

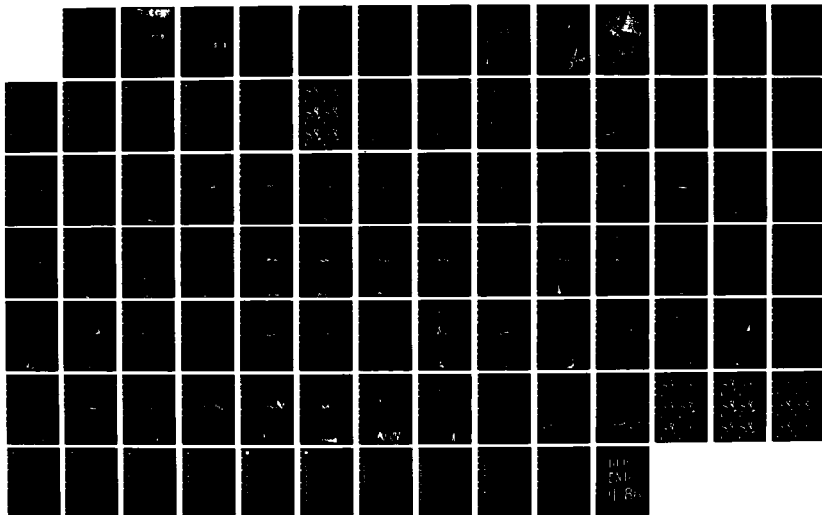
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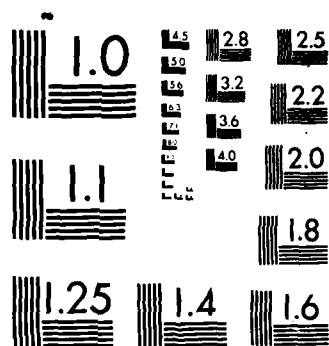
INVESTIGATIONS OF THE MICRO-TURBULENCE IN THE BOTTOM OF 1/1
THE BOUNDARY LAYER(U) SCHMITT (RAINER) GLASHUTTEN
(GERMANY F R) R SCHMITT 31 DEC 85 DAJA45-83-C-0038

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MICROCOPY RESOLUTION TEST CHART
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Investigations of the Micro-Turbulence
in the Bottom of the Boundary Layer

Final Technical Report

Dr. Rainer Schmitt

December 1985

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United States Army

London England

CONTRACT NUMBER : DAJA 45-83-C-0038

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The data-format on the flex.disc is as documented in table No. 1:

Meteorology: DDD= Wind-direction (deg)
VV.V=Wind-speed (m/sec)
TT.T=Temperature (centigrade) (attention: until ..
35 deg.C must be subtracted from the indicated
values
FF.F=Wet-bulb-temperature (Centigrade)
(attention:35.deg must be subtracted
from the indicated values.)
RR.R=Radiation-balance (cal/scm/min)

C2n : Volts, Precision:0.01 Volt. maximum indicated value 9.99
volts

Each measurement period is organized as one file, the maximum time
for one measurement is 17 hours. Every file is organized as follows:

Record No. 1. Title, Location, Position (North, East), discription

Record No. 2. Empty

Record No. 3,4.Discription of data-records:

ST : Location Steinbach

yy : Year, Year: (84)

dd : Day , Day : (03)

hh : hour, hour (24 hour system , 17 = 5 pmm LST)

mm : minute,minute (20)

xyy : C2n-Values every 10 seconds, Volts (9.99)

Record No. 5 and following:

Data: Each Record contains 10 minutes of
measurements with 20-second-single-
values of C2n-signal and one set of
10-minute-mean-values of meteorology.

As a basis for interpretation of the data we submit the following
tables and figures:

The air-mass and the main weather situation according to Hess and
Precowsky is given in table 3. The frequency distribution of the
main weather conditions of the period 1931 to 1960 is presented in
table 4., the figures 4 to 7 give typical examples of these main
weather situations. The collection of tables gives the information
of the air-mass and main weather situations for the months September
1984 to October 1985. The air-mass for Karlsruhe is representa-
tive for the location Steinbach, Bremen is representative for the
location of Bremen (Publication of the German Weather Service).

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18. SUPPLEMENTARY NOTES

Refractive-Index-Structure-Parameter, micro-turbulence, atmospheric scintillation,

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Refractive-Index-Structure-Parameter, micro-turbulence, atmospheric scintillation, West-Germany, Boundary Layer

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Measurements of the microturbulence in the bottom of the atmospheric boundary layer using a two-ended scintillometer system have been performed at two sites in West Germany: more than 500 hours in a hilly area, 180 hours near the coast of the North-Sea. The data are presented as figures: signal as function of time.

The regional distribution of the climatic elements in Central Europe is presented in the maps of figure 8 ff..

The intensity of the two sources were set according to the distance source-receiver, using the curve of calibration setting in the instrument-handbook.

The data were collected using two Hewlett and Packard data-acquisition units (HP 3421) and two HP 71 computers. The linear output-signals of the scintillometers were monitored every 20 seconds, the data were stored in the internal memory of the computer. In Steinbach 10 min-mean values of the meteorological parameters: wind-direction, wind-speed, wet-bulb-temperature, temperature and radiation balance, were calculated.

The optical alignment of the system was controlled before starting the measurements and several times during the day. At Bremen the voltage-signal of the control-led was monitored to get an information of bad alignment or fog. It has been testet, that in case of fog the signal-value is constant, the voltage equals 0.34 volts.

From Steinbach the data were transferred to our laboratory via telephone-line using a software-controlled modem-system. The maximum uninterrupted measuring-time was 17 hours.

In this final technical report the data collected at Steinbach are presented in the figures at the end of the report. The scale of the Cn2-signal represents Volts (linear output of the instrument),

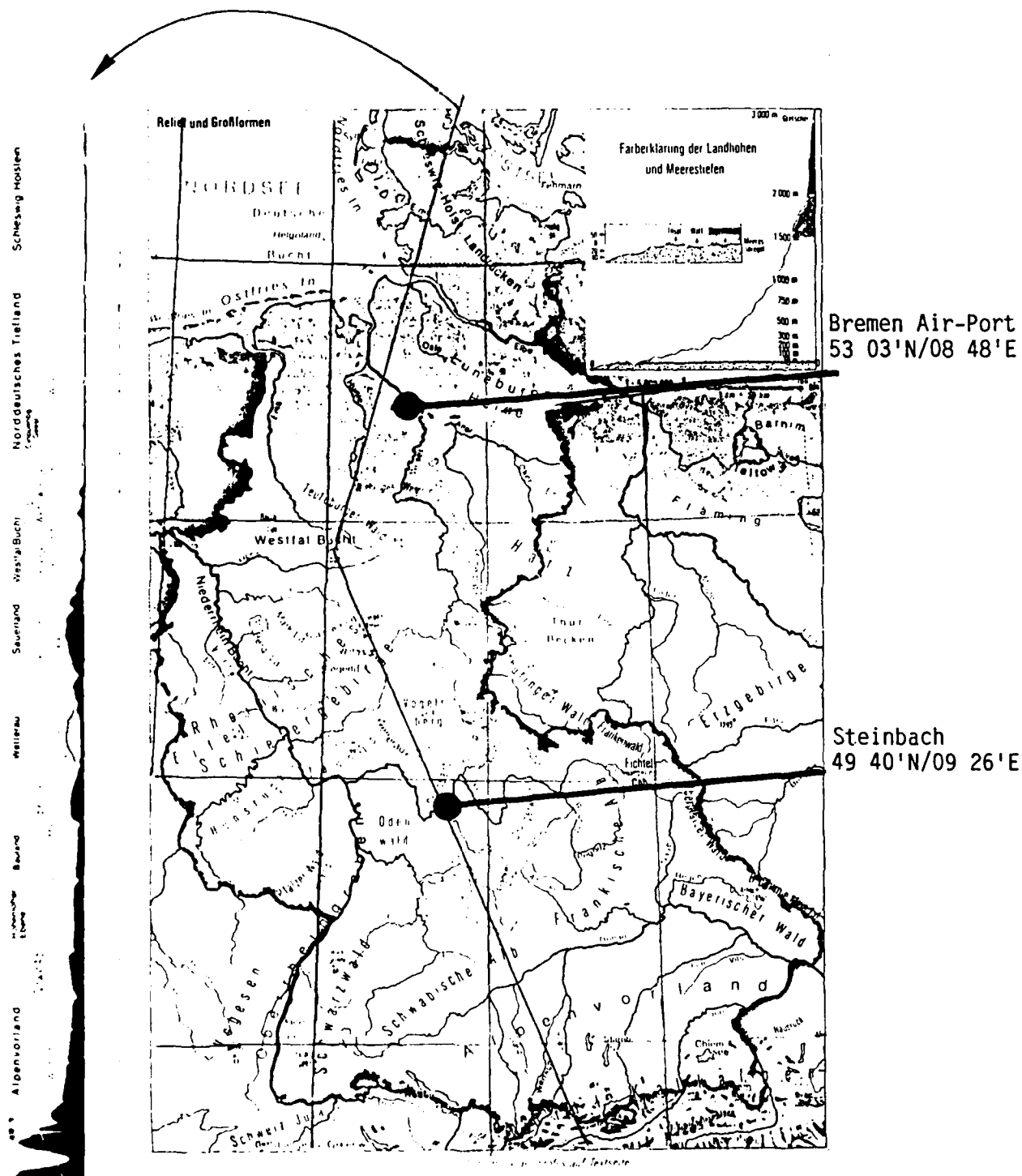
In the upper part of the pictures the meteorological conditions are documented: Temperature, humidity -as wet-bulb-temperature-, radiation-balance, and windspeed. From the indicated temperature-values 35 deg. Celsius must subtracted.

The data collected in the HP 71 have been transferred via a HP9845 desk-top computer to 8" HP formatted disketts and hereafter to IBM-4370 formatted 8"-ABCDIC-disketts. These diskettes were send to:

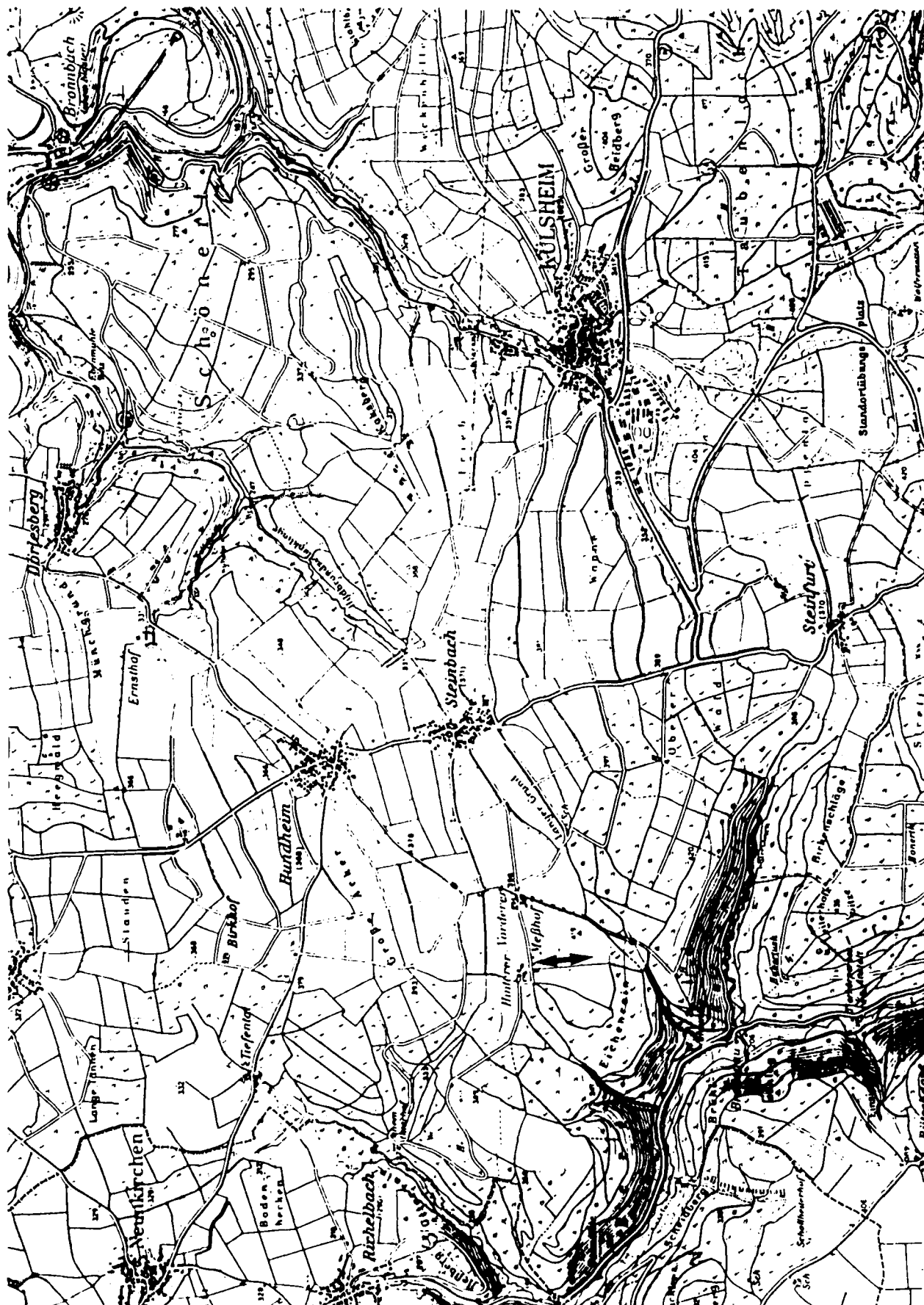
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AND DEVELOPMENT COMMAND
US ARMY ATMOSPHERIC SCIENCE LABORATORY
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WHITE SANDS MISSILE RANGE, NEW MEXICO 88002

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Justification	
By	
Distribution /	
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Dist	Avail and/or Special
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Locations of measurements in West Germany



▲ Steinbach
49° 40' N / 09° 26' E



▲ Bremen Air-Port
53 03'N/08 48'E

During the years 1984 and 1985 measurements of the micro turbulence in the bottom of the boundary layer were carried out at two sites in the Federal Republic of Germany.

The signal monitored corresponds to the refractive index structure parameter (C_n^2) averaged over the path between a incoherent light source and a signal-receiver. The reported values are proportional to the logarithm of C_n^2 . C_n^2 can be calculated by applying the formular: $C_n^2 = 10^{**(-14)} * \log^{**(-1)} \text{Signal}$ (Signal eq. Volts)

Figure 1 + 2 as marked on the maps, show the two locations in Germany. The details of the sites are shown in figure 2 (Steinbach) and 3 (Bremen); the scales of the maps are 1:50.000. Location 1 (Steinbach) is situated in a rural environment in a hilly terrain. The mean altitude is approximately 400 m MSL. The second location, Bremen, is in the northern Part of Germany, 100 km south east from the coast of the North-Sea. The site itself was at the airport of the city of Bremen.

To one of the copies of the report a coloured oro-hydrographic map (1:1.000.000) of the Federal Republic of Germany and two coloured maps of the area of the sites (1:50.000) are attached.

Maps:

Steinbach: Topographische Karte 1:50.000 No. L 6322

Bremen: Topographische Karte 1: 50.000 No. L 2918

Two auto-calibrating atmospheric scintillometers (Model IV-L) manufactured by Lockheed Engineering and Management Service Comp. Inc. were used. The instruments (sources and receivers) were mounted on aluminium-tower segments at a height of approximately 2 m to 2.5 m above ground. The distance between the source and the receiver was approx. 650 m at Bremen and 520 m at Steinbach. The surface was completely flat at Bremen, the systems were orientated horizontally. In Steinbach the surface between source and detector was flat within approx. 2 meters. The source was at a height of 415 m MSL, the receiver at 410 m MSL.

The surface at Bremen was covered with grass, at Steinbach rape was growing.

The system at Steinbach was orientated in north-south direction (source: south), at Bremen the orientation was west-east (source: east).

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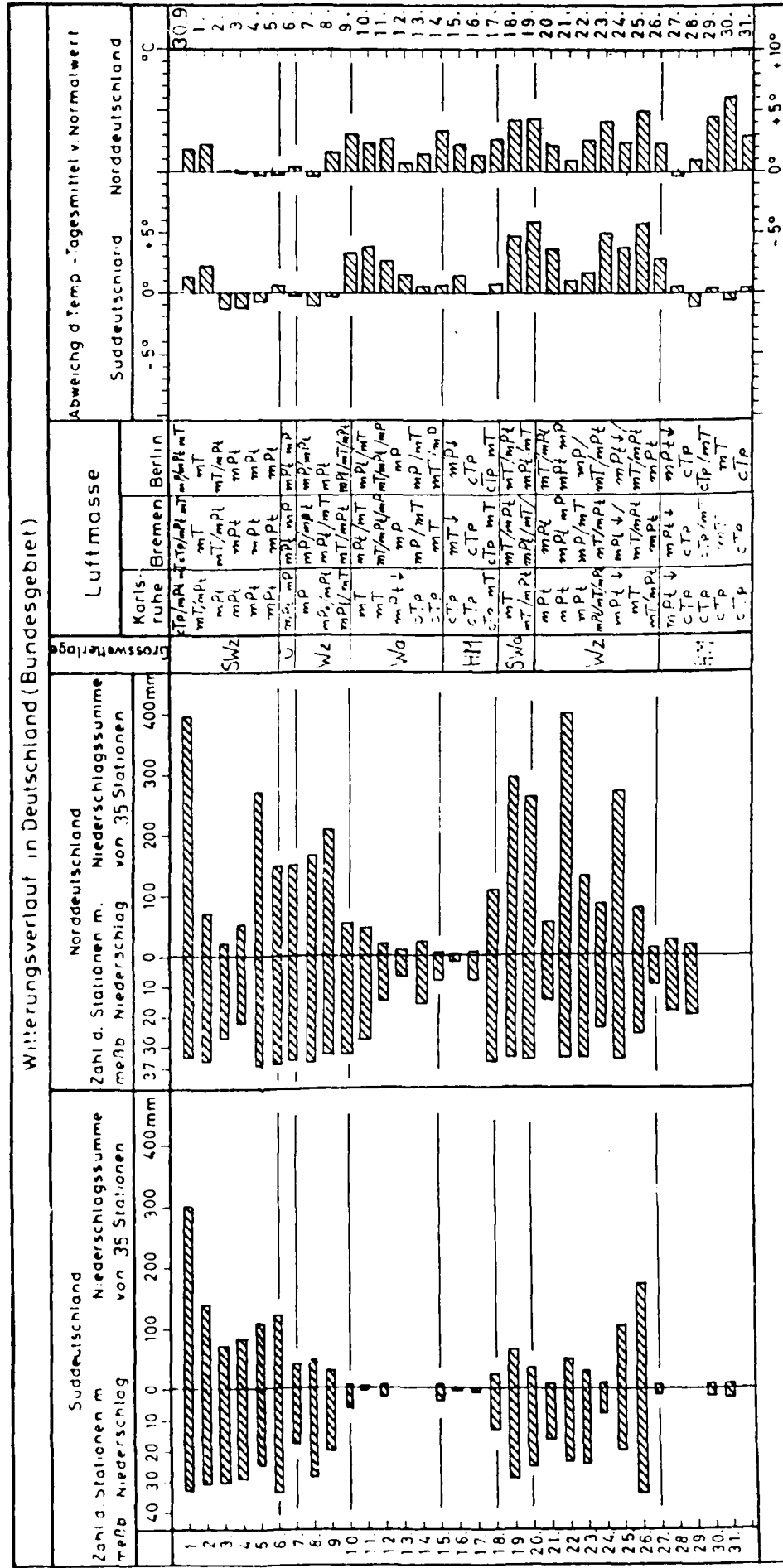
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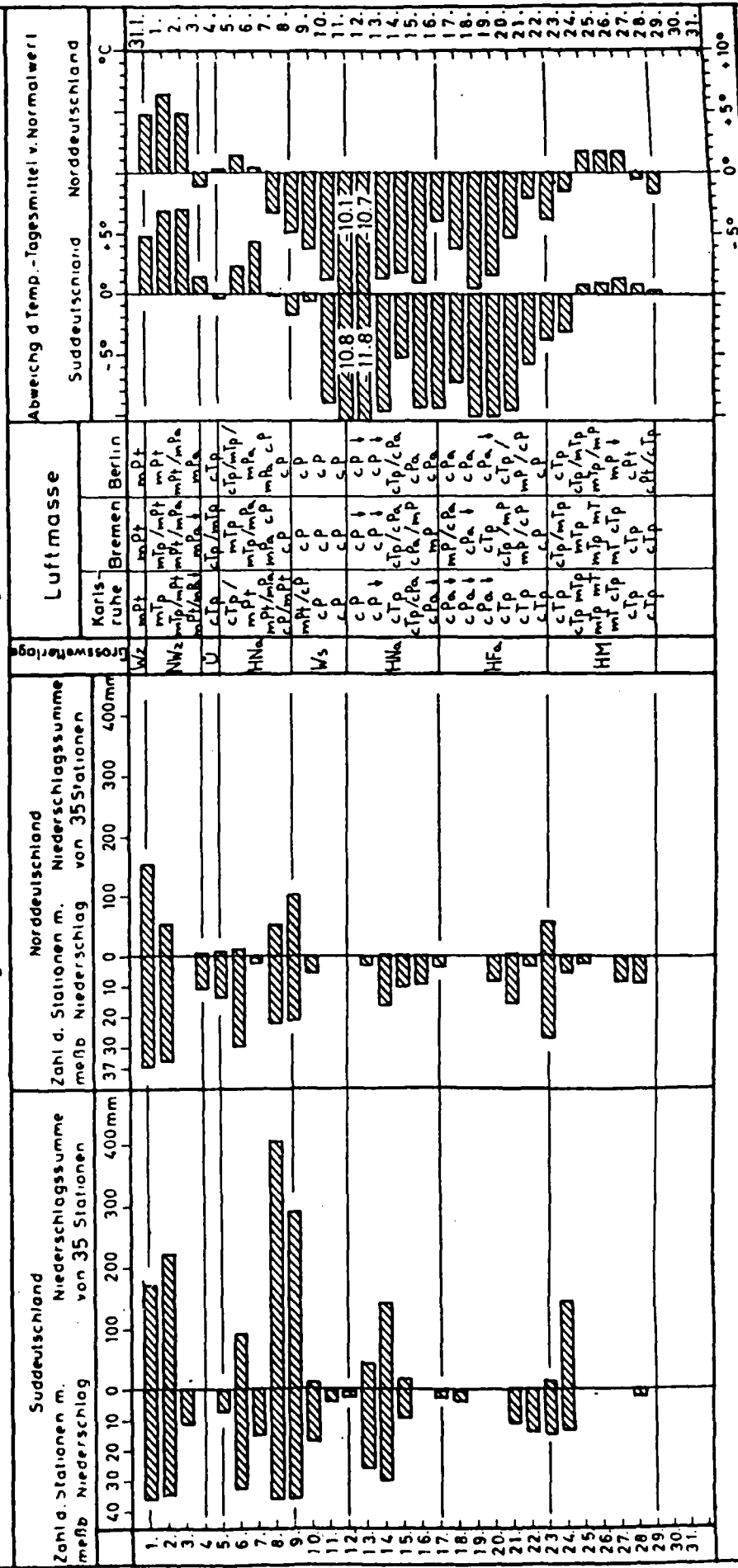
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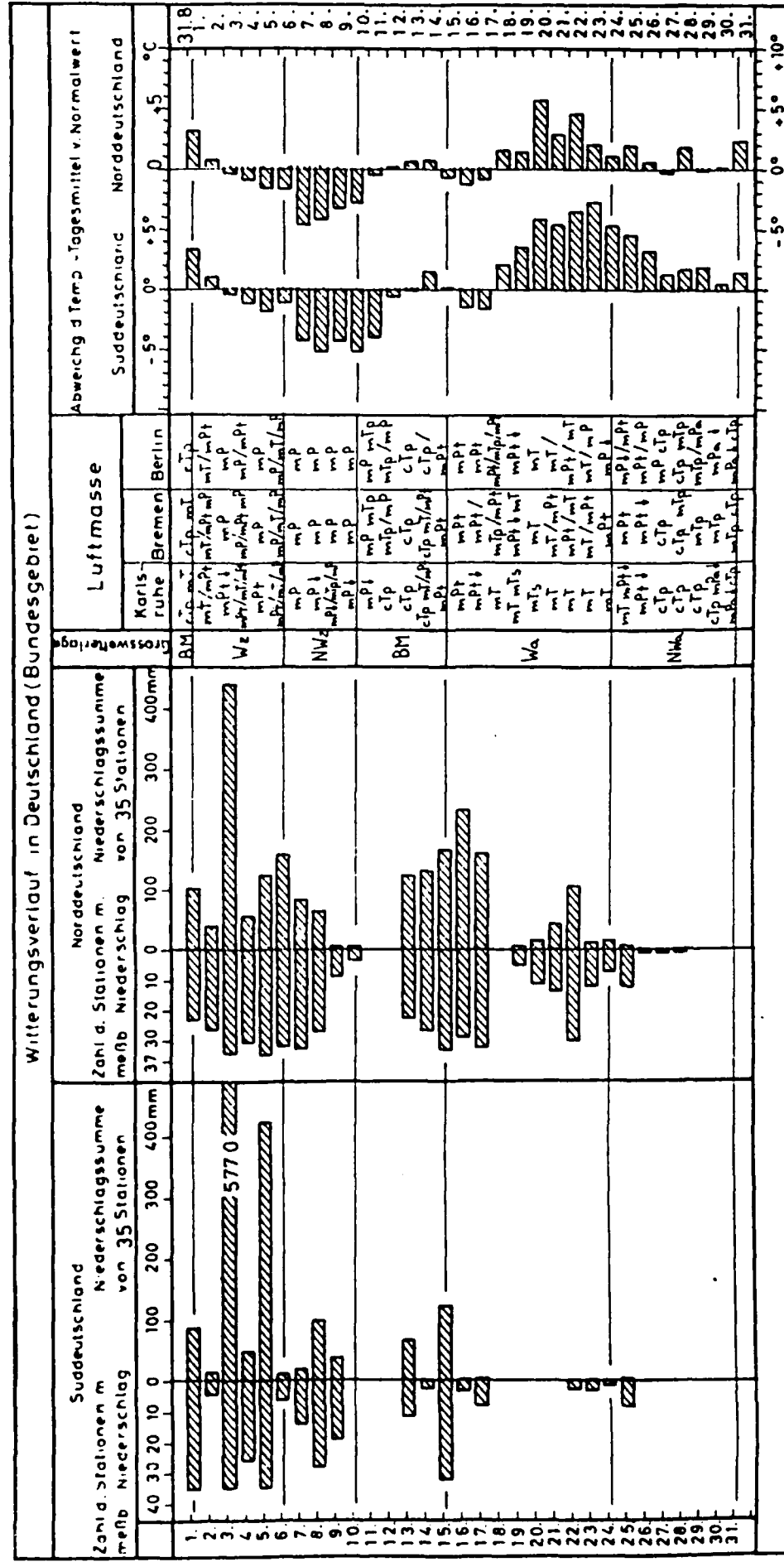
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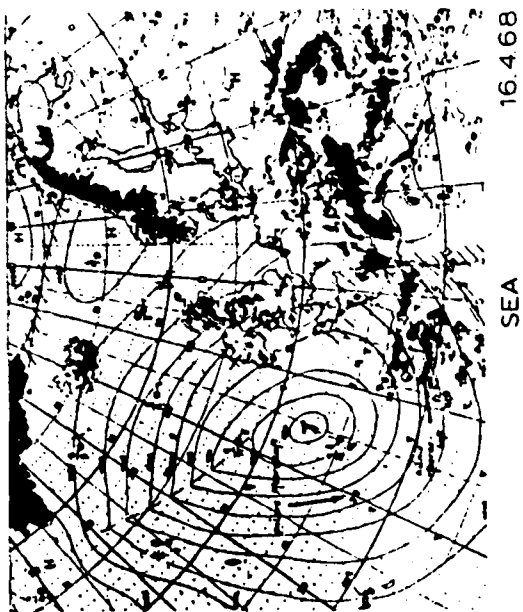


Relative Frequency Distribution of Main-Weather-Situations (GW) and Weather-Typs (GT) according to HESS/BREZOFISKY, as defined by the German Weather Service for the years 1881 to 1966.

The daily Main-Weather-Situation for the days of measurements are taken from "Die Grosswetterlagen Europas" published by the German Weather Service on a monthly basis.

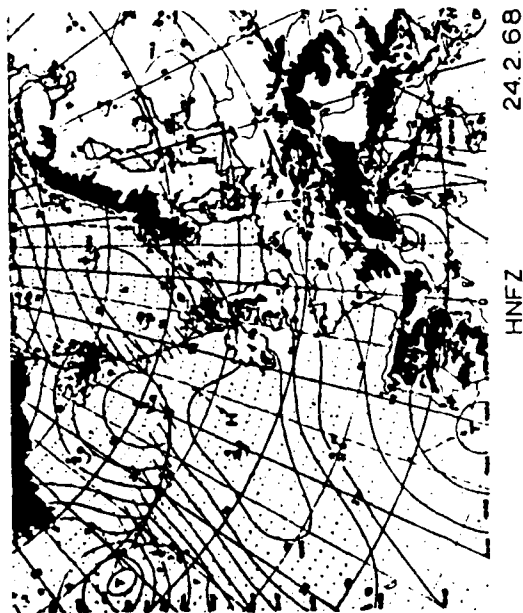
The Main-Weather-Situations are characterized by the attached typical weather maps.

GW-Lage	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Jahr	mittlere Streuung
WA	6.1	4.7	4.2	4.6	4.2	6.1	7.3	8.7	8.1	6.5	5.5	3.6	5.8	
WZ	13.5	12.3	11.4	11.7	12.2	15.7	19.9	23.5	15.1	14.7	13.7	17.9	15.2	
WS	4.3	5.8	6.1	2.6	0.7	1.8	1.8	2.1	1.0	3.4	3.4	6.8	3.3	
WW	3.4	1.4	3.3	2.1	1.1	2.1	1.2	2.9	2.4	2.1	4.5	5.1	2.6	
W (GT)	27.3	24.2	25.0	21.0	18.2	25.7	30.2	37.2	26.6	26.7	27.1	33.4	26.9	± 1.8
SWA	2.8	3.0	2.1	1.6	1.3	1.0	1.2	1.4	1.4	2.9	2.7	2.9	2.0	
SWZ	3.9	2.5	1.1	1.4	1.1	0.5	0.4	0.8	0.8	2.3	3.0	2.1	1.0	
SW (GT)	6.7	5.5	3.2	3.0	2.4	1.5	1.6	2.2	2.2	5.2	5.7	5.0	3.6	± 1.6
NWA	3.4	3.9	4.1	3.6	3.8	7.7	10.0	7.1	3.5	2.6	3.9	2.7	4.7	
NWZ	4.7	4.7	3.3	4.3	2.7	4.2	8.2	5.5	4.2	3.2	4.2	4.7	4.5	
NW (GT)	8.1	8.6	7.4	7.9	6.5	11.9	18.2	12.6	7.7	5.8	8.1	7.4	9.2	± 1.7
HM	14.5	13.7	11.3	6.6	9.4	9.7	10.8	10.0	16.0	12.5	7.8	10.1	11.0	
BM	4.1	4.8	3.5	5.5	3.6	4.8	5.1	6.9	7.5	7.6	9.8	9.3	6.0	
HM (GT)	18.6	18.5	14.8	12.1	13.0	14.5	15.9	16.8	23.5	20.1	17.6	19.4	17.0	± 1.0
TM	3.2	2.6	3.5	3.9	3.8	2.1	2.7	1.5	1.7	2.3	3.2	1.5	2.7	± 0.5
gemischte Zirkulation	36.6	35.2	28.9	26.9	25.7	30.0	38.4	33.1	35.1	33.4	34.6	33.2	32.5	
NA	0.3	0.4	1.2	1.0	2.7	2.6	1.7	1.3	1.0	0.3	0.6	0.7	1.1	
NZ	2.3	2.1	3.7	4.1	5.7	5.5	2.4	1.8	2.9	2.0	1.6	1.2	2.9	
HNA	2.3	2.1	2.8	5.7	6.5	6.9	3.3	3.1	3.8	3.4	2.1	2.3	3.7	
HNZ	1.2	1.4	1.8	1.8	2.3	1.9	0.9	0.8	0.4	2.1	0.9	0.9	1.4	
HB	2.8	4.5	3.8	3.3	3.9	4.3	2.0	2.5	4.6	3.3	2.6	2.1	3.3	
TRM	3.5	4.4	4.1	5.4	3.6	2.9	3.8	2.6	4.4	3.7	5.5	3.3	3.9	
N (GT)	12.4	14.9	17.4	21.3	24.7	24.1	14.1	12.1	17.1	14.8	13.3	10.5	16.3	± 0.7
NEA	1.7	2.5	2.9	2.6	4.8	5.1	4.5	3.0	2.4	1.1	0.8	1.1	2.7	
NEZ	2.0	1.7	2.3	4.4	3.5	3.1	2.4	2.1	2.6	1.6	0.6	1.8	2.3	
HFA	6.1	5.1	3.9	4.4	3.5	2.2	1.9	2.4	3.8	4.6	2.8	4.2	3.7	
HFZ	1.0	1.1	1.2	1.0	0.5	0.5	0.2	0.3	0.4	0.8	1.2	1.2	0.8	
HNFA	1.1	1.8	0.7	1.8	4.2	1.9	0.3	0.2	0.9	0.9	0.7	0.5	1.2	
HNFZ	1.1	1.8	3.9	2.8	3.3	0.8	0.7	0.8	0.6	0.6	1.5	0.6	1.5	
SEA	1.4	1.4	3.8	2.6	2.8	0.9	0	0.1	2.2	4.2	3.6	2.9	2.2	
SEZ	3.6	3.1	2.9	2.5	0.7	0	0	0.1	0.9	1.4	1.7	1.7	1.5	
E (GT)	18.0	18.5	21.6	22.1	23.3	14.5	10.0	9.0	13.8	15.2	12.0	14.0	15.9	± 1.3
SA	3.3	1.5	2.7	1.8	1.0	0.1	0.2	0.3	2.8	2.9	5.0	2.5	2.0	
SZ	0.6	2.3	1.0	0.7	0	0	0	0	0.3	1.2	2.0	2.4	0.9	
TB	0.8	1.7	1.0	2.6	3.5	1.7	2.8	4.3	1.1	2.1	1.9	2.1	2.1	
TRW	1.1	1.5	1.8	2.8	2.8	2.4	3.8	3.7	2.7	3.2	2.9	1.8	2.5	
S (GT)	5.8	7.0	6.5	7.9	7.3	4.2	6.8	8.3	6.9	9.4	11.8	8.8	7.5	± 1.4
meridionale Zirkulation	36.2	40.4	45.5	51.3	55.3	42.8	30.9	29.4	37.8	39.4	38.0	33.3	39.7	
U	0	0.2	0.6	0.8	0.7	1.5	0.5	0.3	0.5	0.5	0.3	0	0.9	



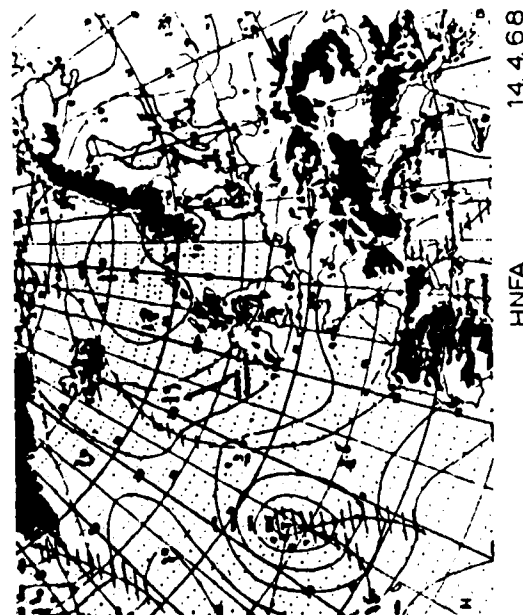
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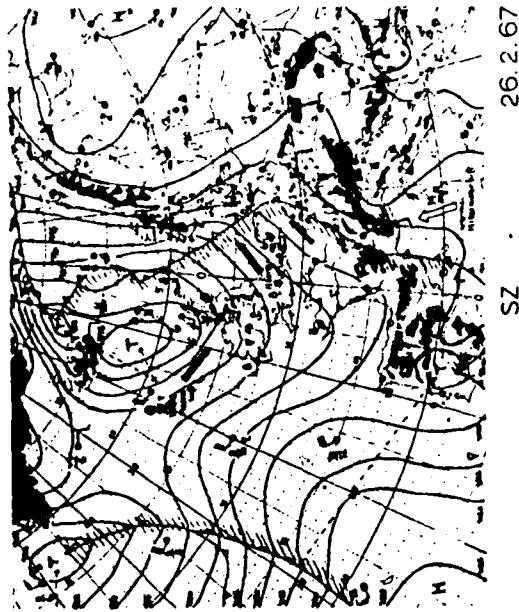
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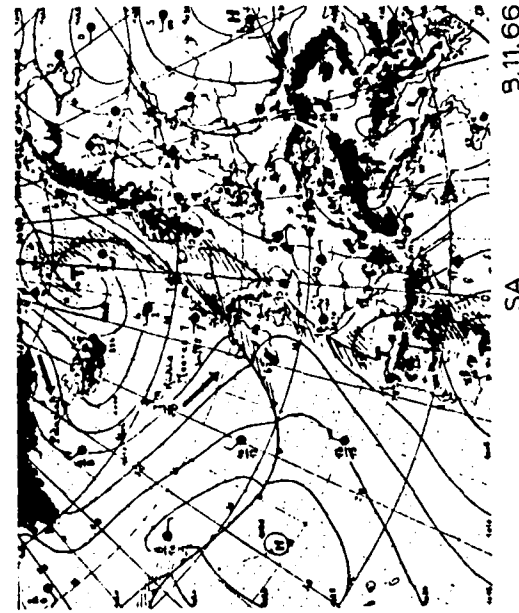
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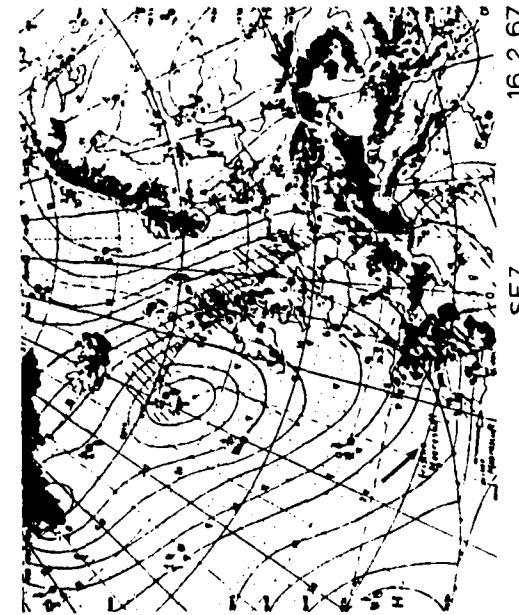
SZ

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SA

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6 Typical Examples of European Main-Weather-Typs

Mean duration (days) of the frost-free period 1931-1960

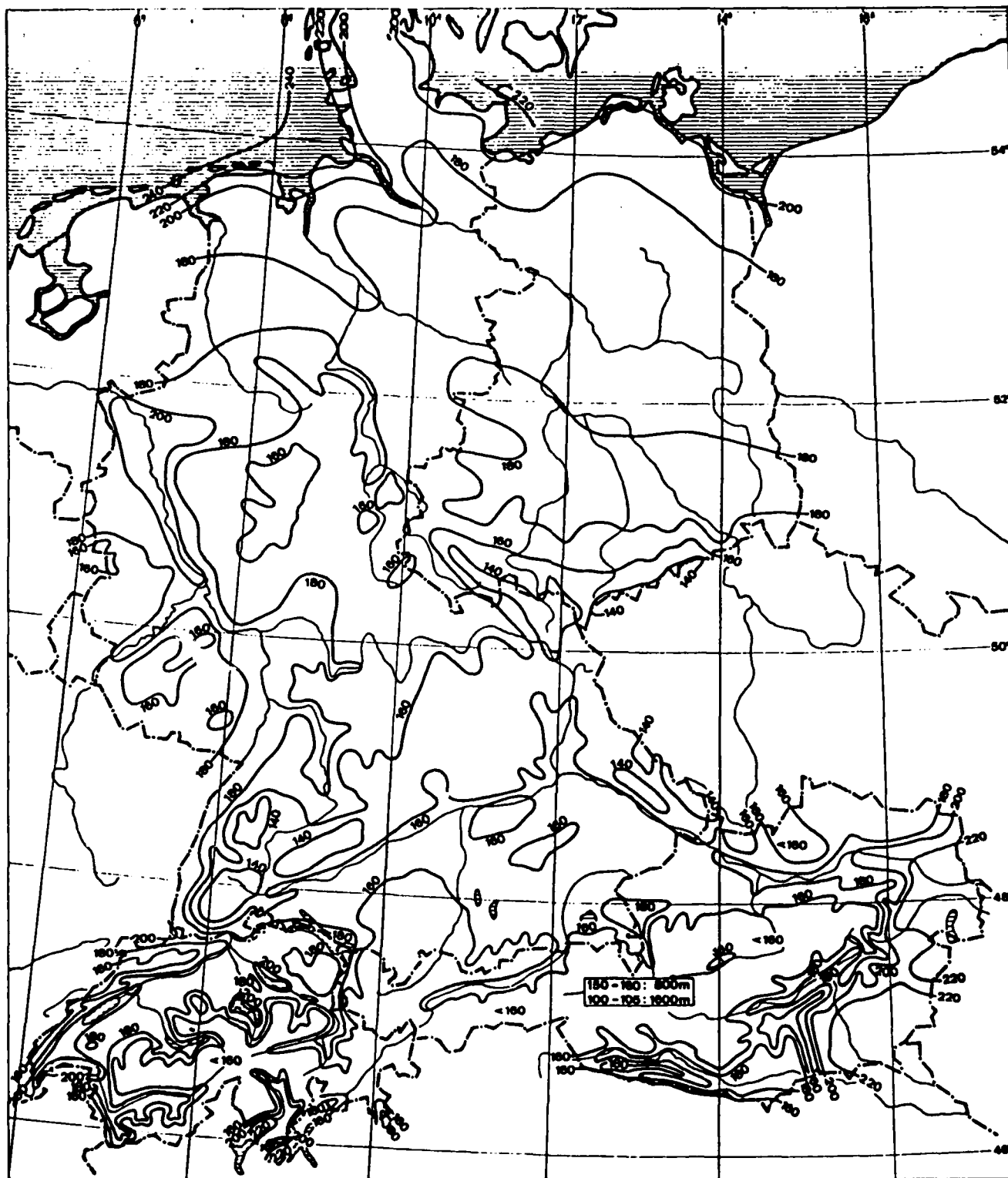


Fig.21. Mean duration (days) of the frost-free period 1931-1960.

Mean diurnal temperature variations in Celsius in January (1931-1960)

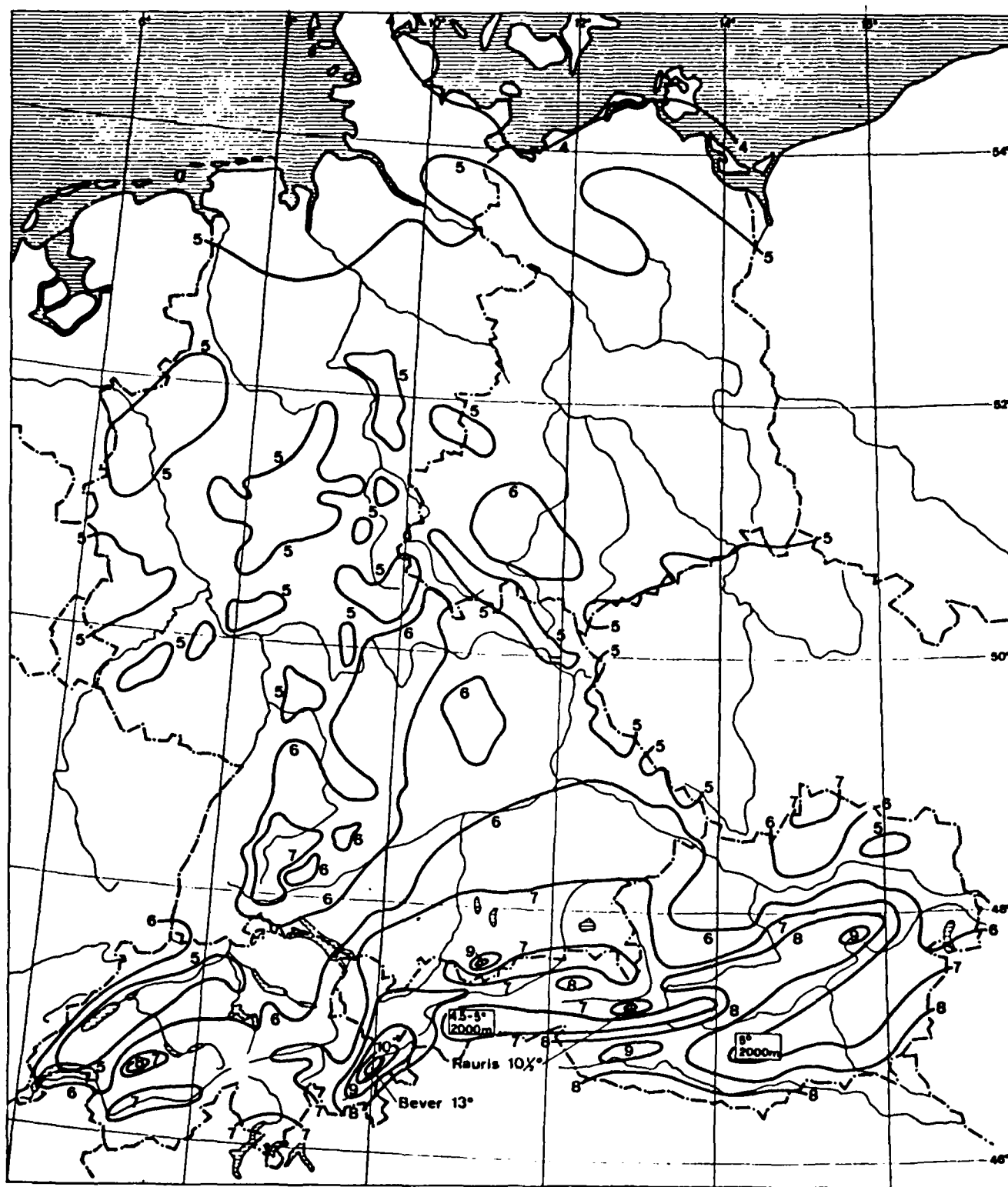


Fig.19. Mean diurnal temperature variation (°C) in January, 1931 -1960.

Mean diurnal temperature variations in Celsius in July (1931-1960)

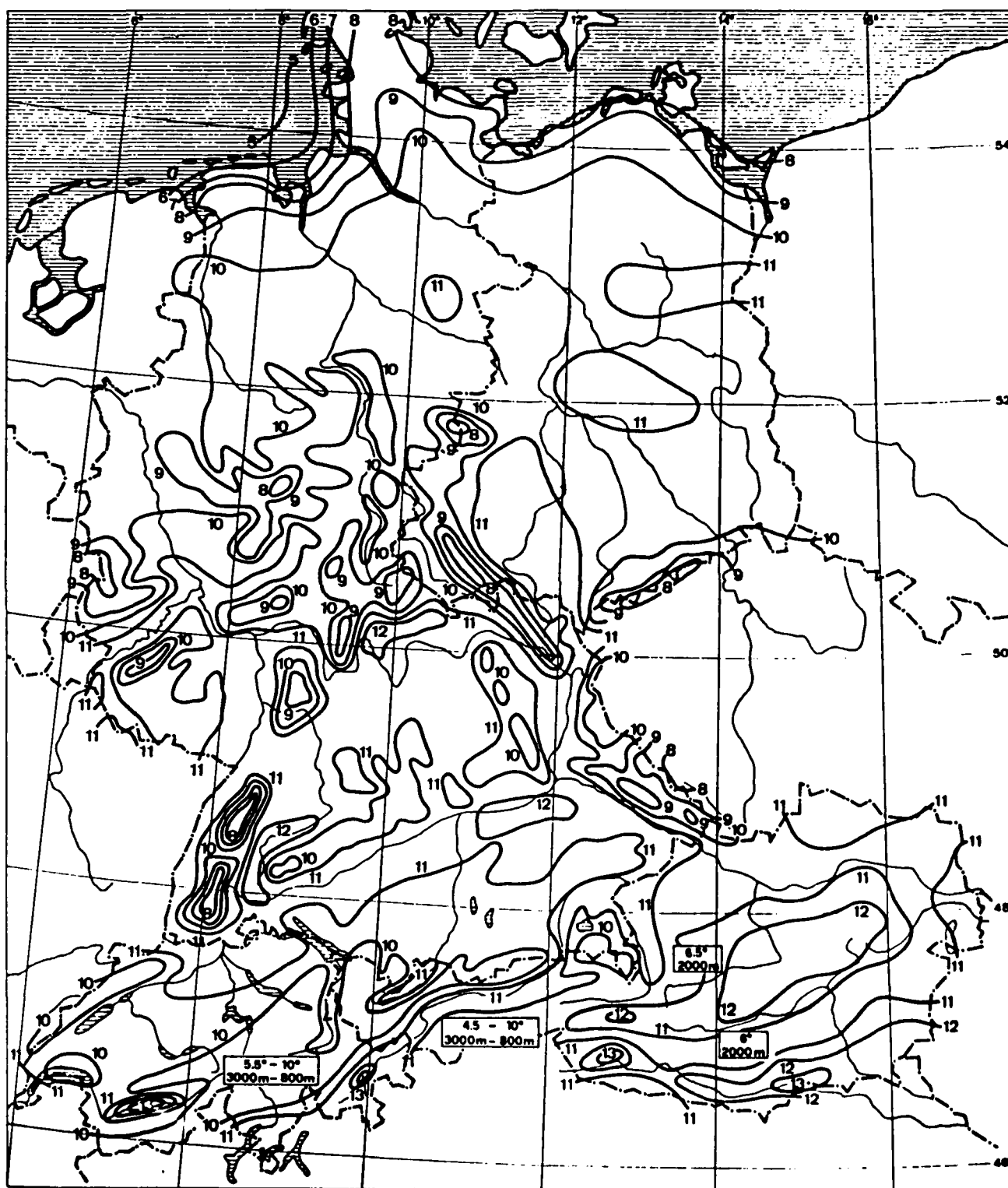


Fig.20. Mean diurnal temperature variation (°C) in July, 1931-1960.

