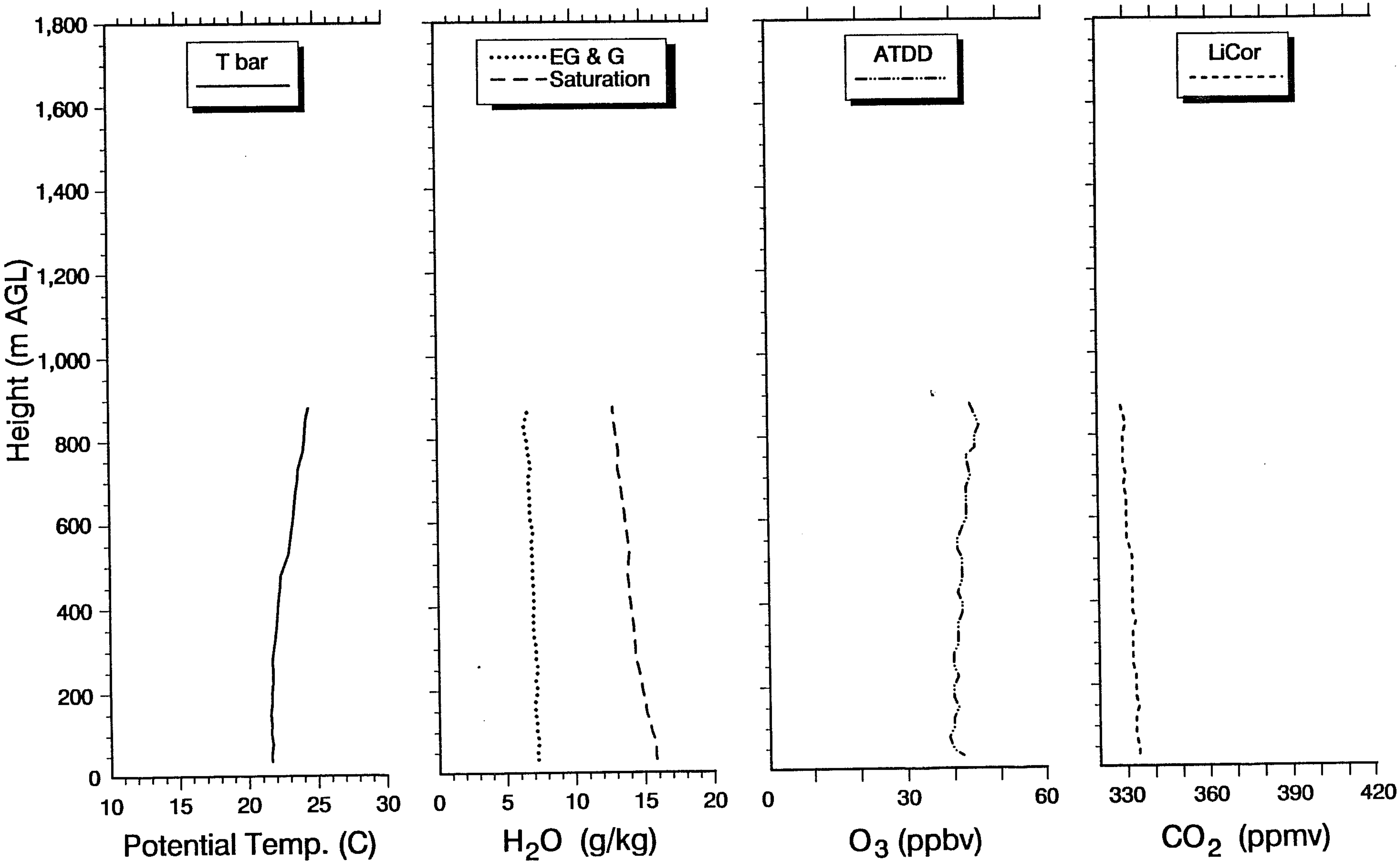
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 7, 1991 Start = 1219 PDT, End = 1226 PDT



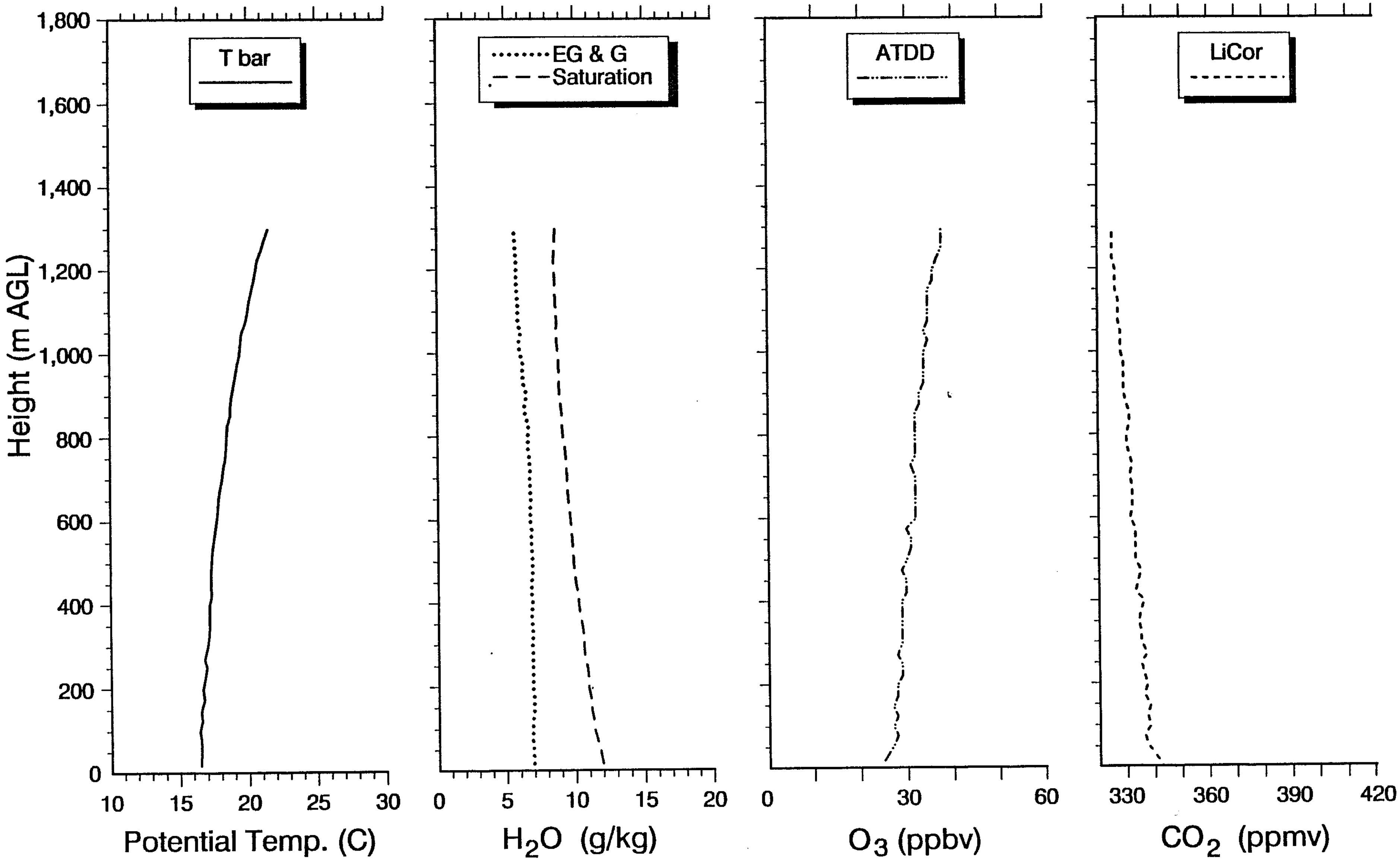