Mean annual duration of sunshine (h) 1931-1960

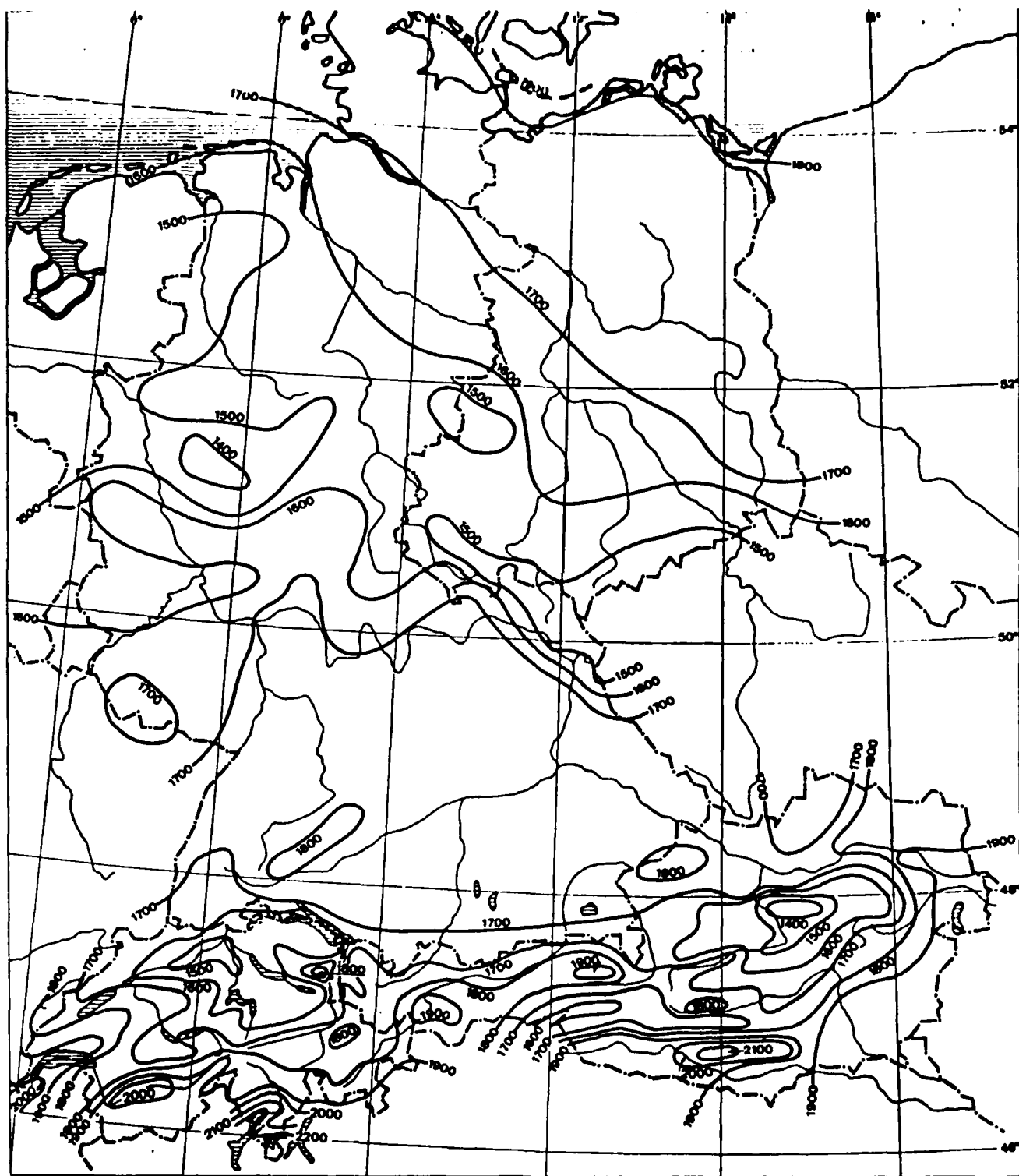


Fig.23. Mean annual duration of sunshine (h), 1931-1960.

Mean annual precipitation (decimeters) 1931-1960

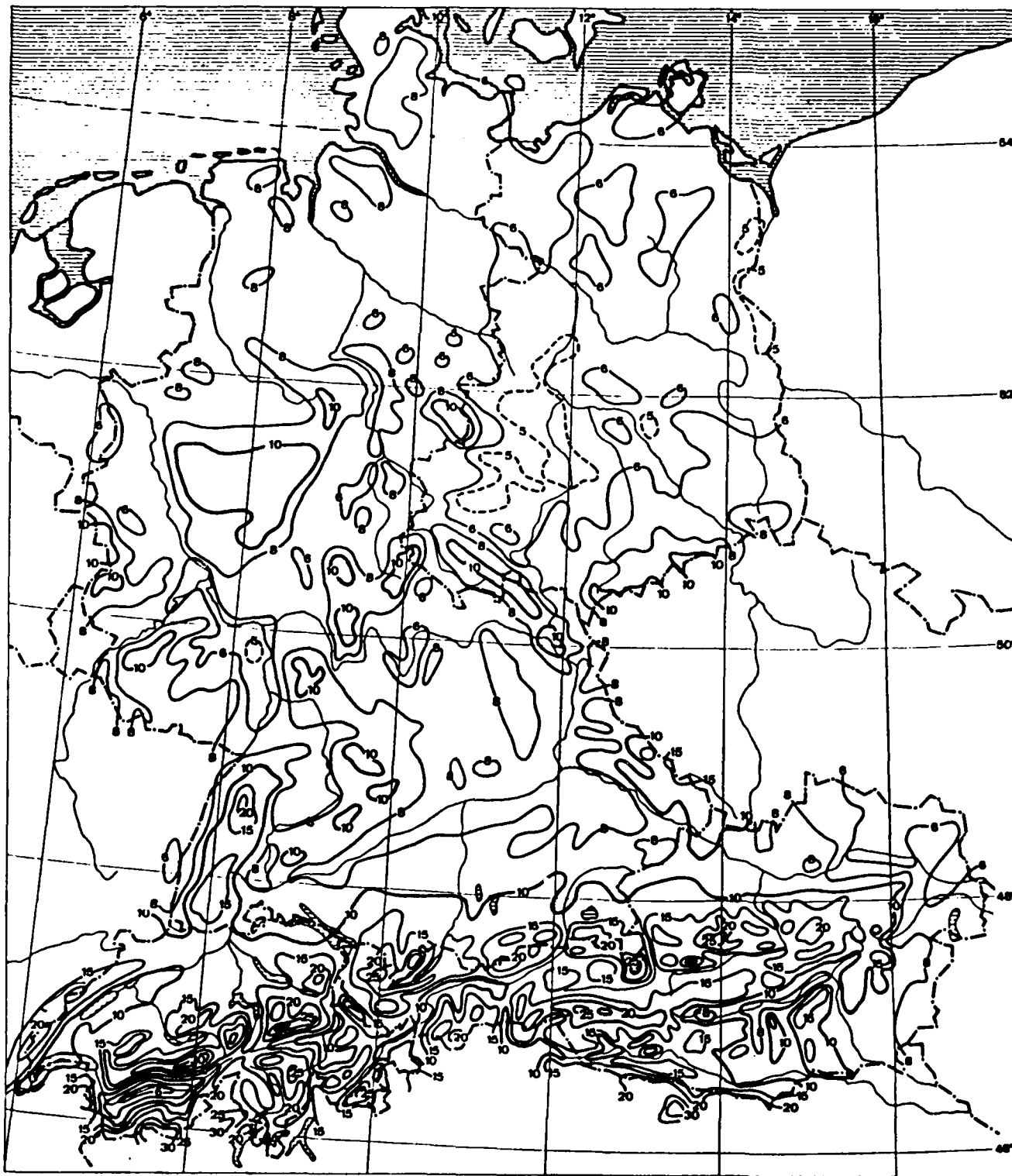


Fig. 22. Mean annual precipitation. Isohyets shown in decimetres (1931-1960).

Mean cloudiness (%) in January 1931-1960

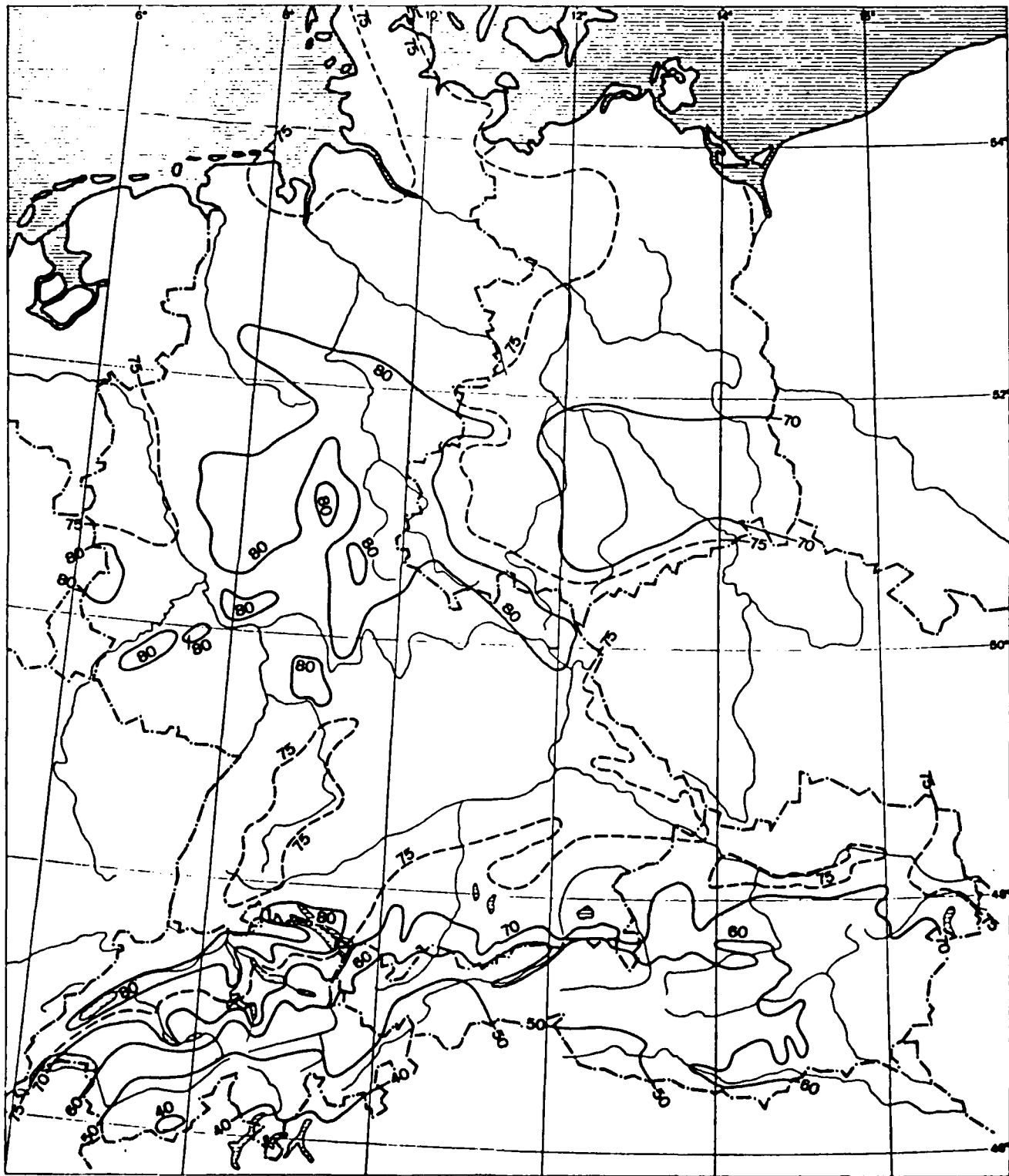


Fig.25. Mean cloudiness (%) in January, 1931-1960.

Mean cloudiness (%) in July 1931-1960

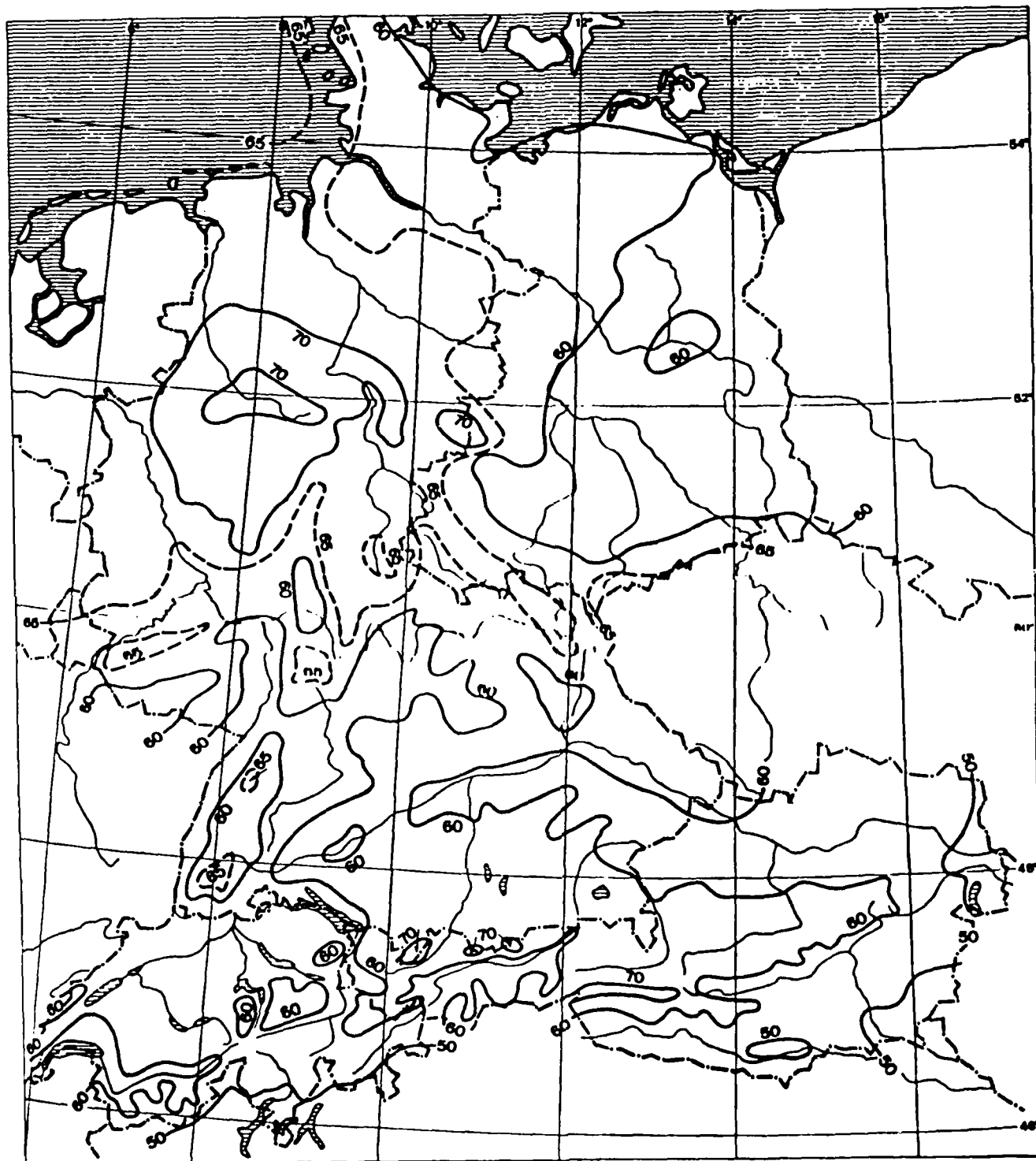


Fig.26. Mean cloudiness (%) in July, 1931-1960.

Annual mean wind distribution; figures in the circles are calms (% 1 mm is 1.9%)

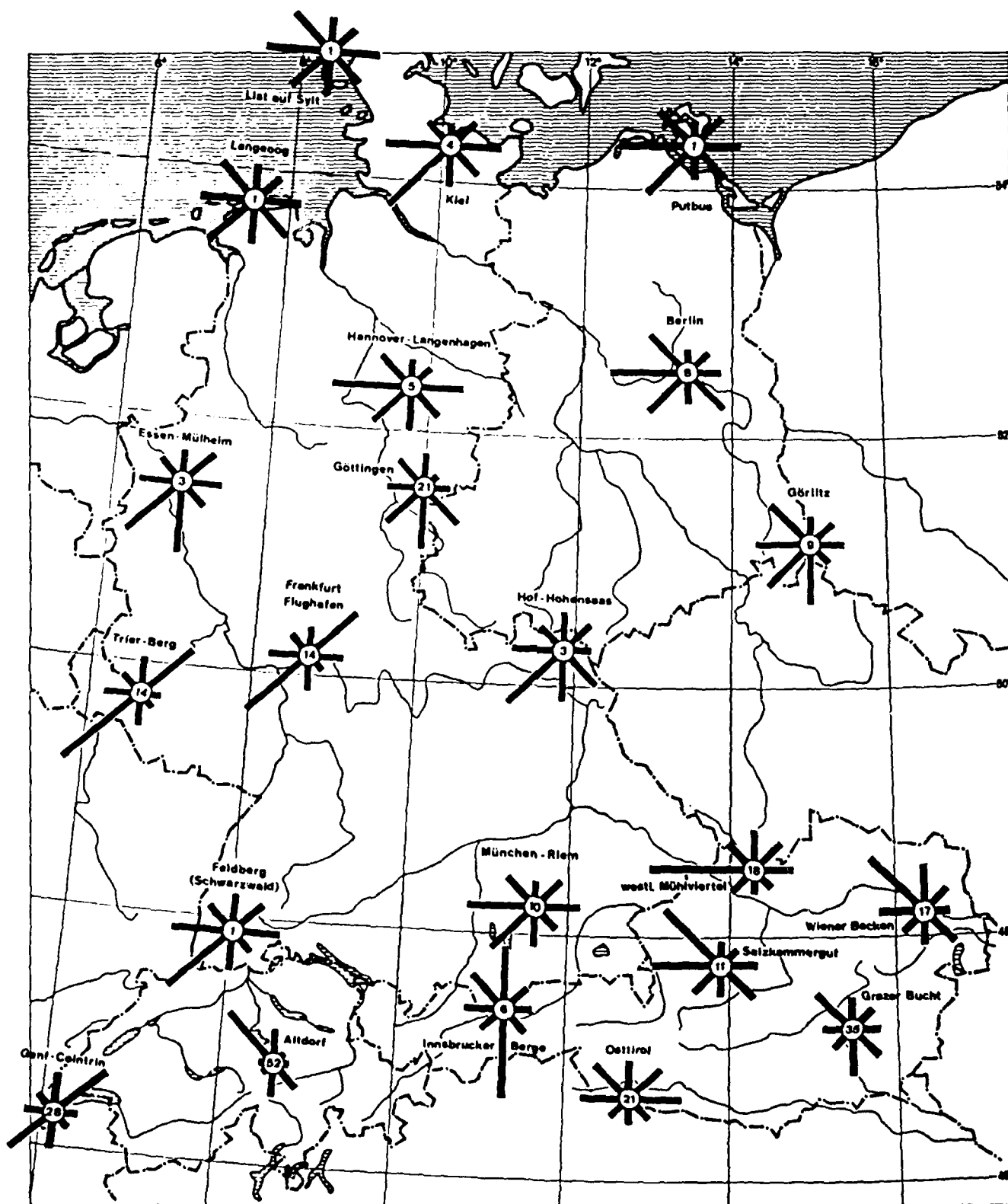
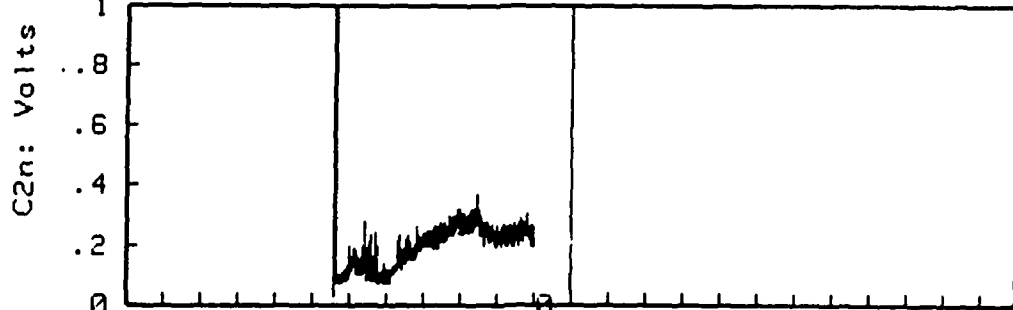
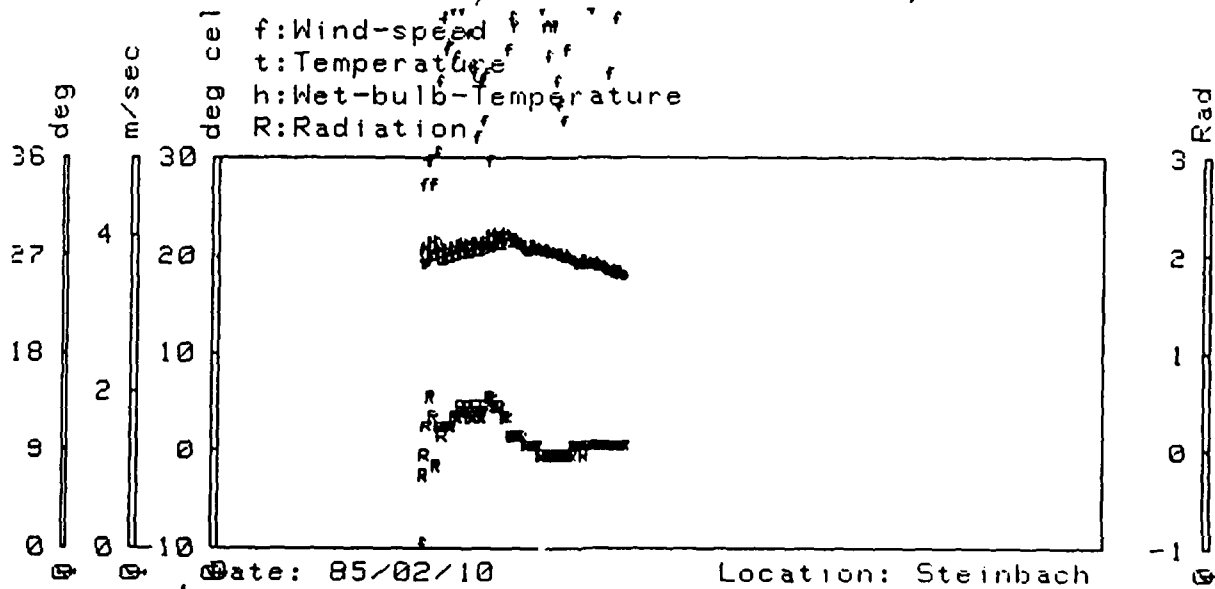
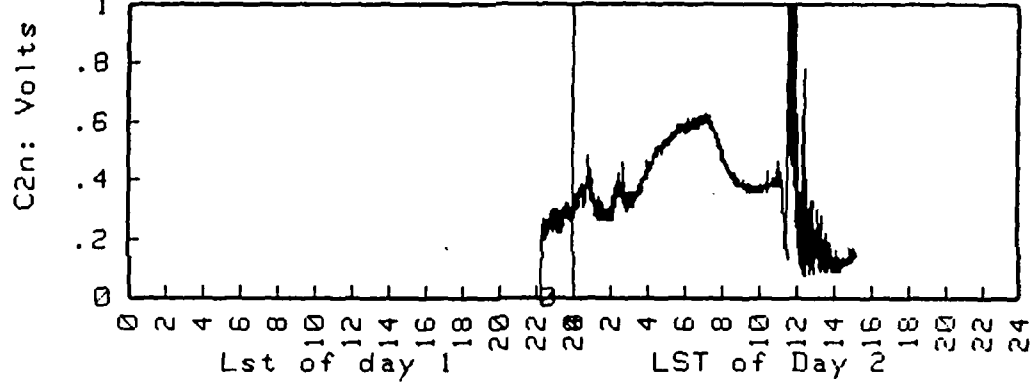
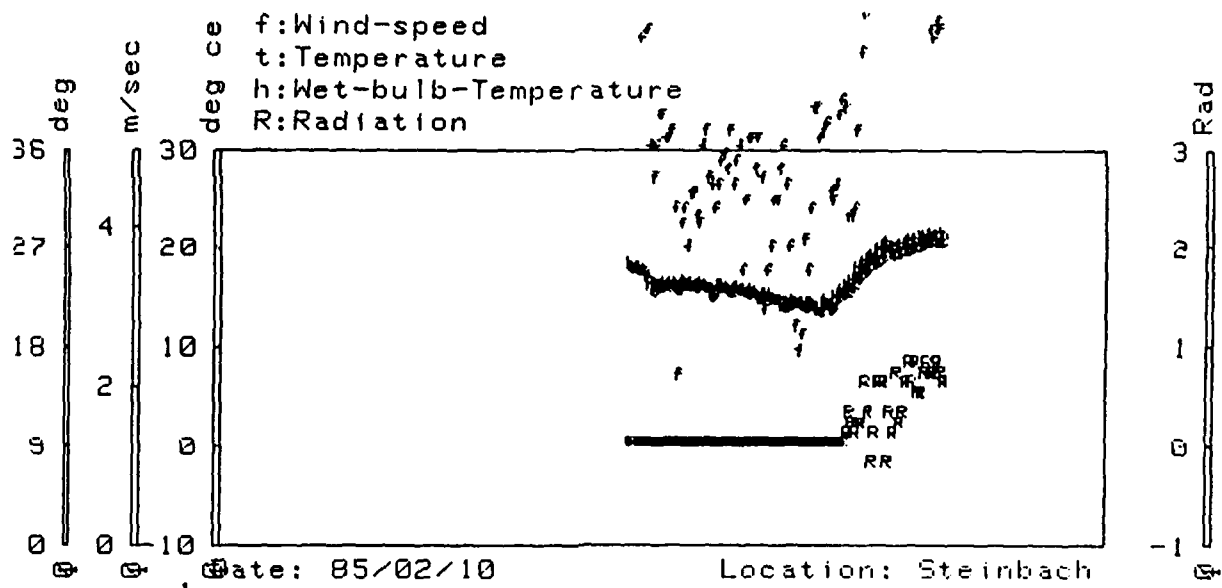
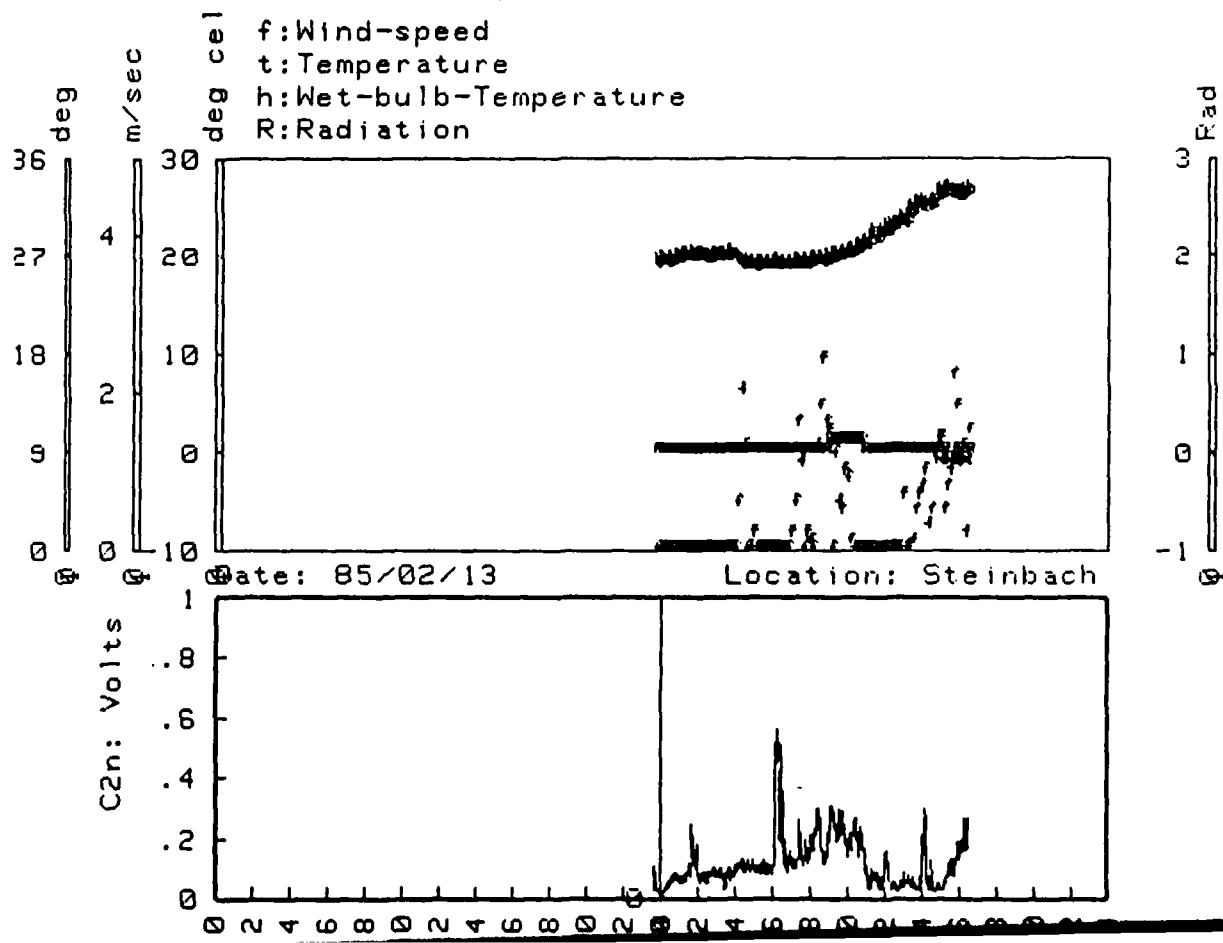
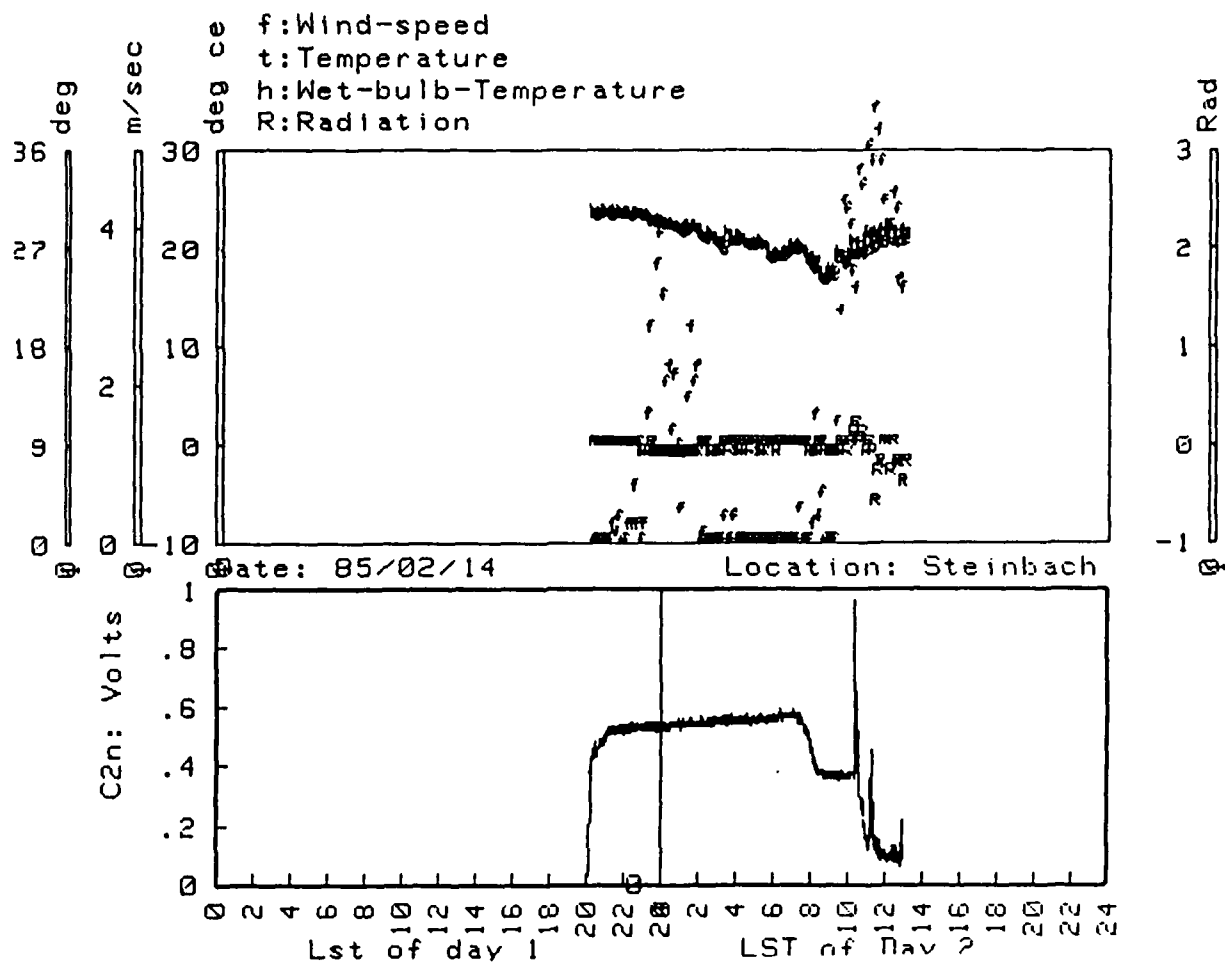
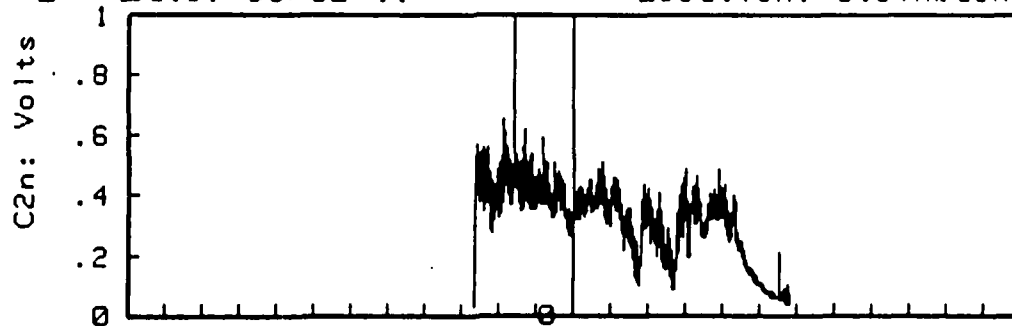
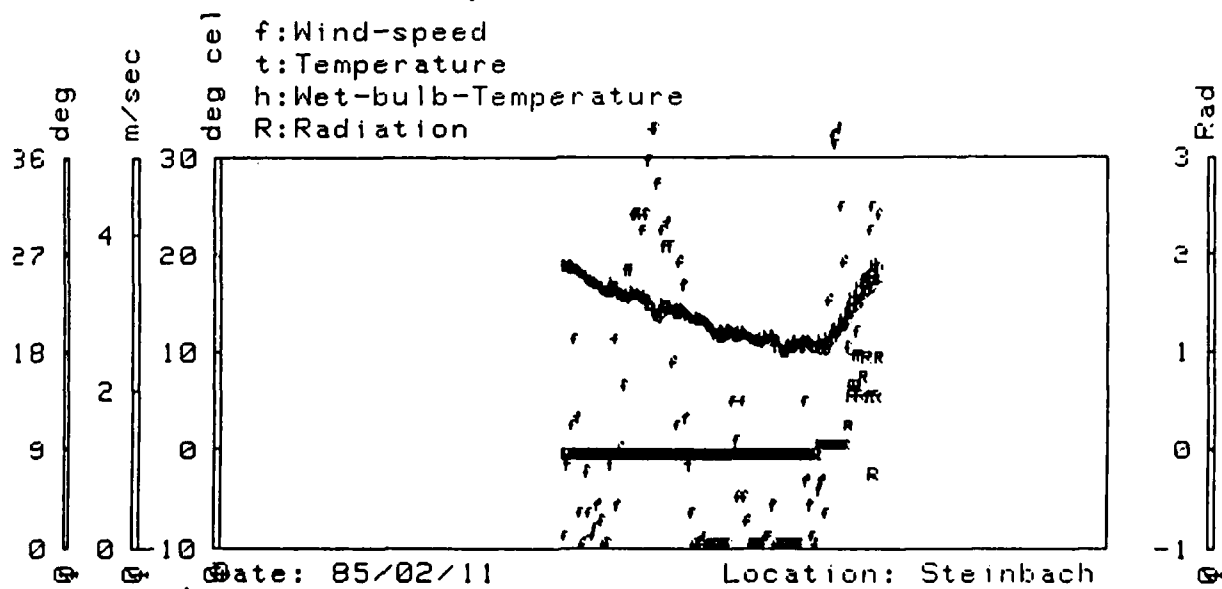
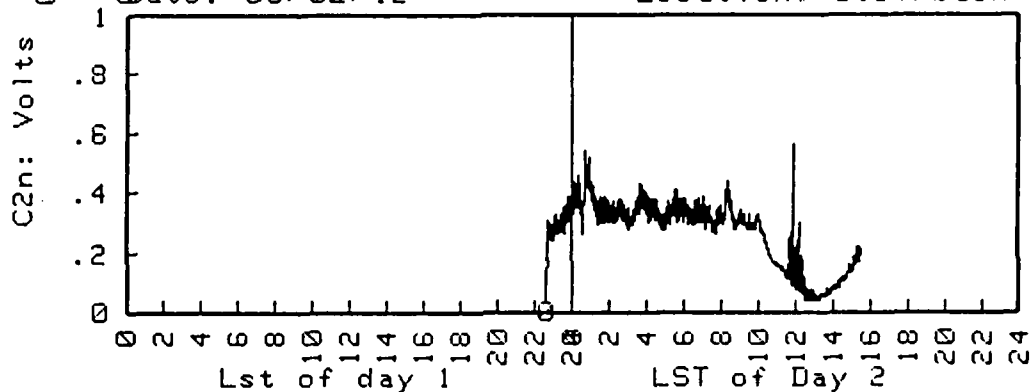
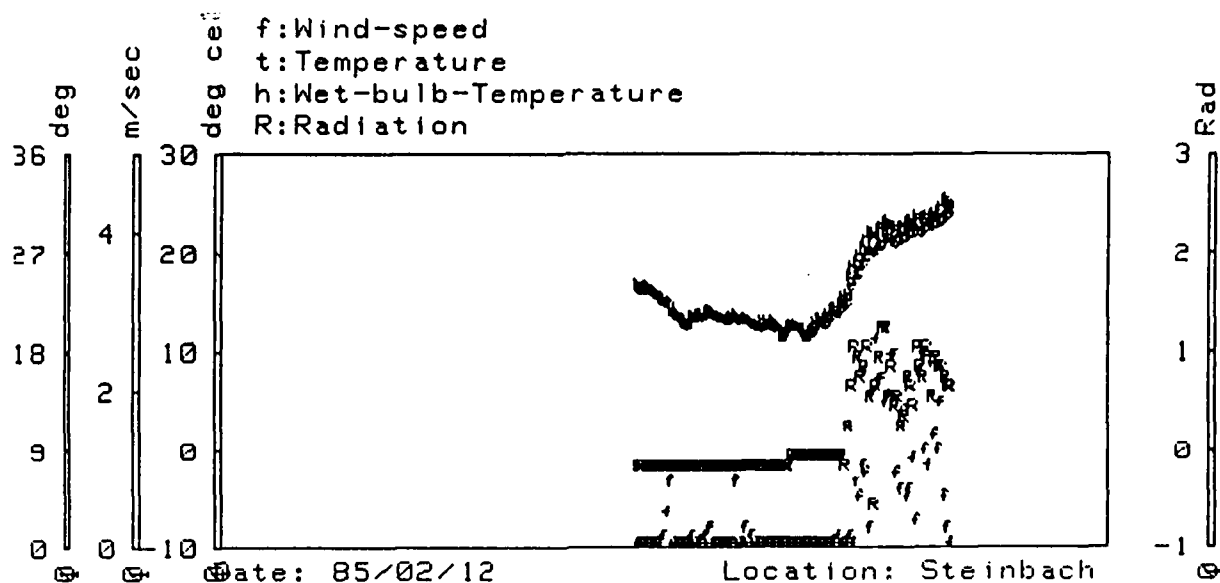
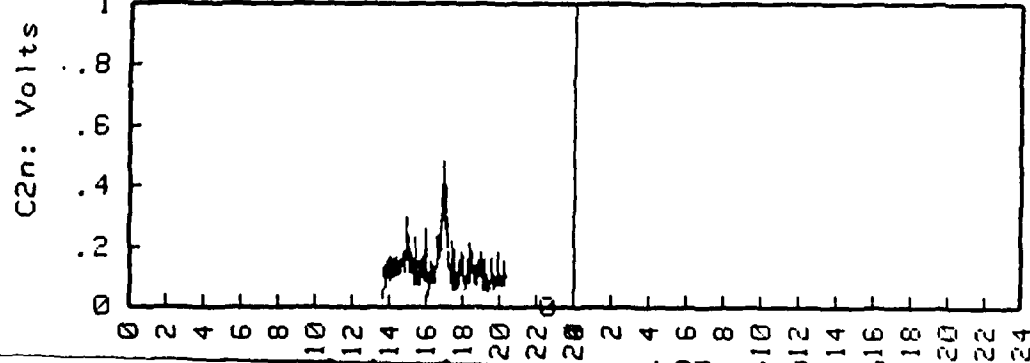
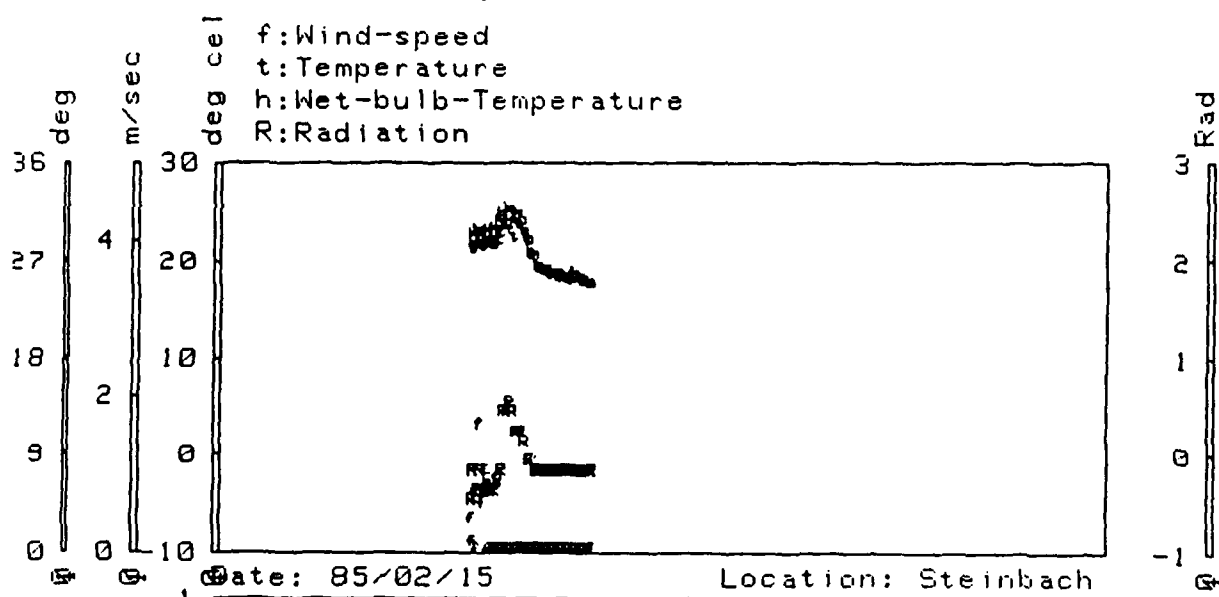
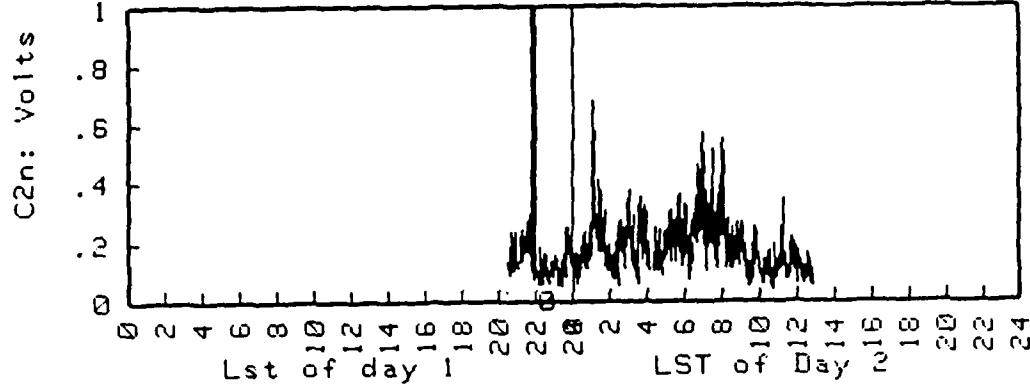
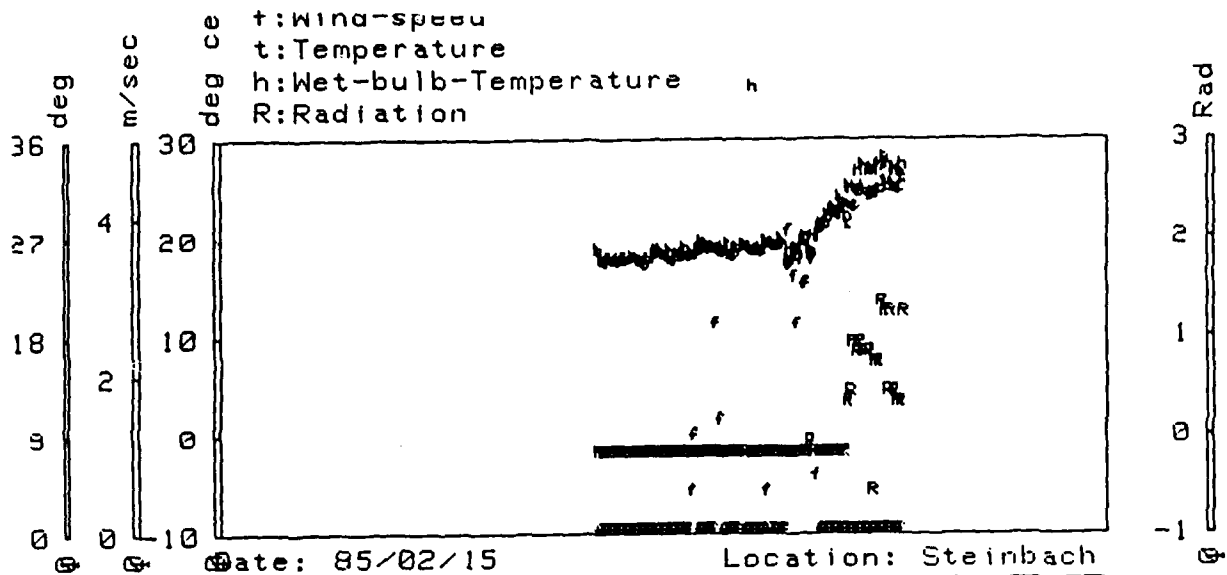


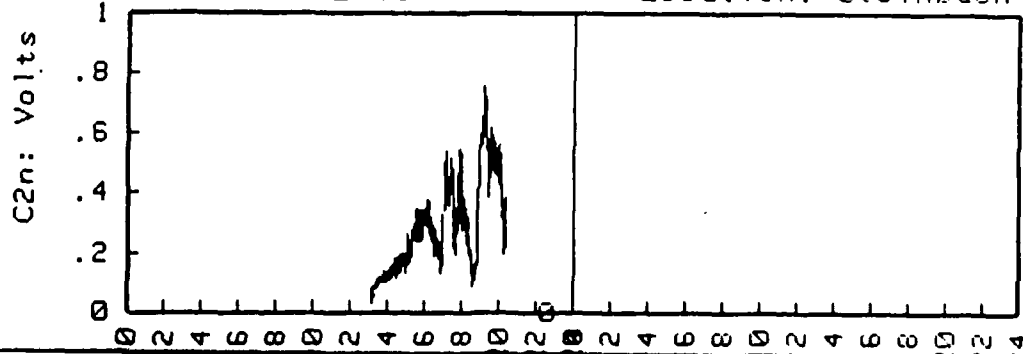
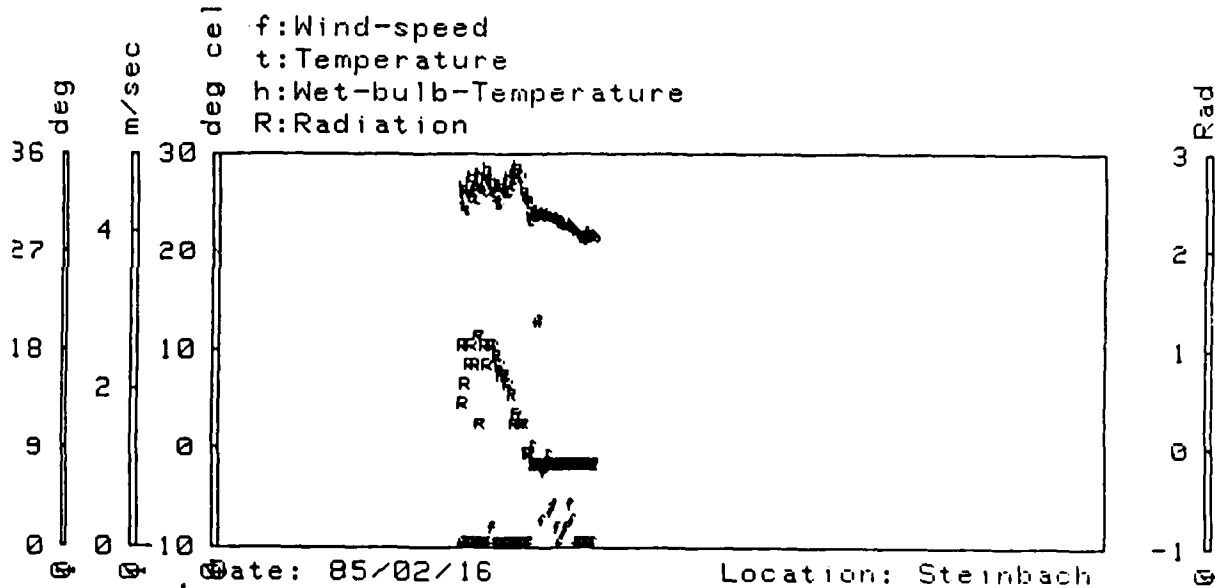
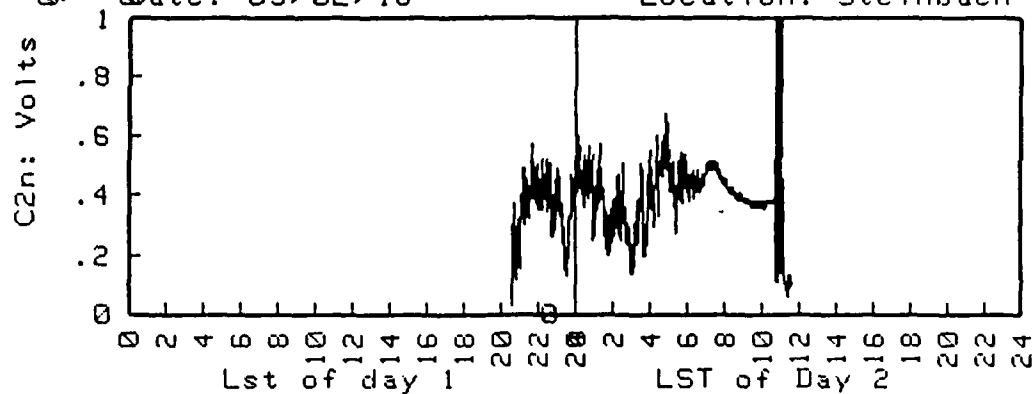
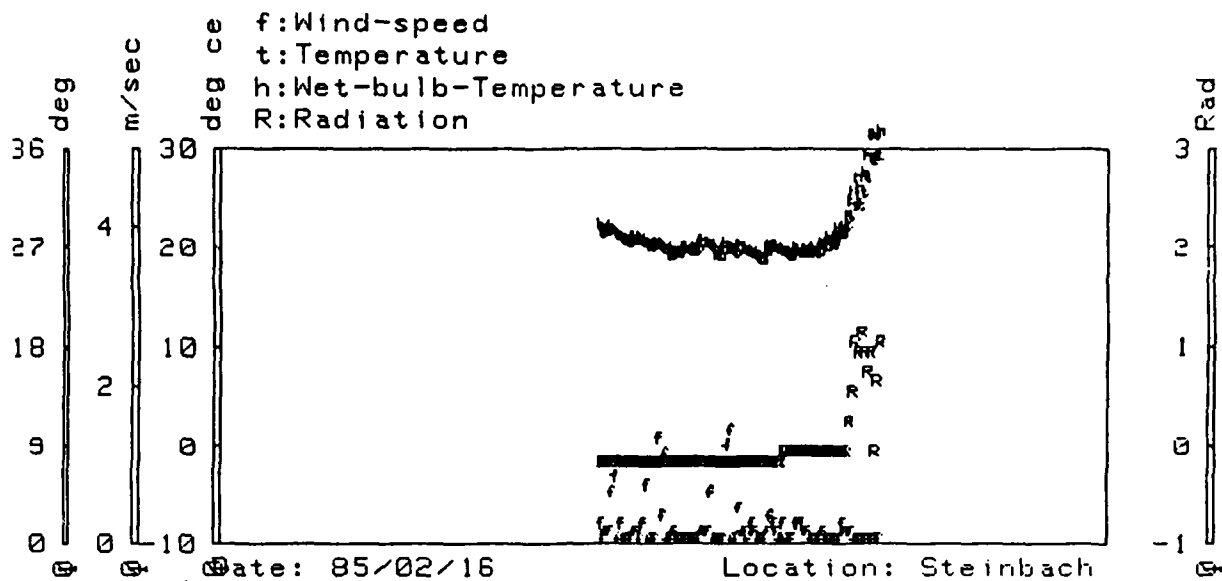
Fig. 27. Annual mean wind distribution; figures in the circles are calms (%; 1 mm is 1.9%).