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 7, 1991 Start = 1601 PDT, End = 1605 PDT



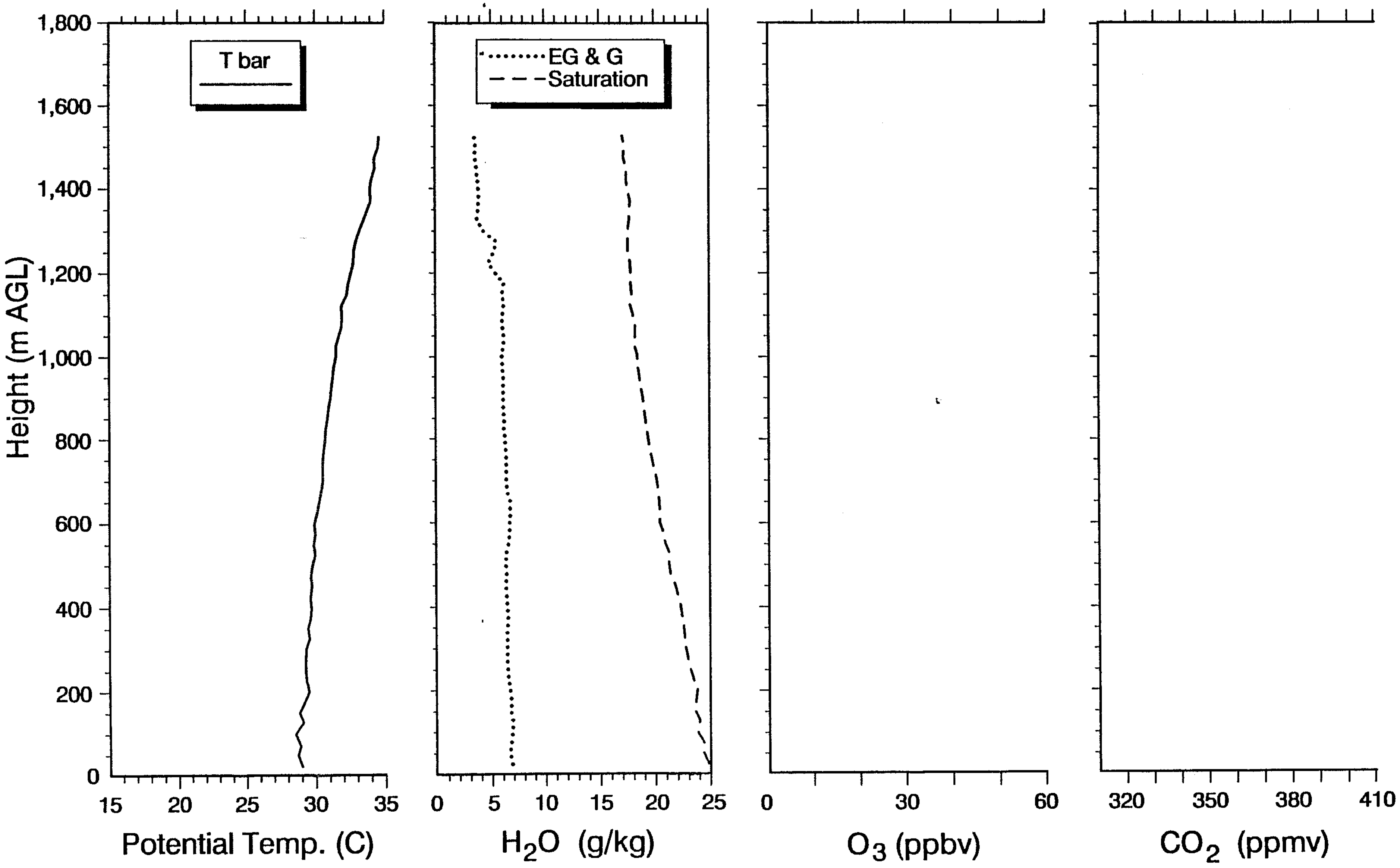