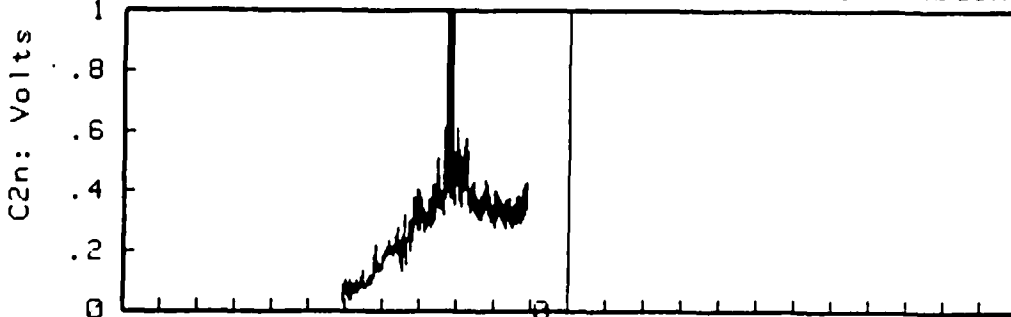
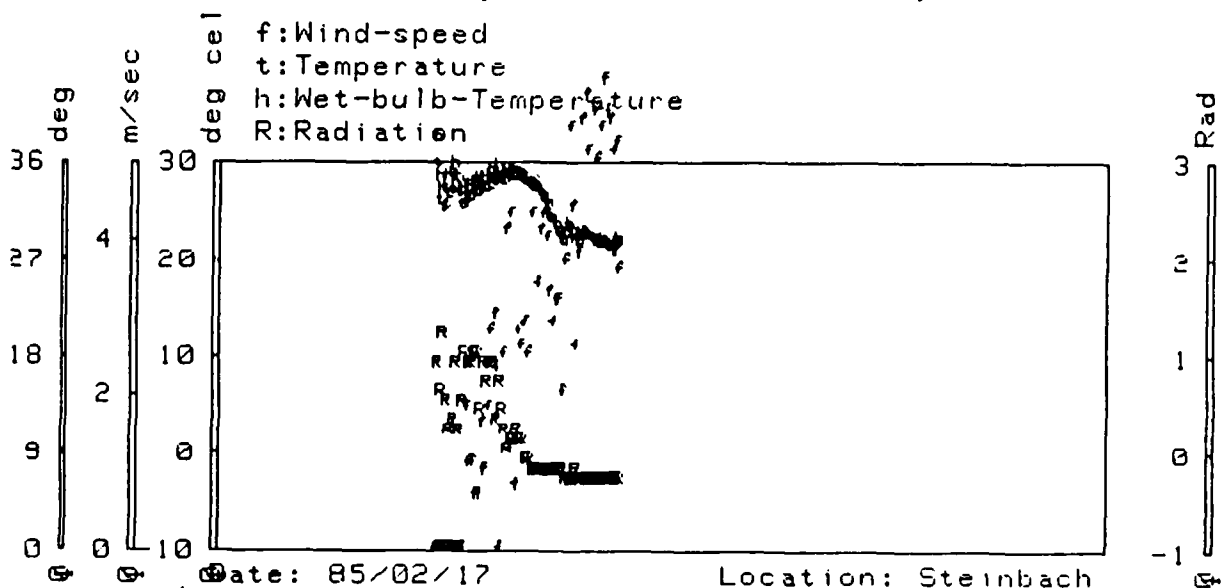
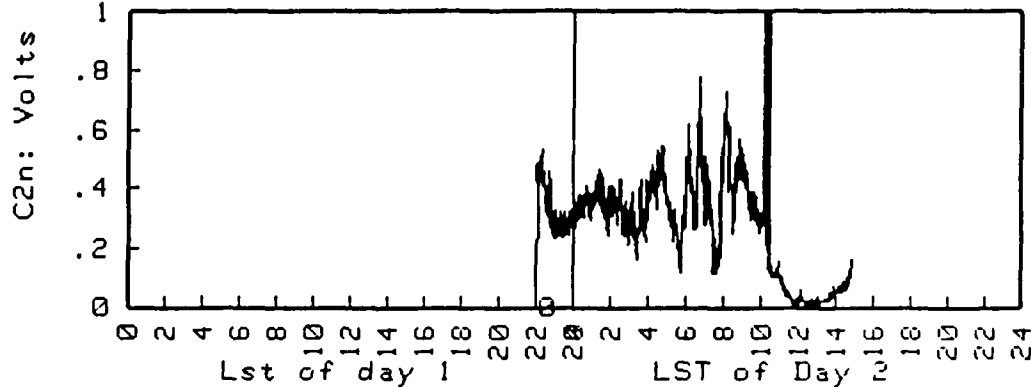
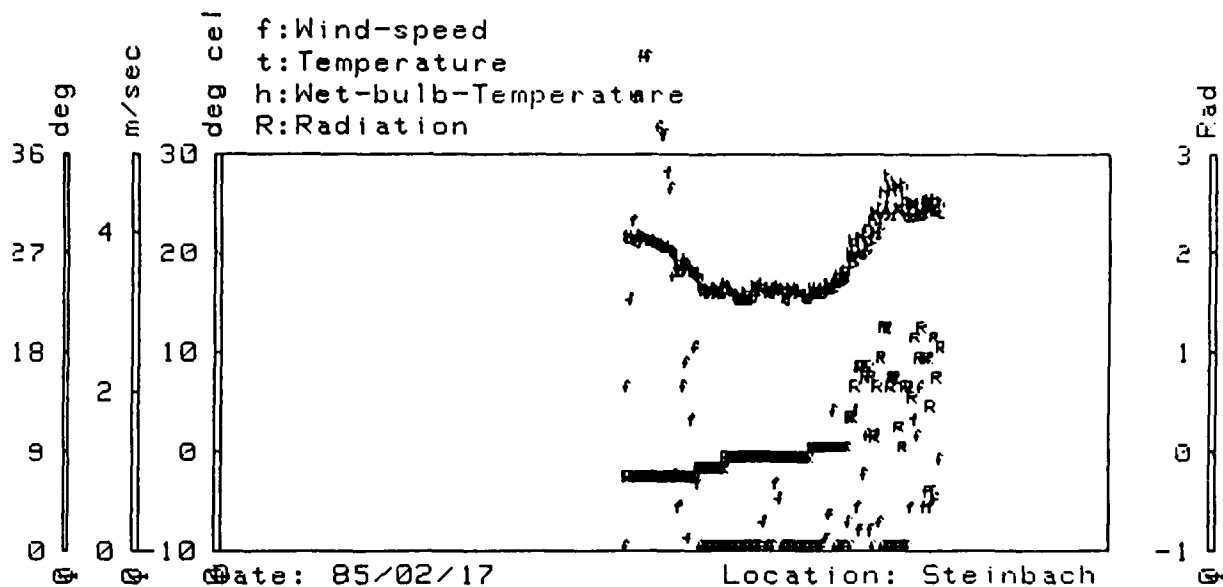


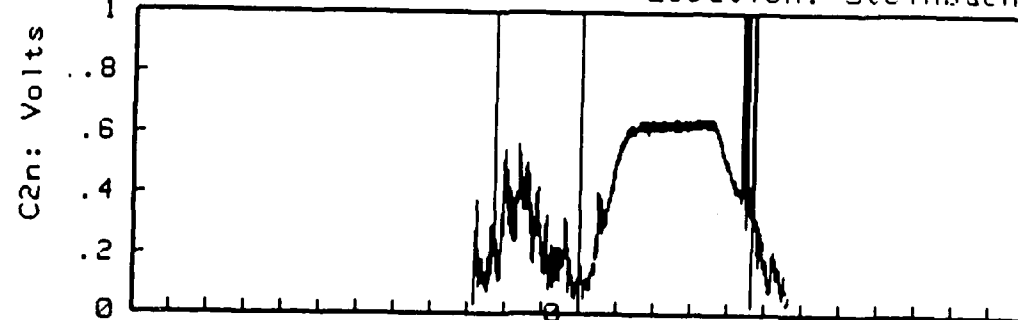
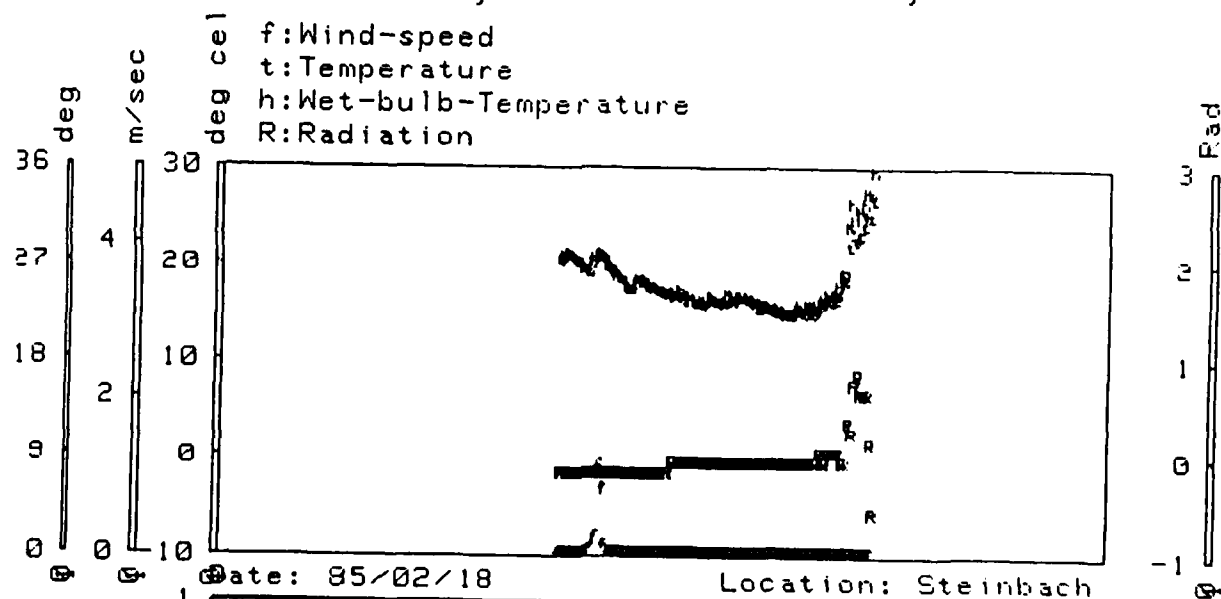
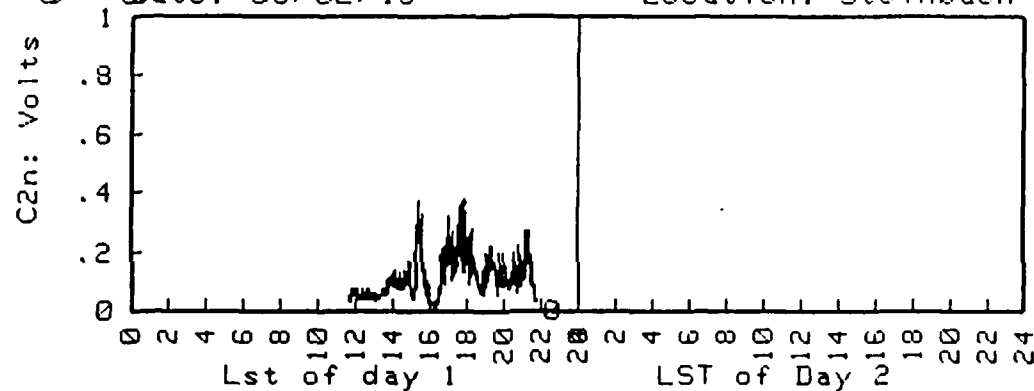
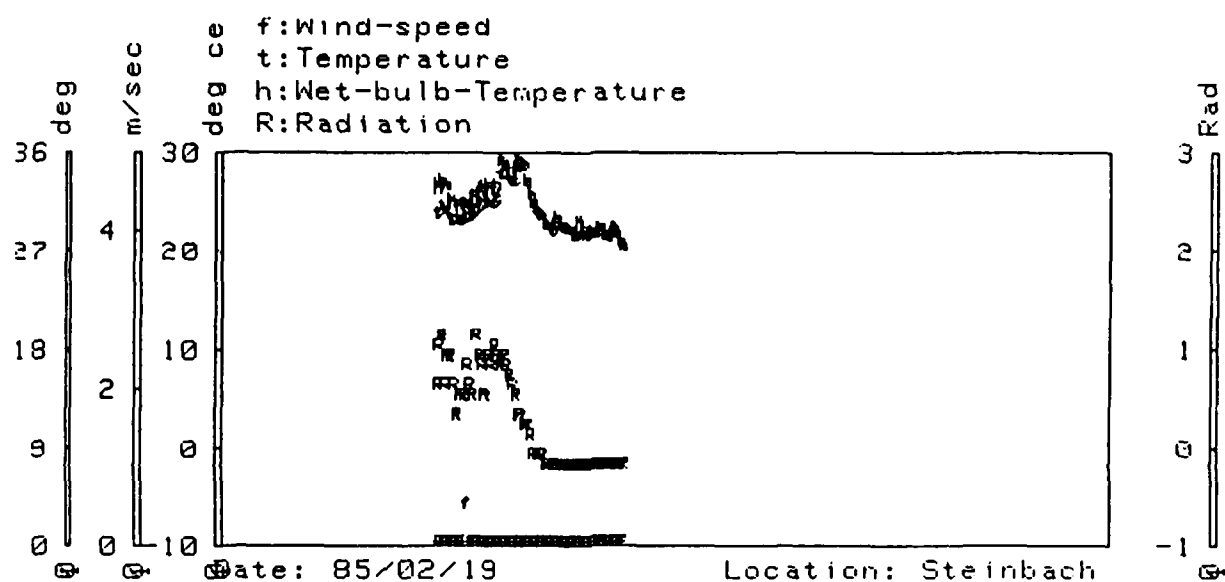


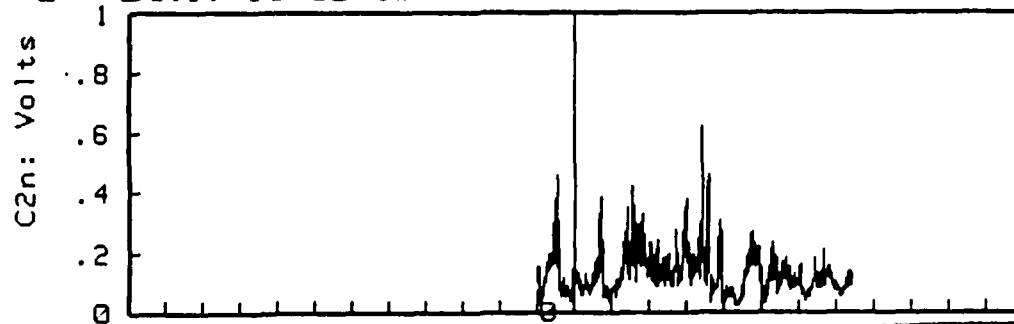
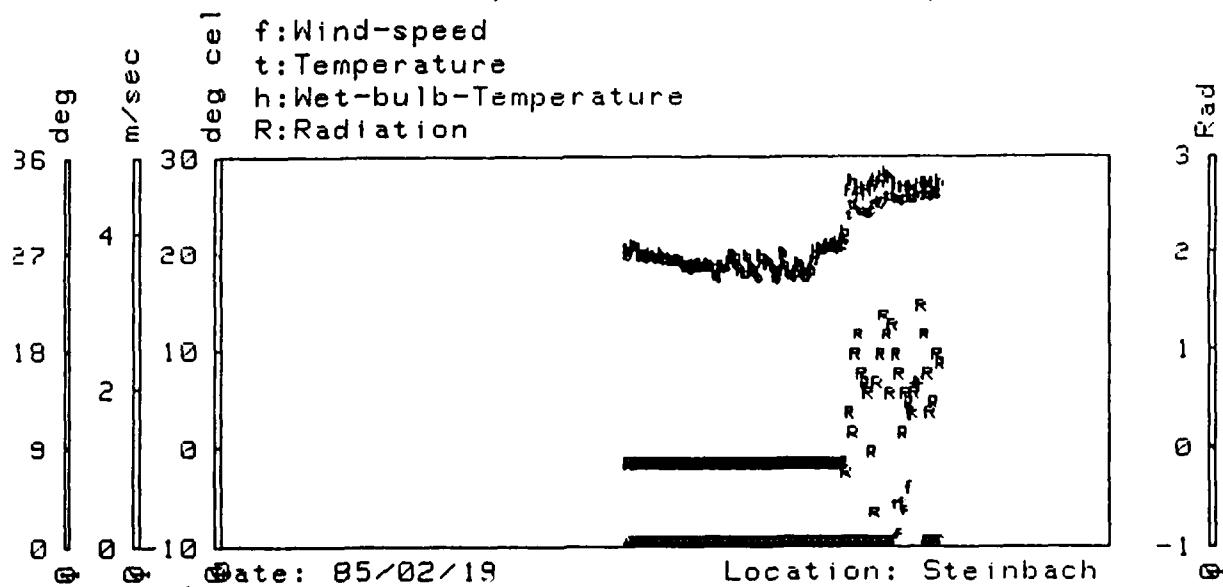
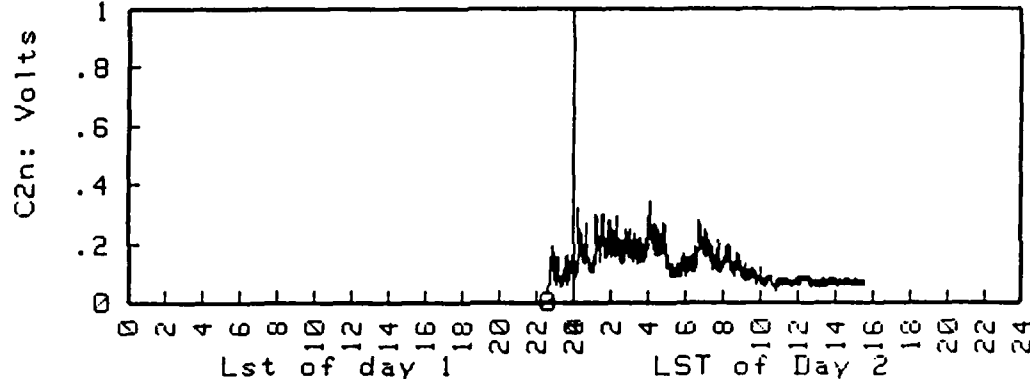
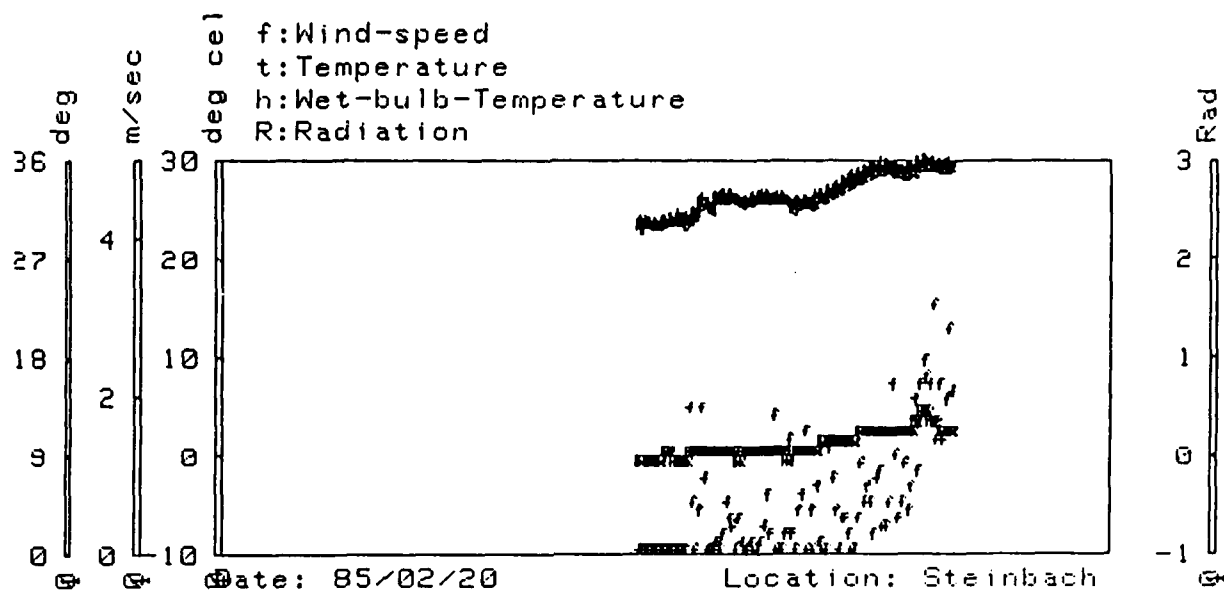


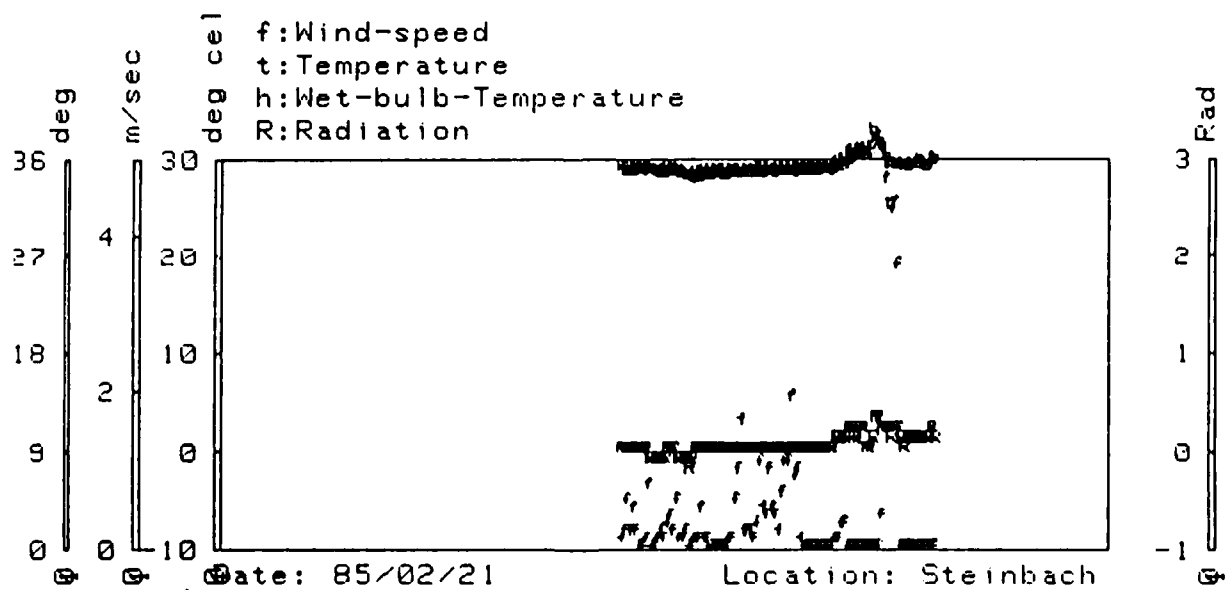
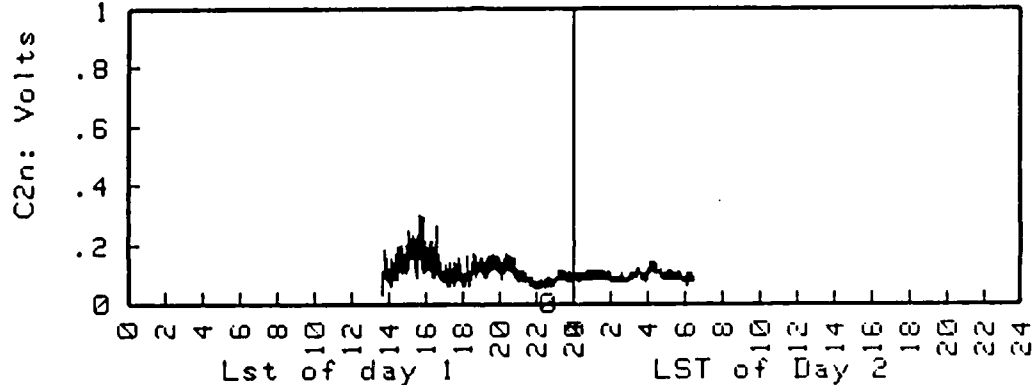
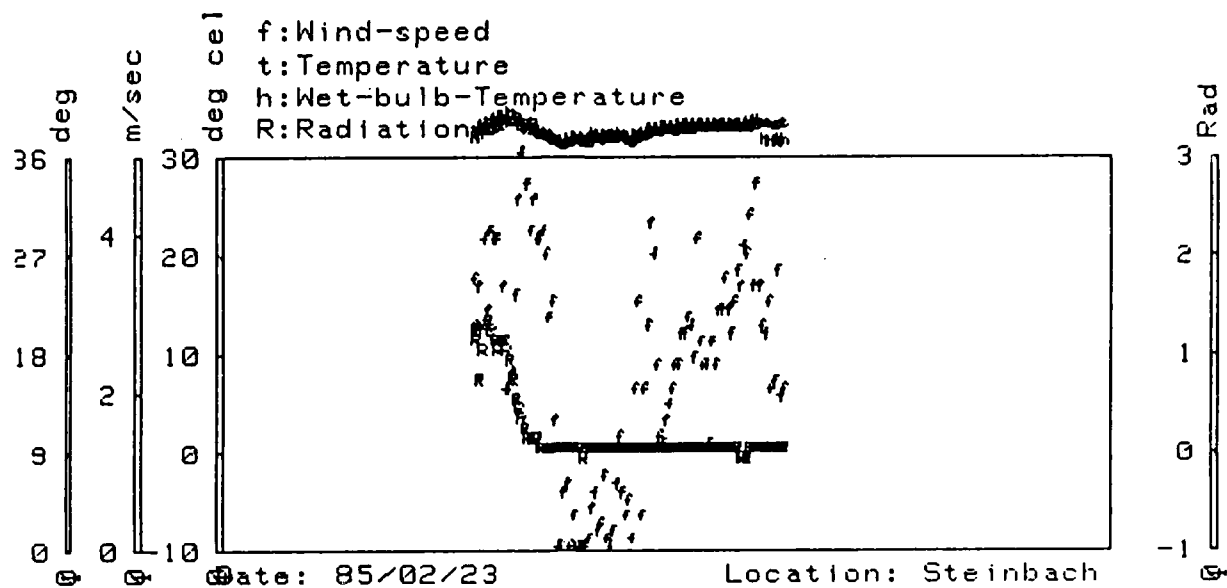


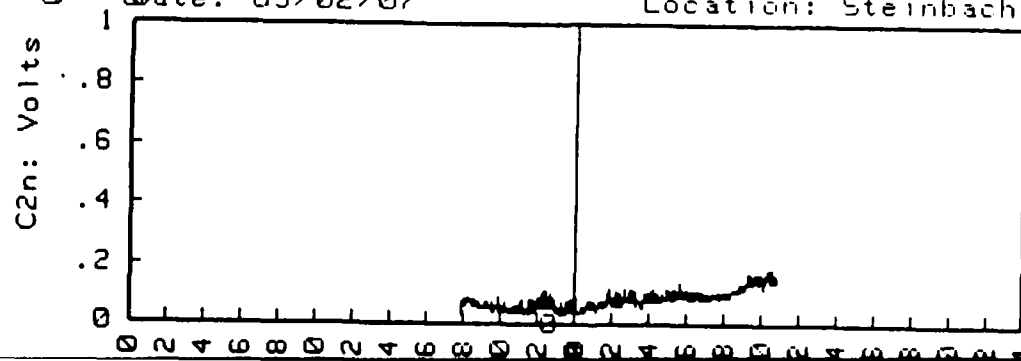
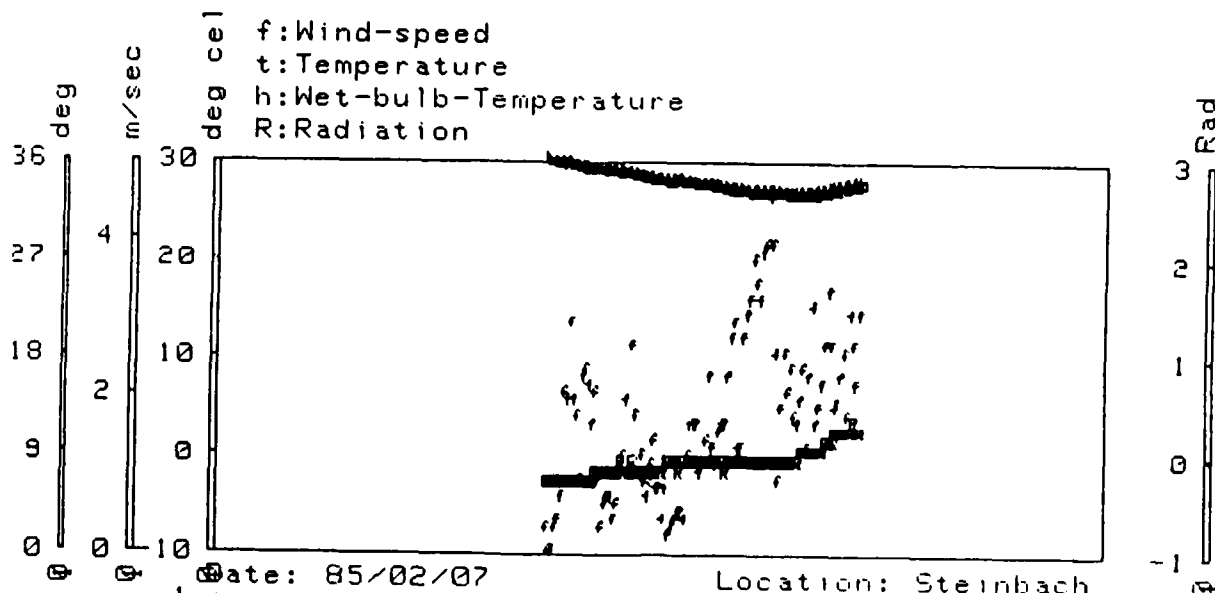
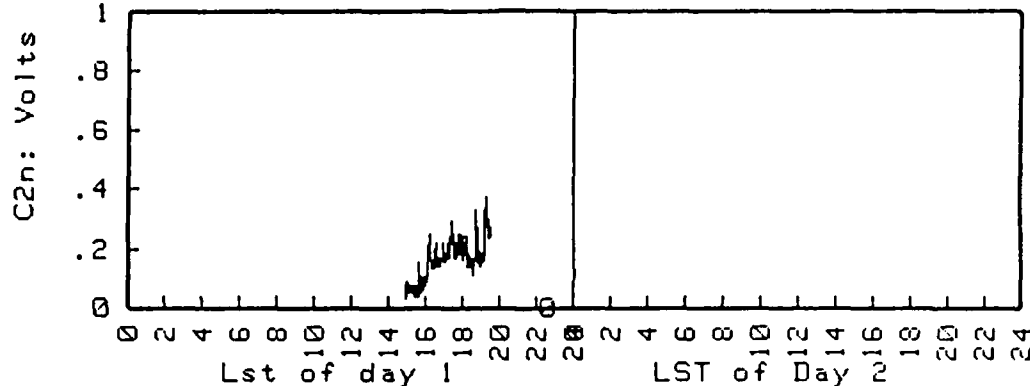
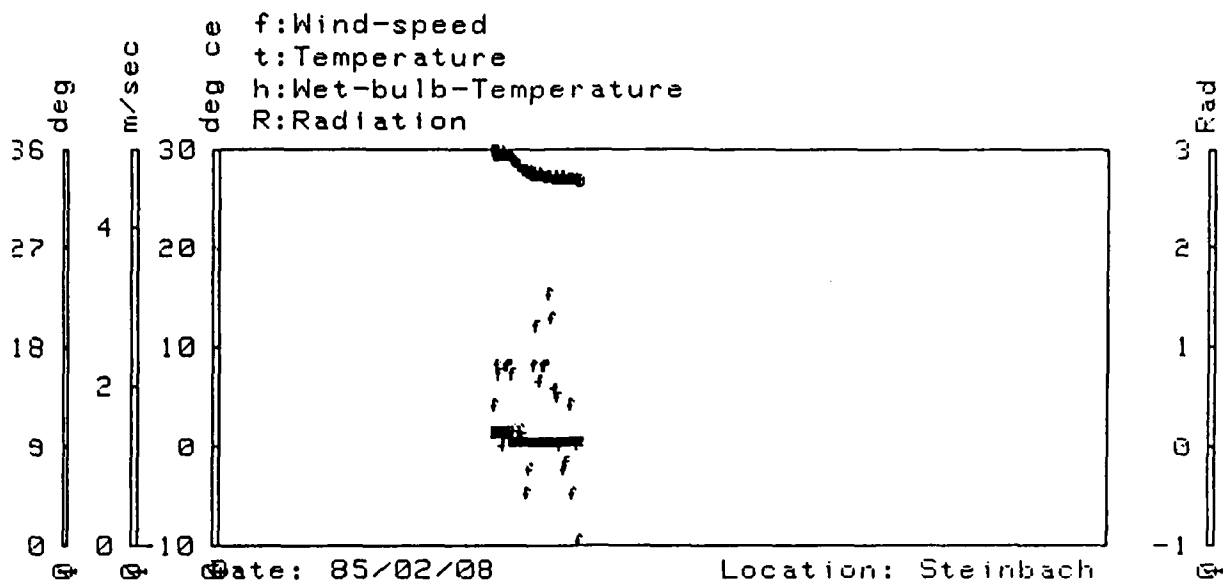


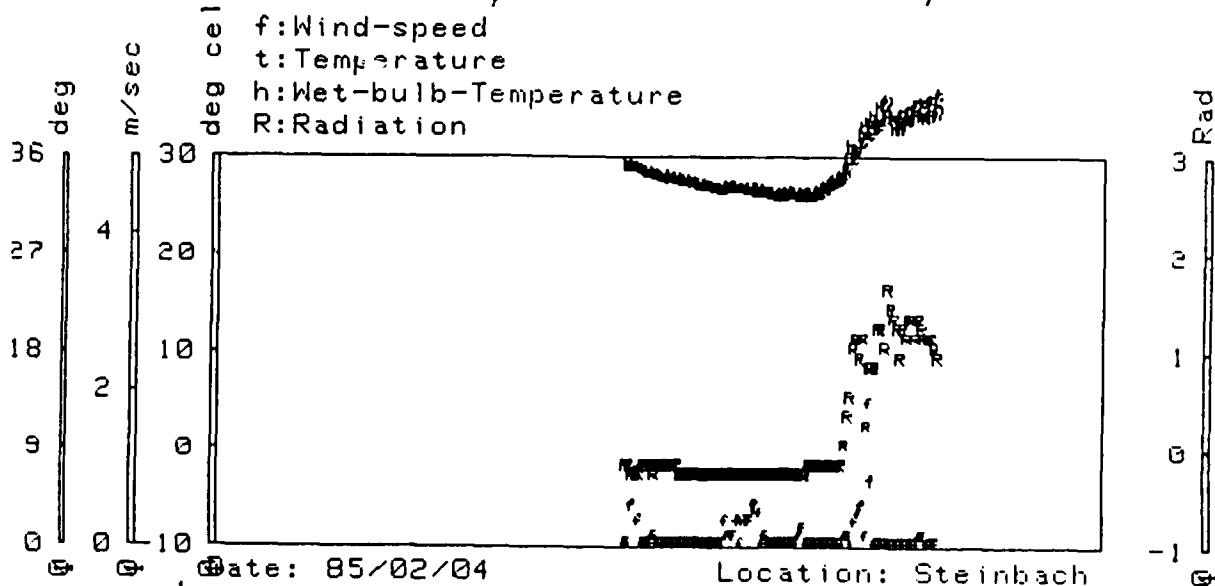
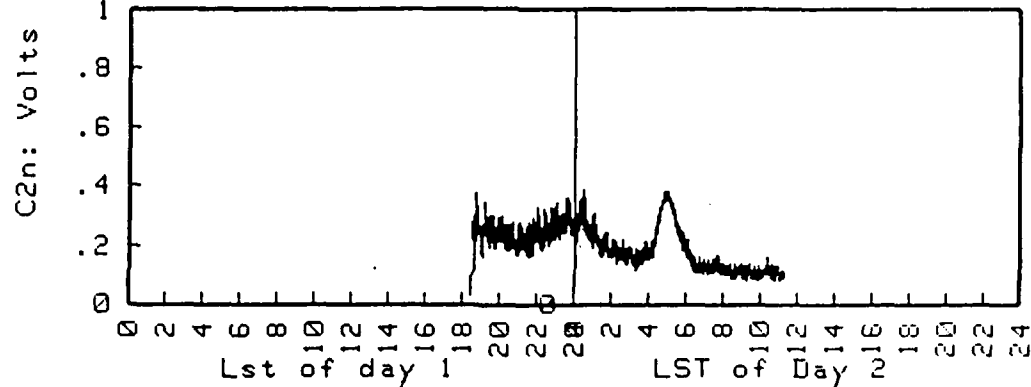
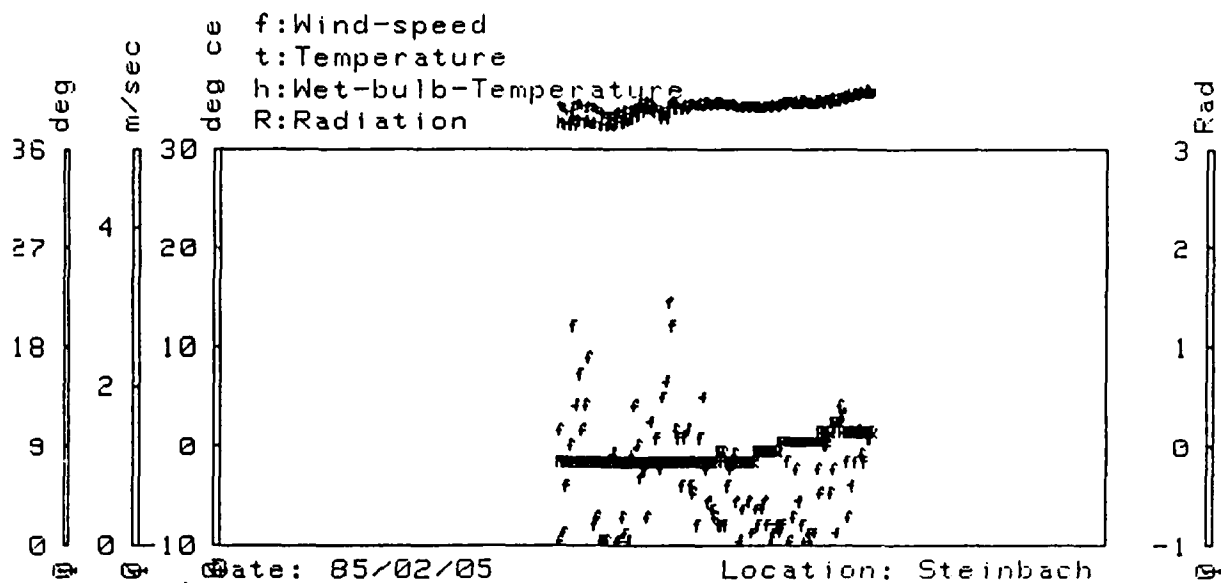


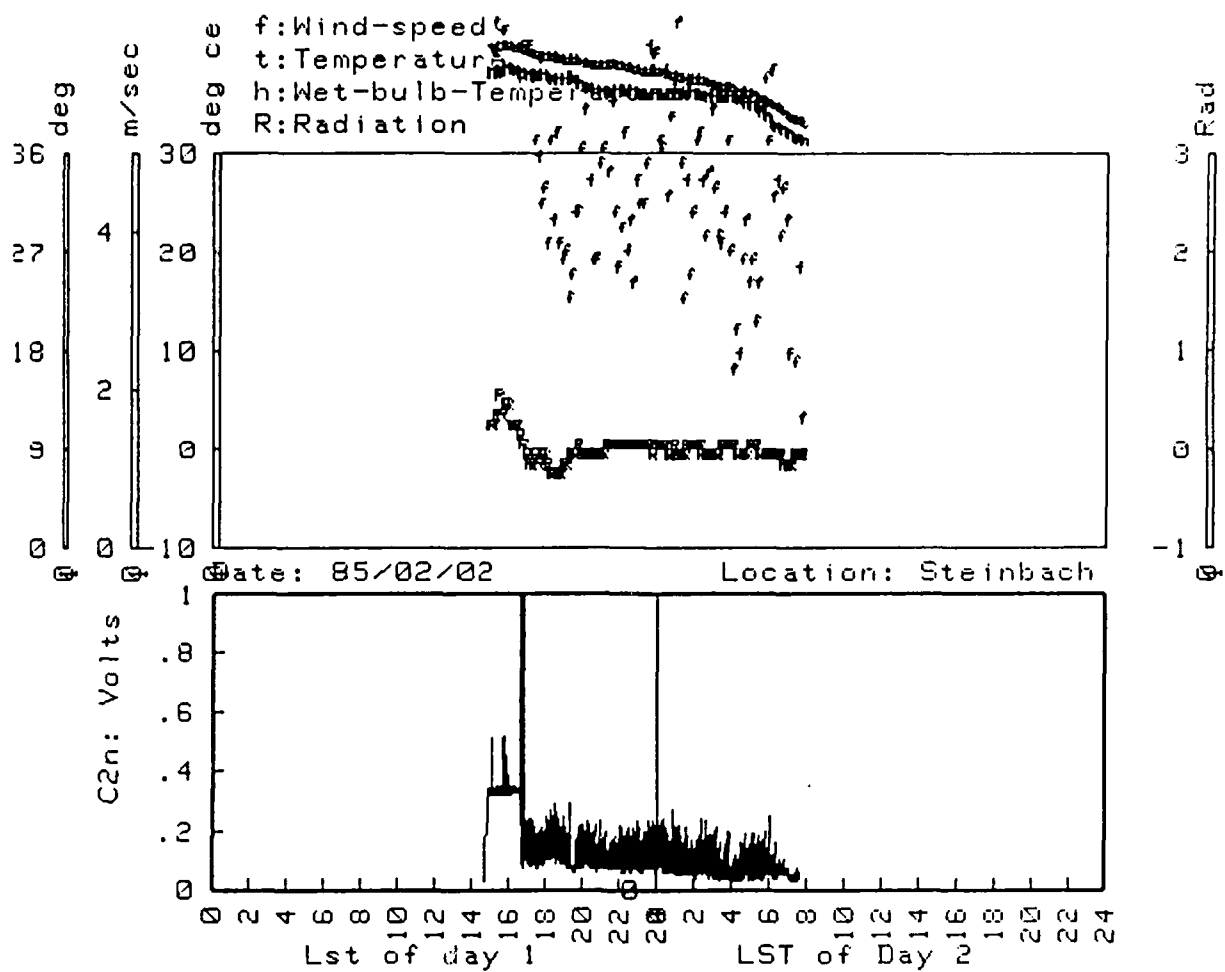


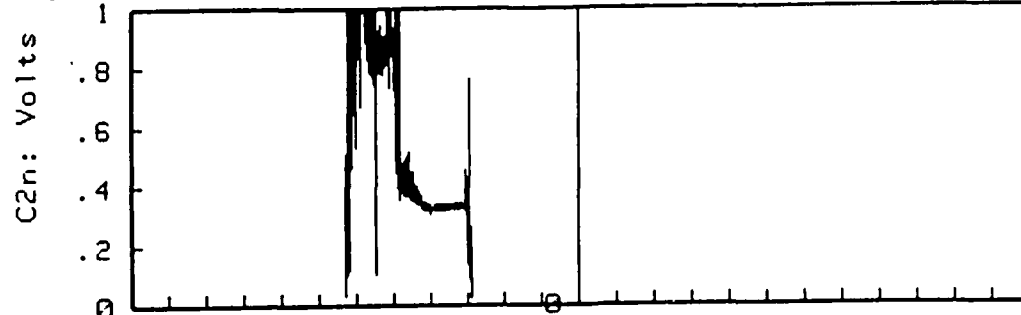
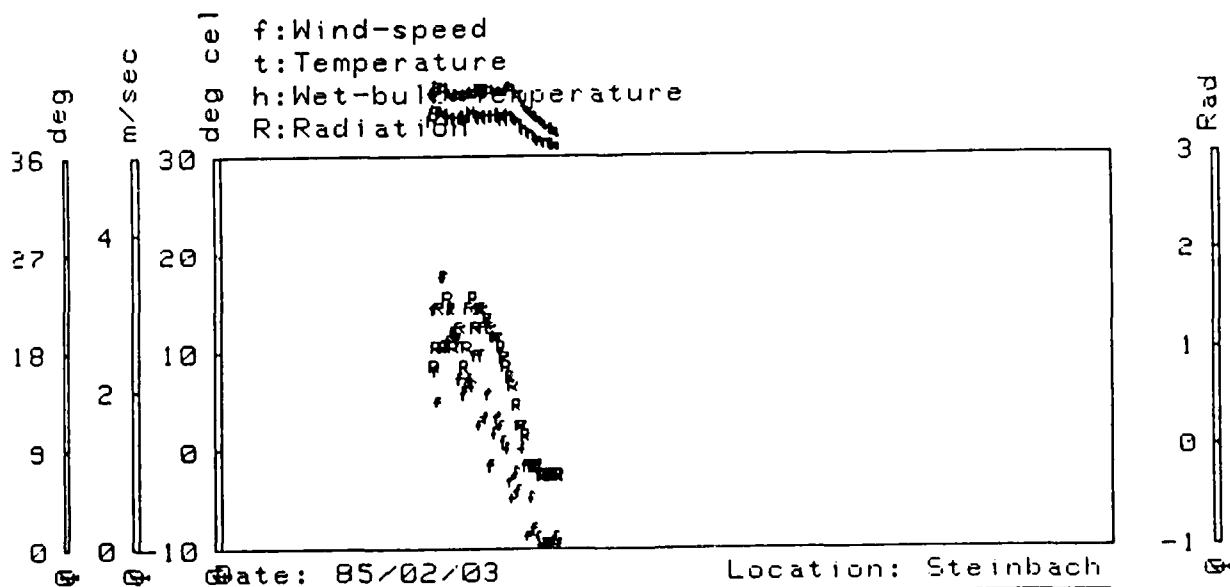
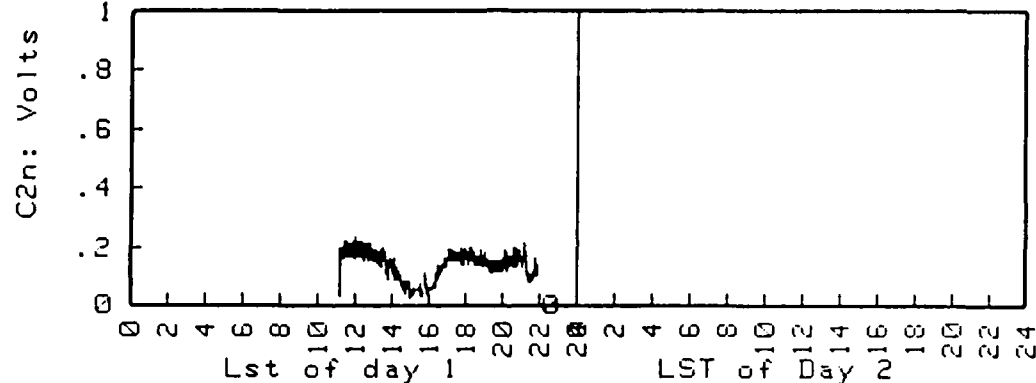
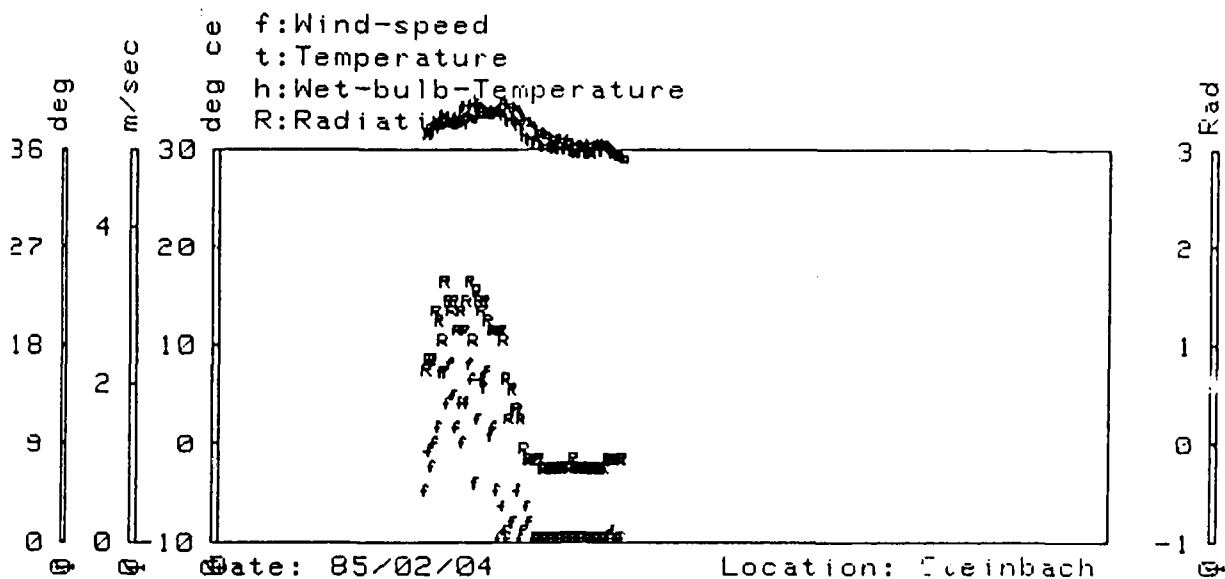