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 8, 1991 Start = 0807 PDT, End 0823 PDT



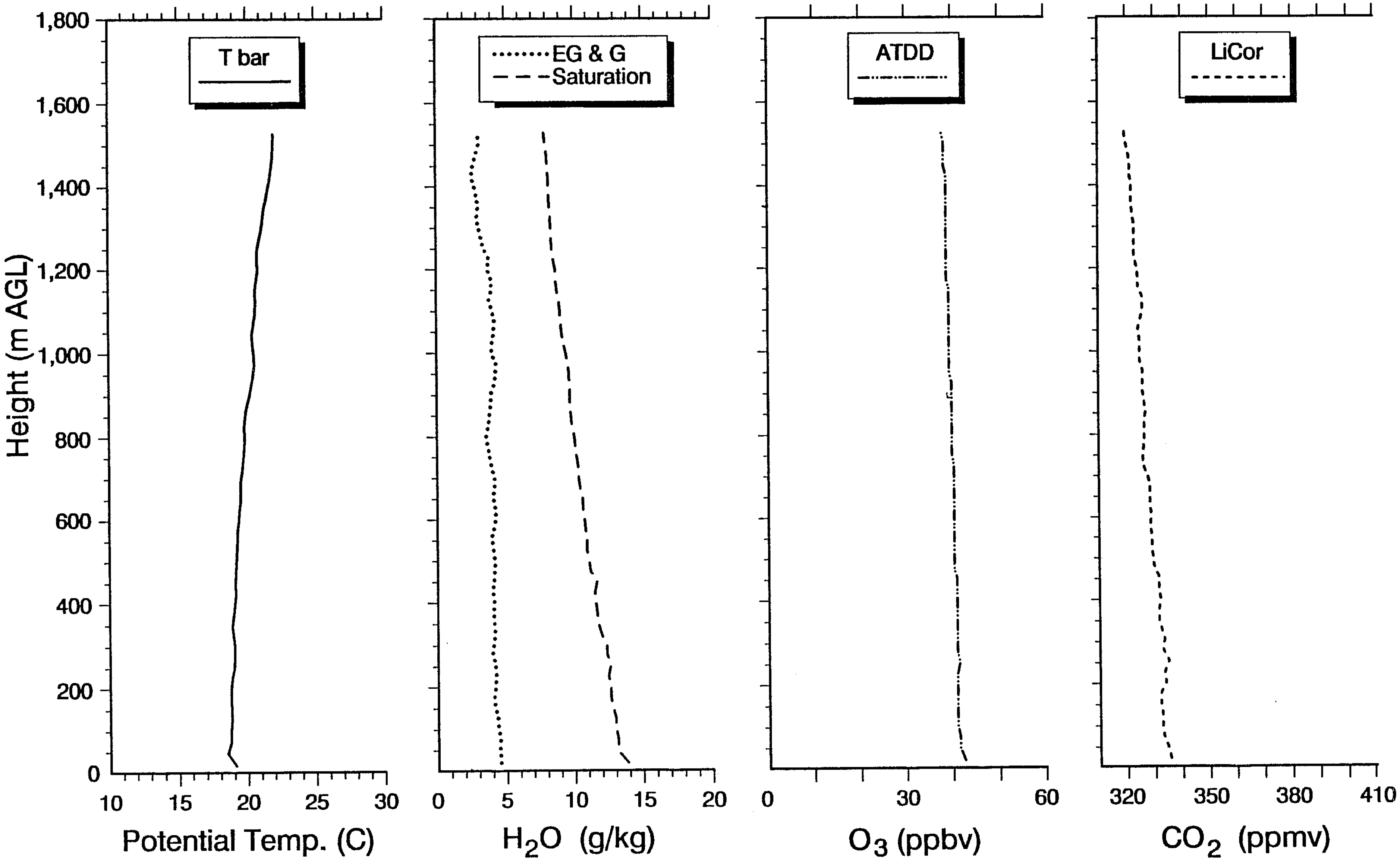
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 