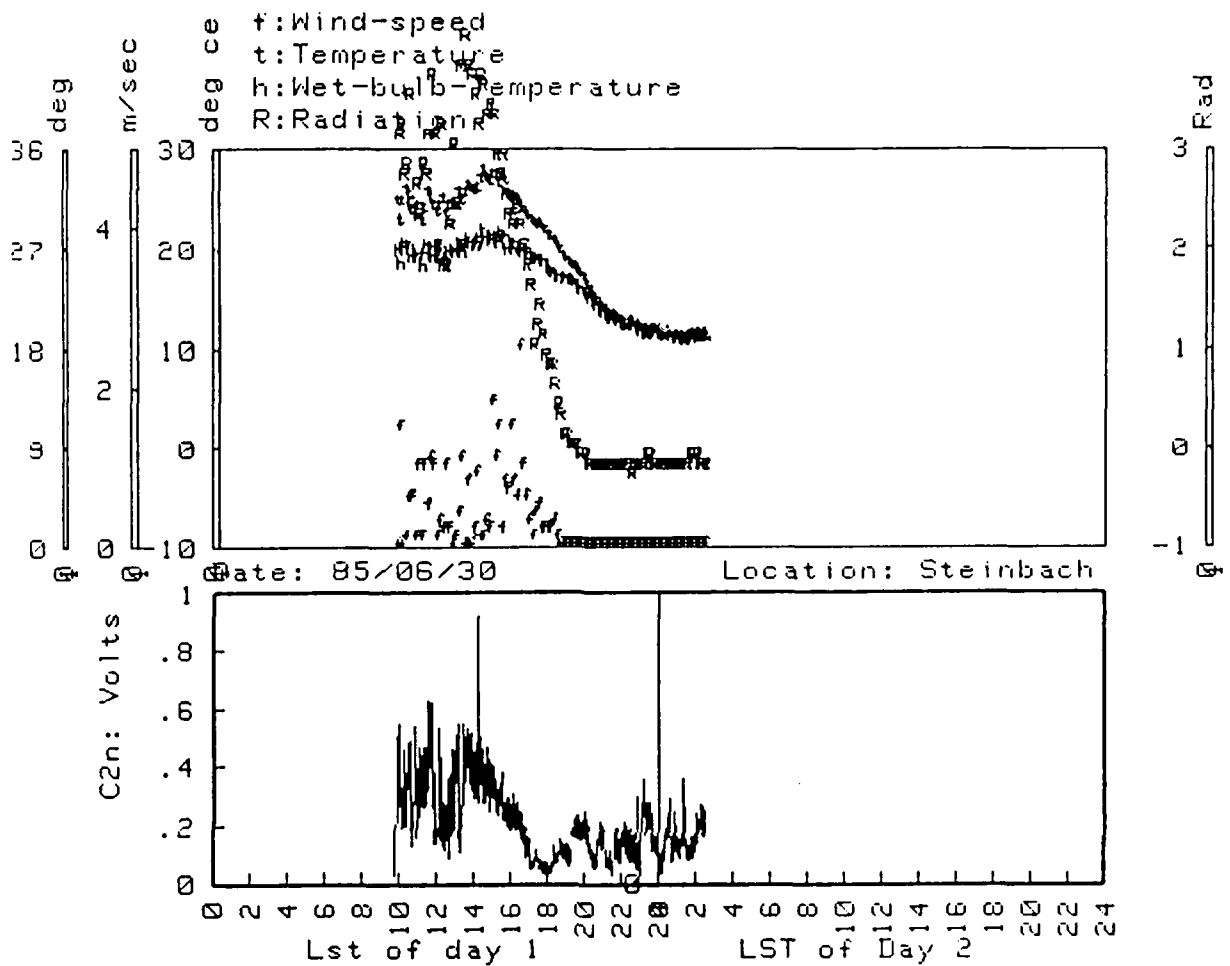


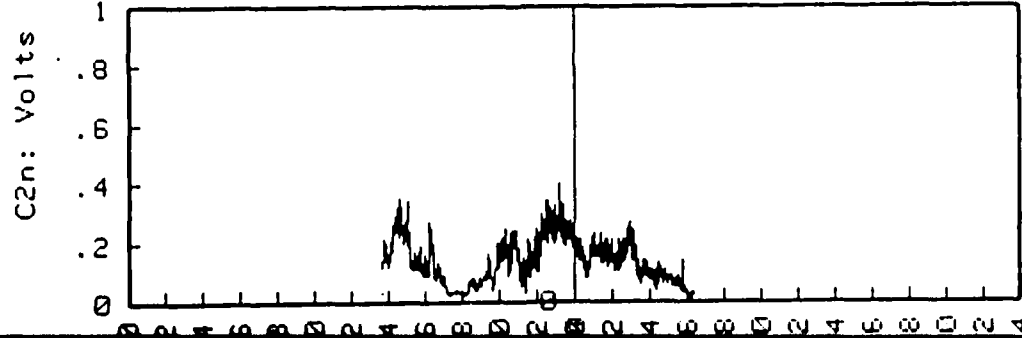
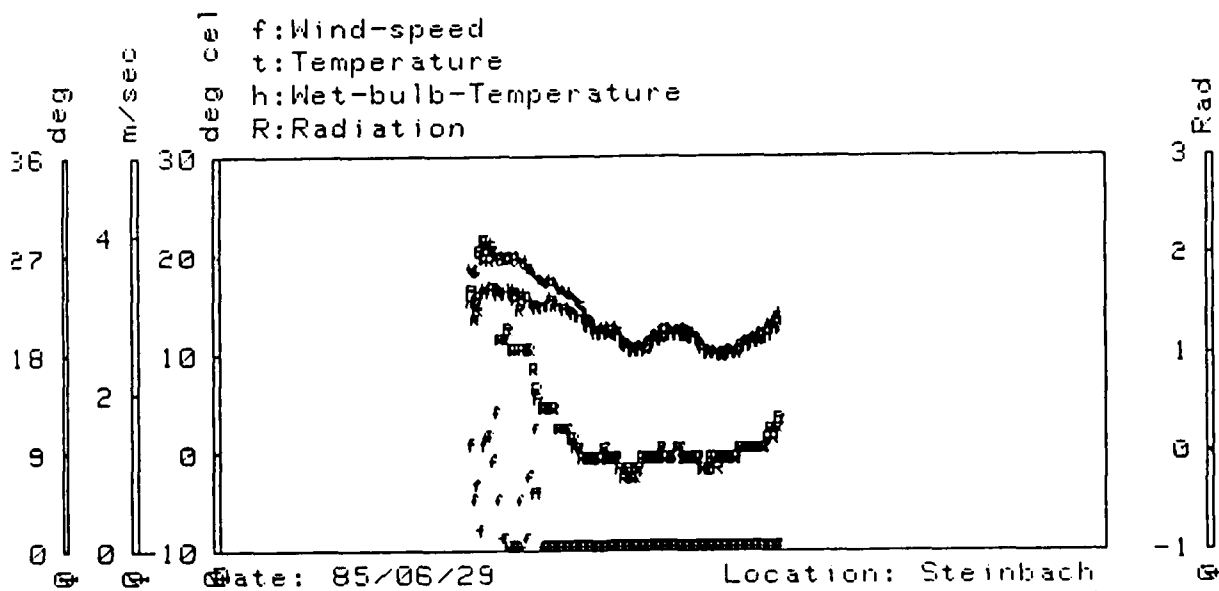
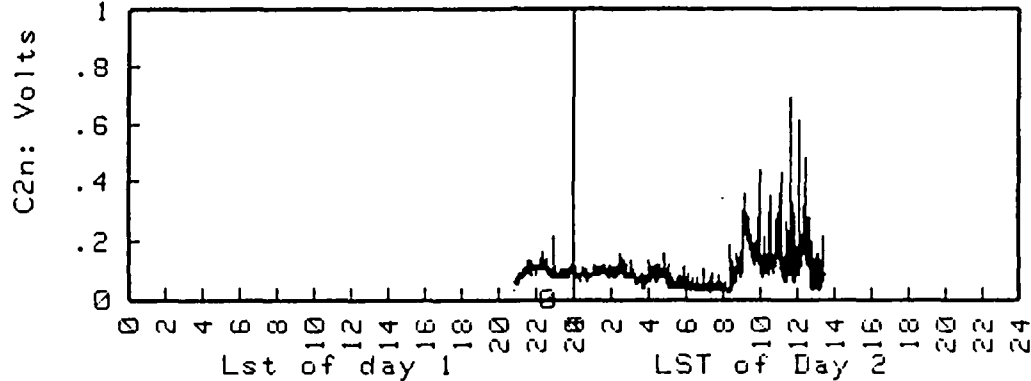
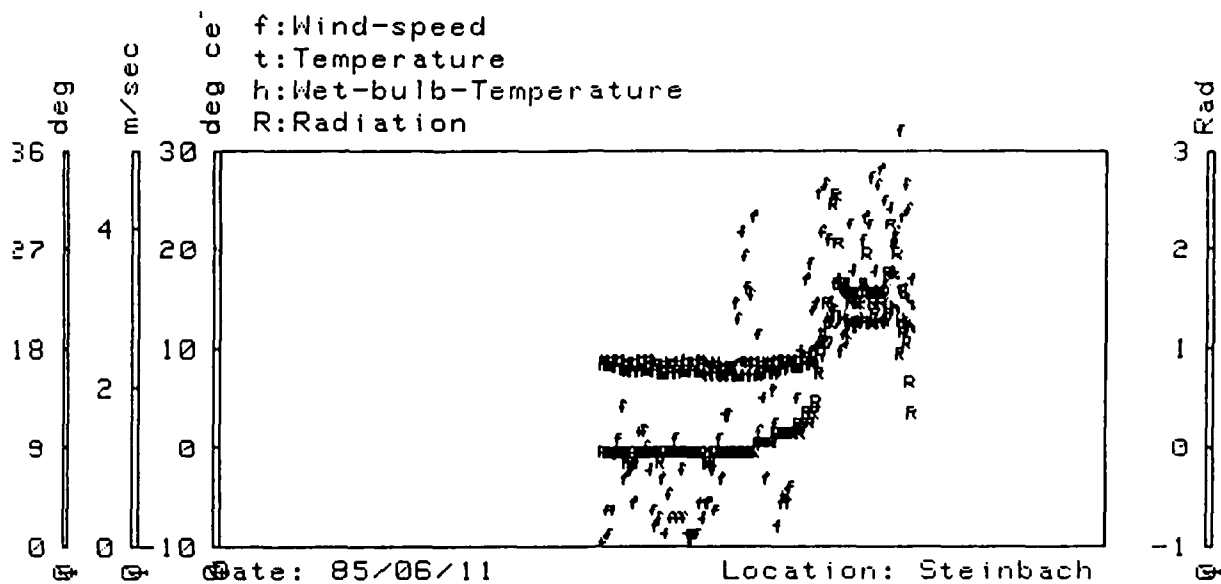


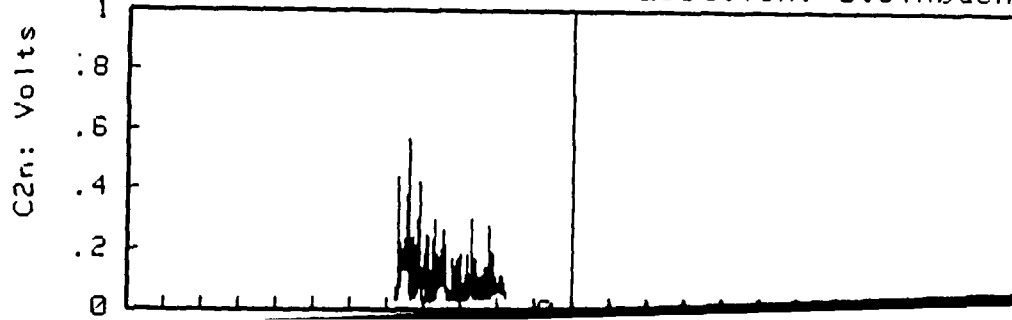
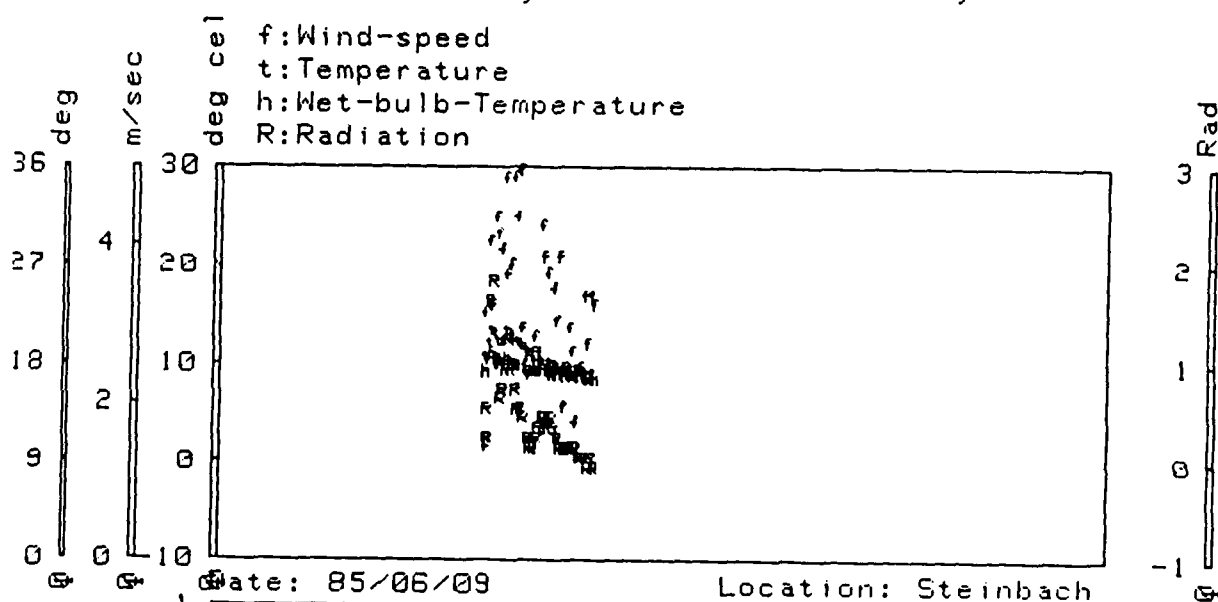
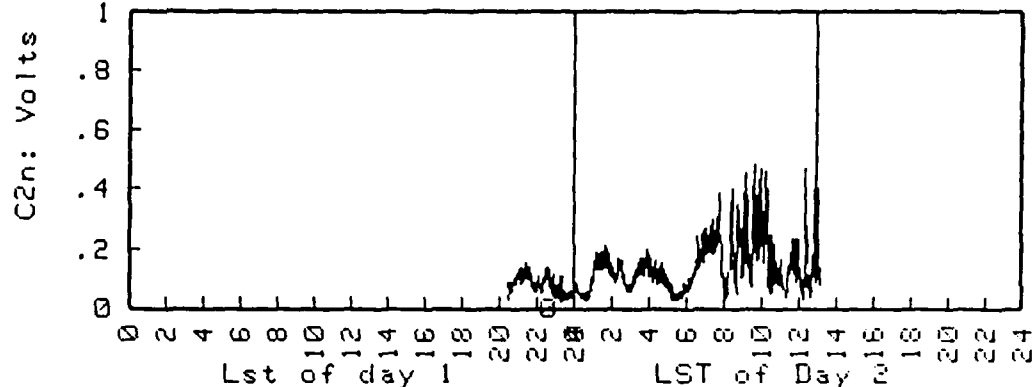
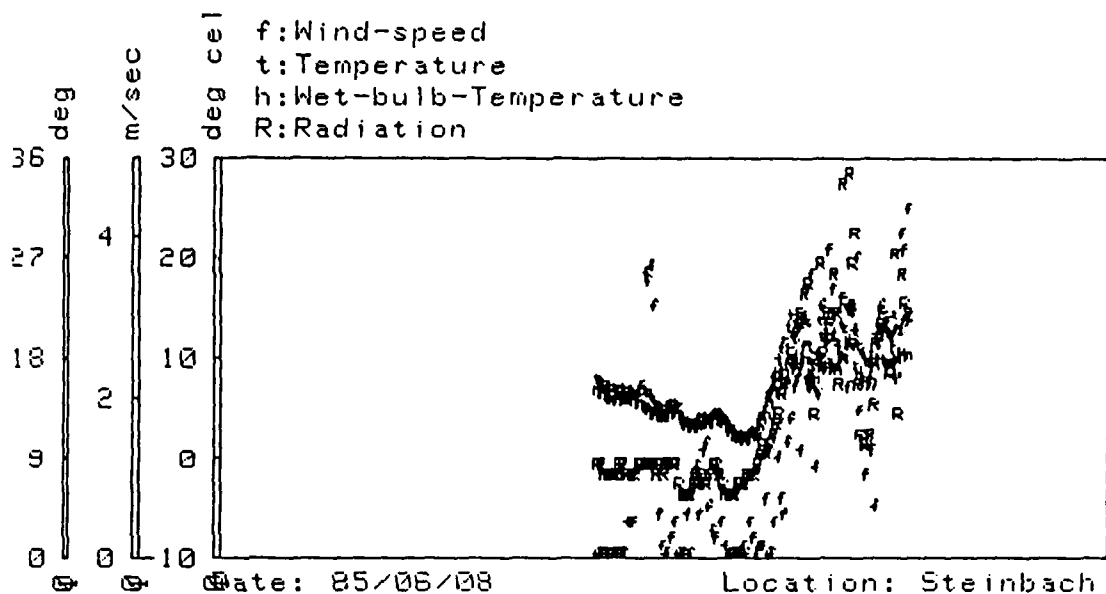


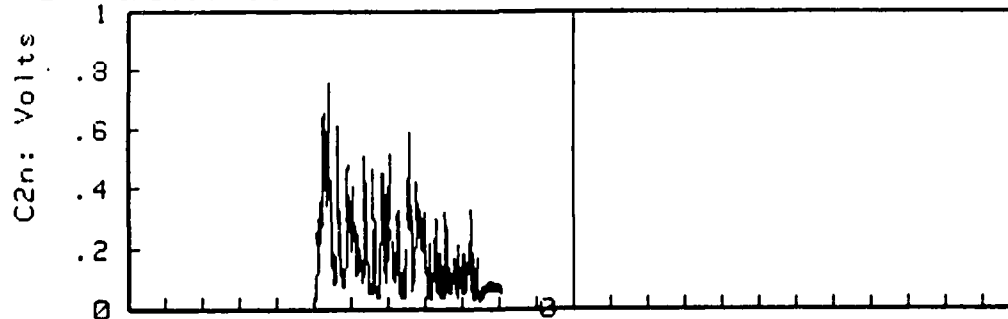
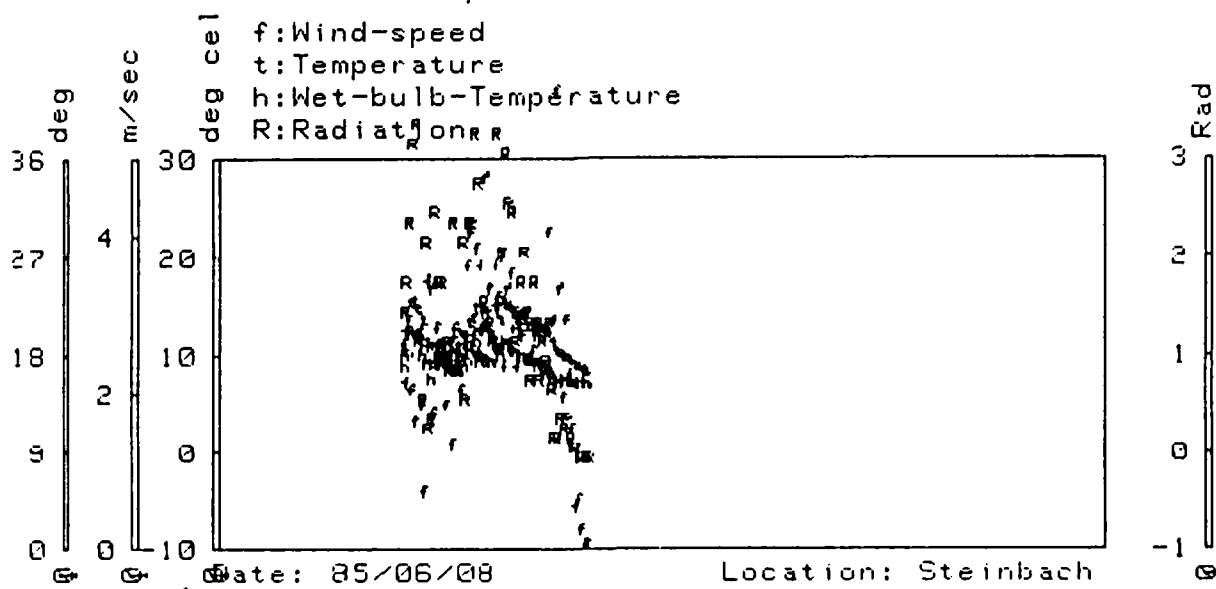
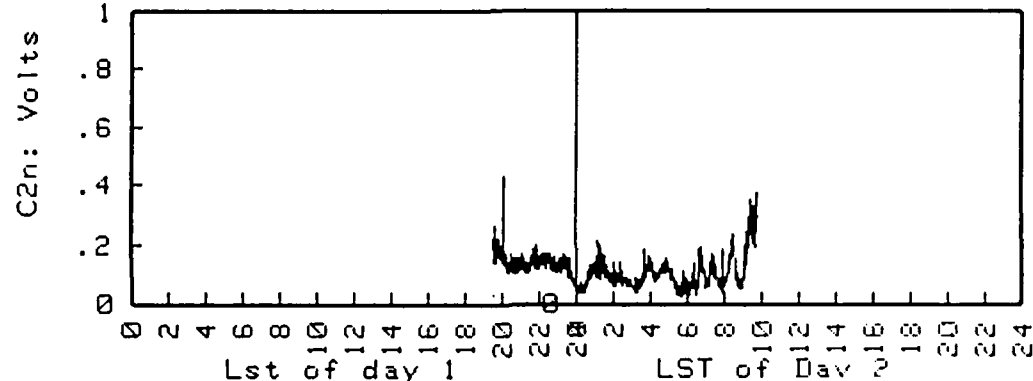
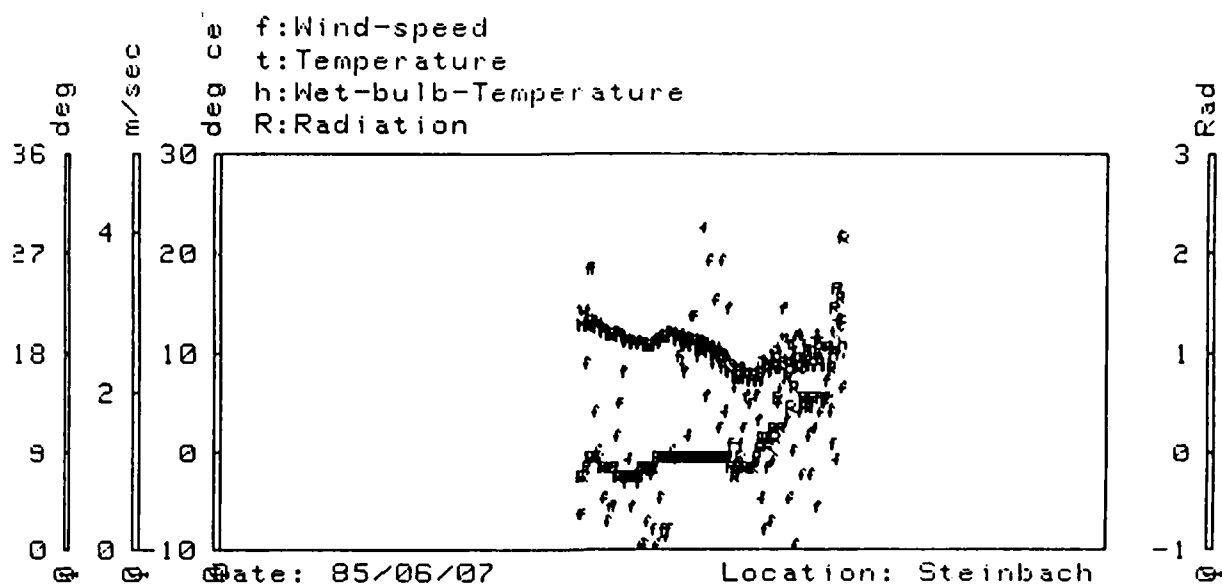


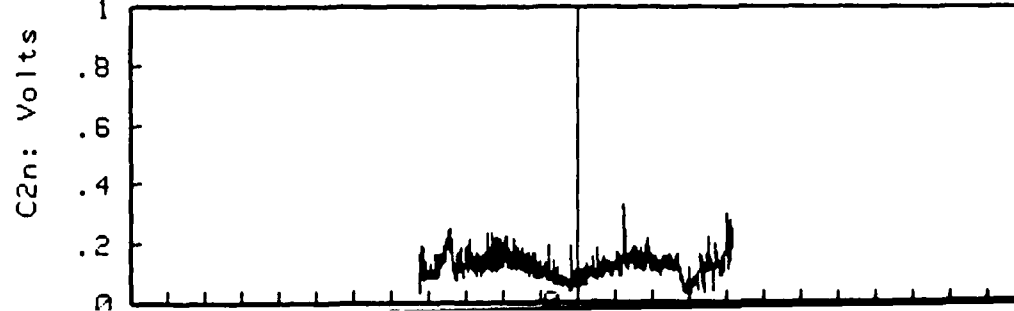
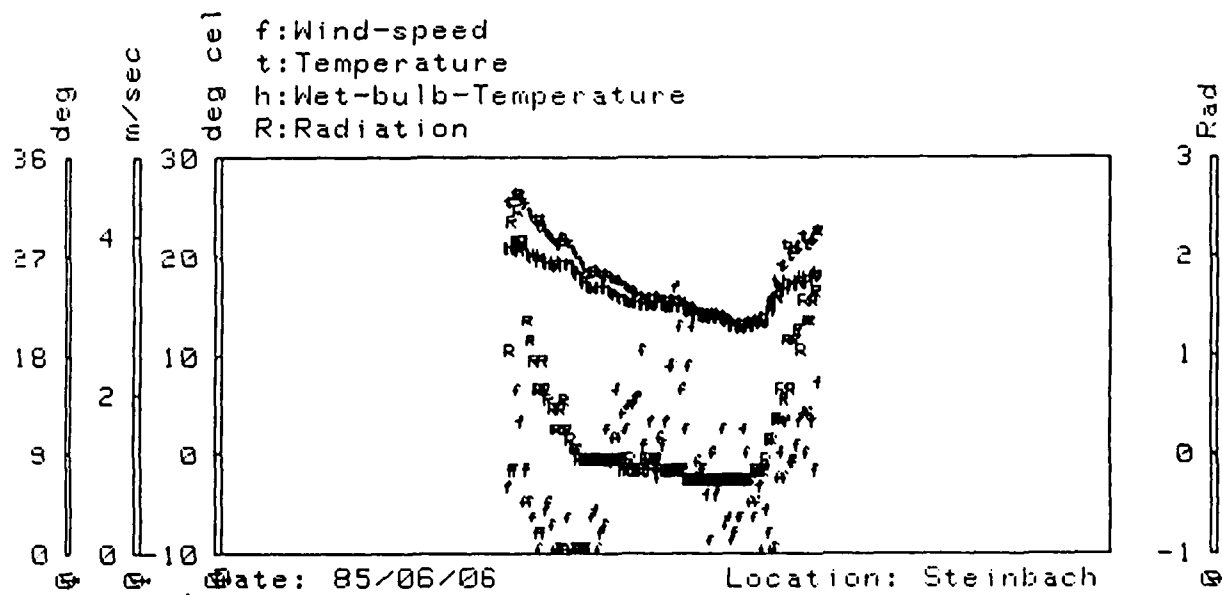
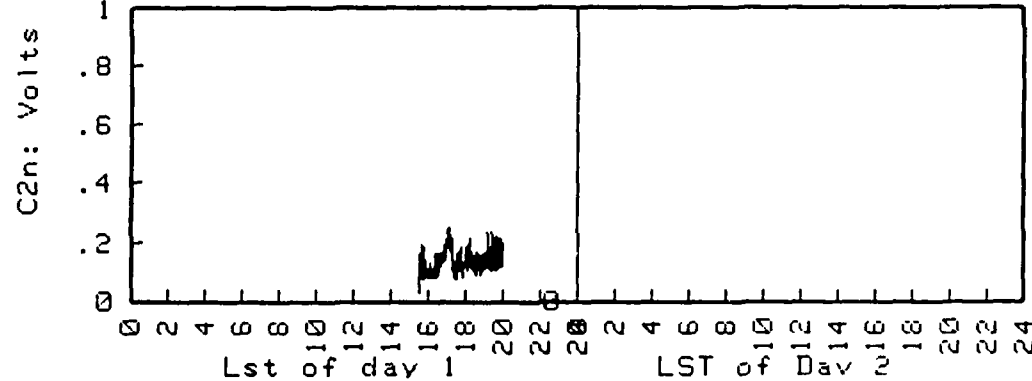
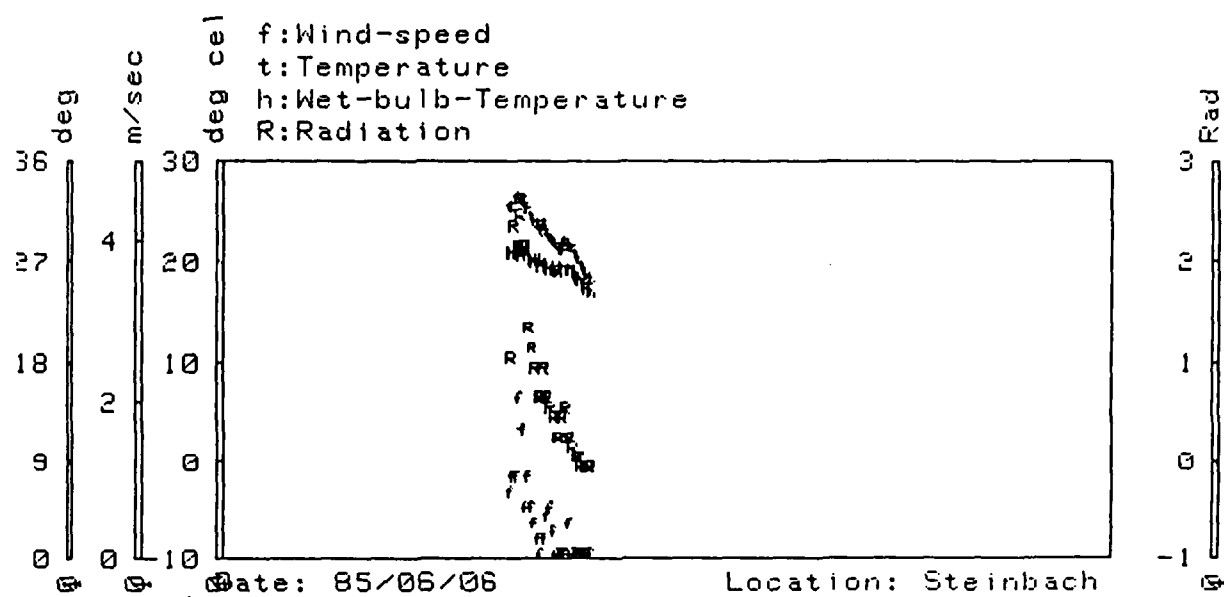


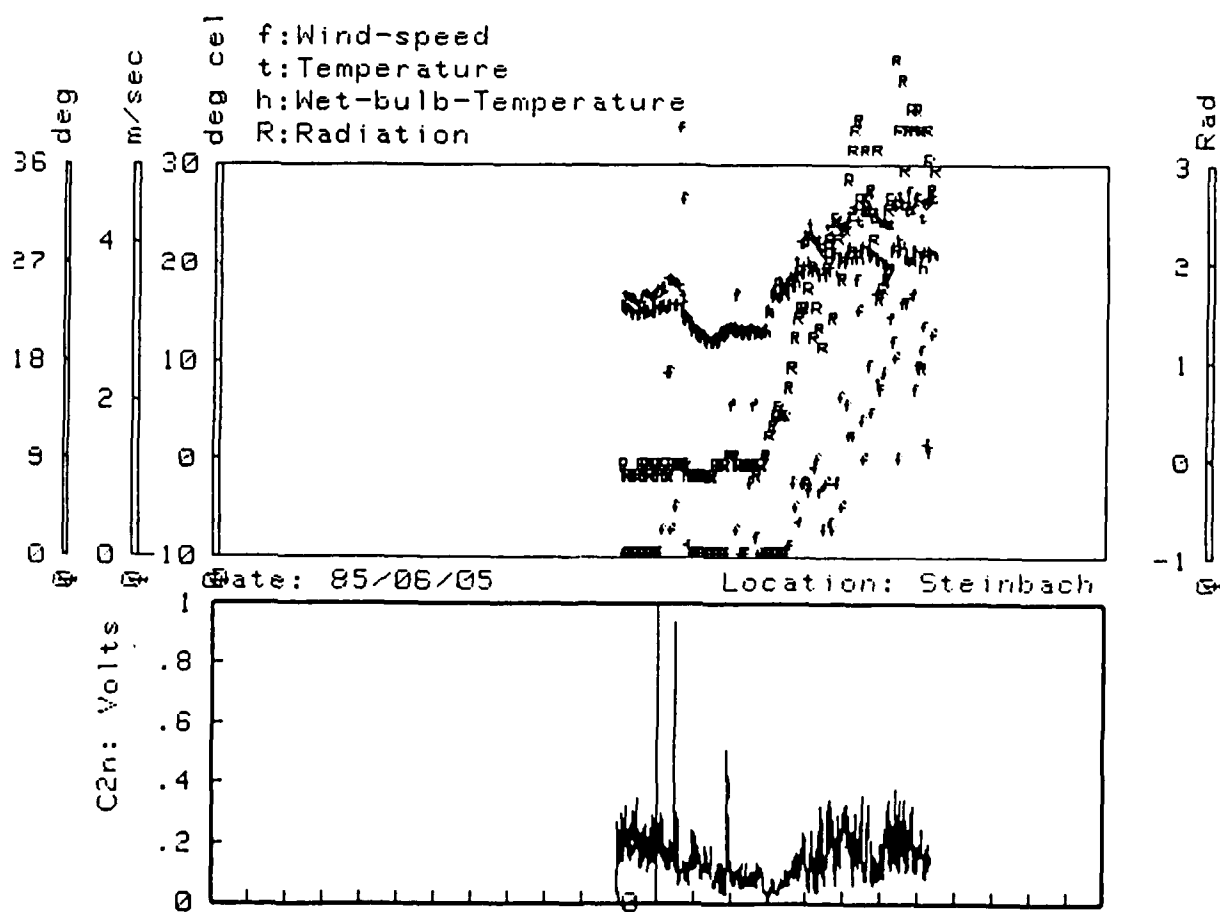
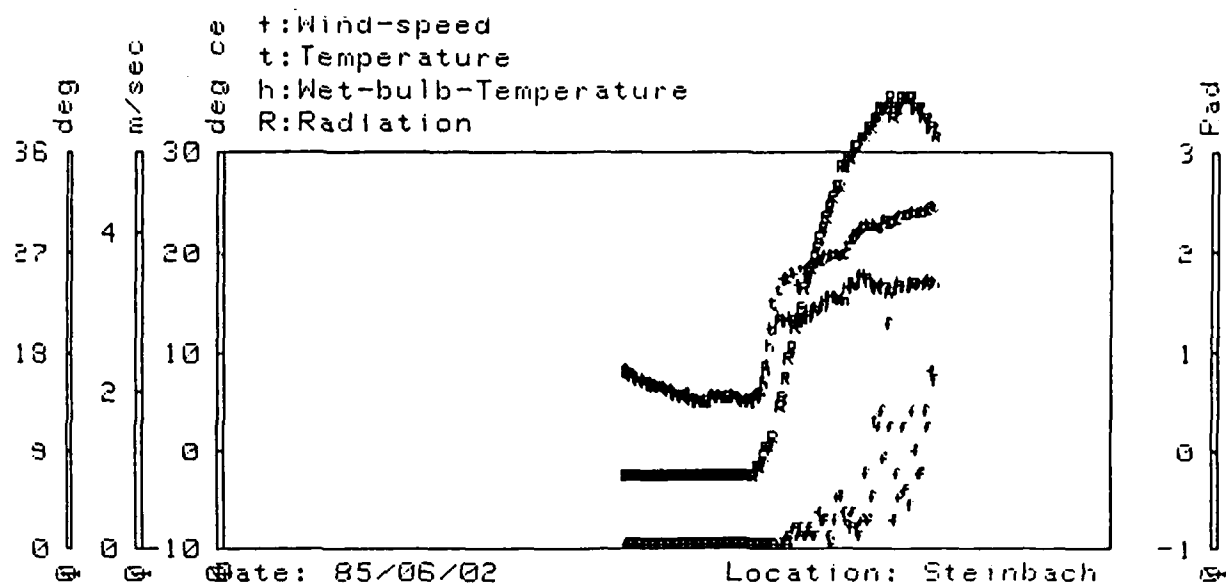


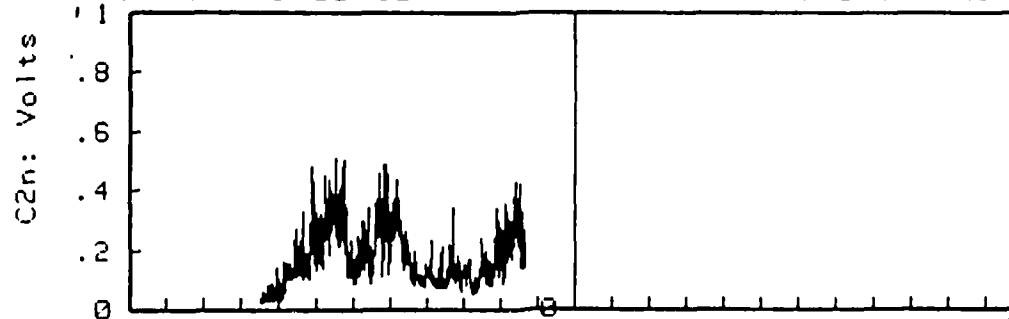
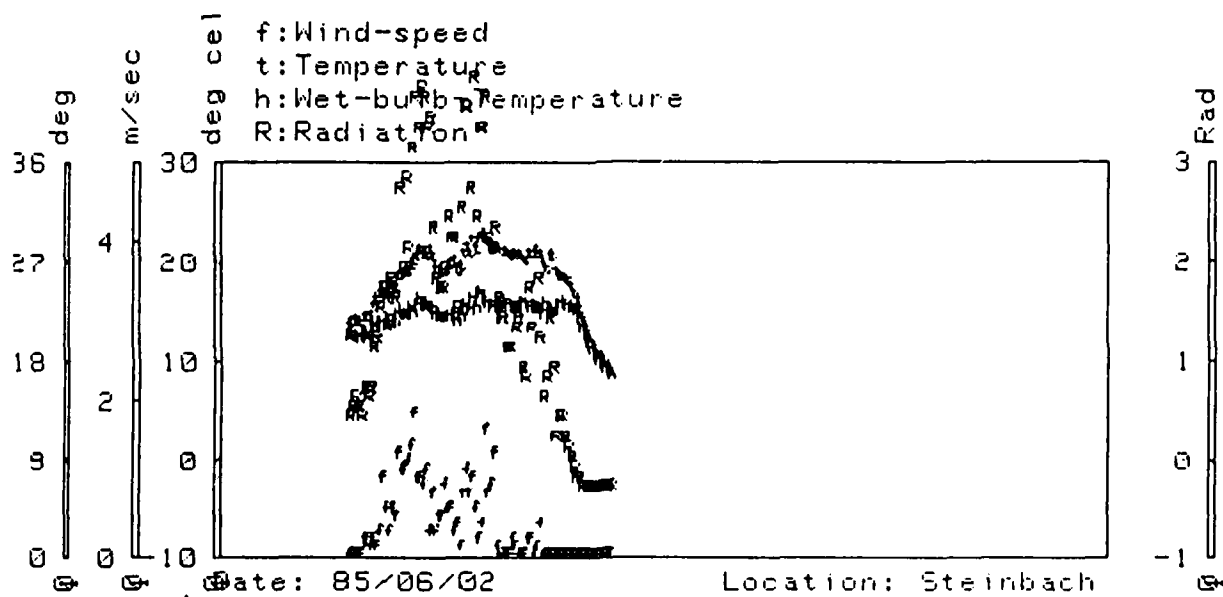
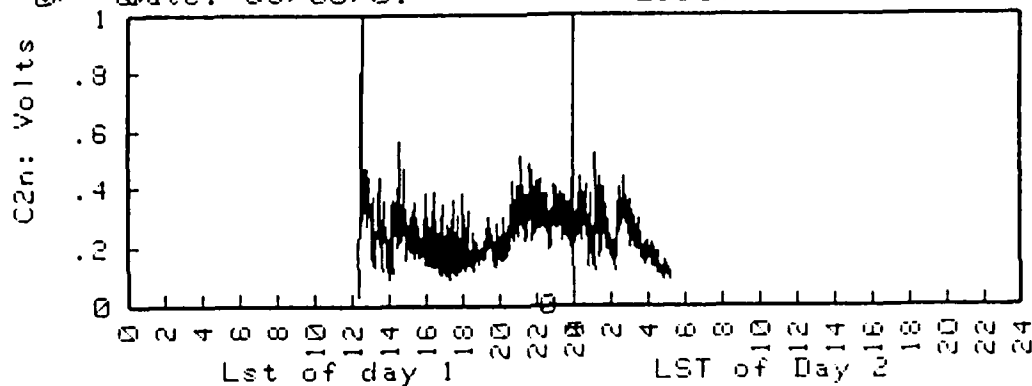
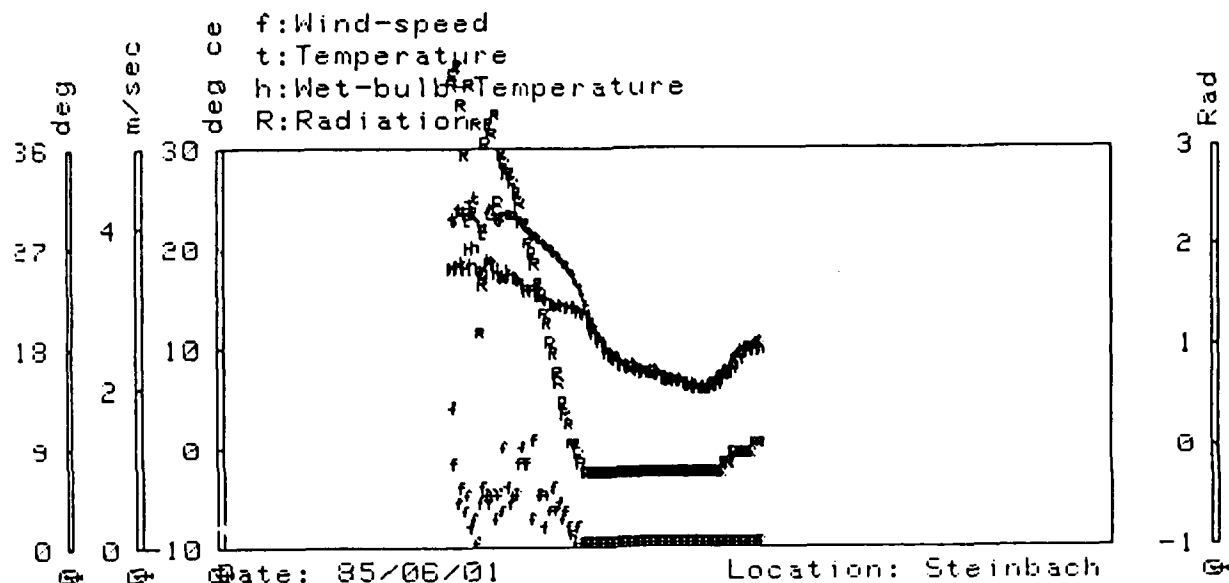


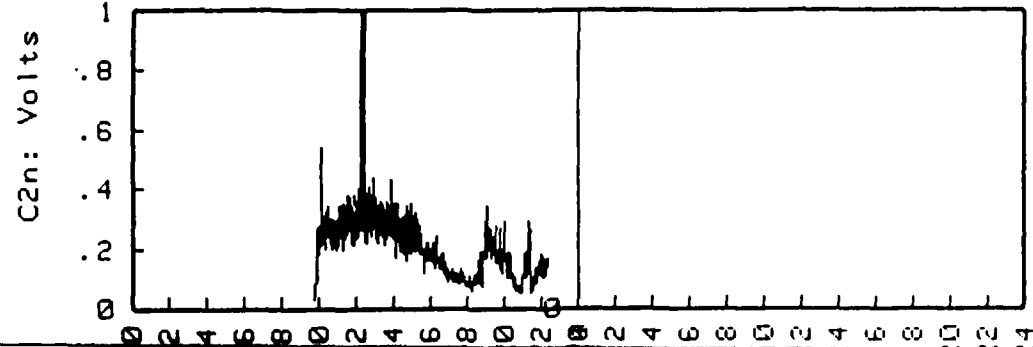
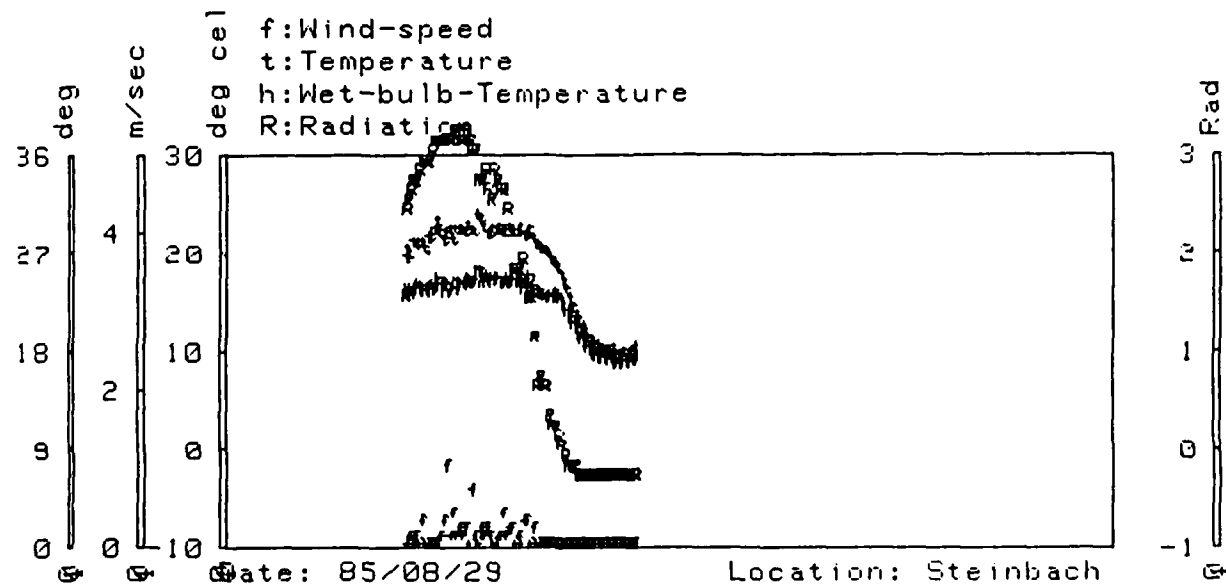
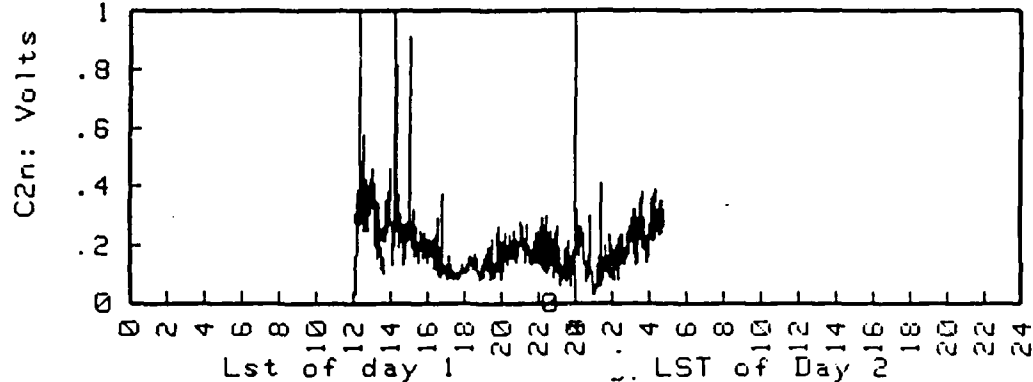
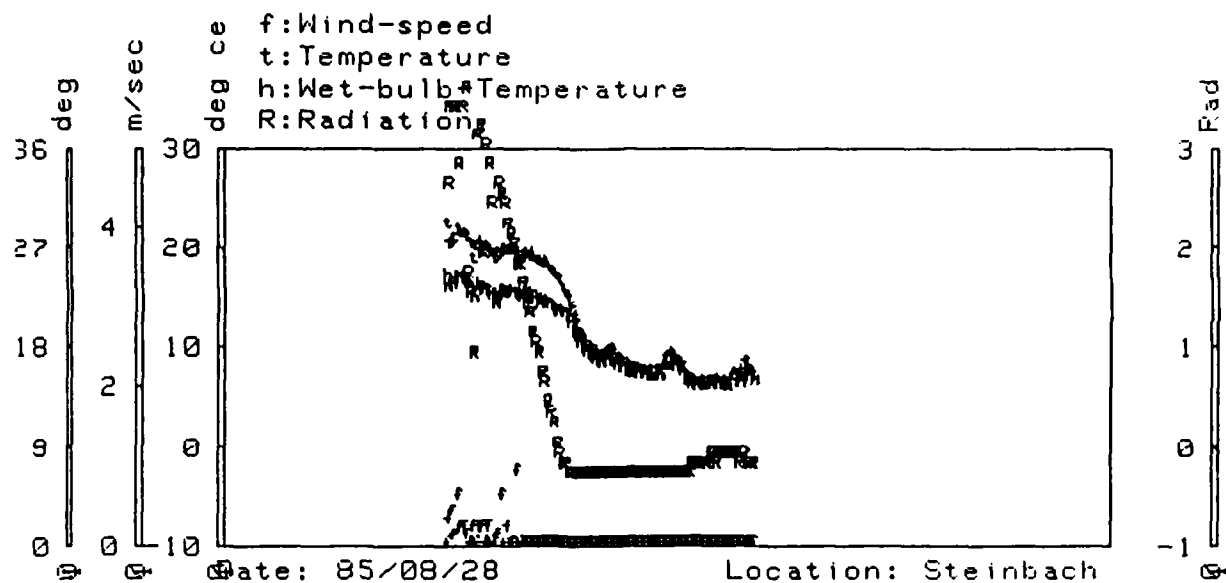


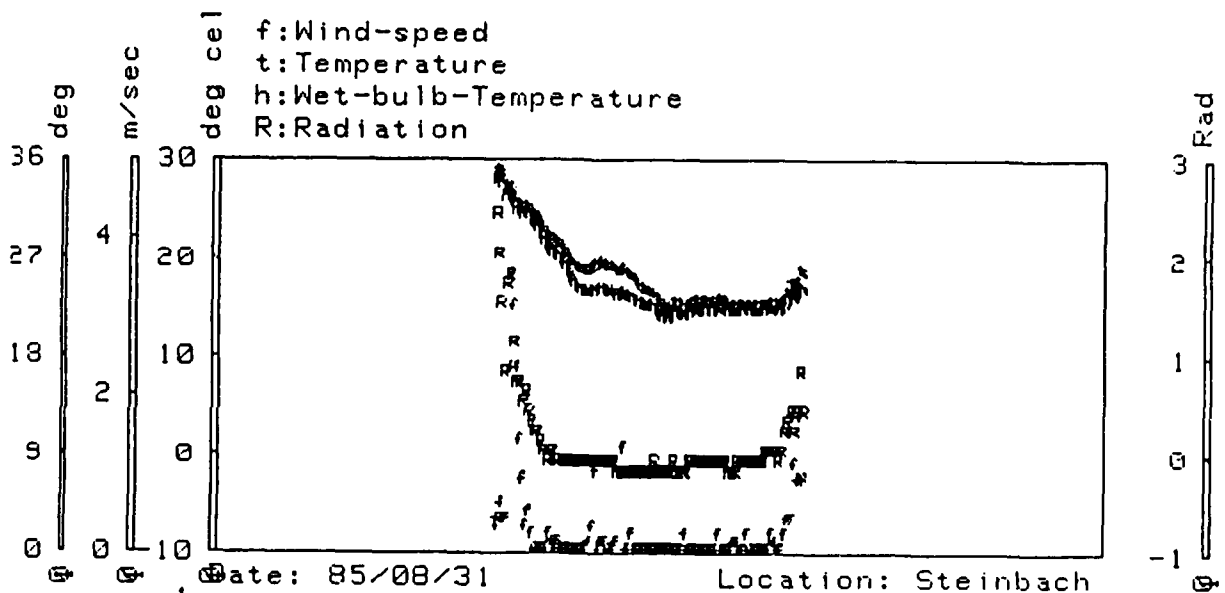
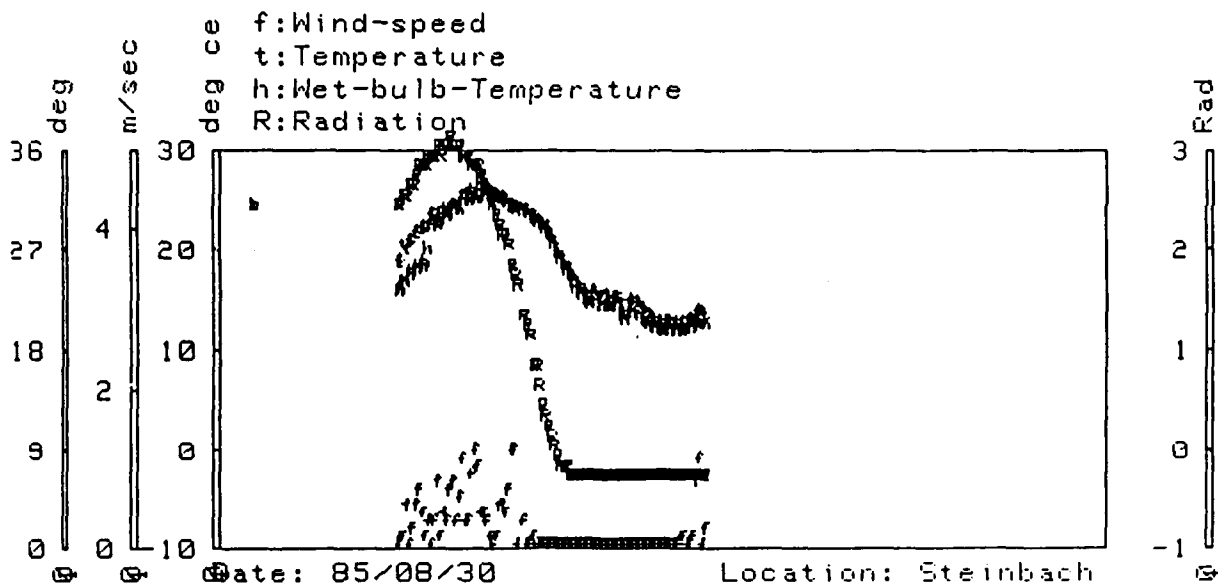


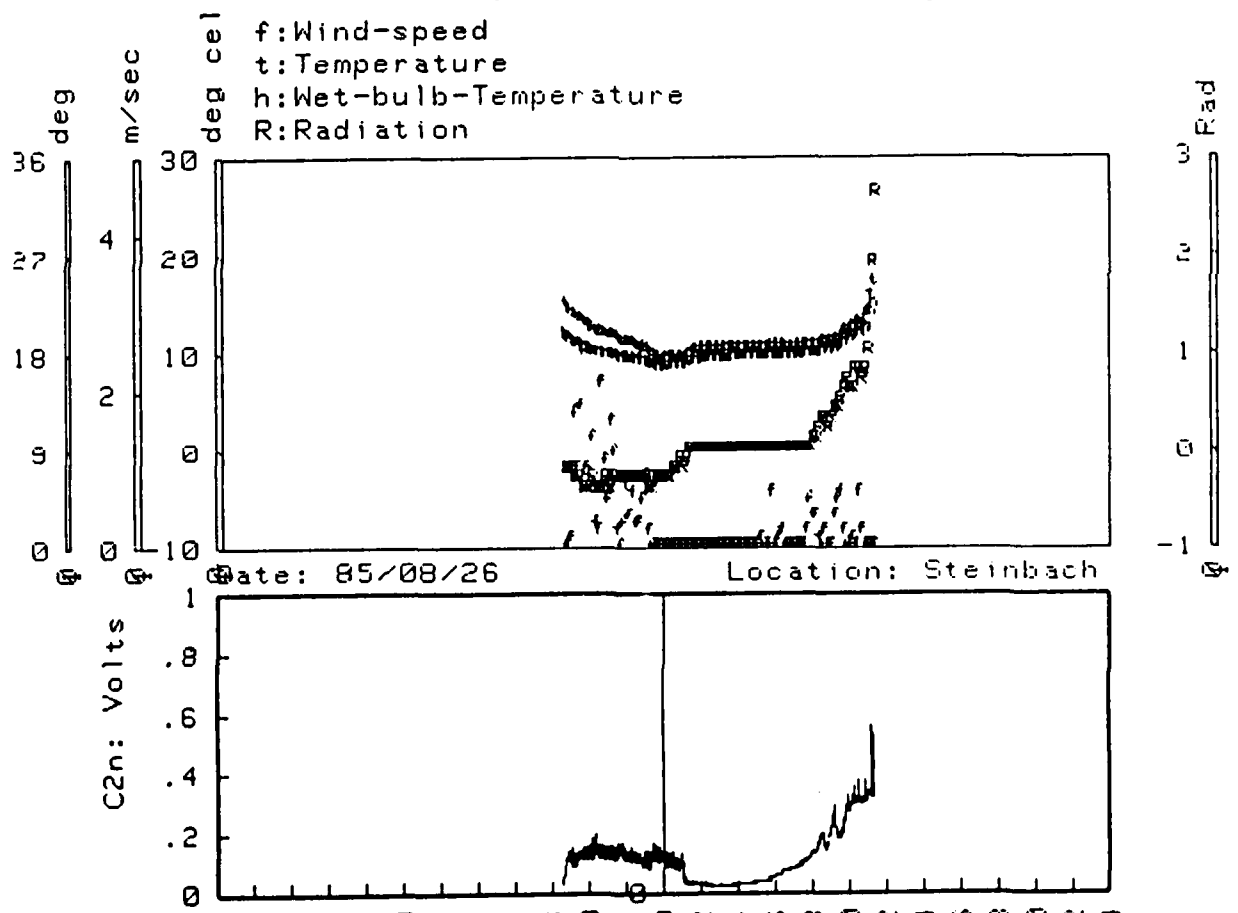
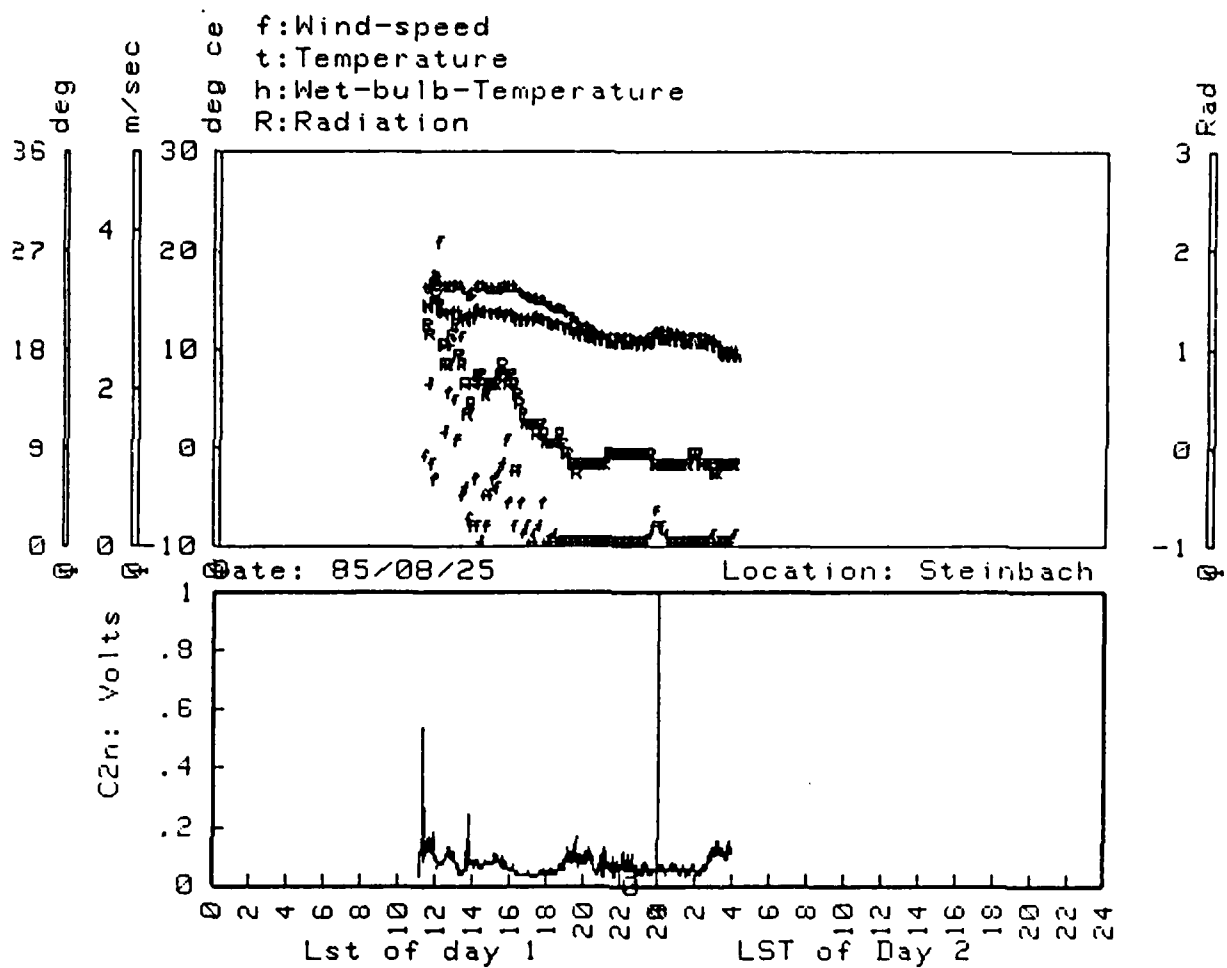


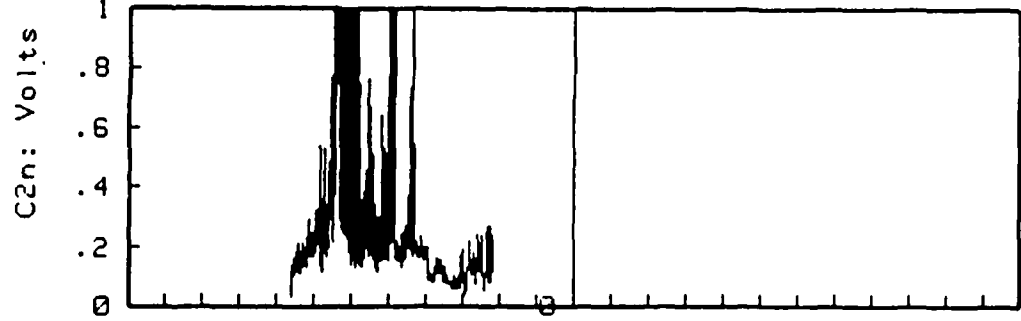
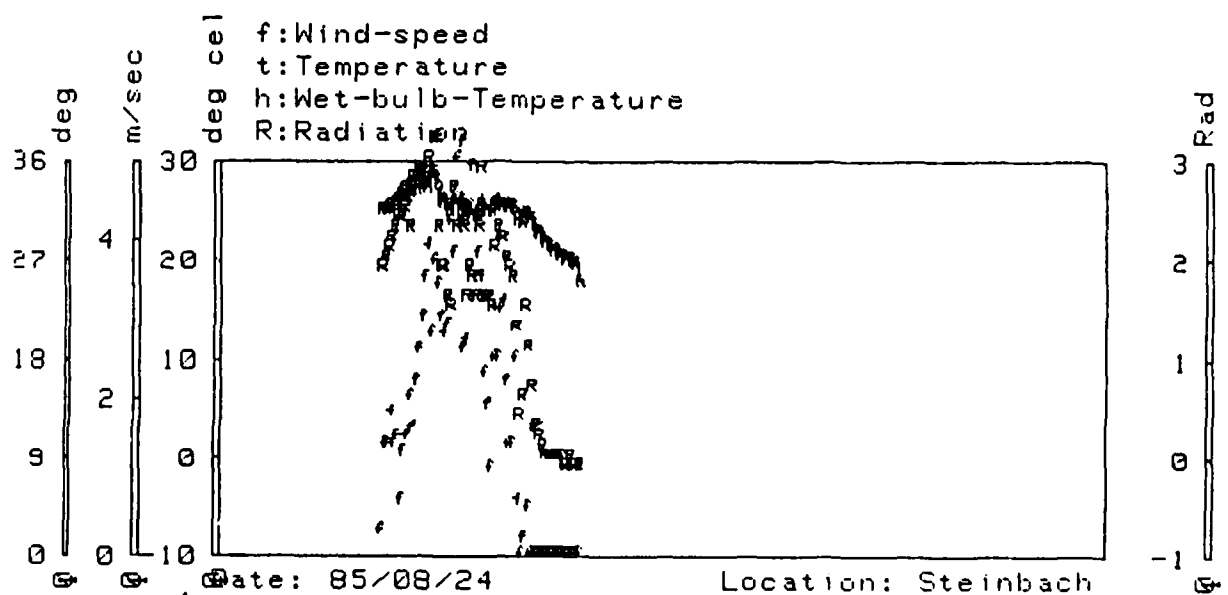
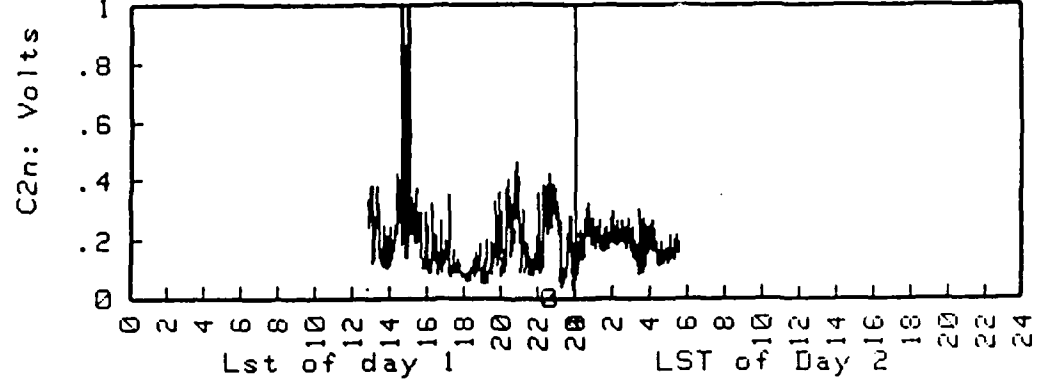
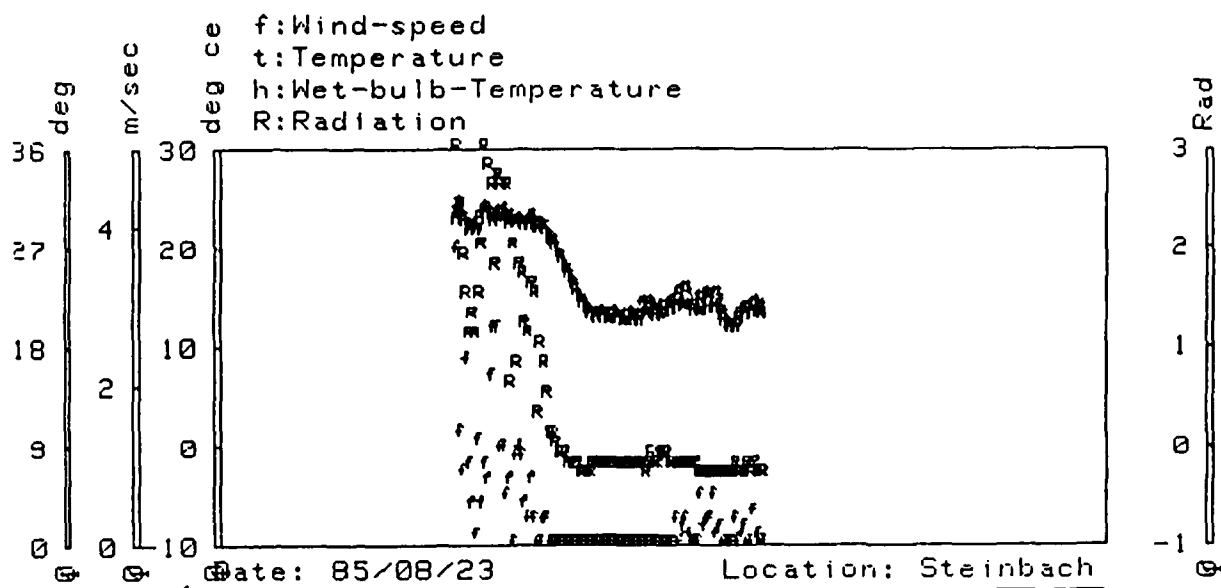


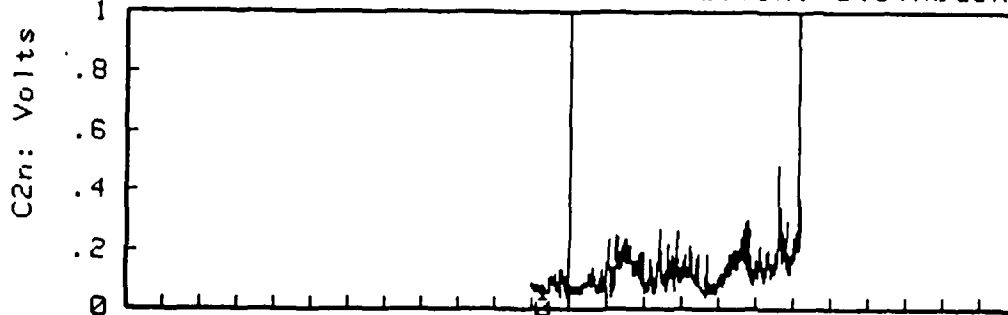
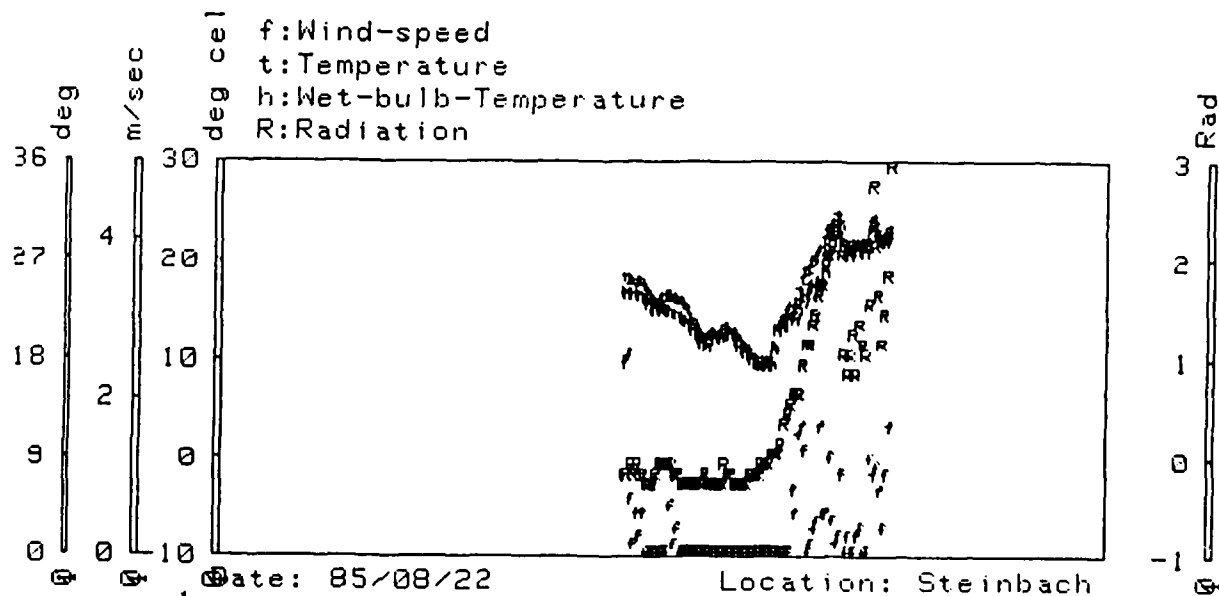
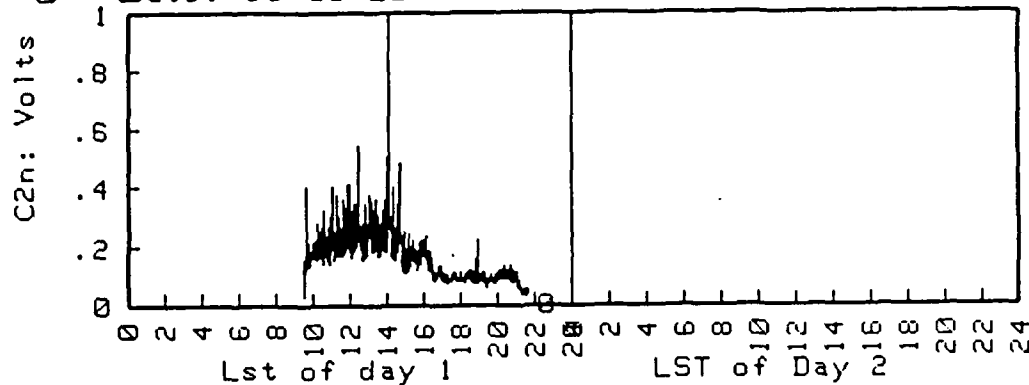
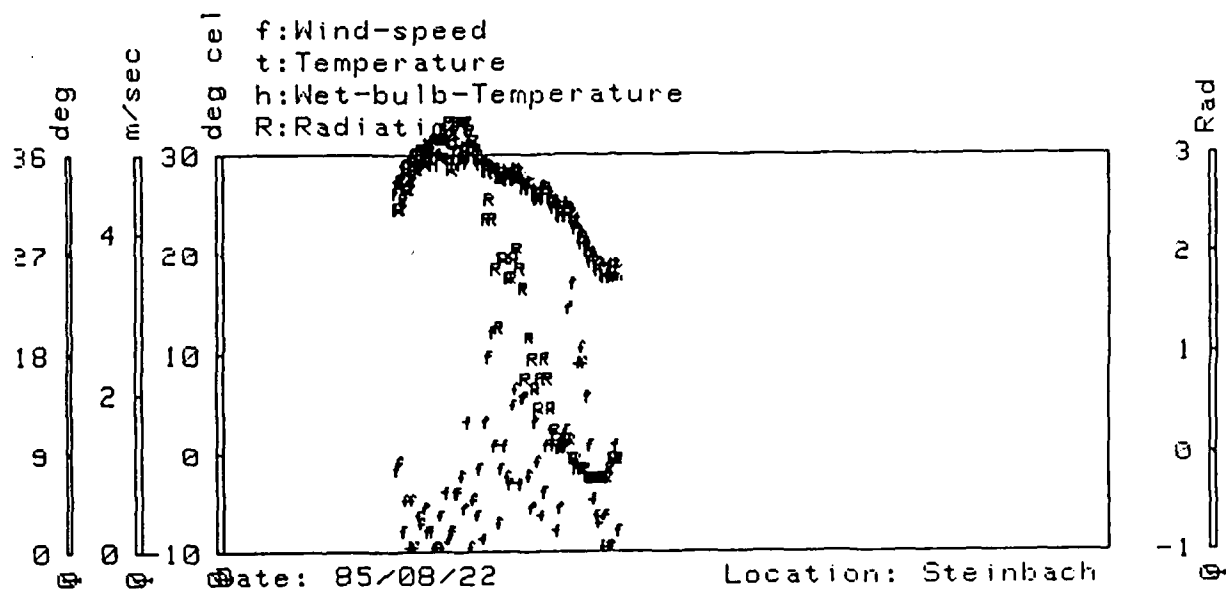


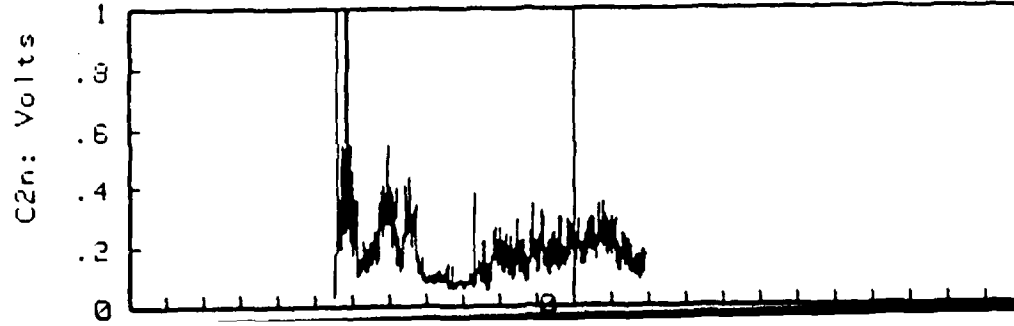
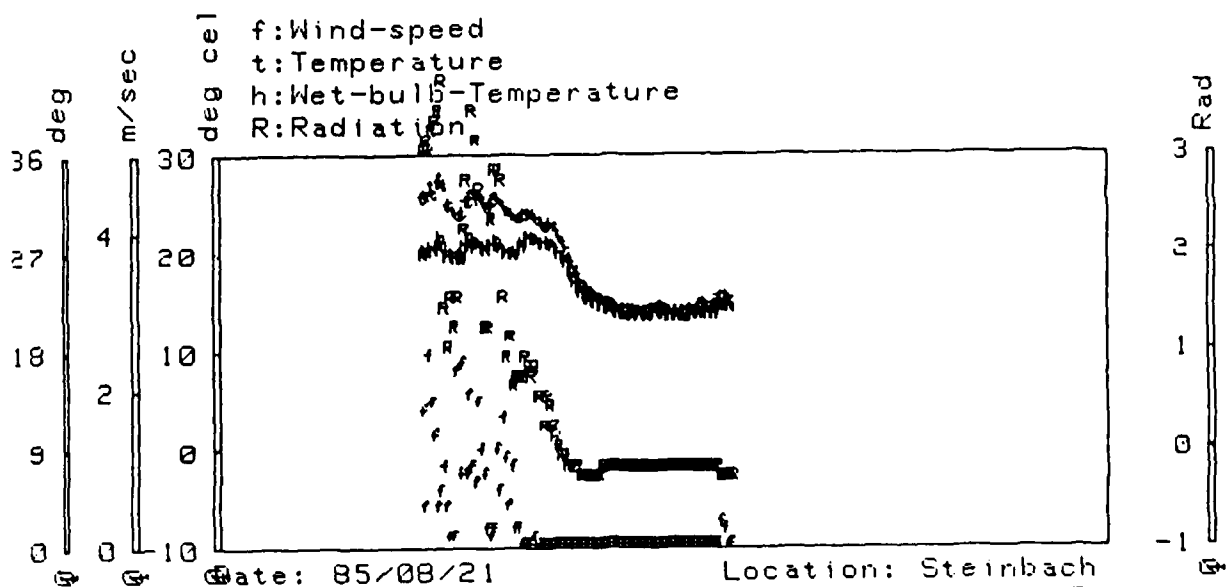
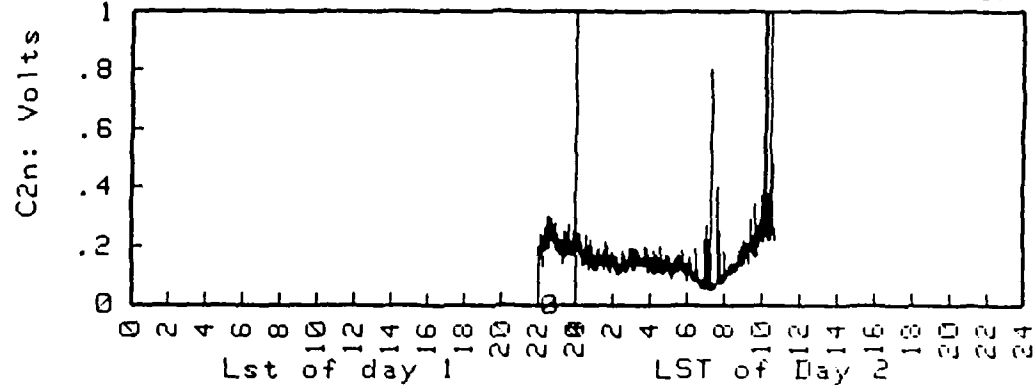
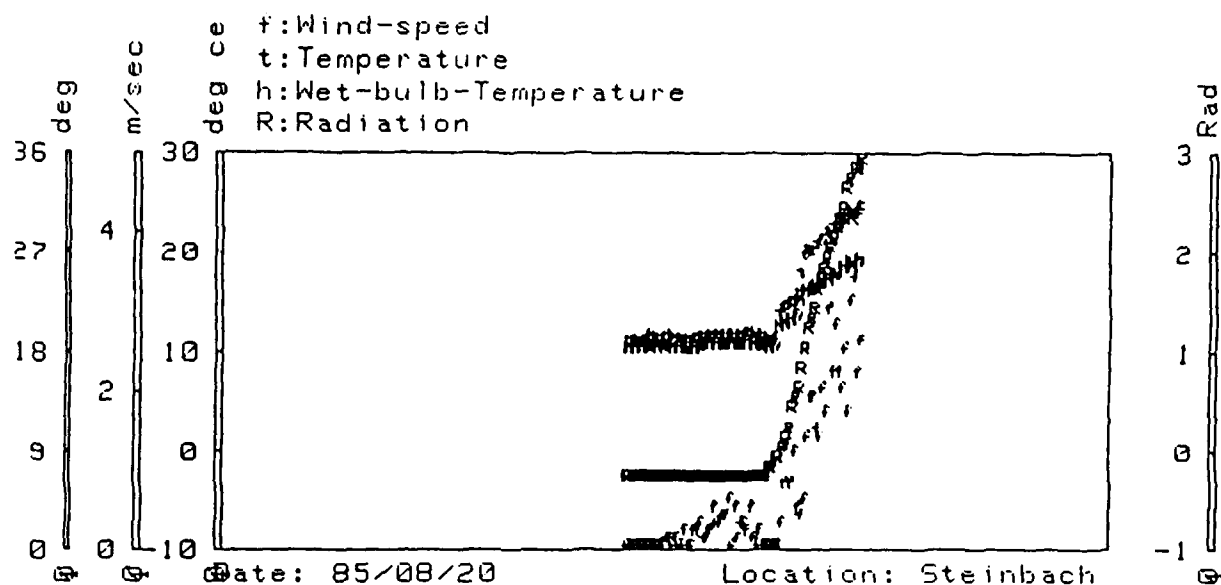


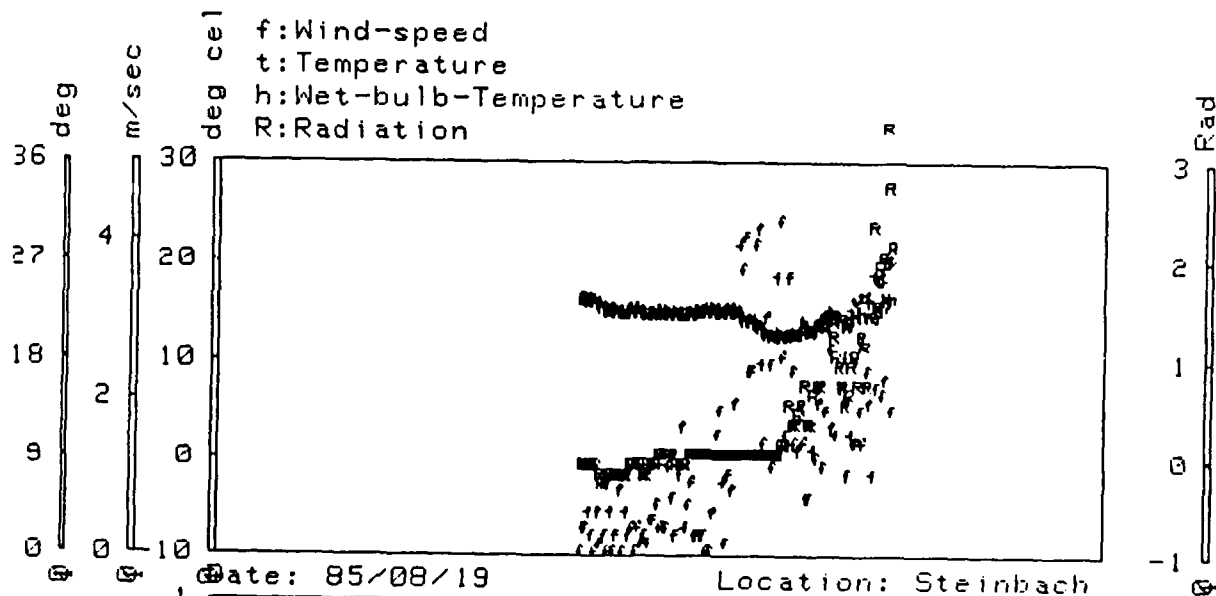
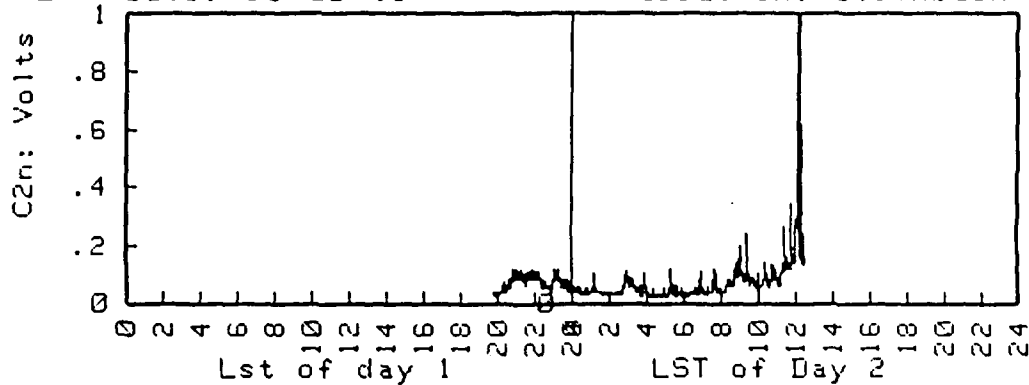
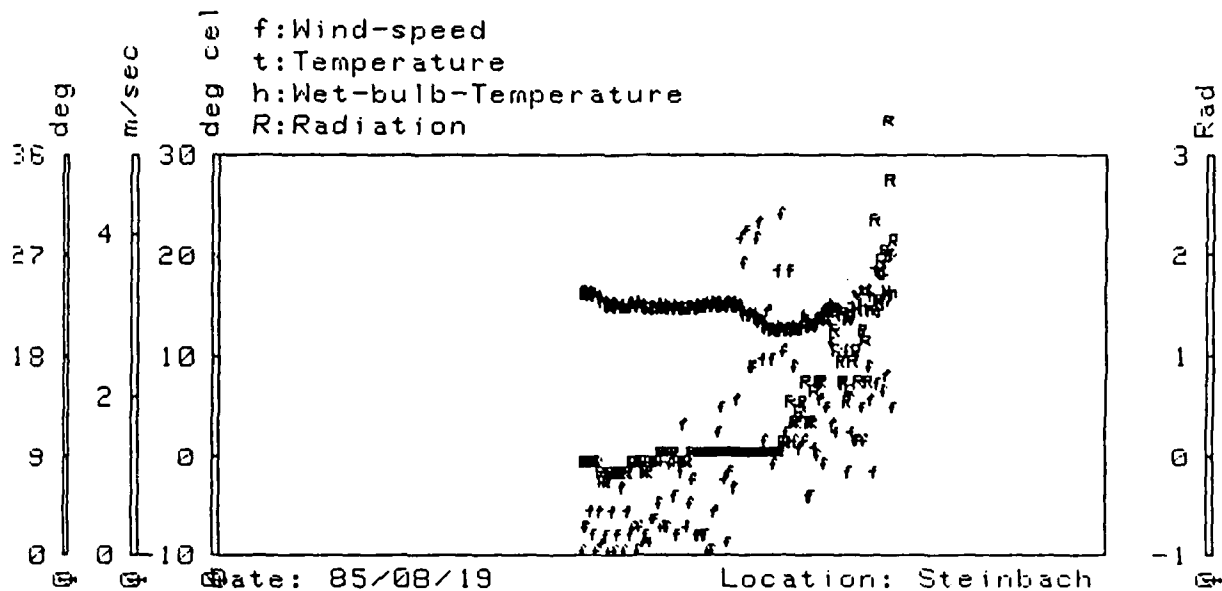


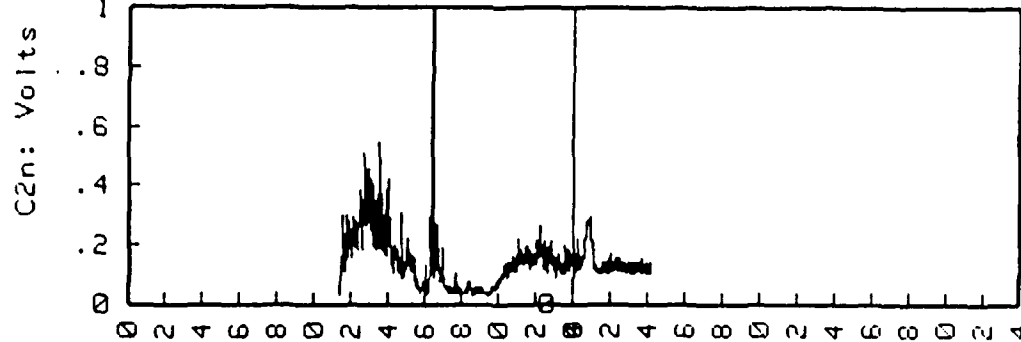
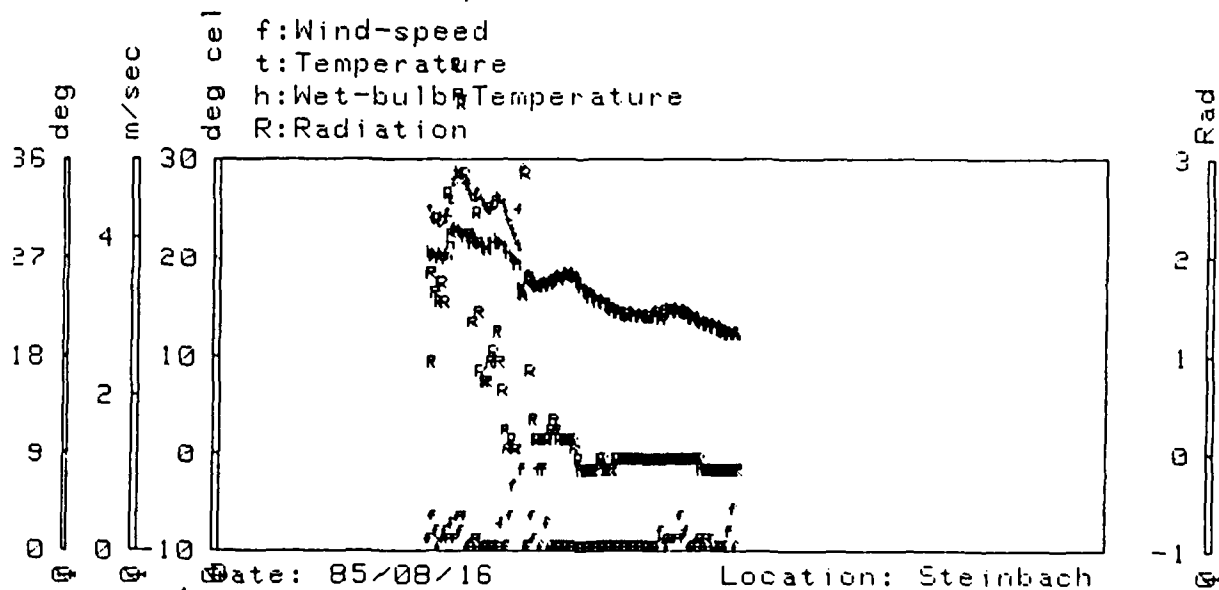
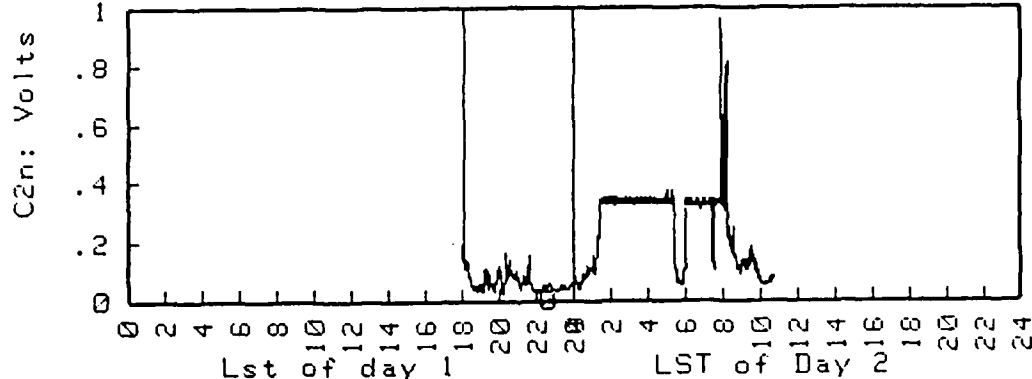
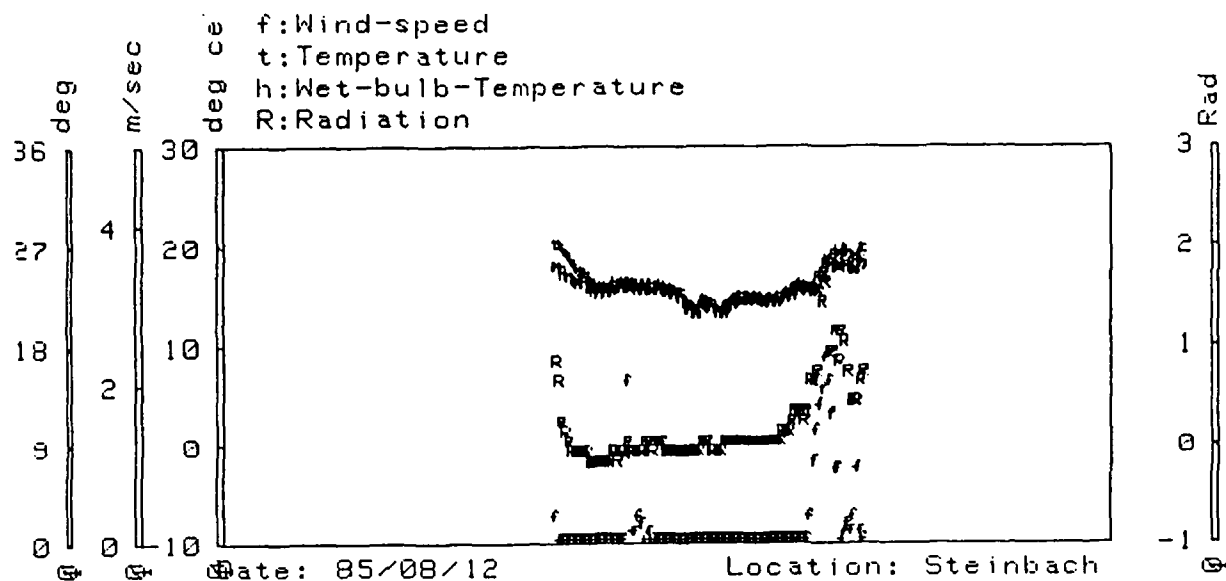


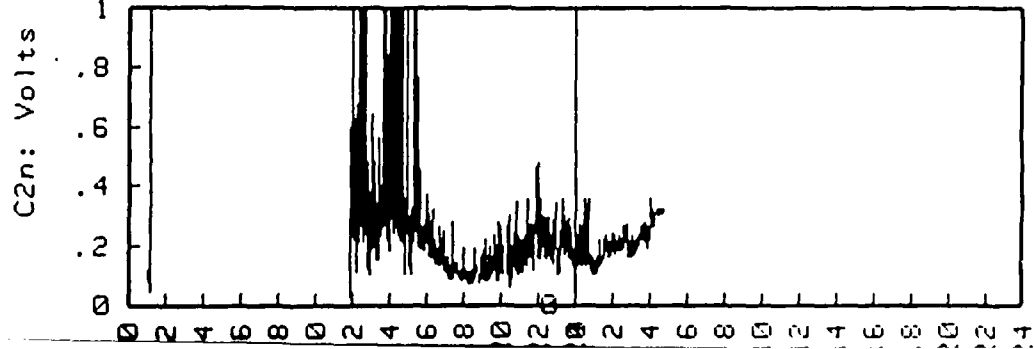
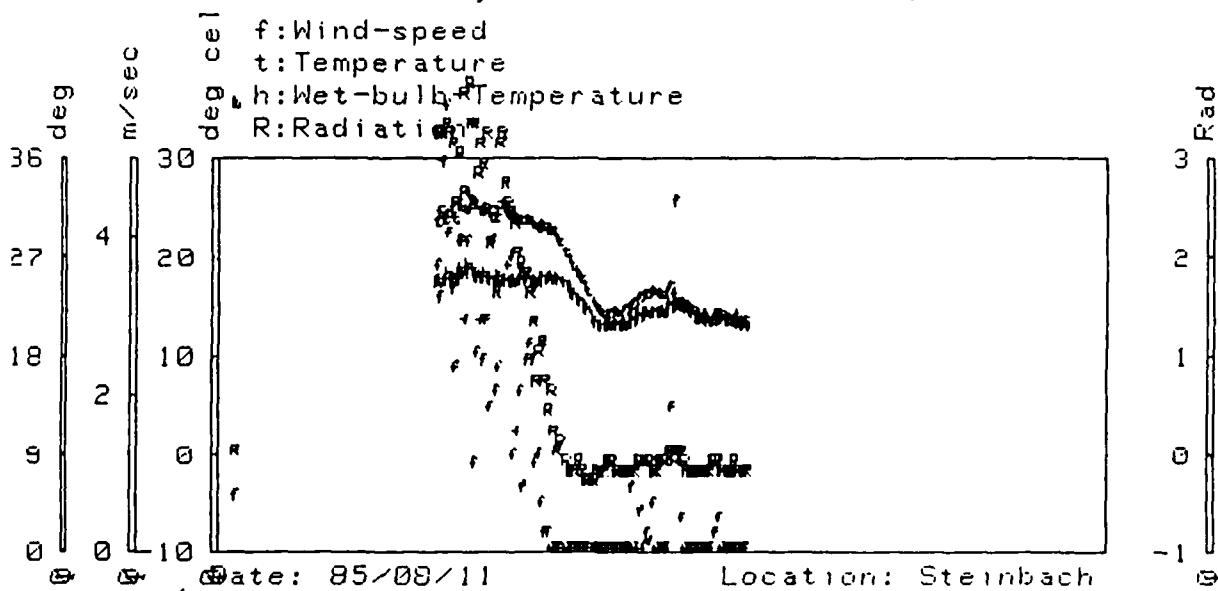
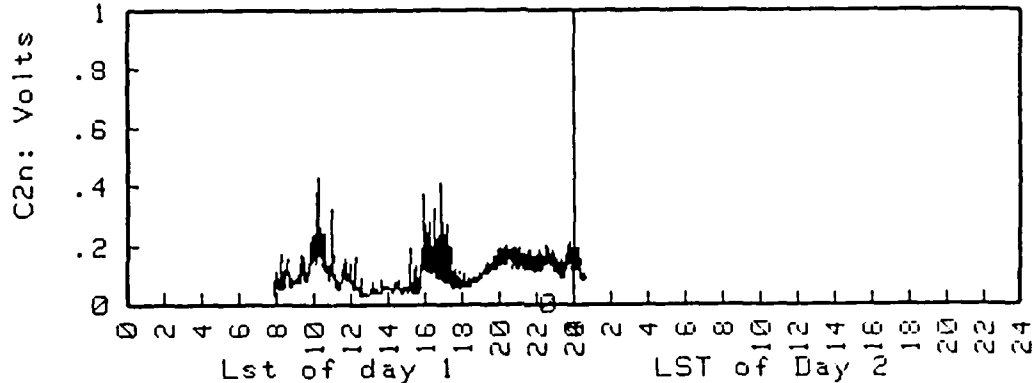
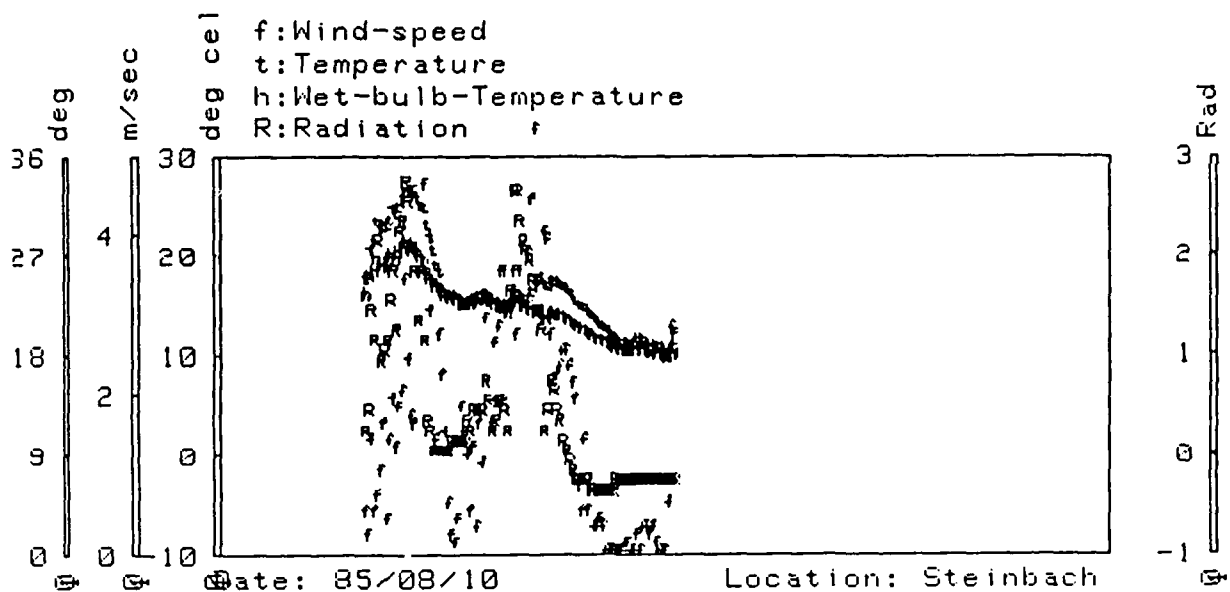