10, 1991 Start = 1407 PDT, End = 1428 PDT



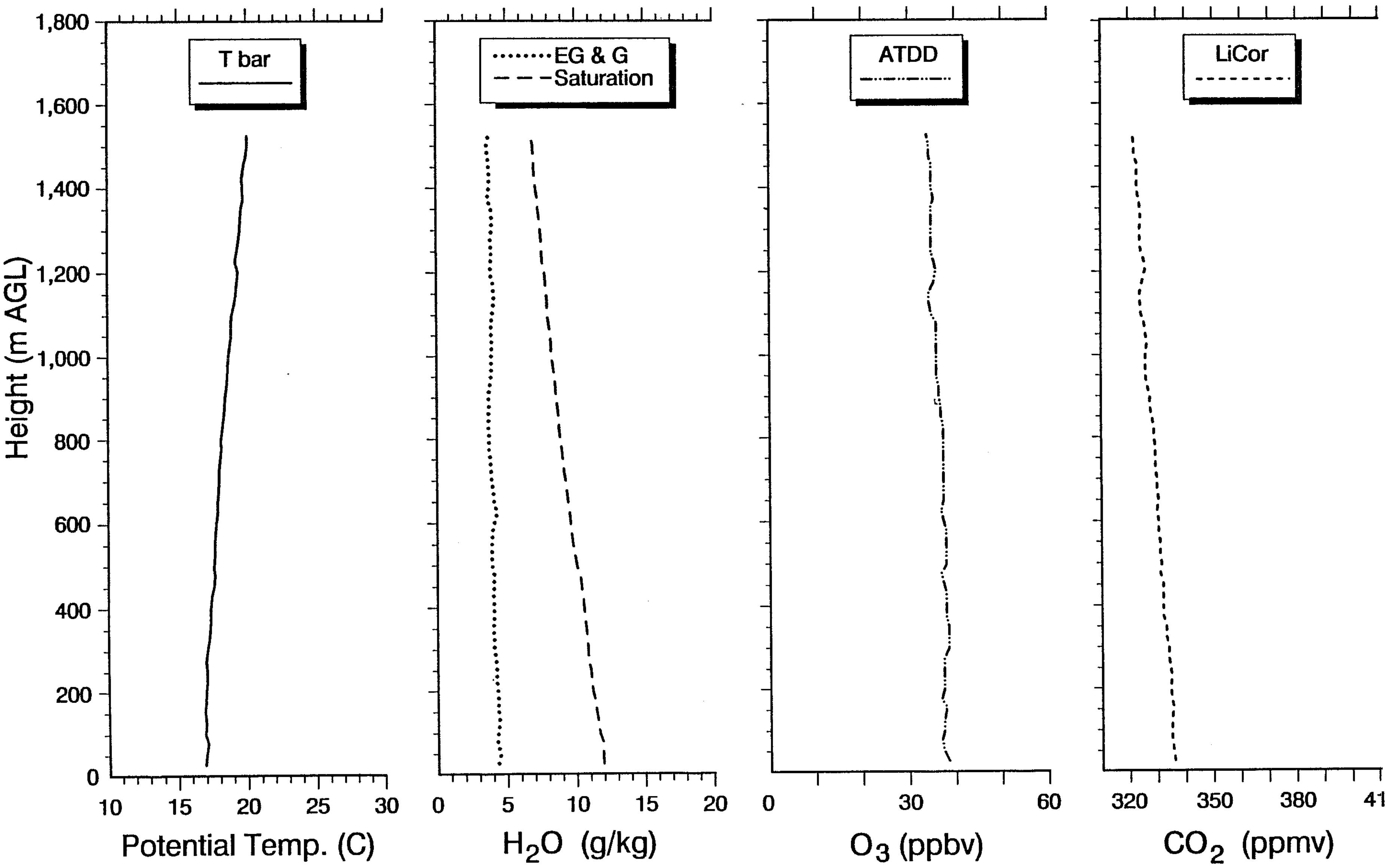
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 12, 1991 Start = 1324 PDT, End = 1351 PDT



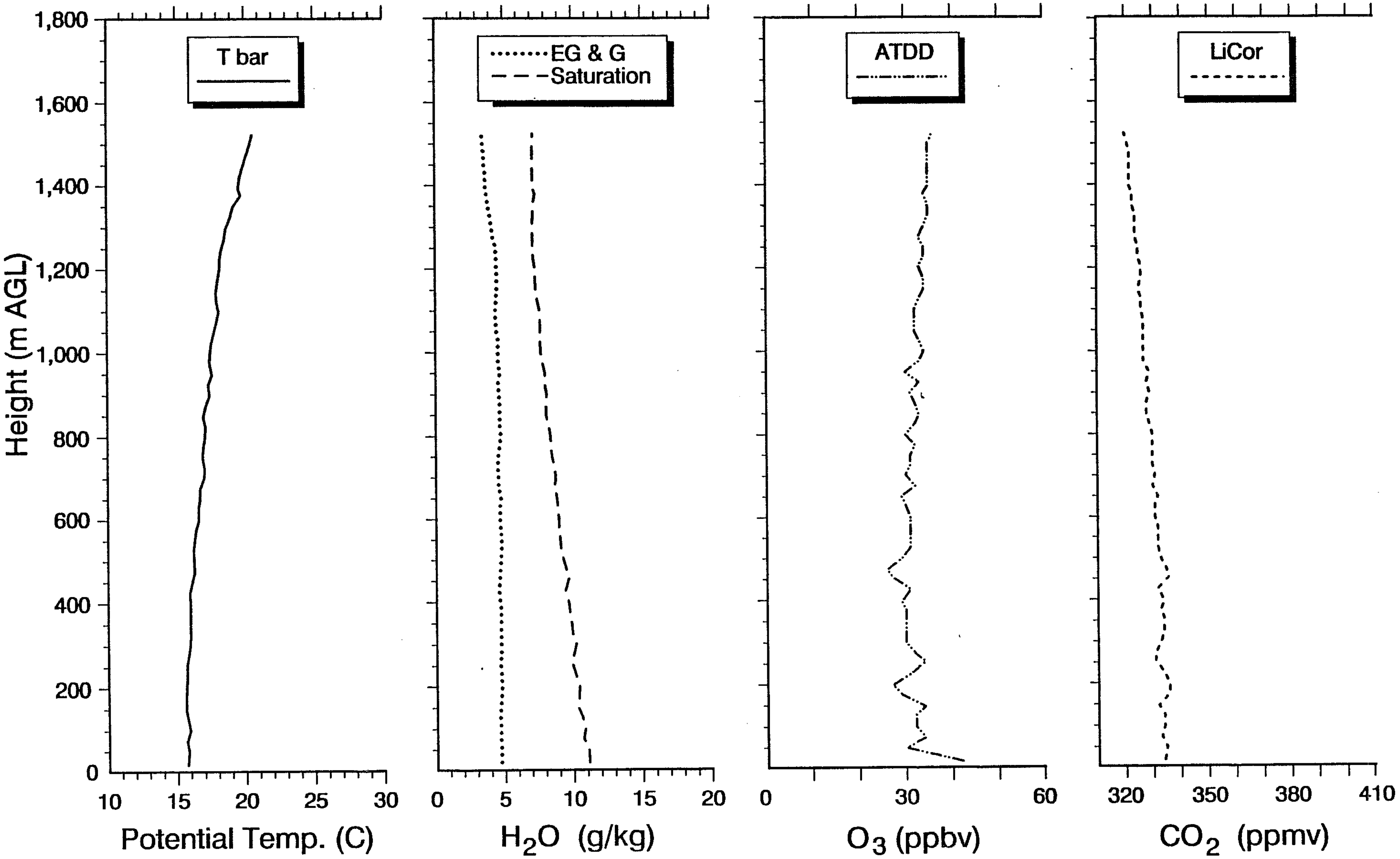
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 13, 1991 Start = 1116 PDT, End = 1140 PDT