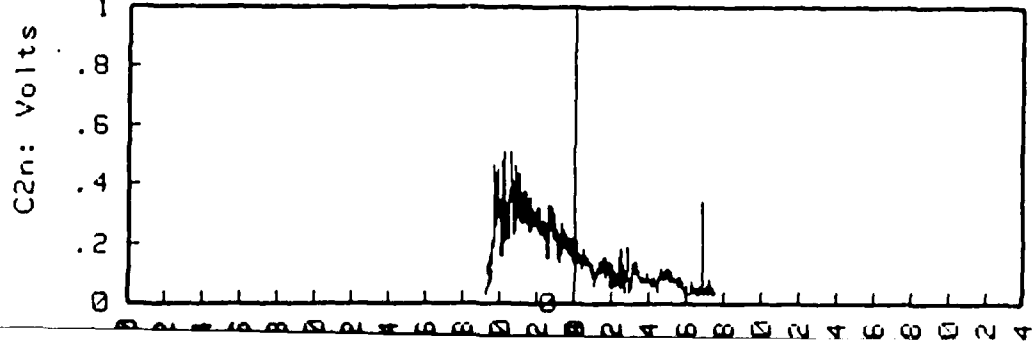
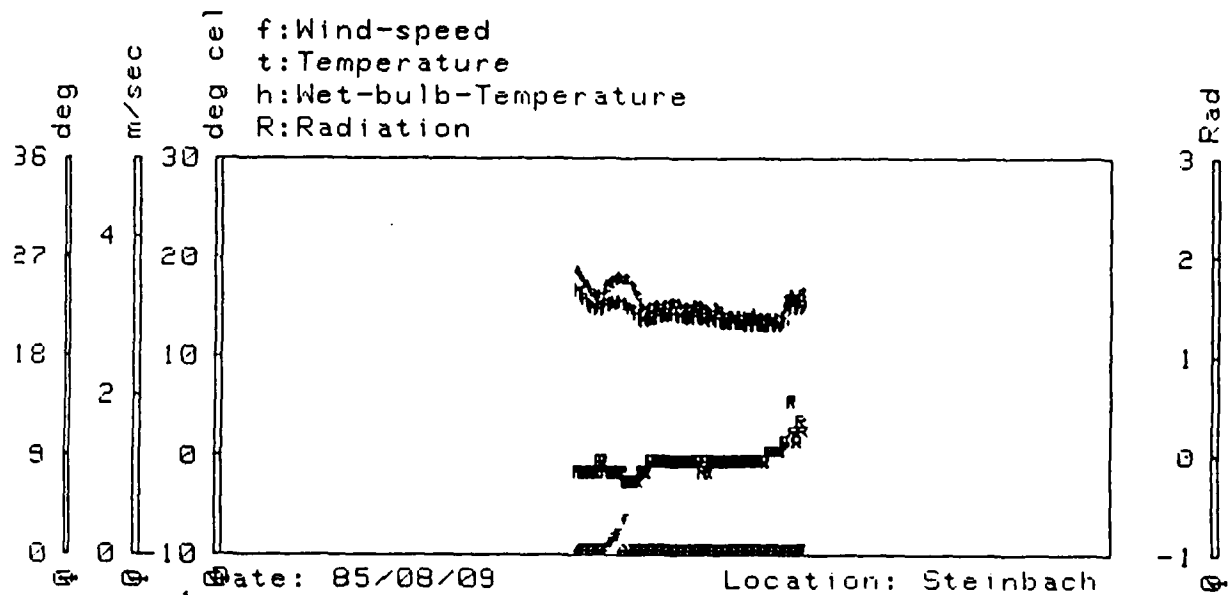
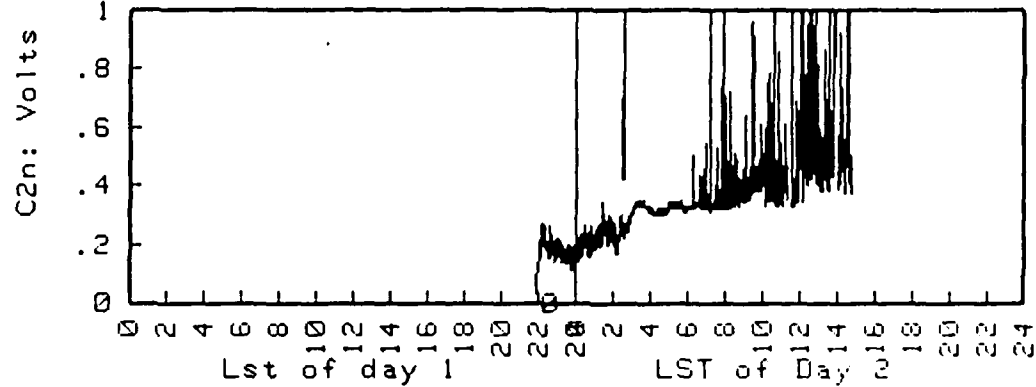
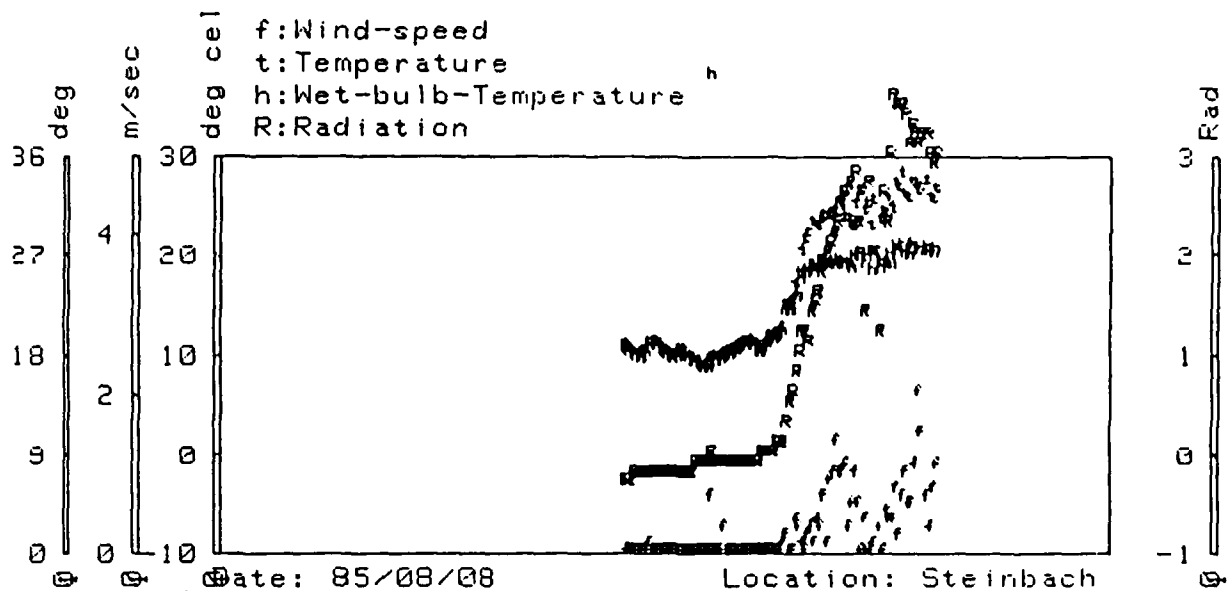


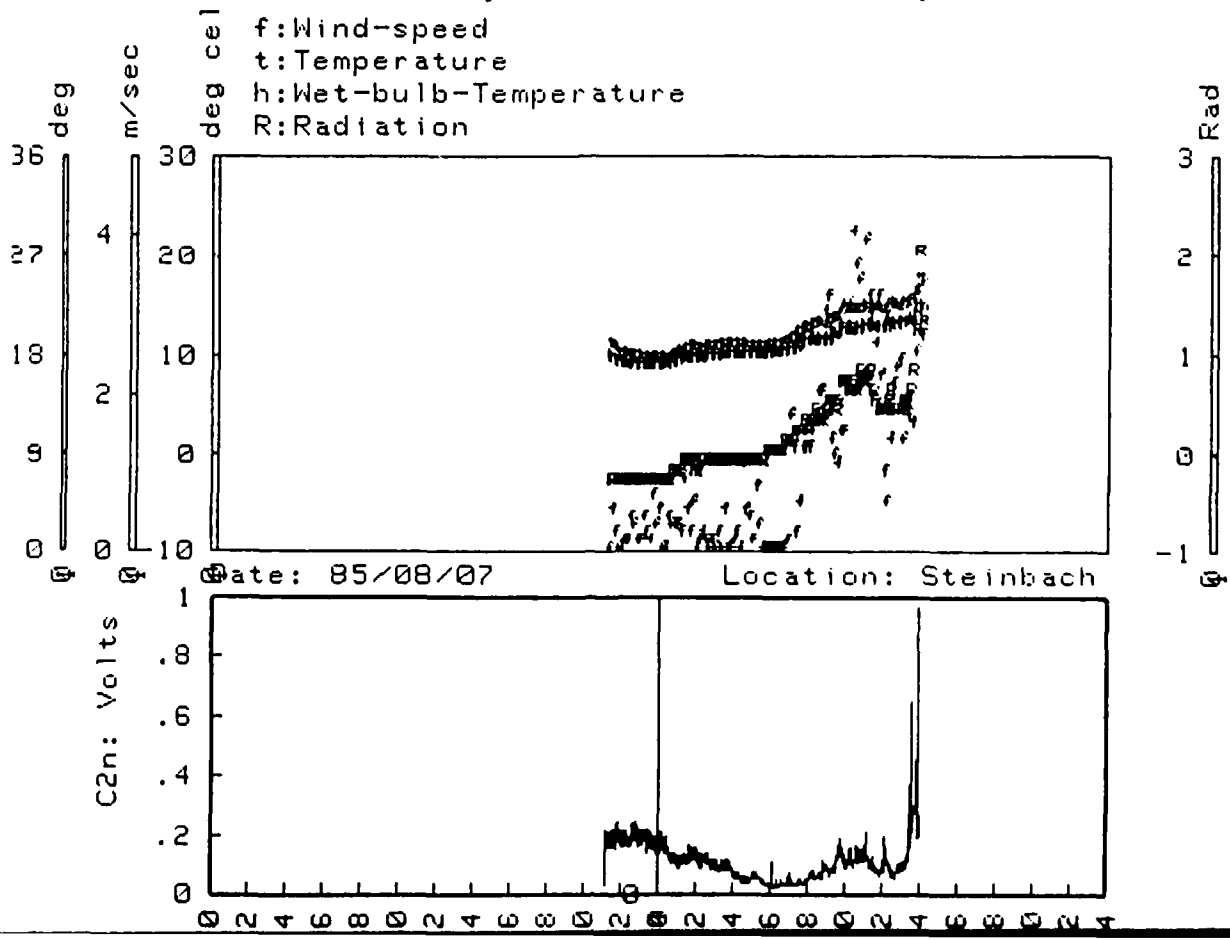
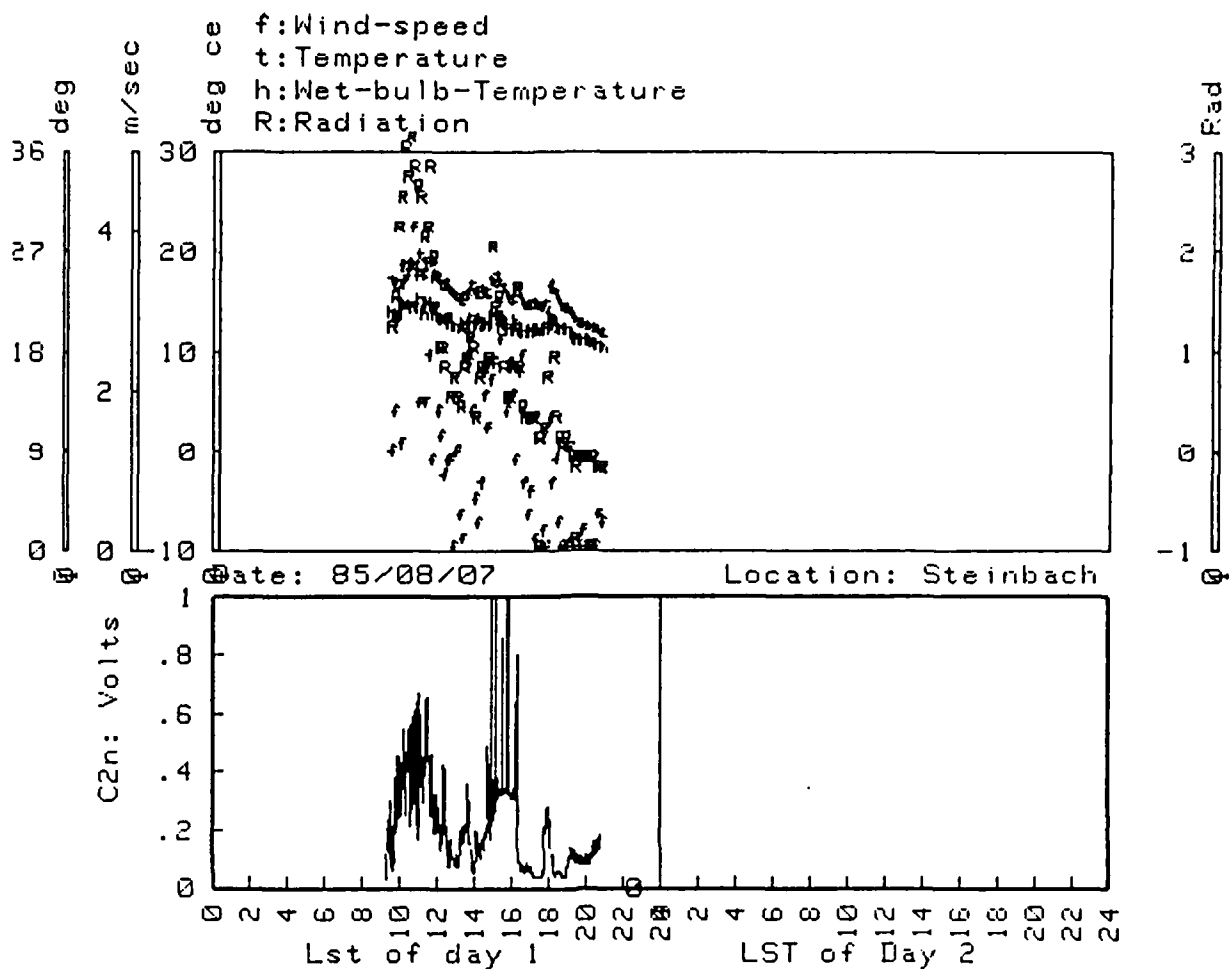


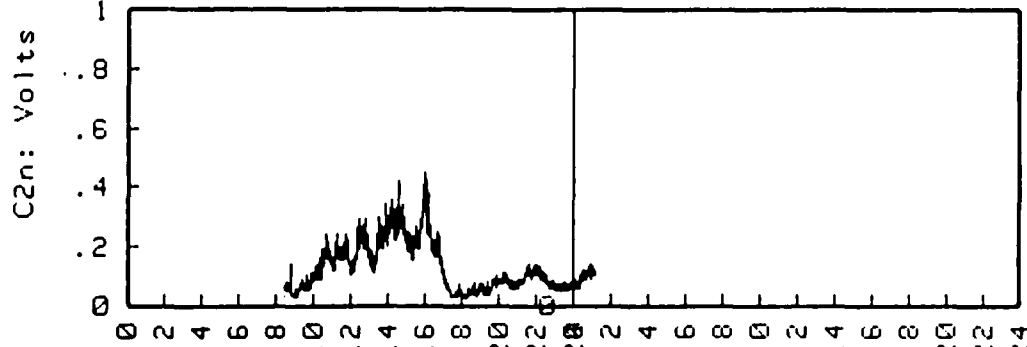
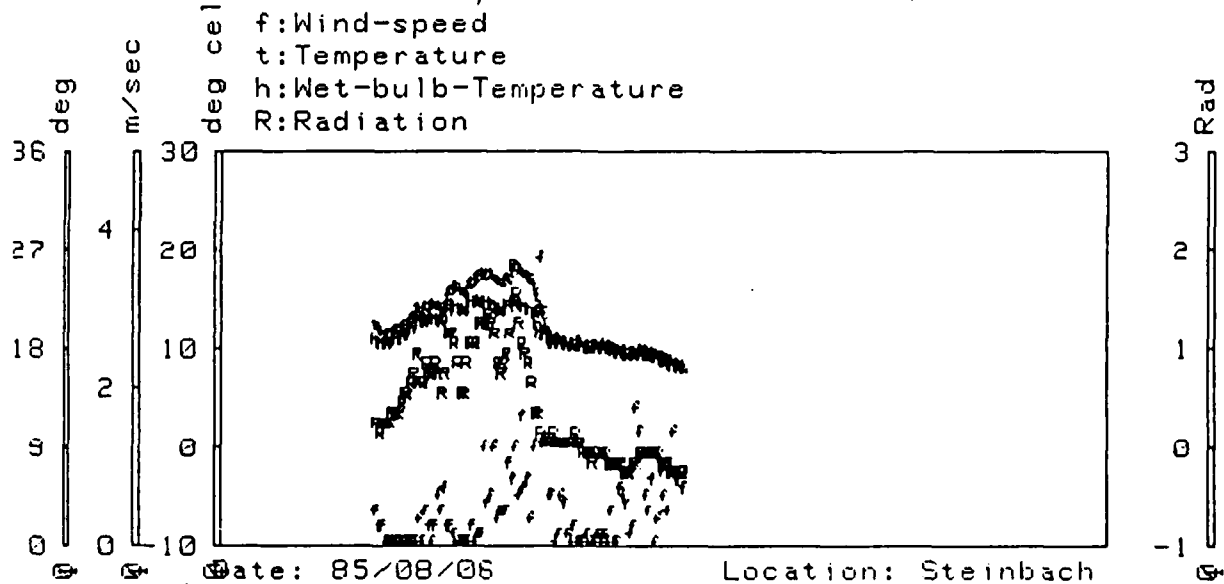
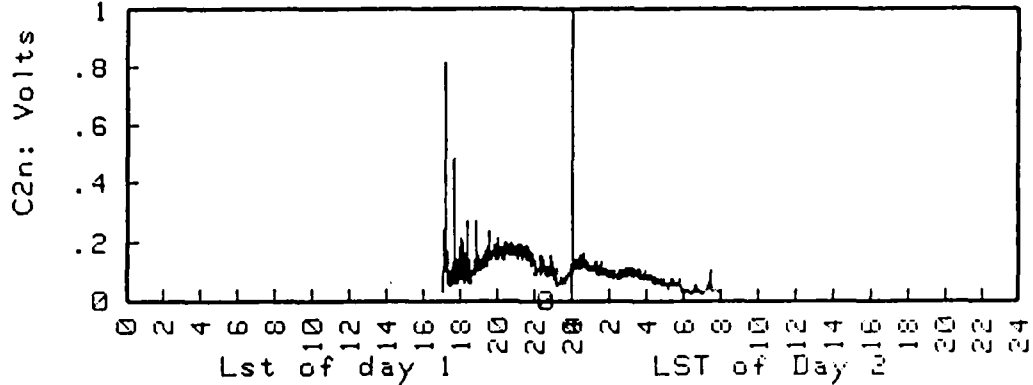
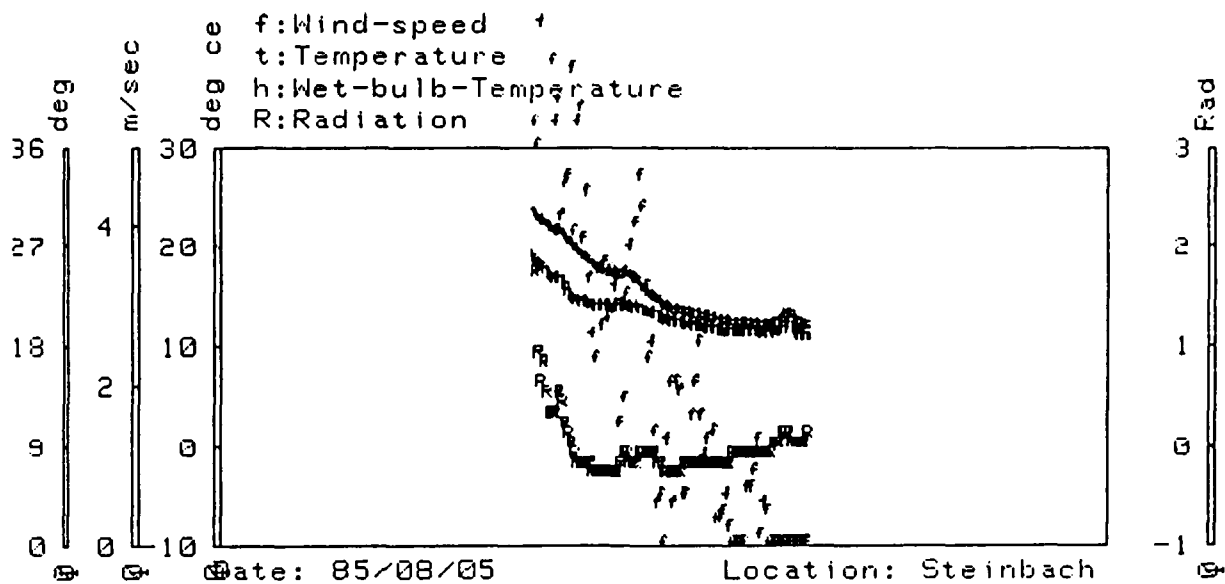


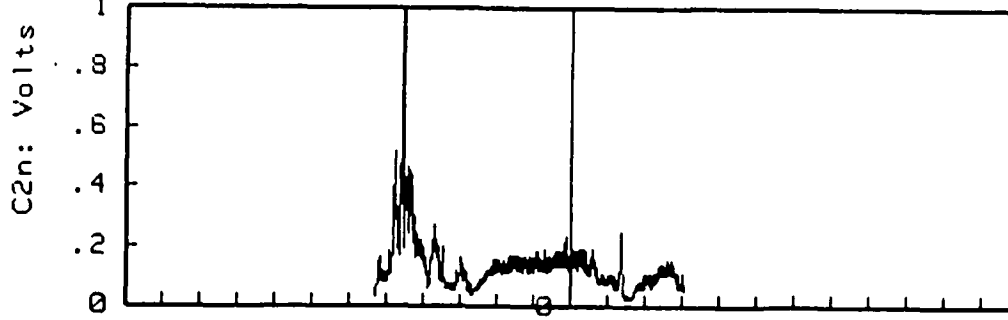
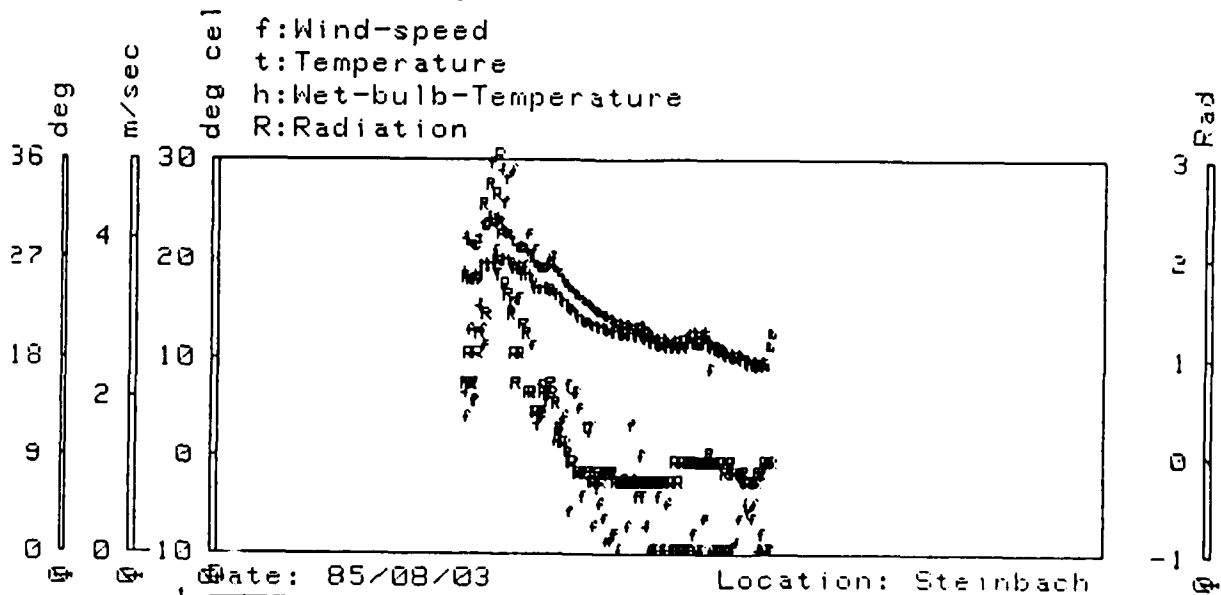
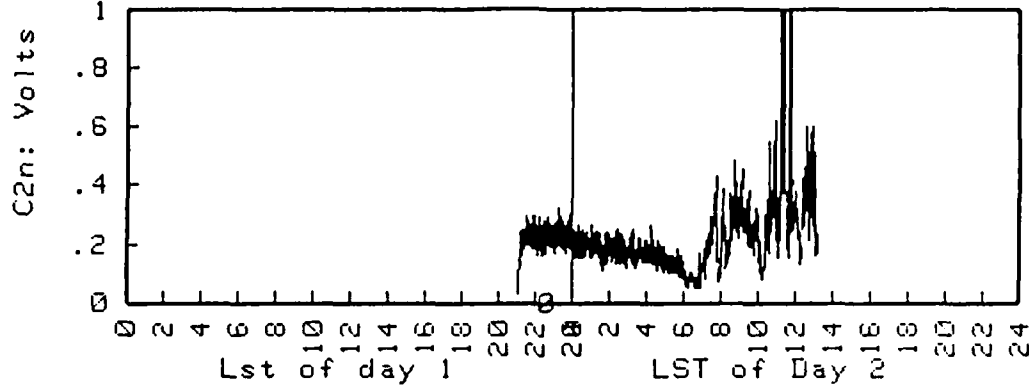
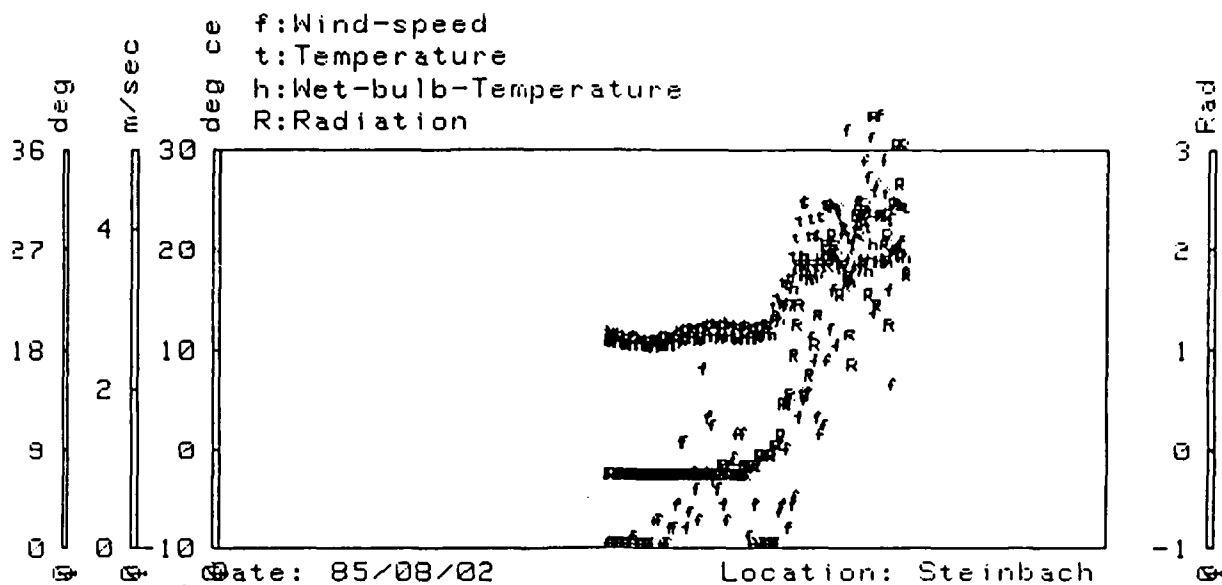


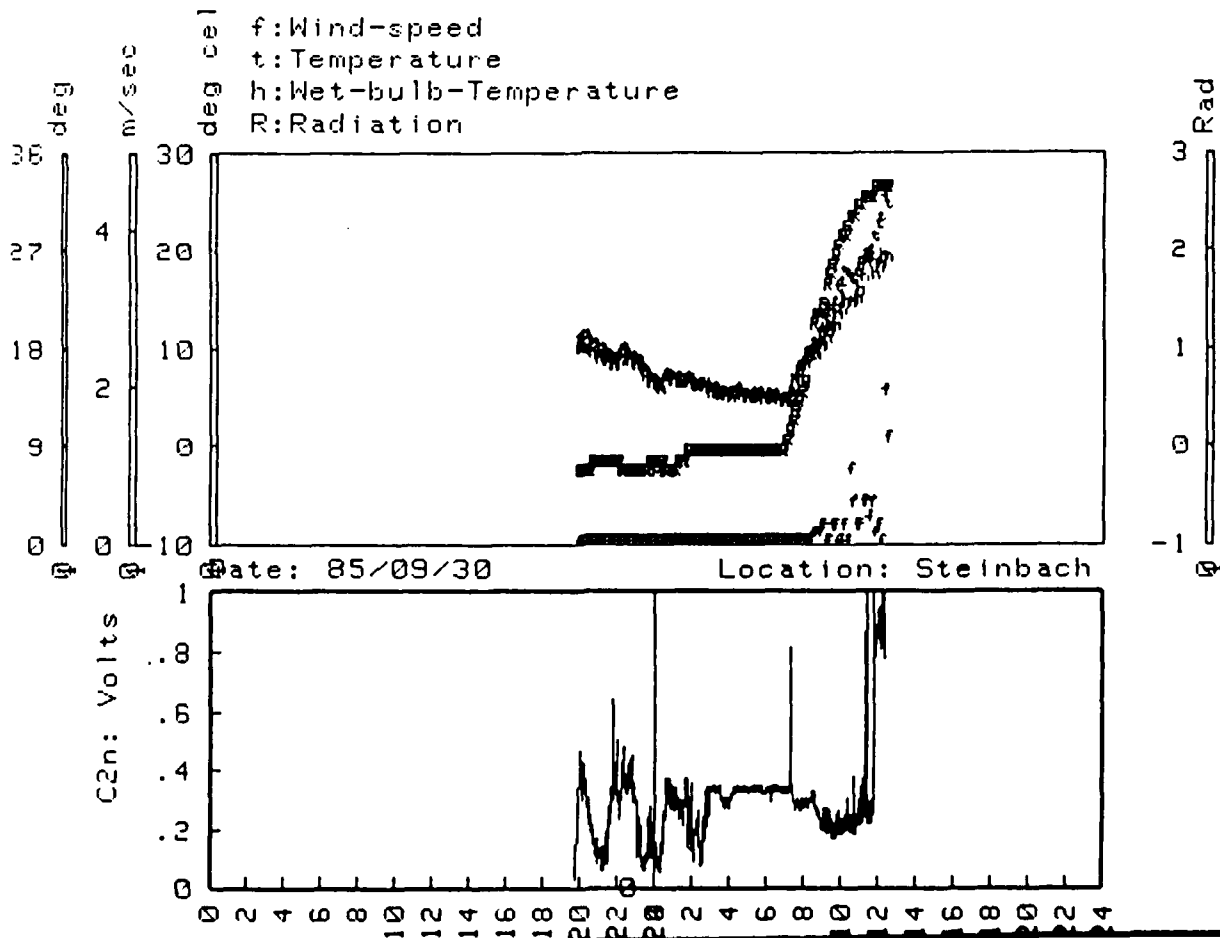
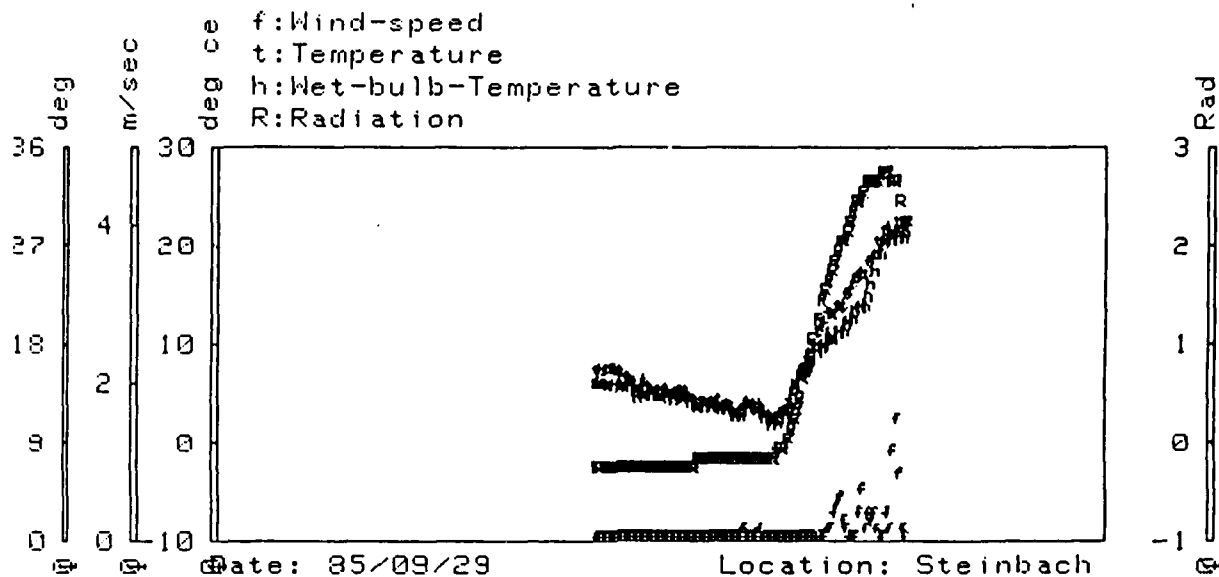


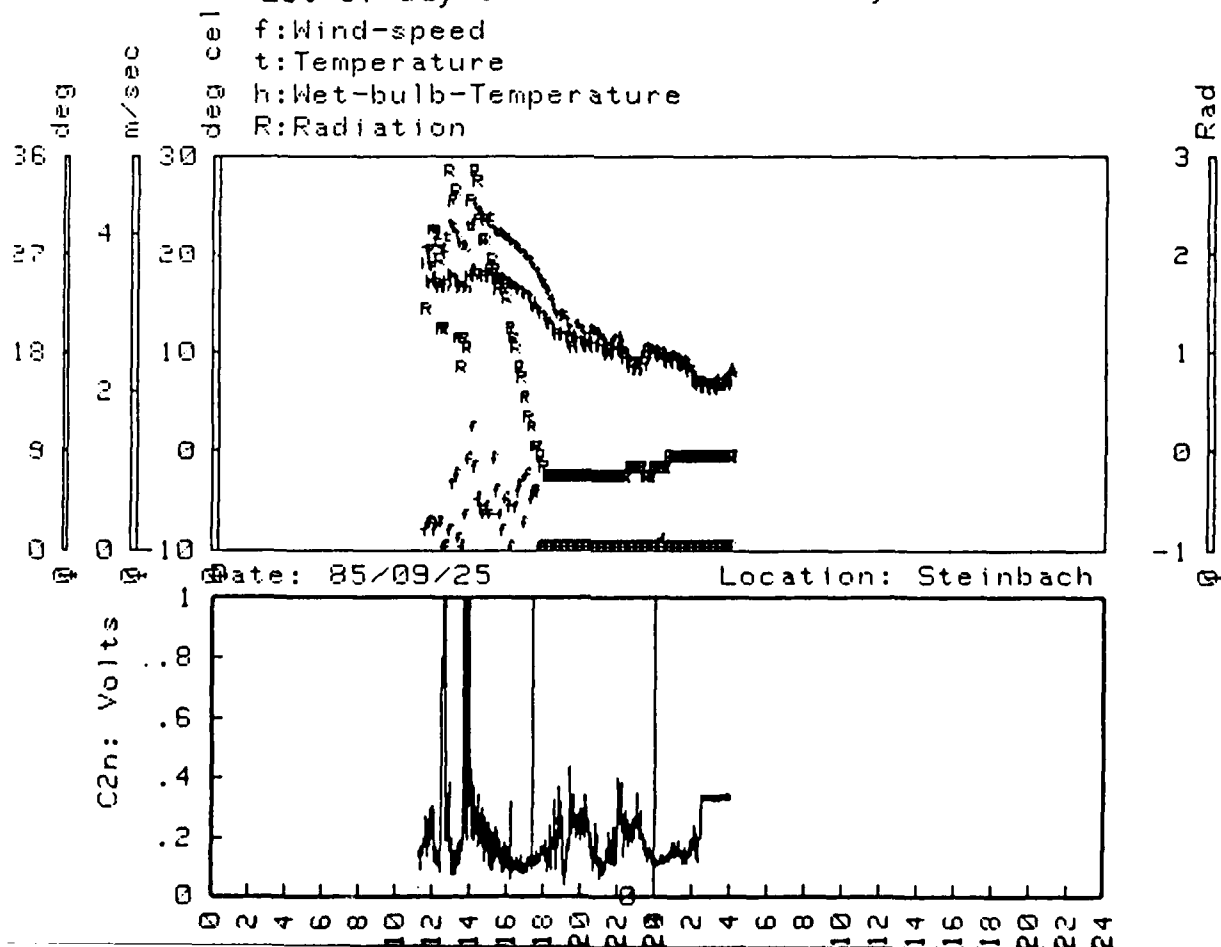
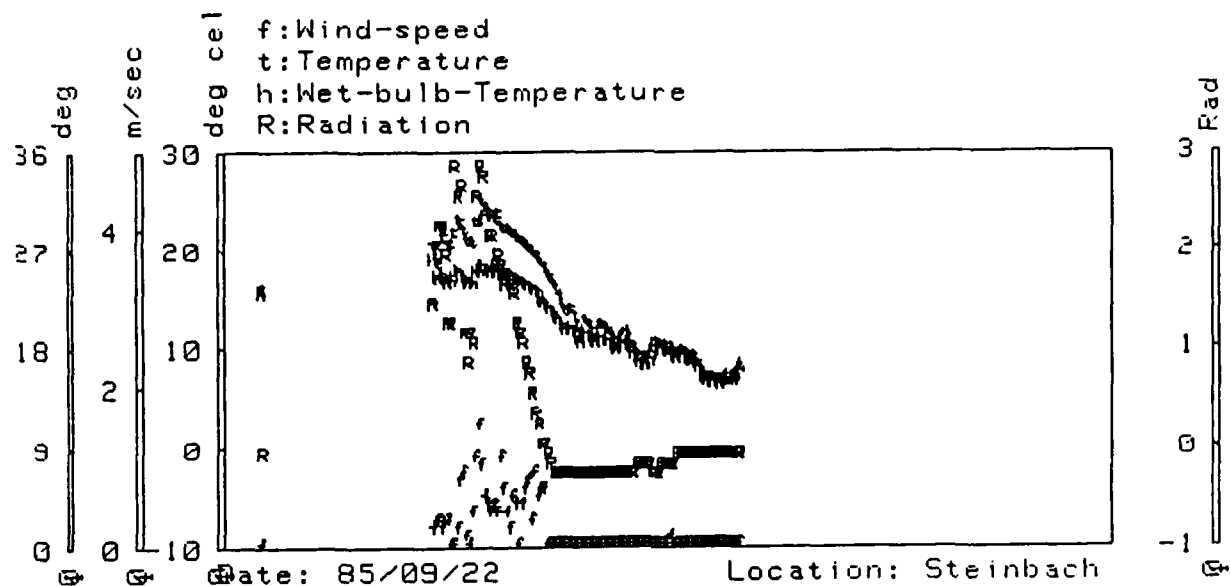


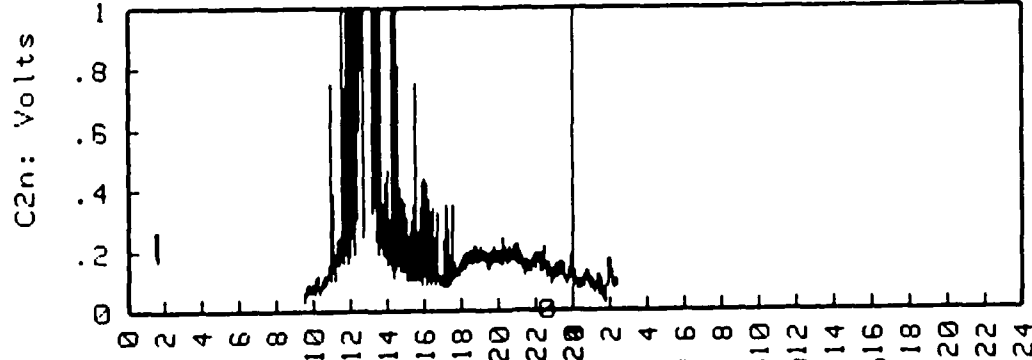
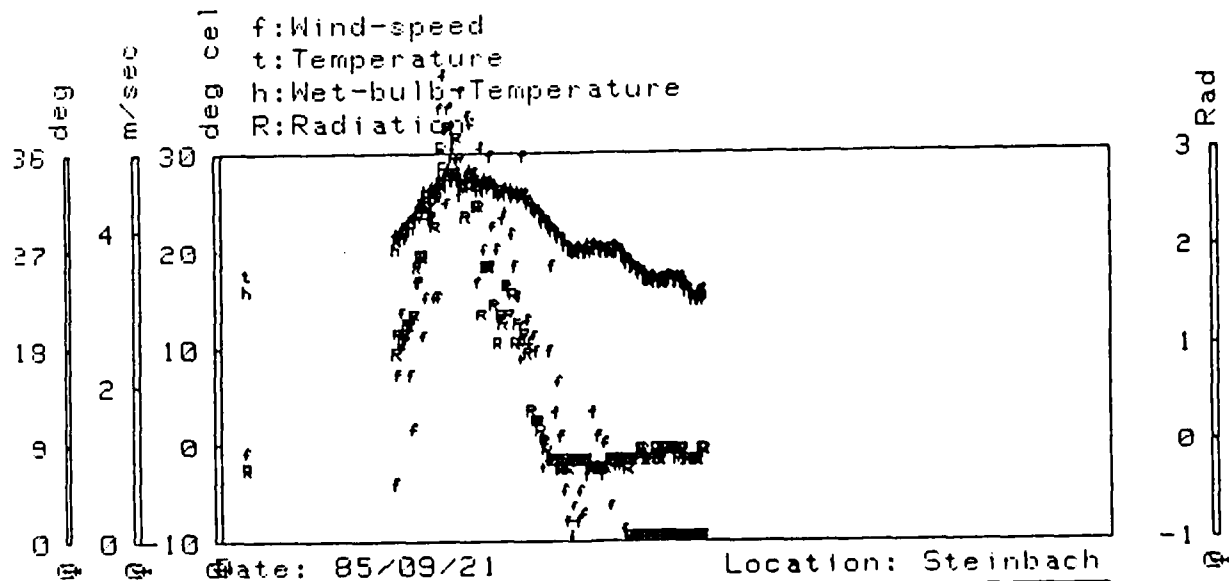
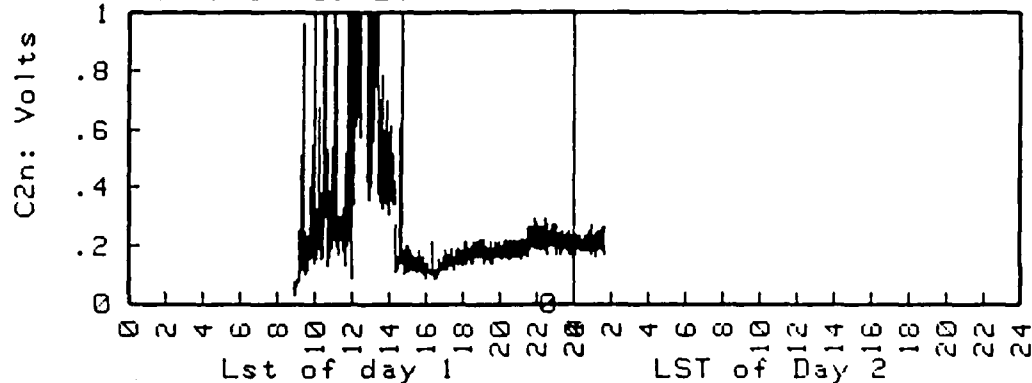
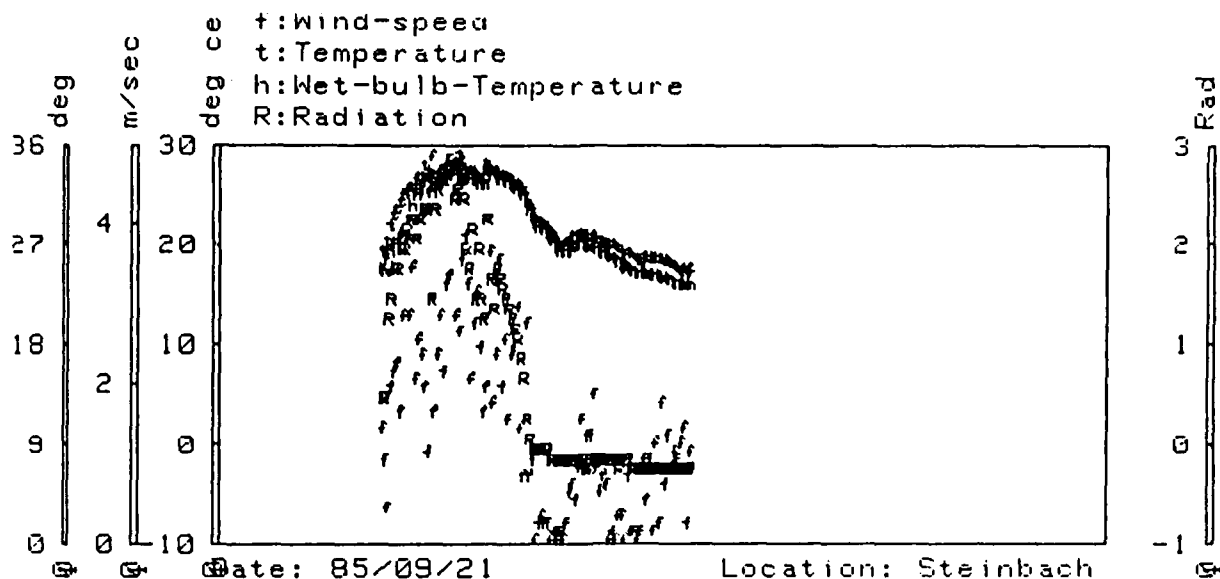