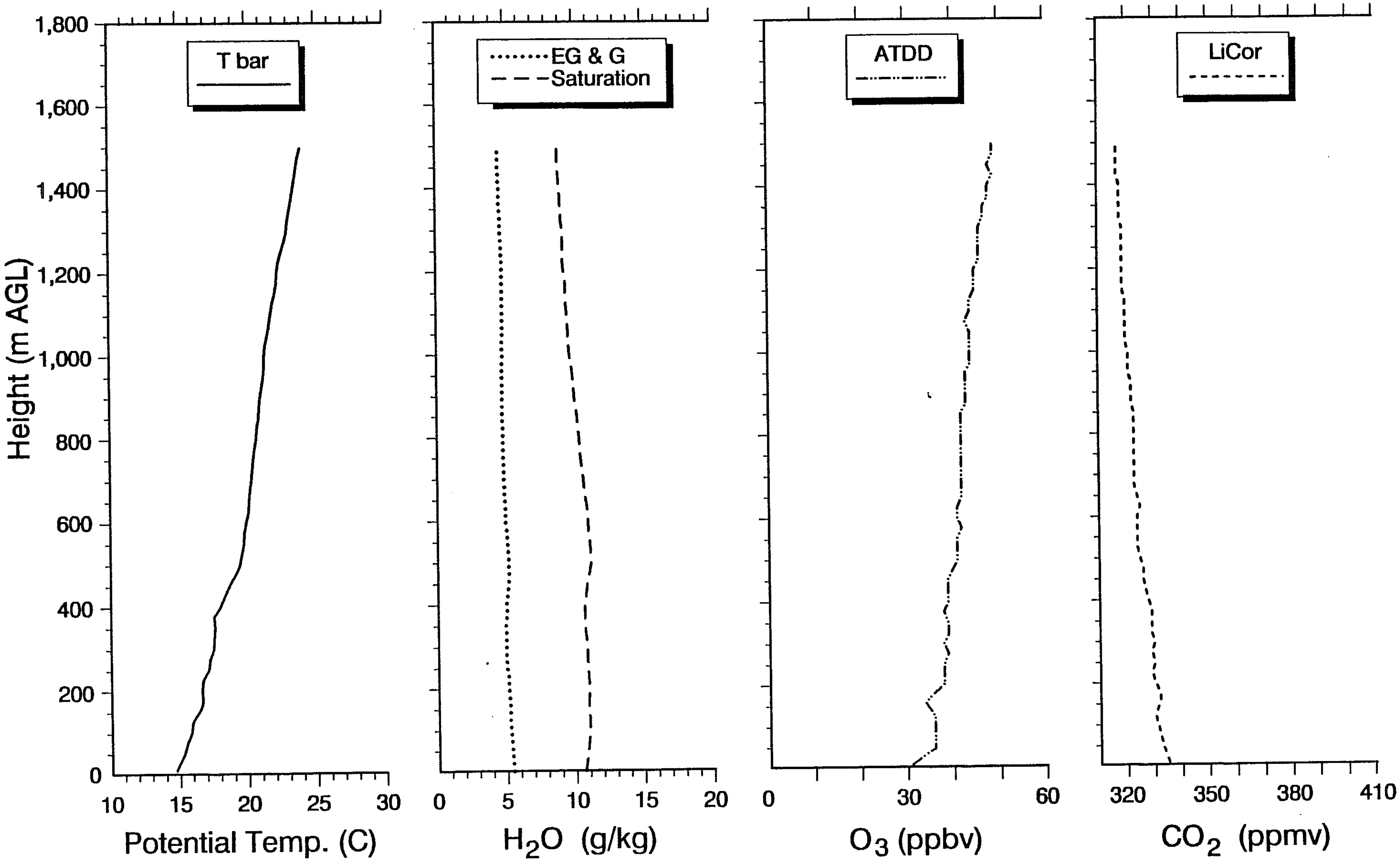
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 14, 1991 Start = 0947 PDT, End = 1008 PDT



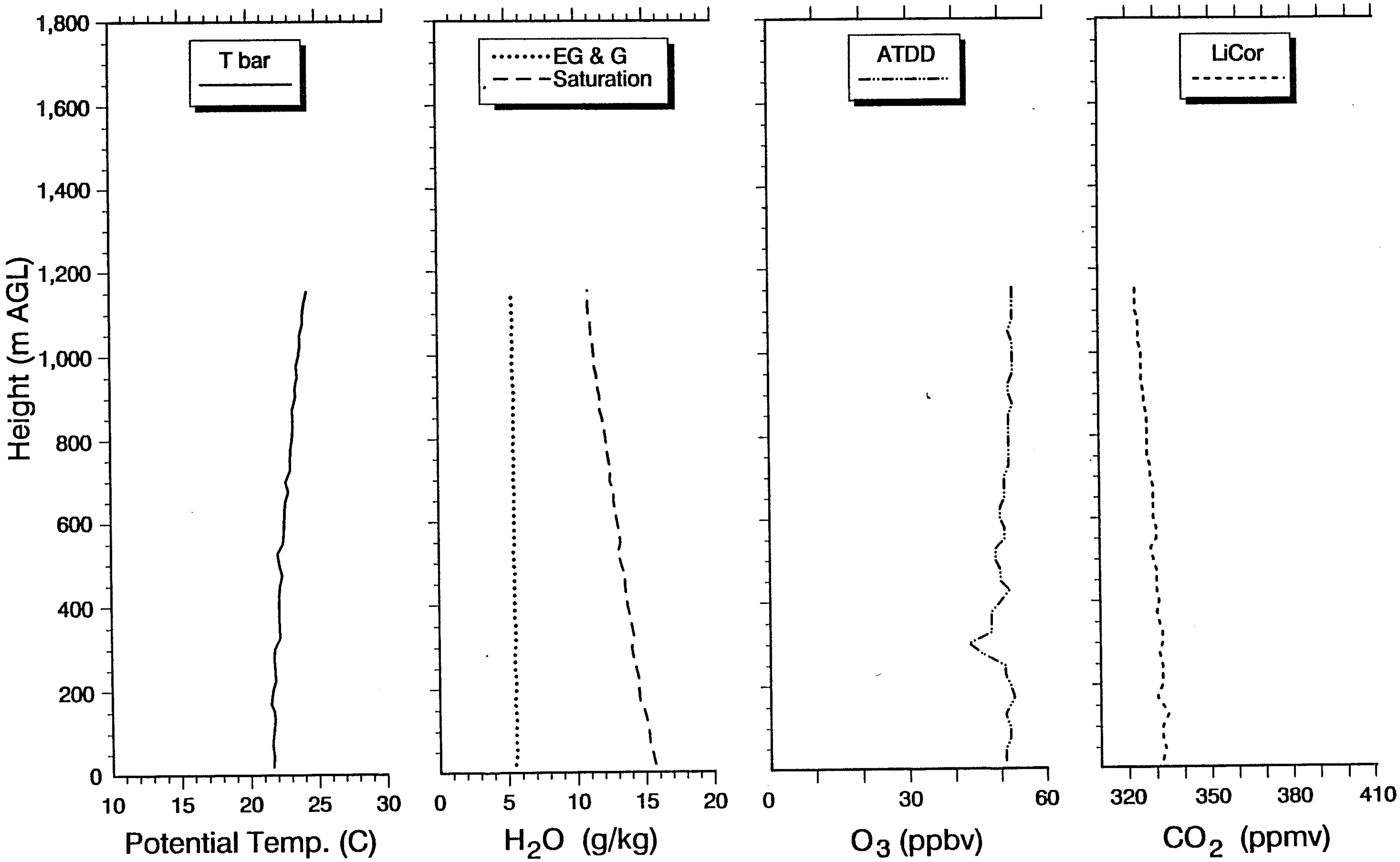
ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 15, 1991 Start = 0612 PDT, End = 0627 PDT



ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 15, 1991 Start = 1321 PDT, End = 1335 PDT



ARM NOAA-ATDD AIRCRAFT PROFILE: Boardman, OR

June 17, 1991 Start = 0752 PDT, End = 0814 PDT