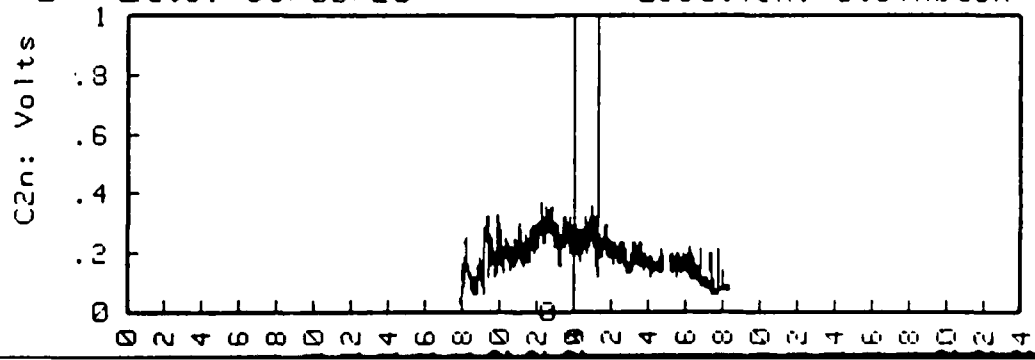
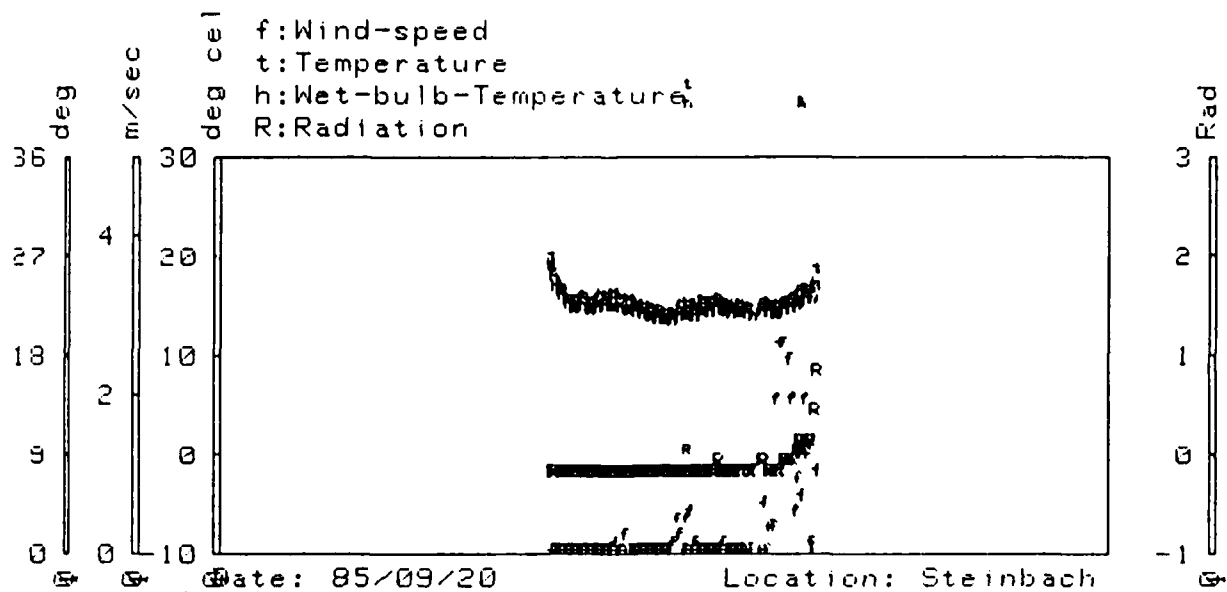
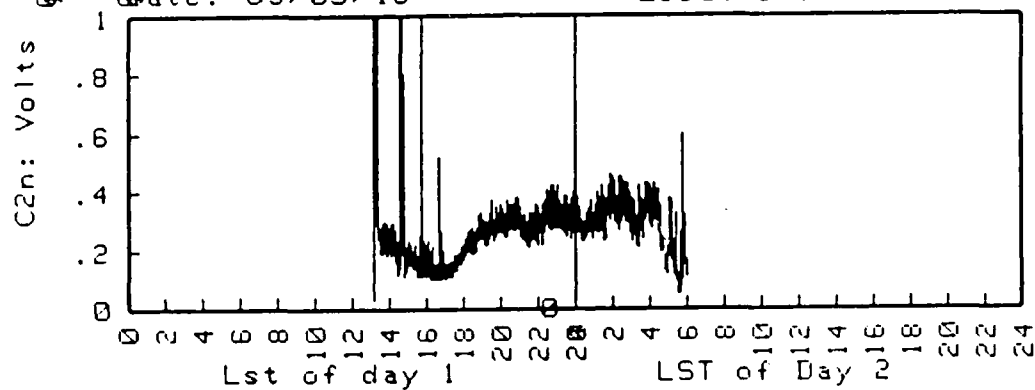
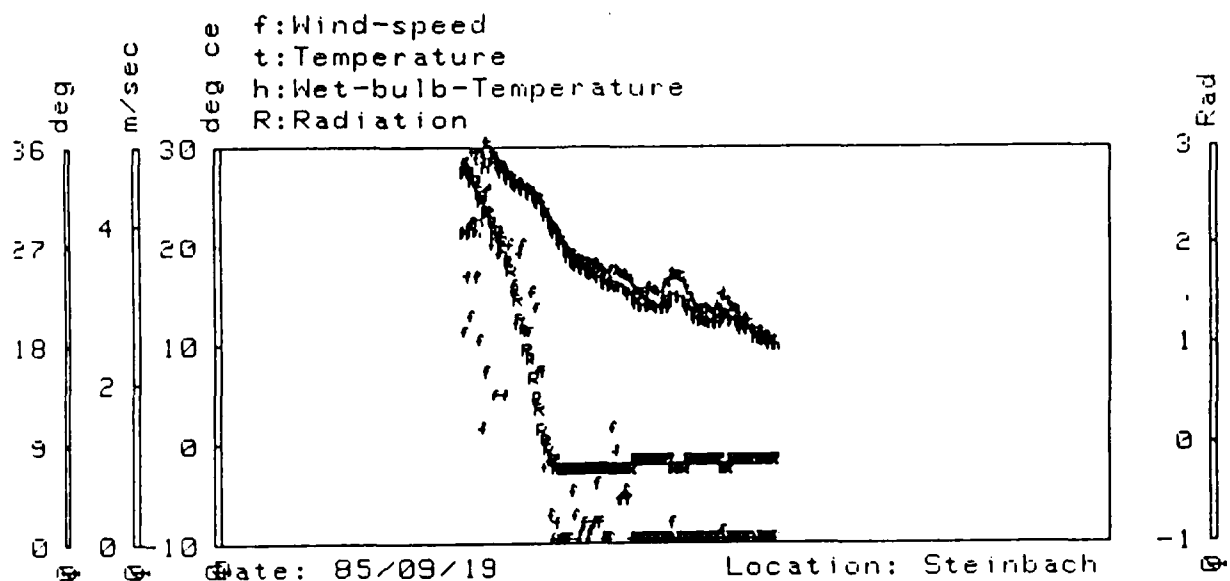


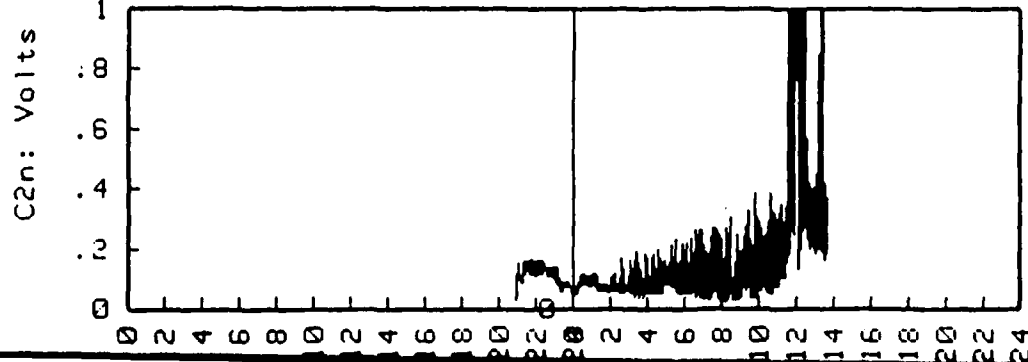
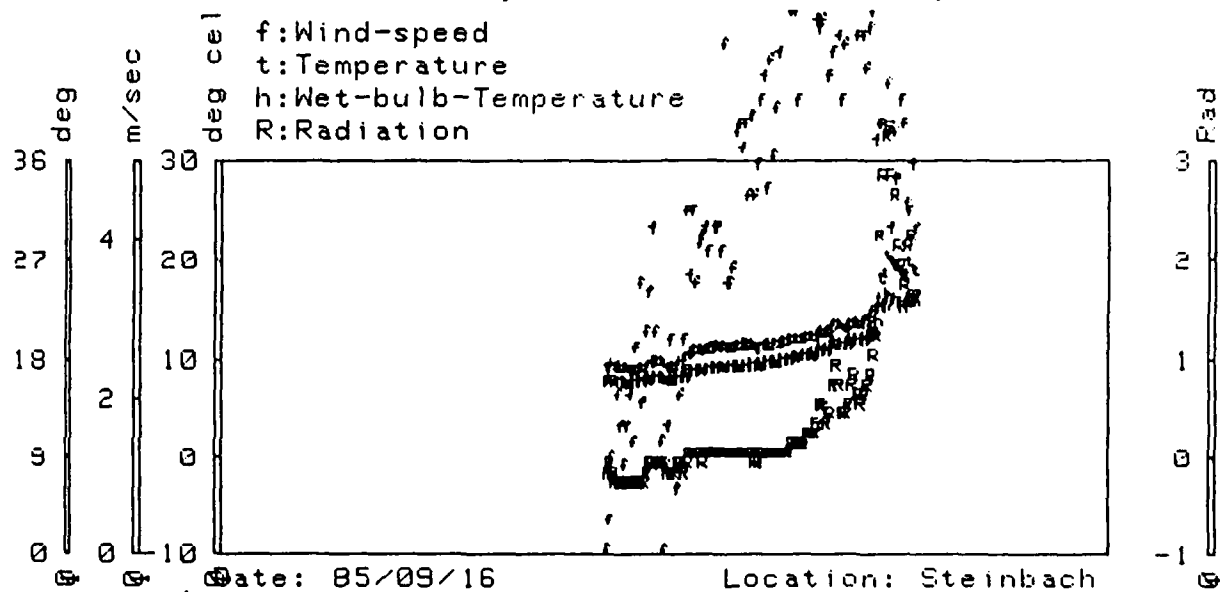
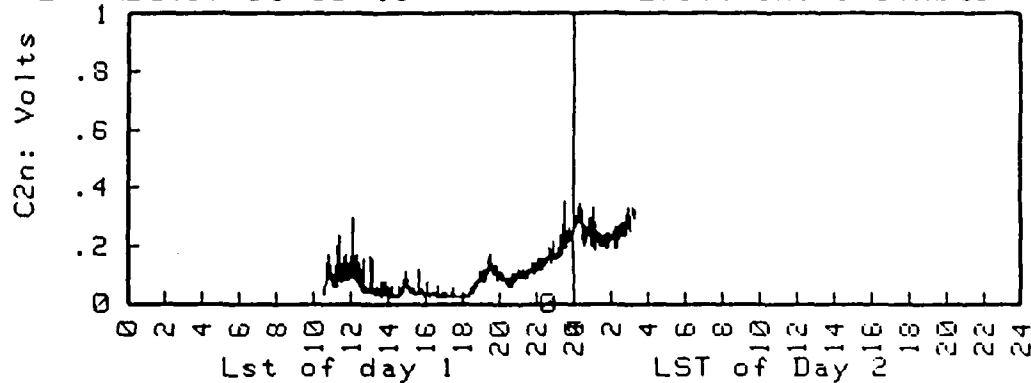
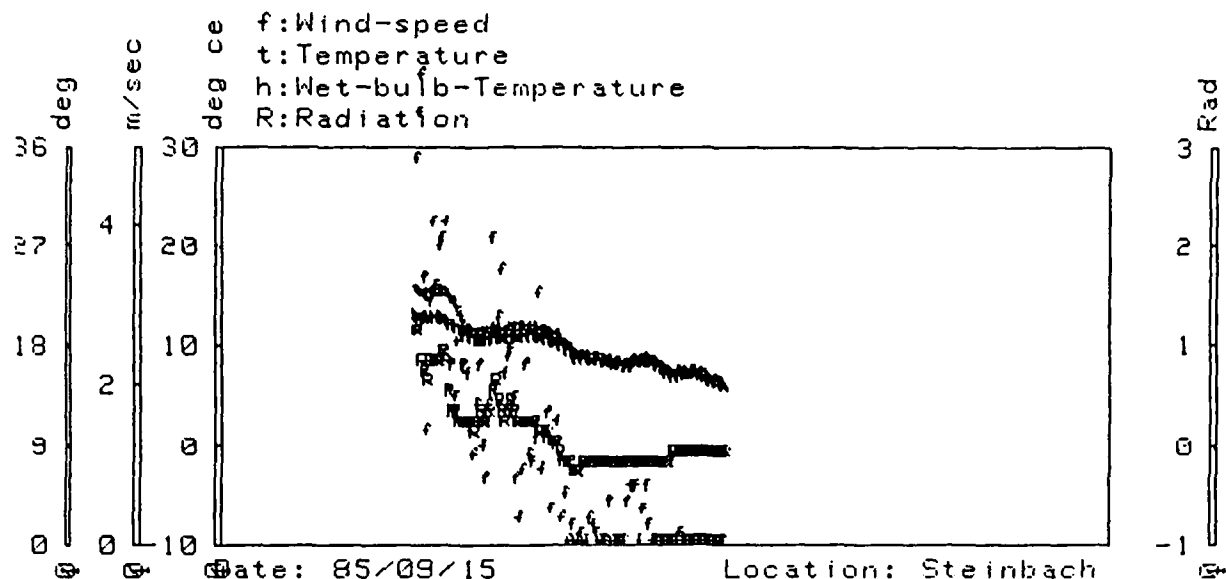


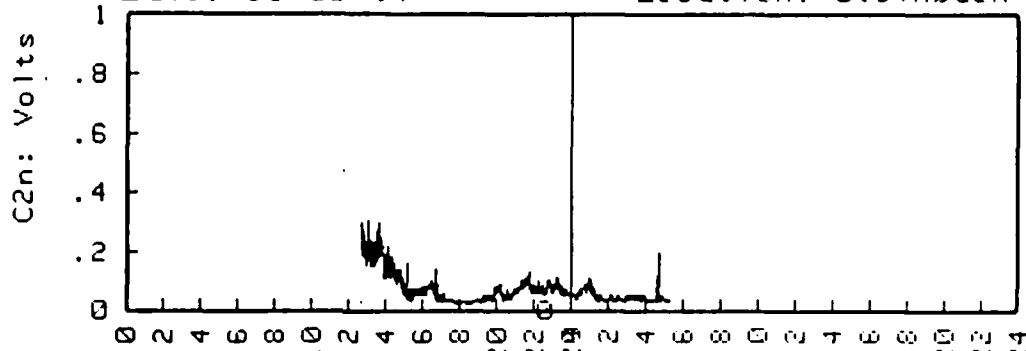
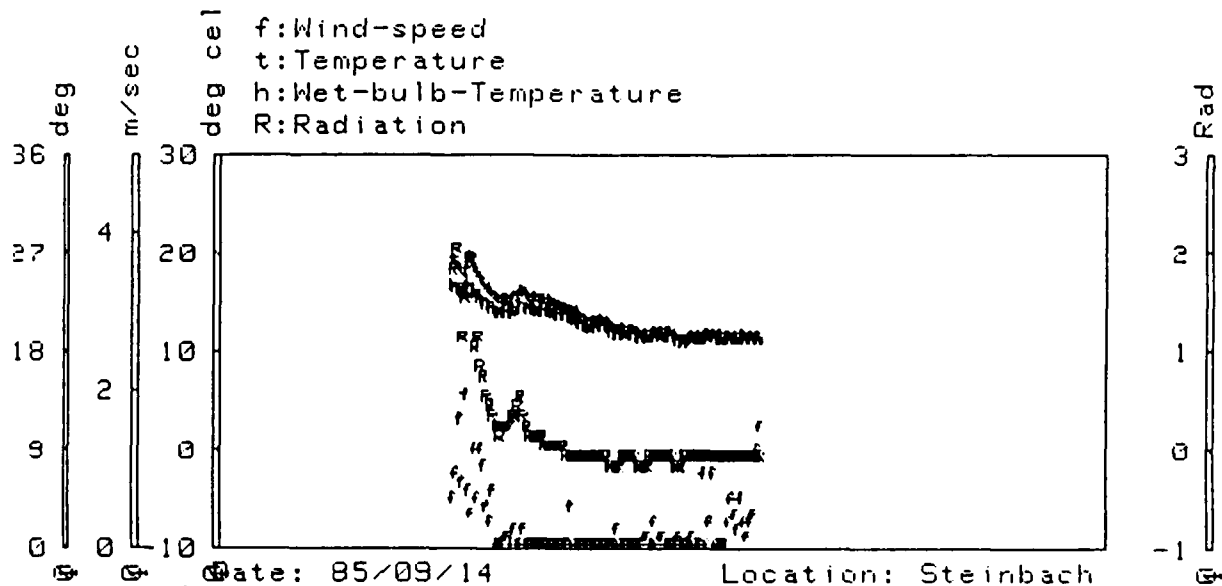
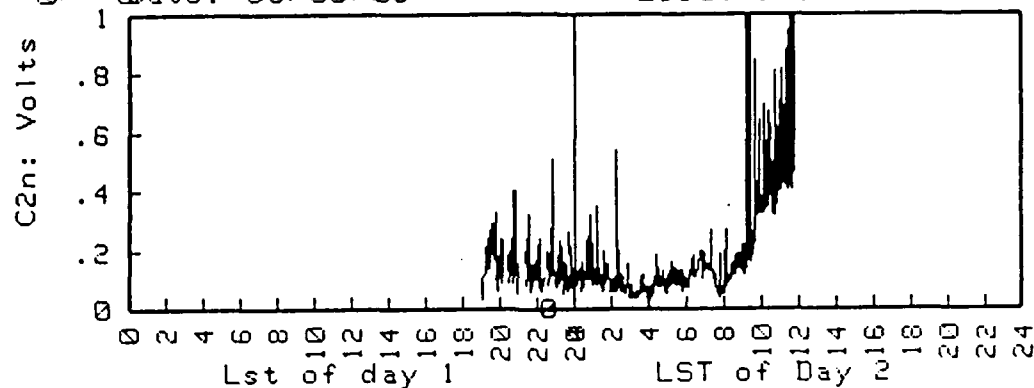
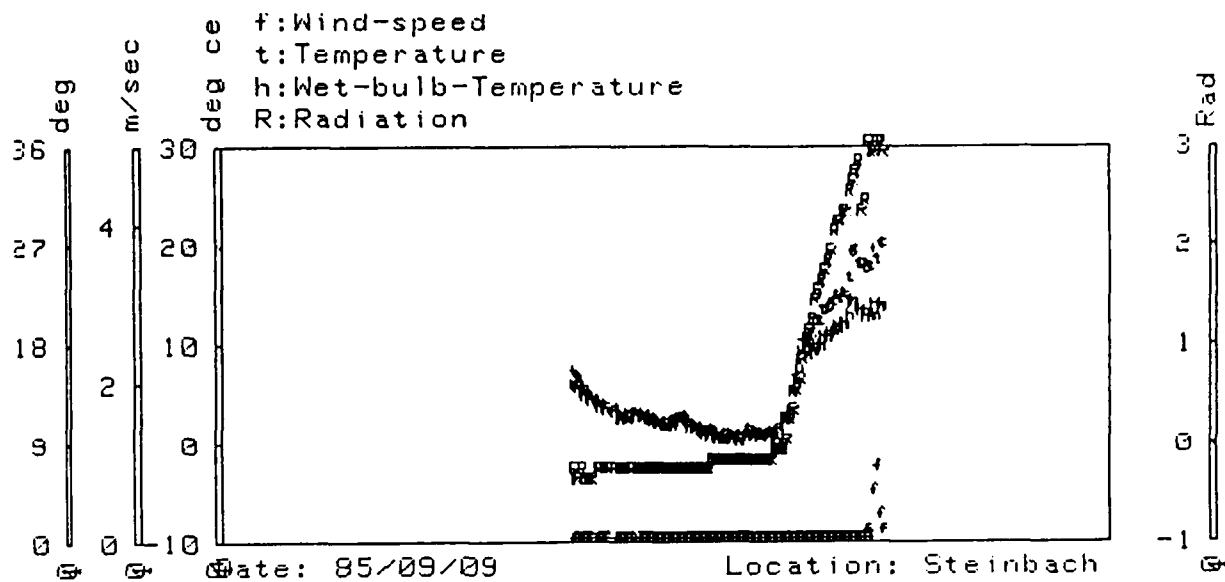


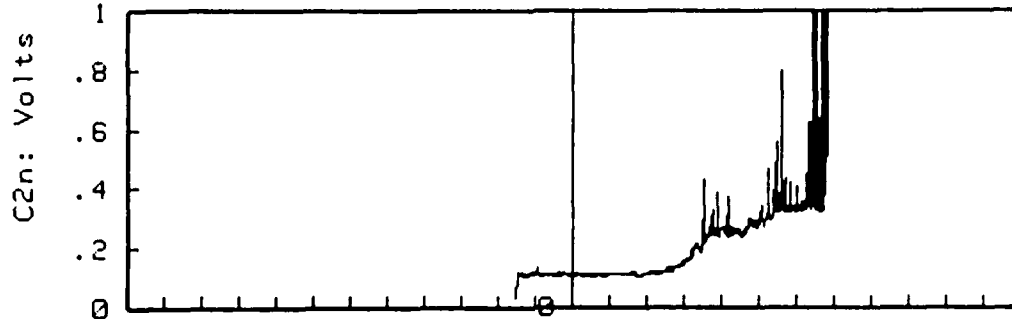
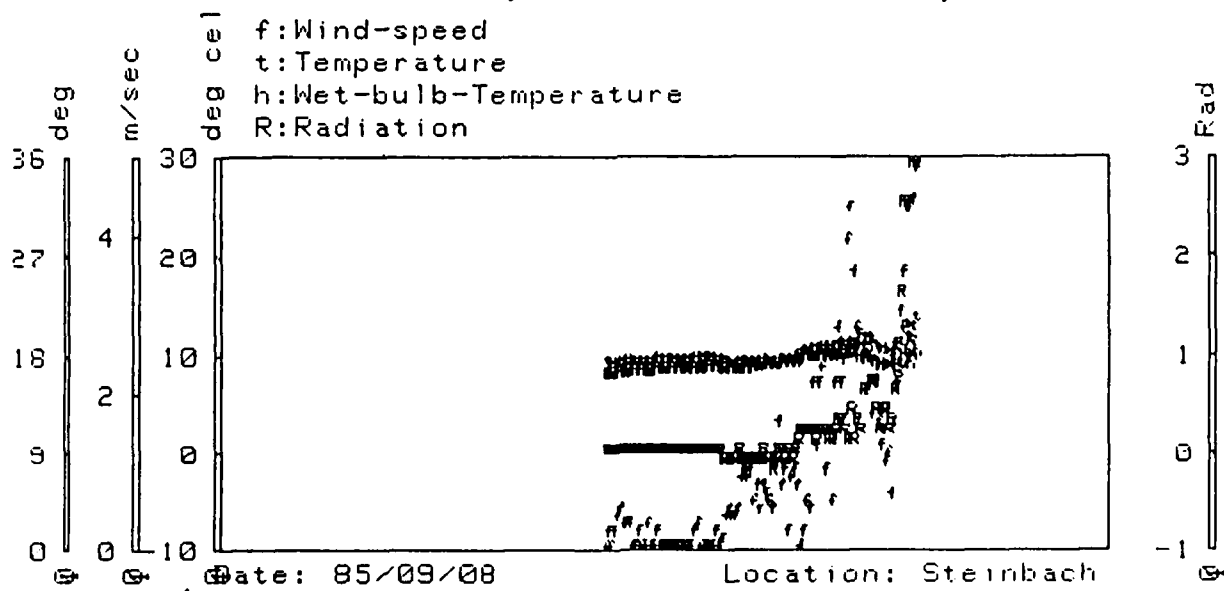
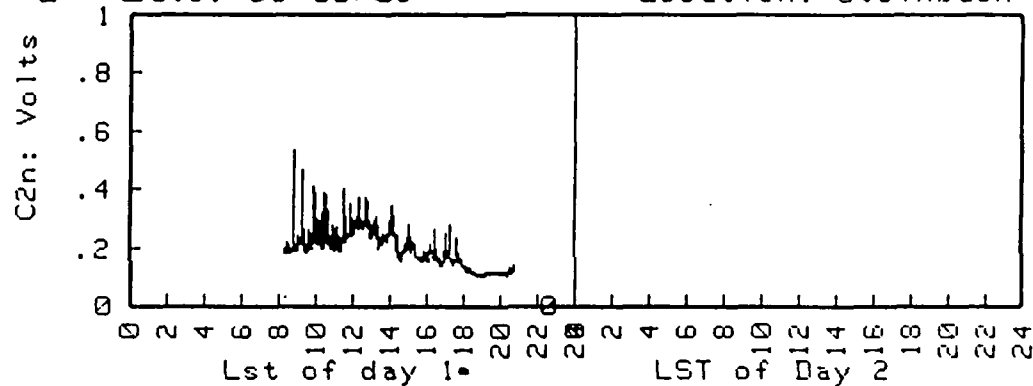
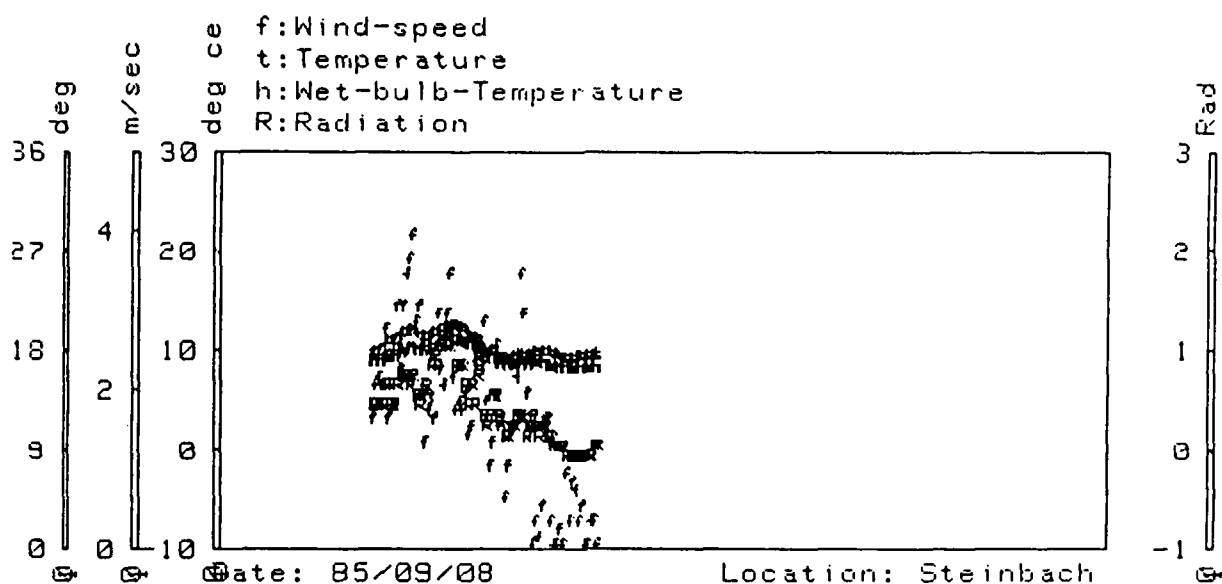


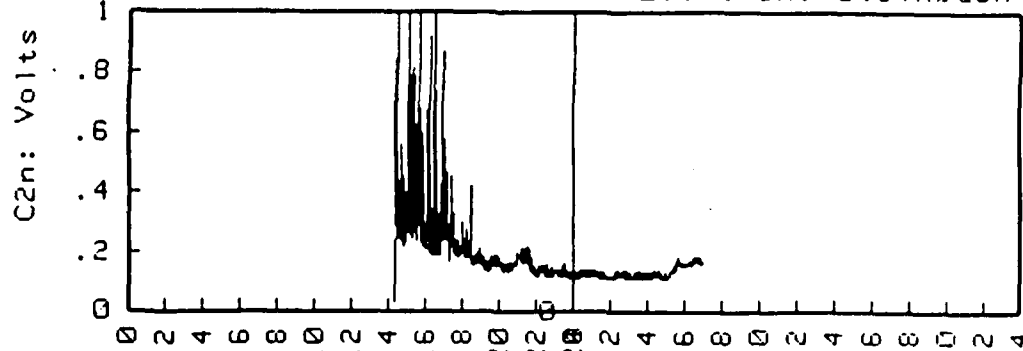
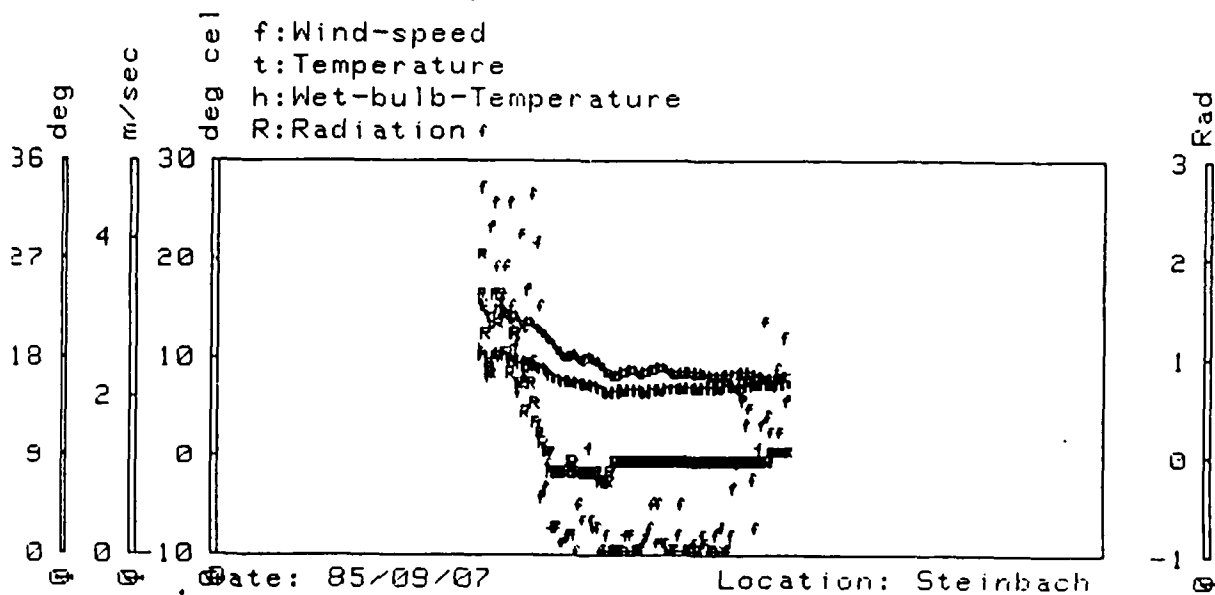
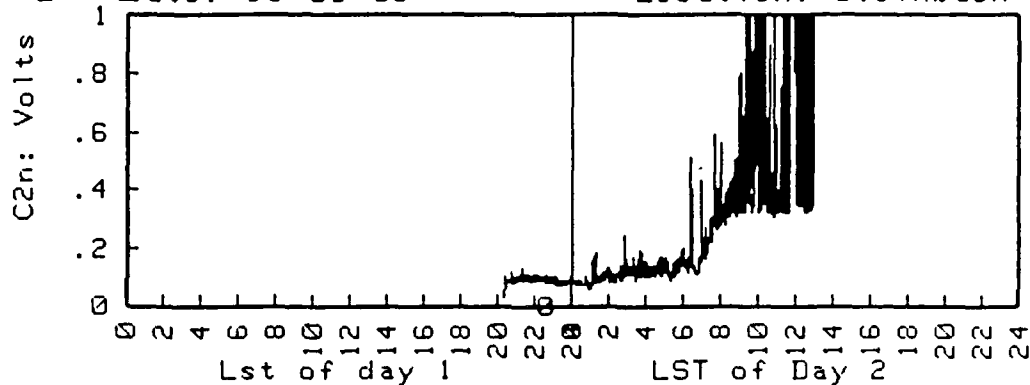
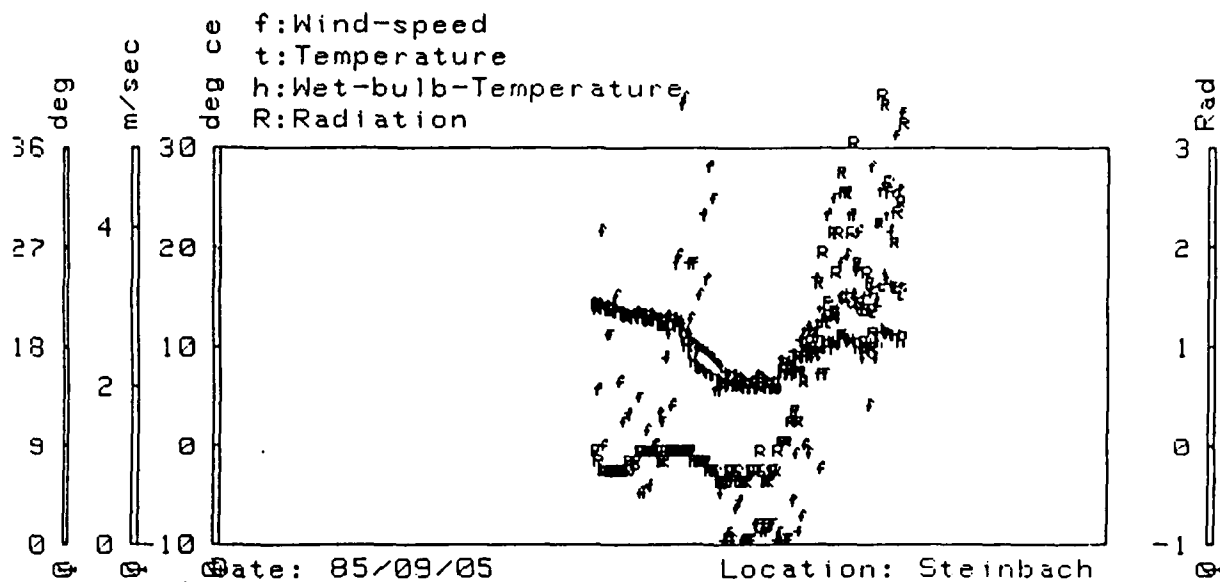


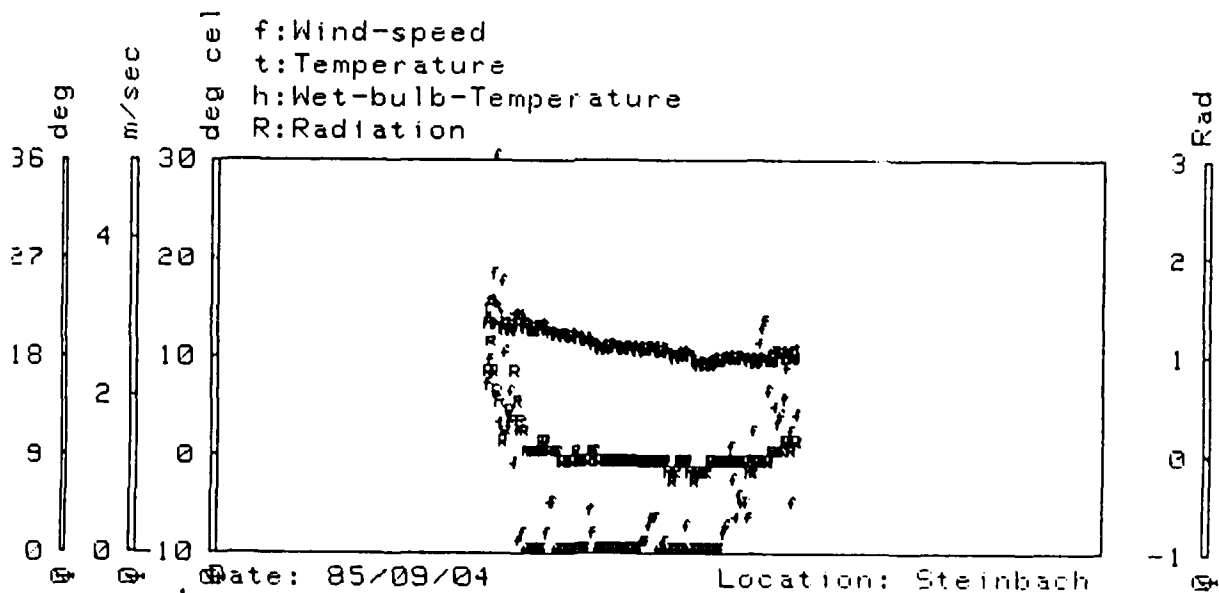
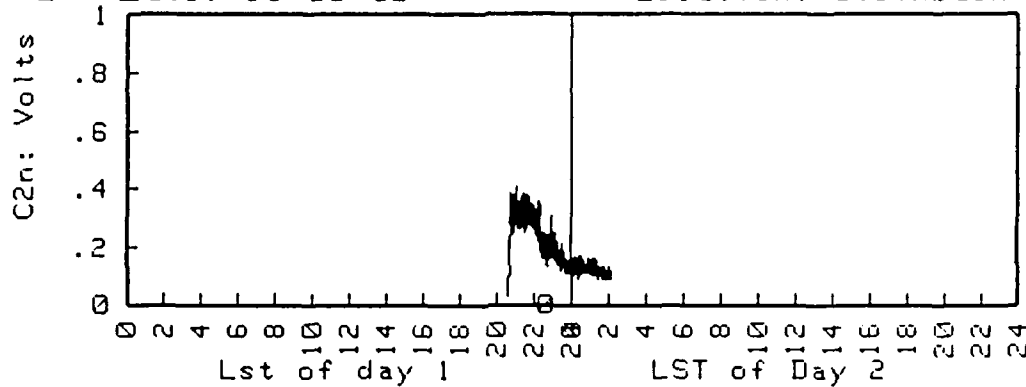
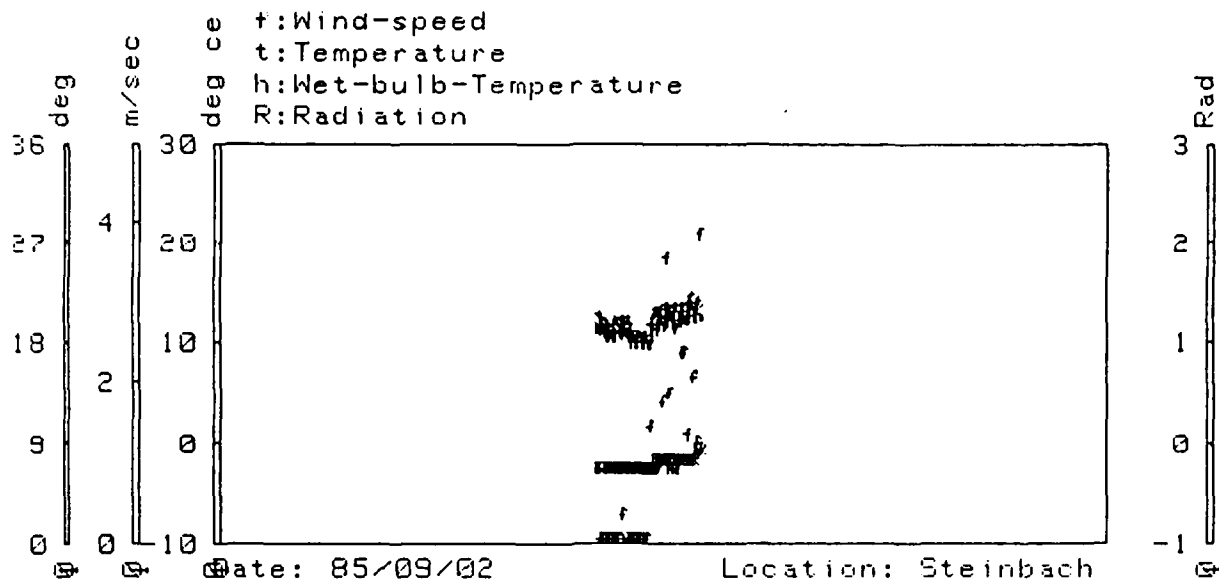


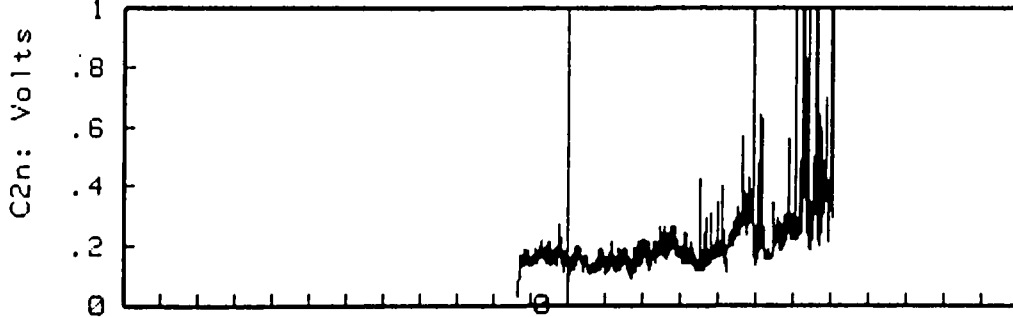
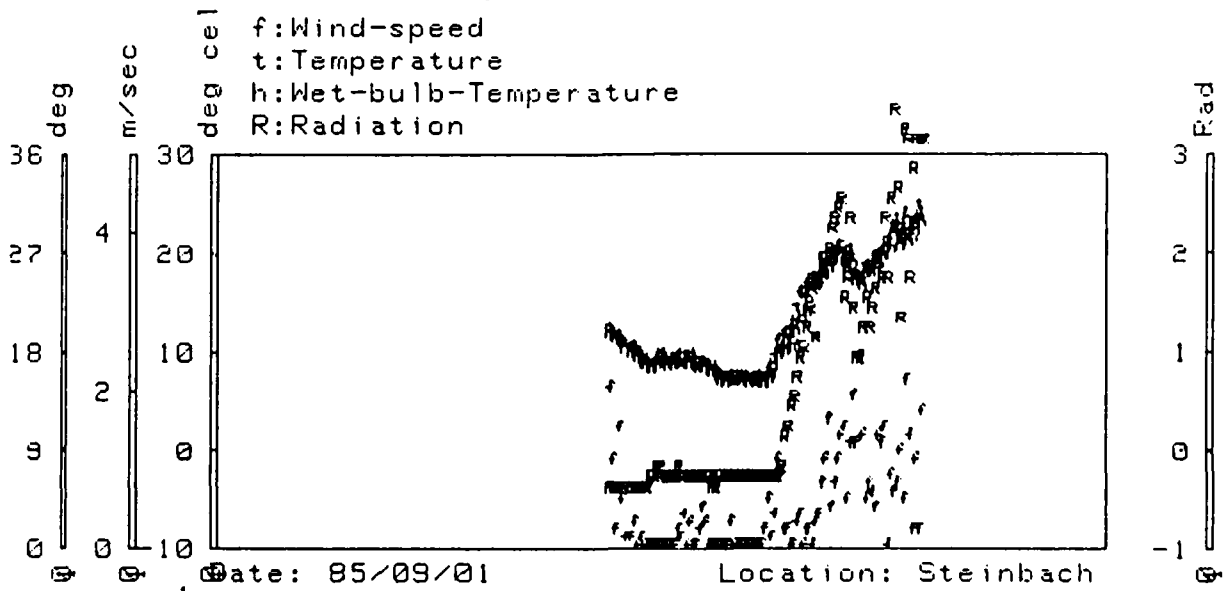
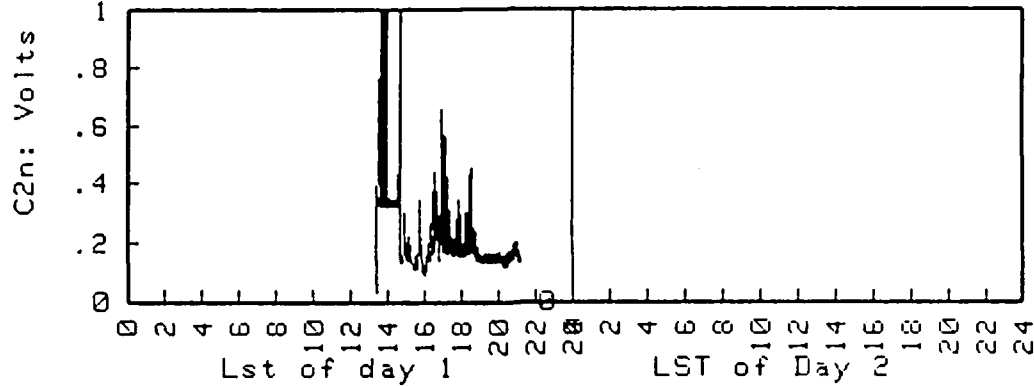
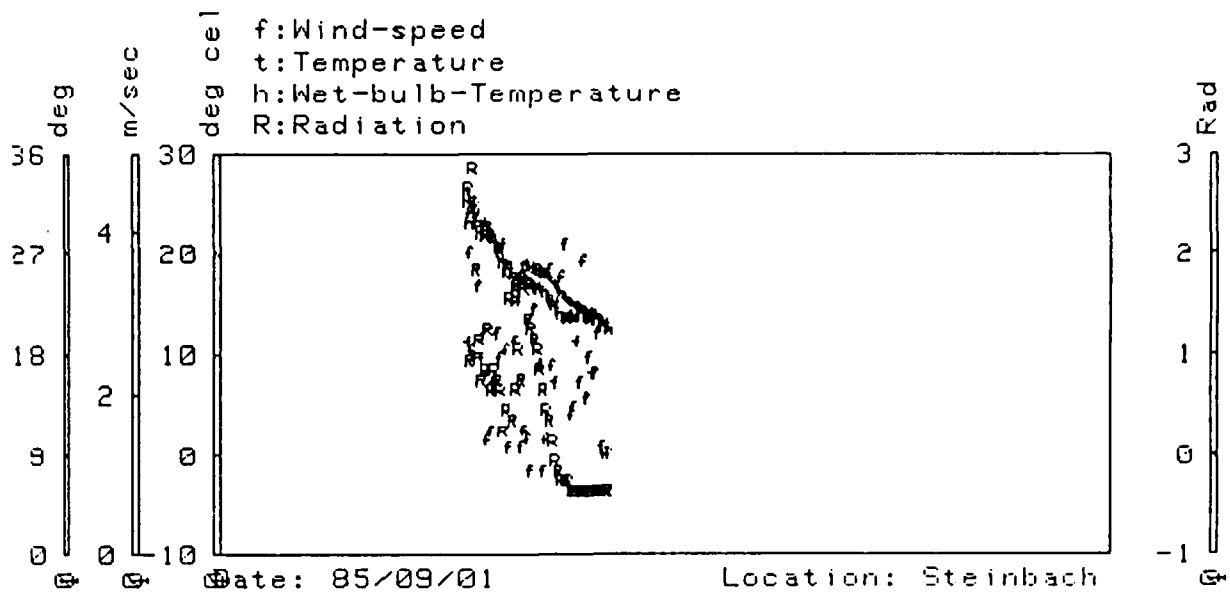






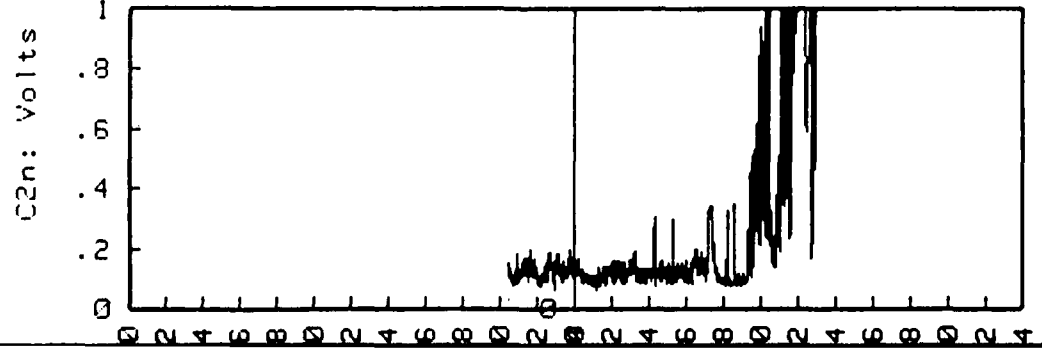
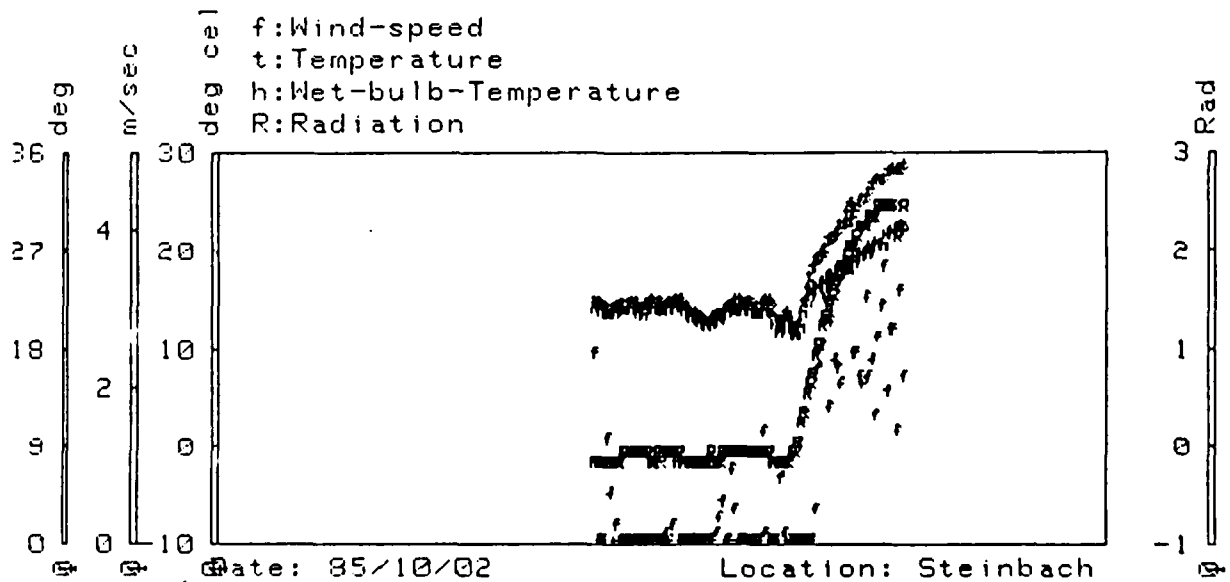
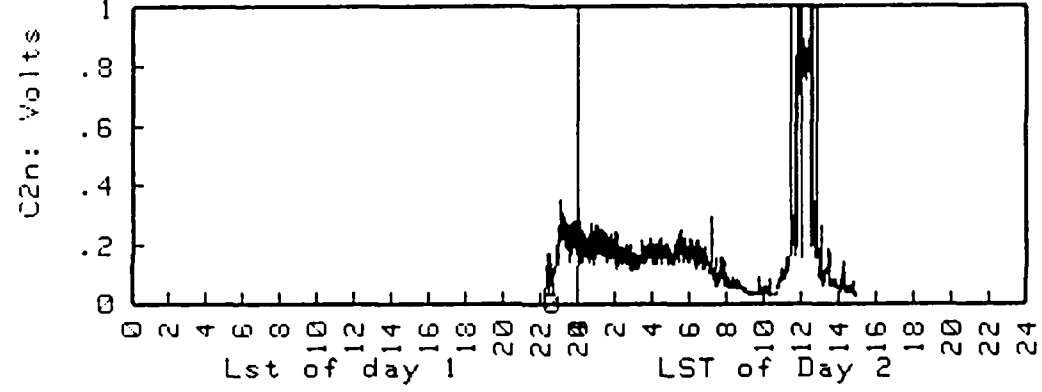
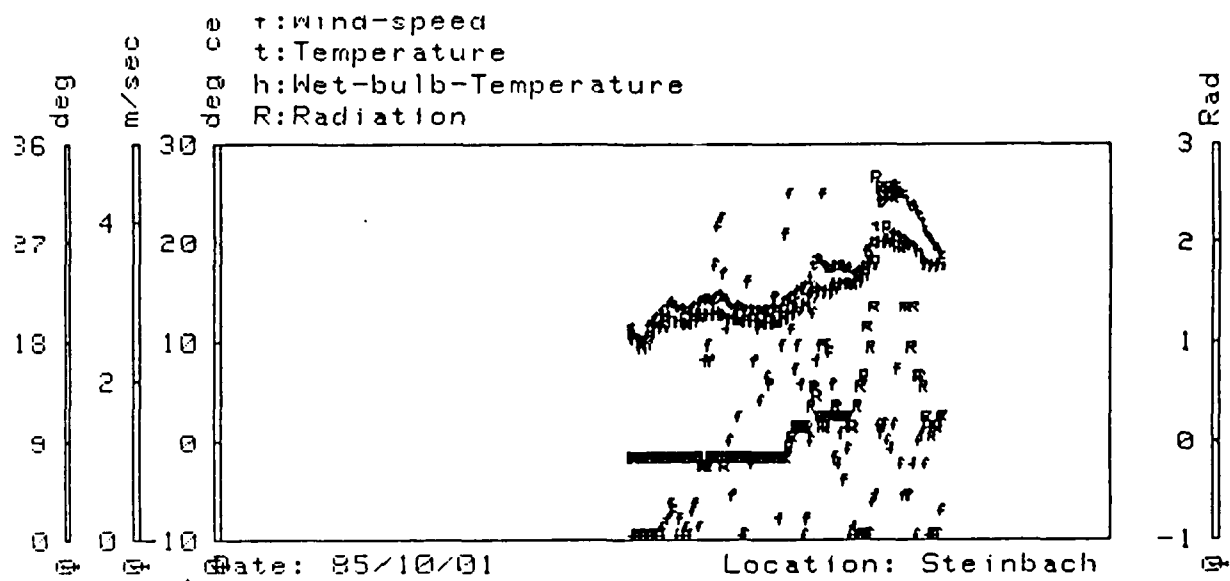


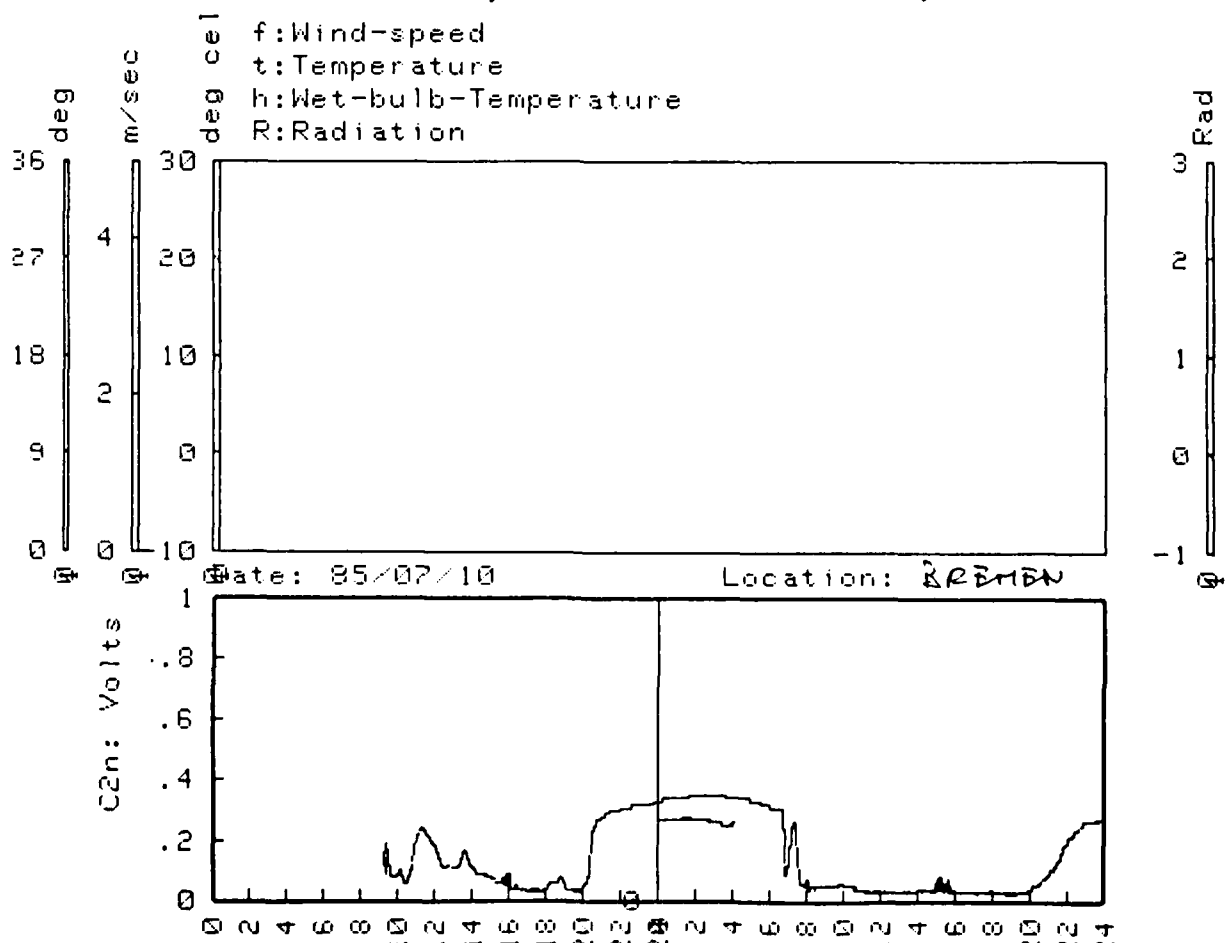
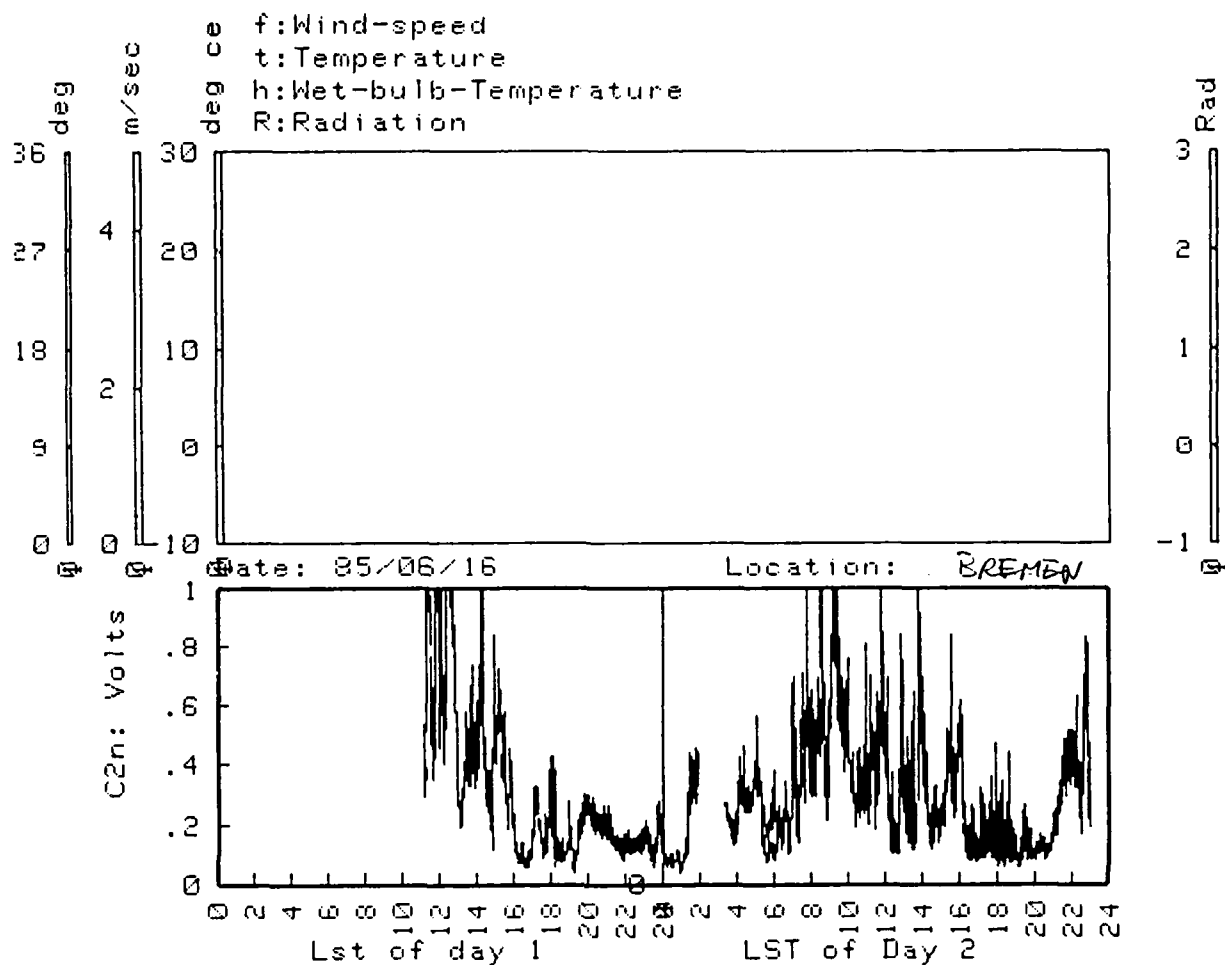


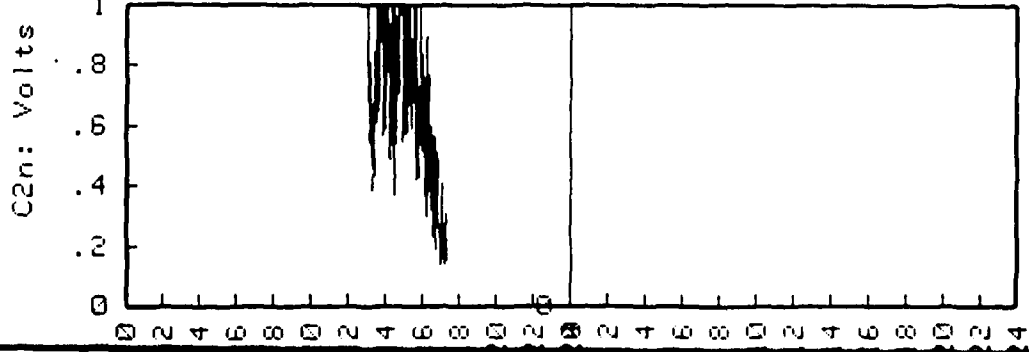
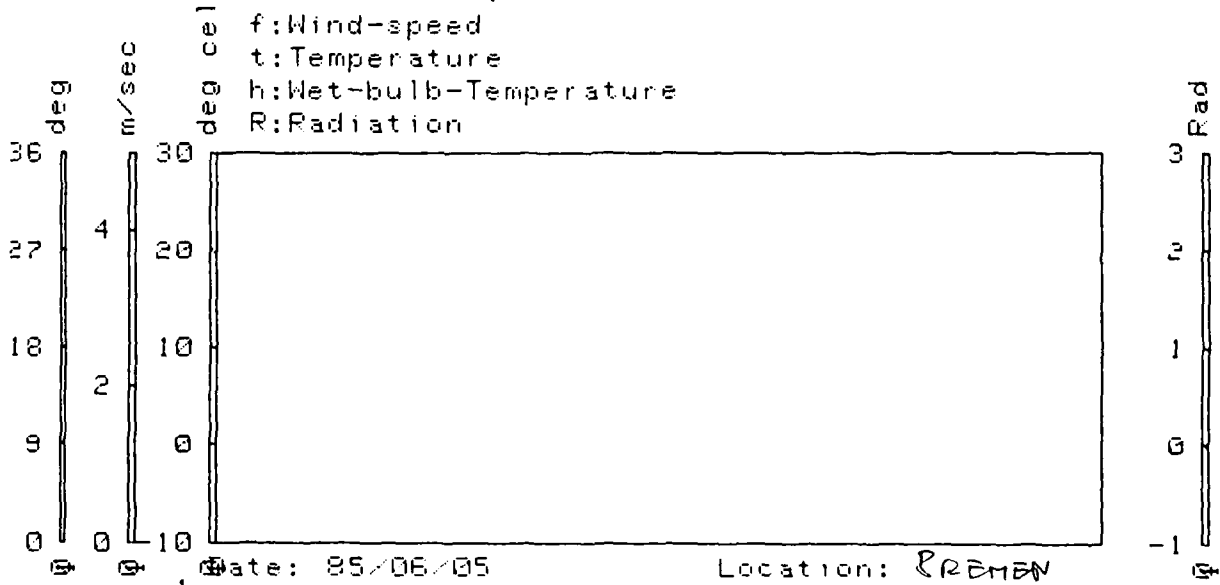
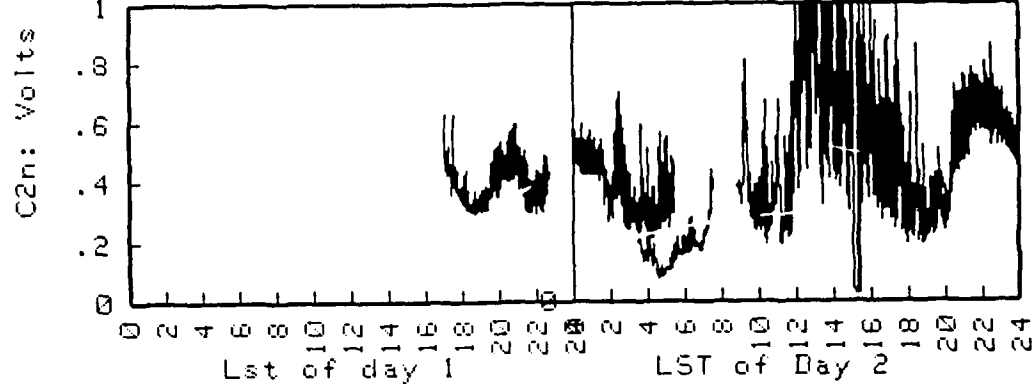
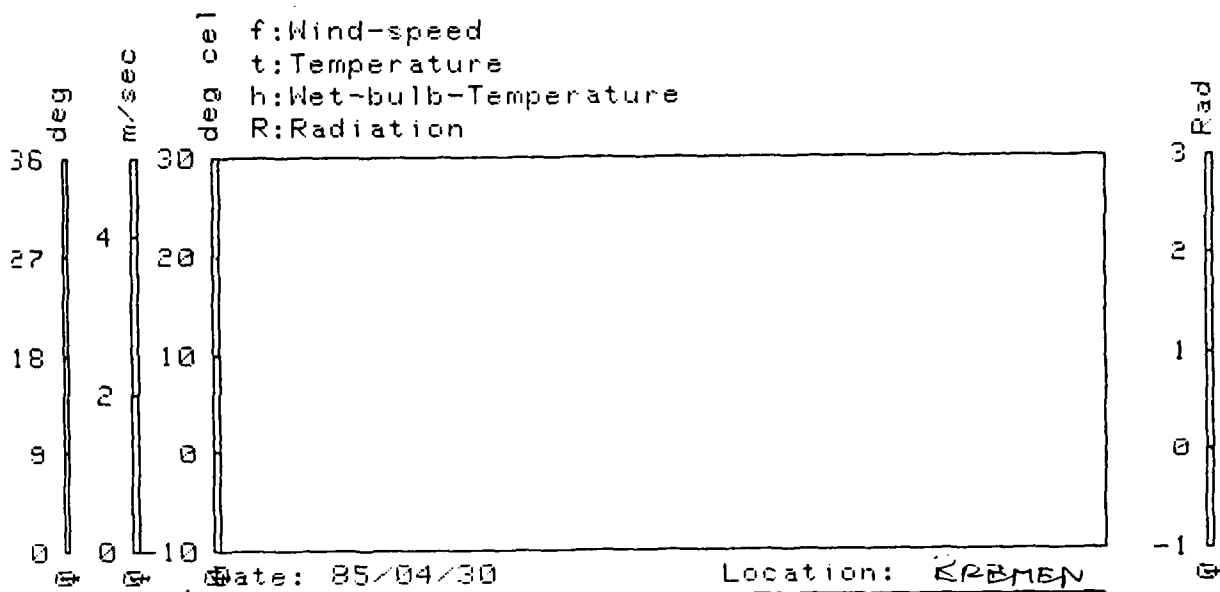


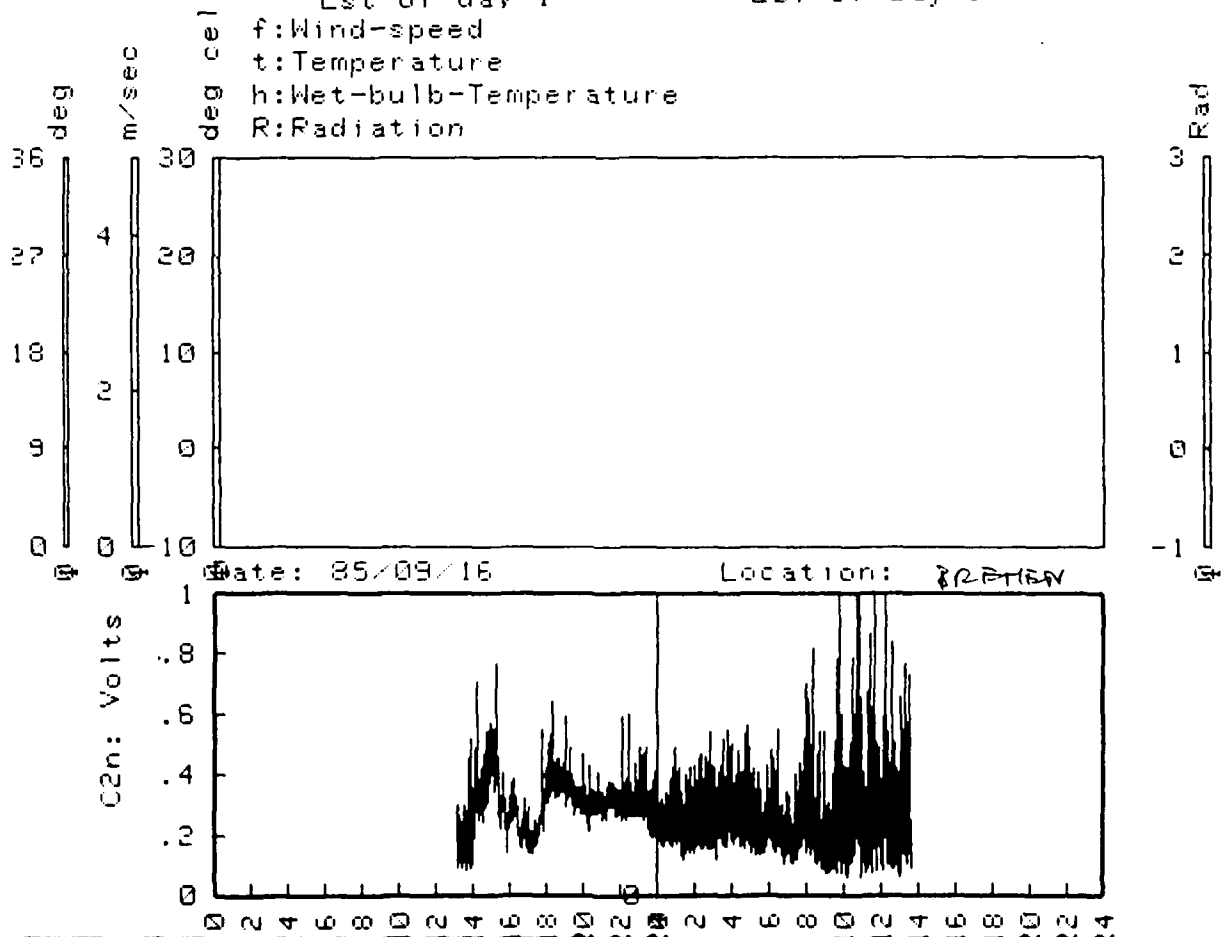
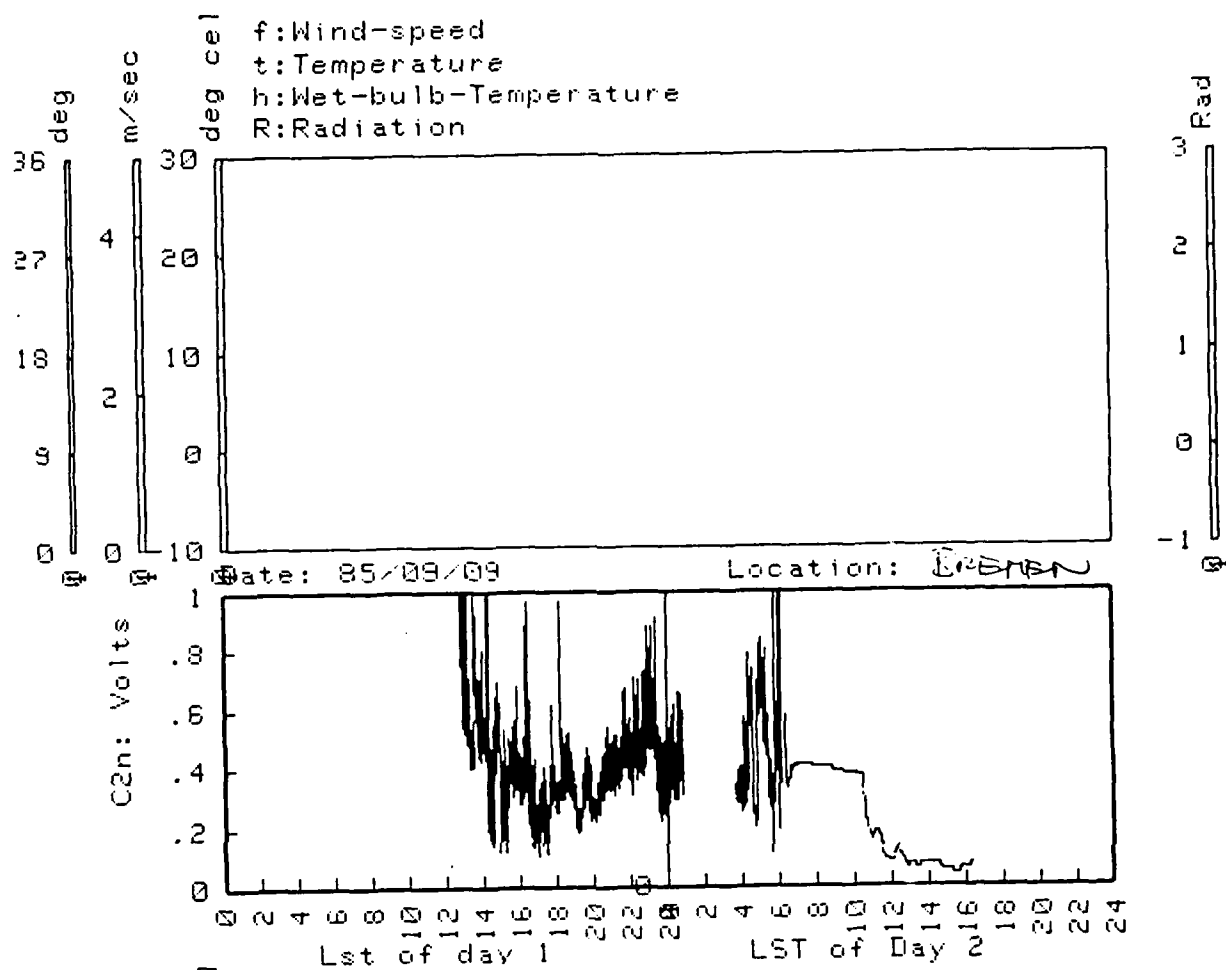
v: Wind speed
 t: Temperature
 h: Wet-bulb-Temperature
 R: Radiation

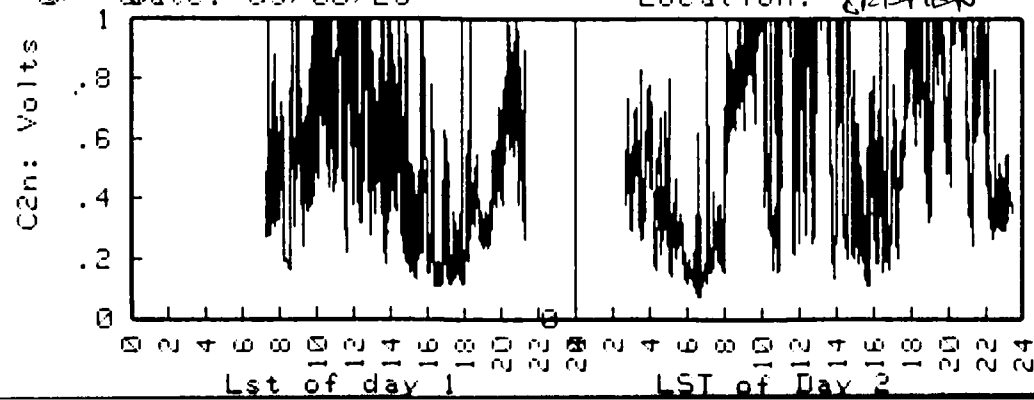
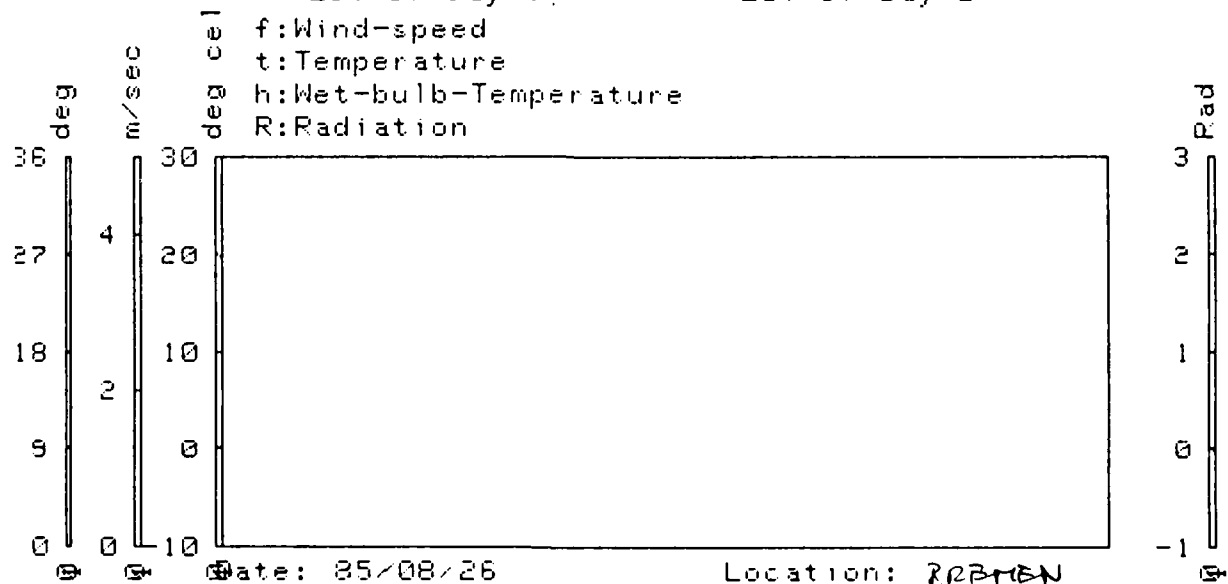
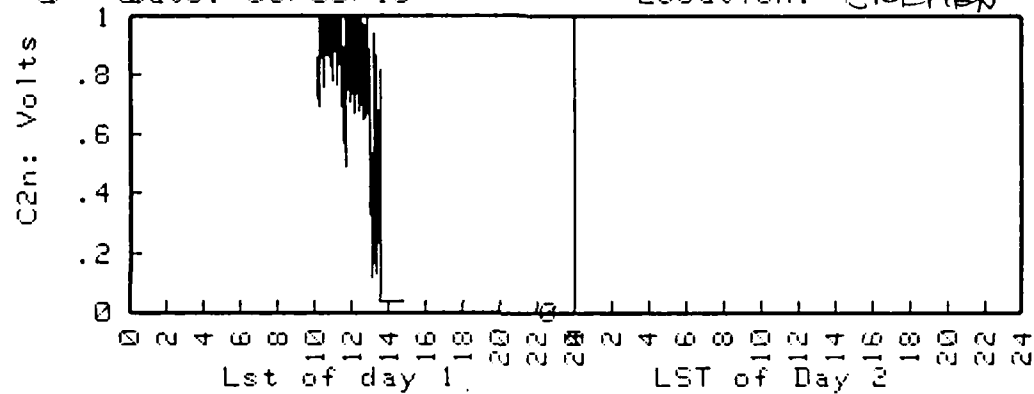
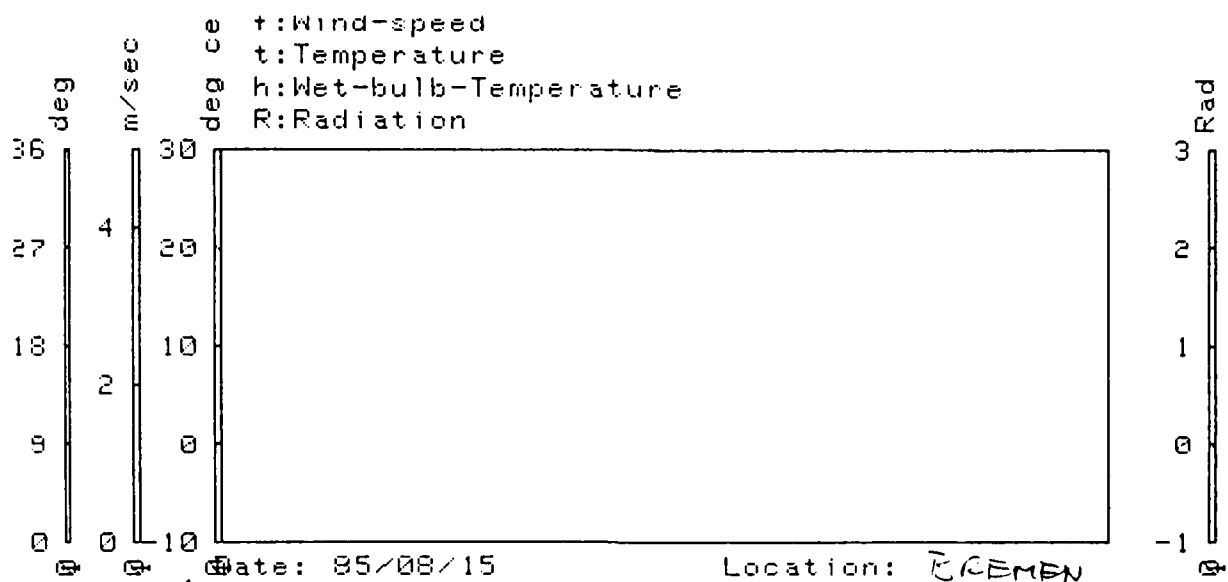
Date: 85/10/03
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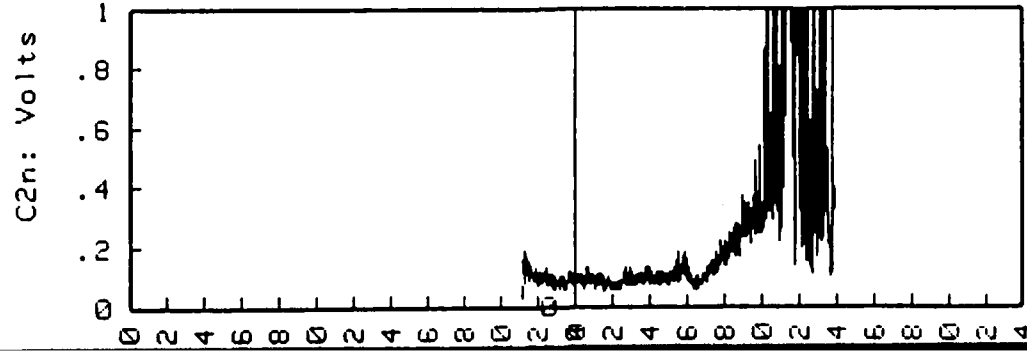
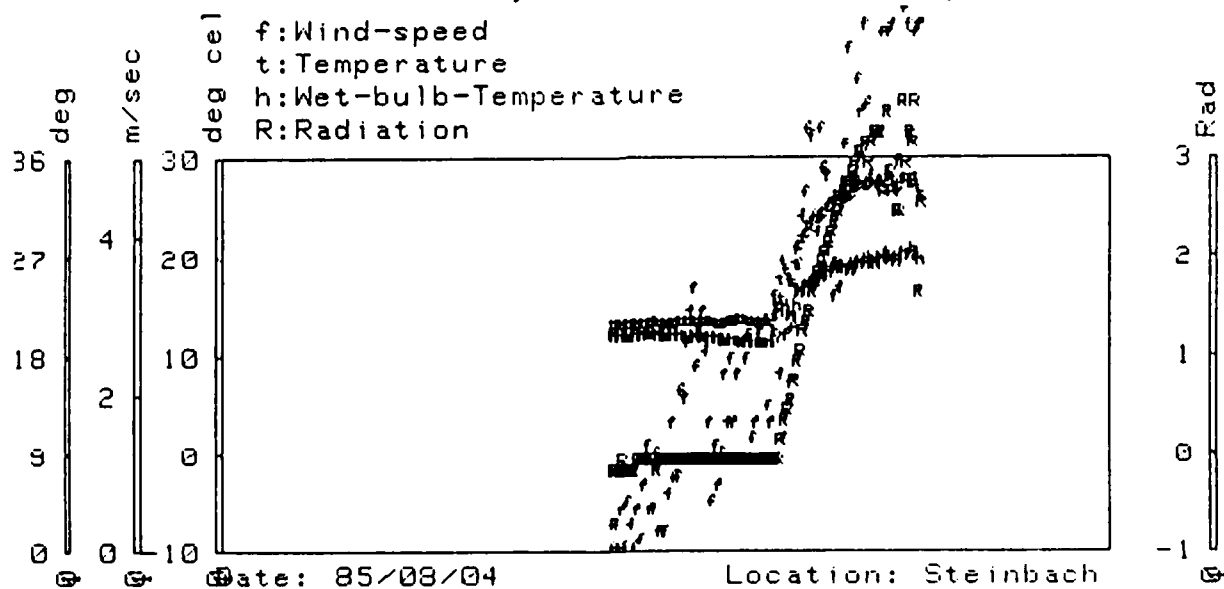
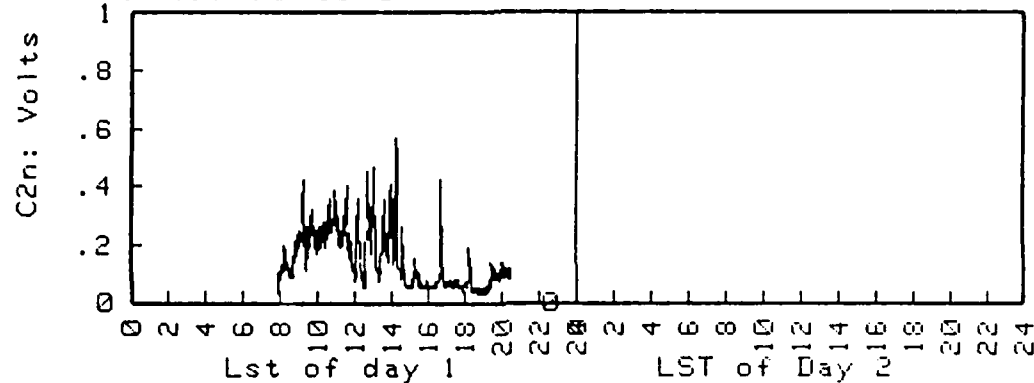
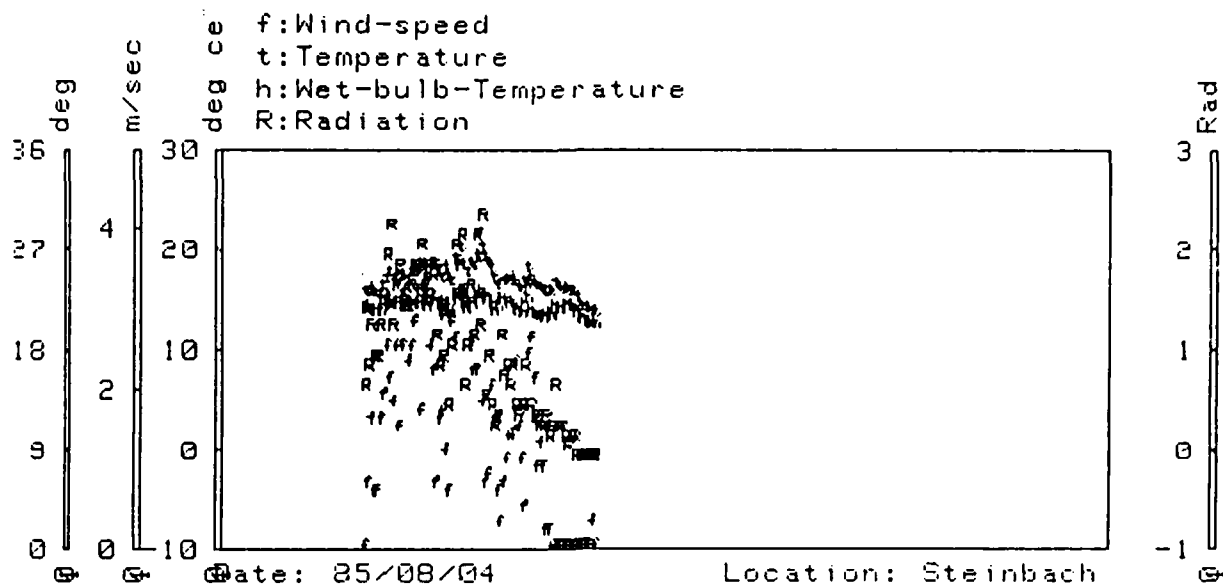












Figures:

Measurements of C2n (lower part) and meteorological parameters
for STEINBACH

Measurements of C2n (lower part)
for BREMEN

Mean temperature in Celsius in January (1931-1960)

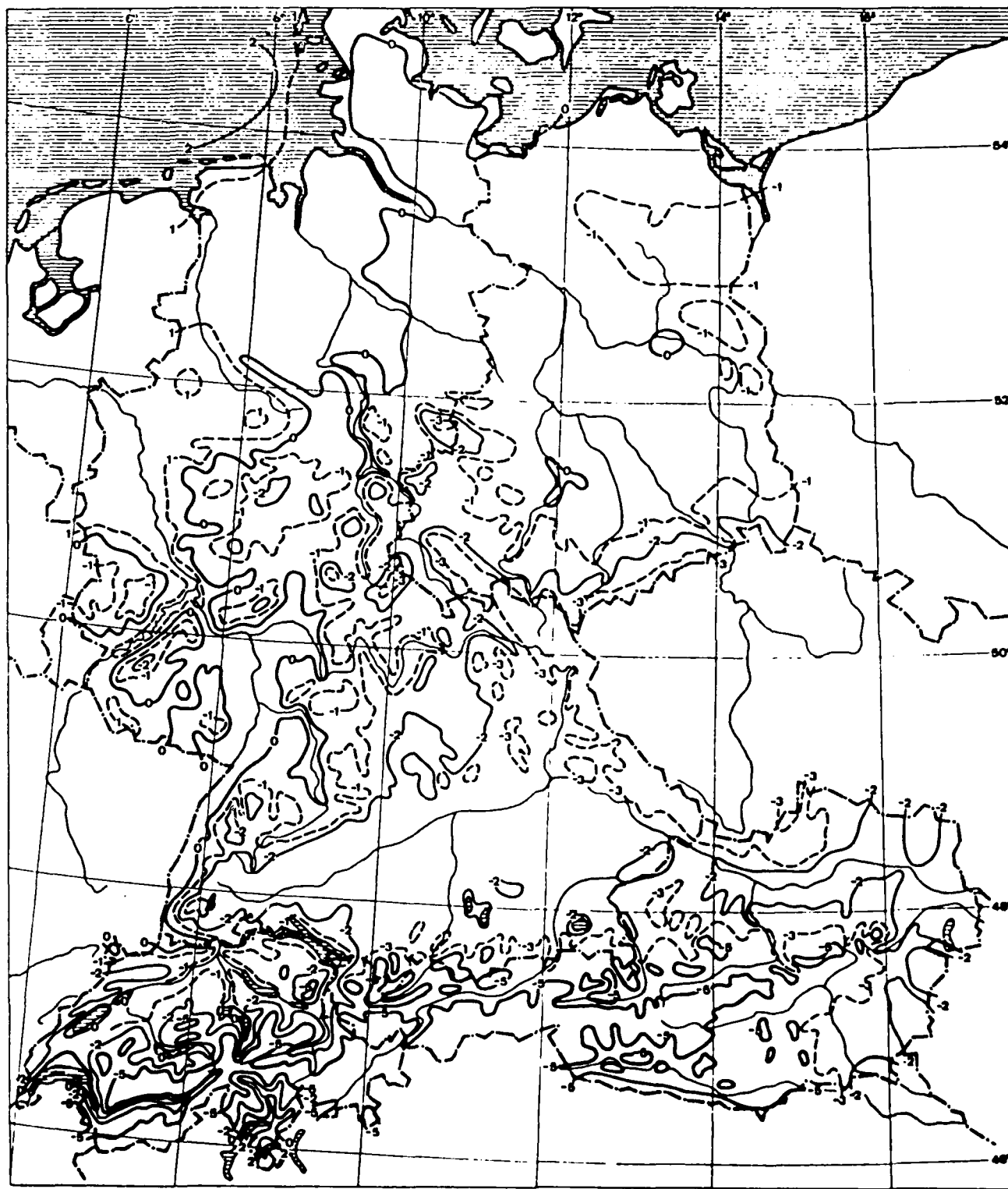


Fig.17. Mean temperature (C) in January, 1931-1960.

Mean temperature in Celsius in July (1931-1960)

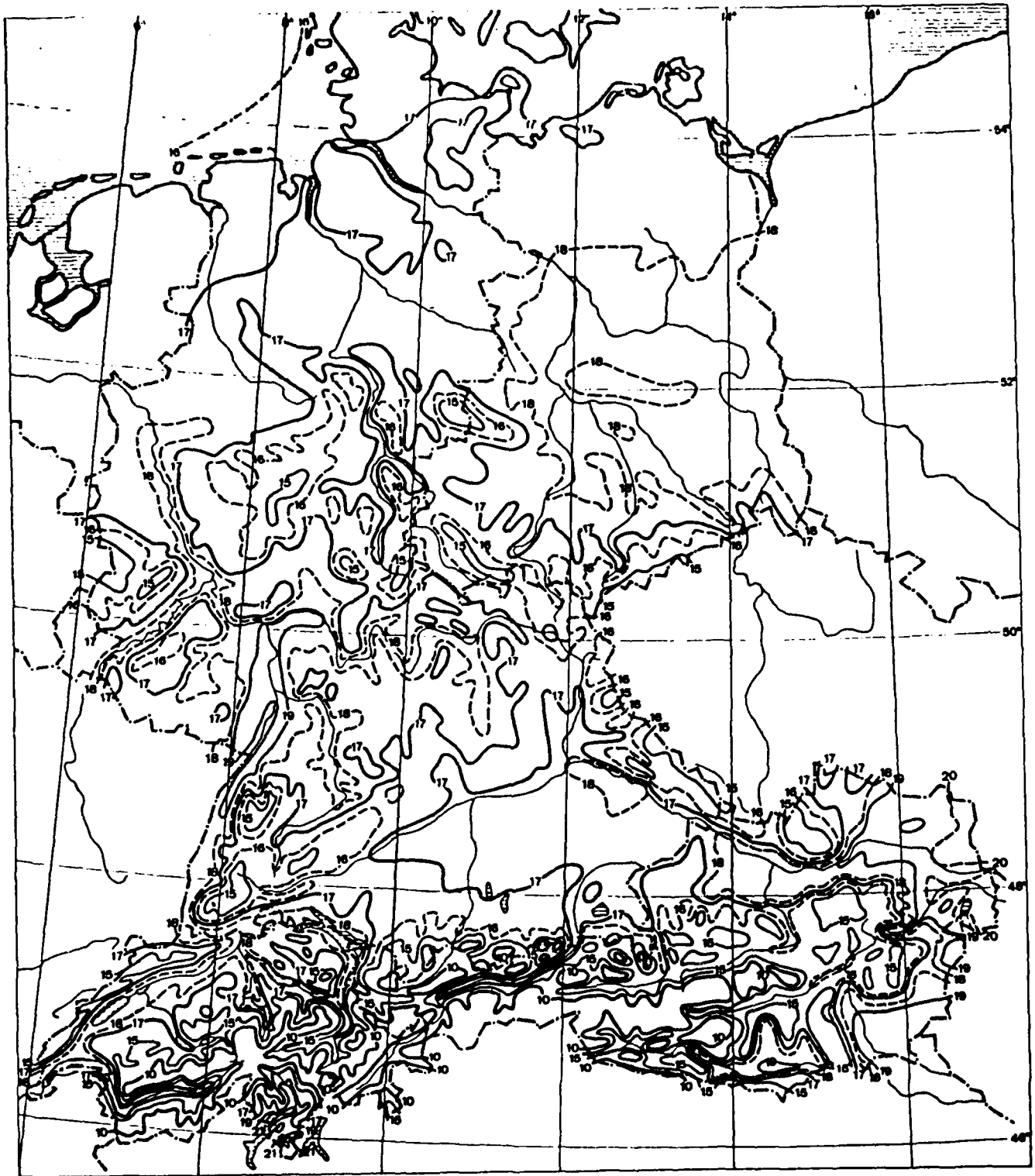
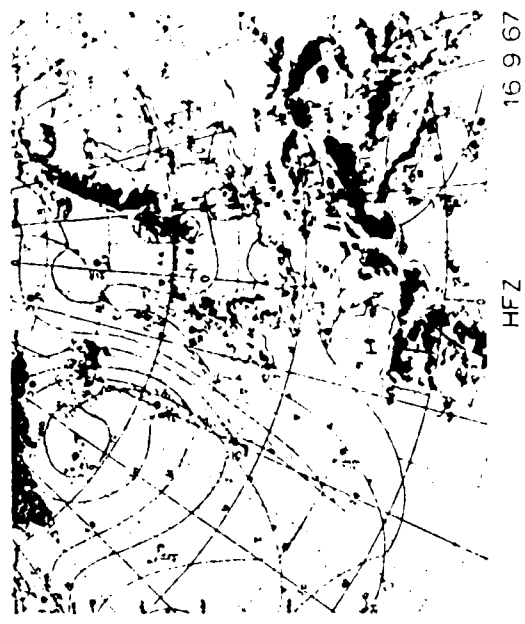
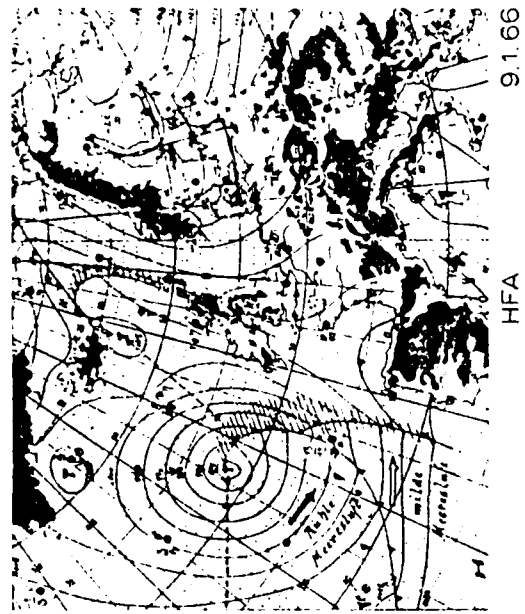
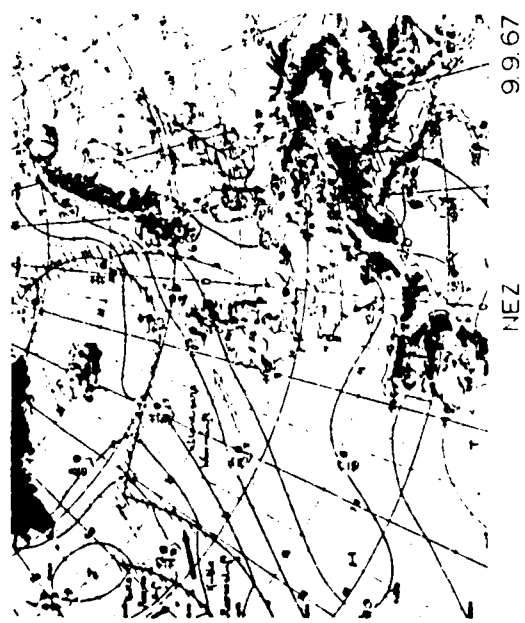
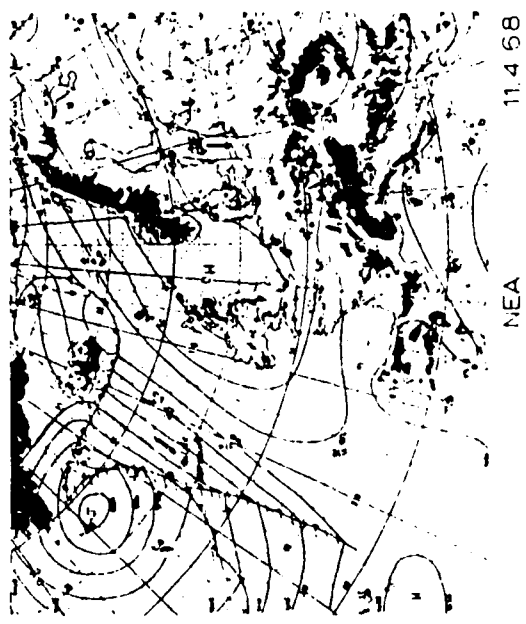
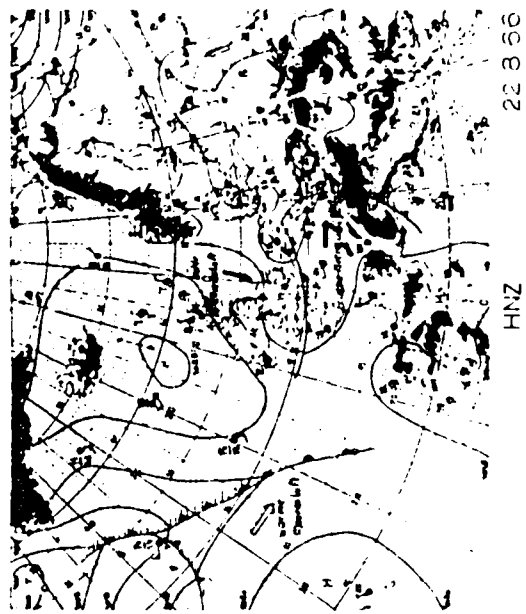
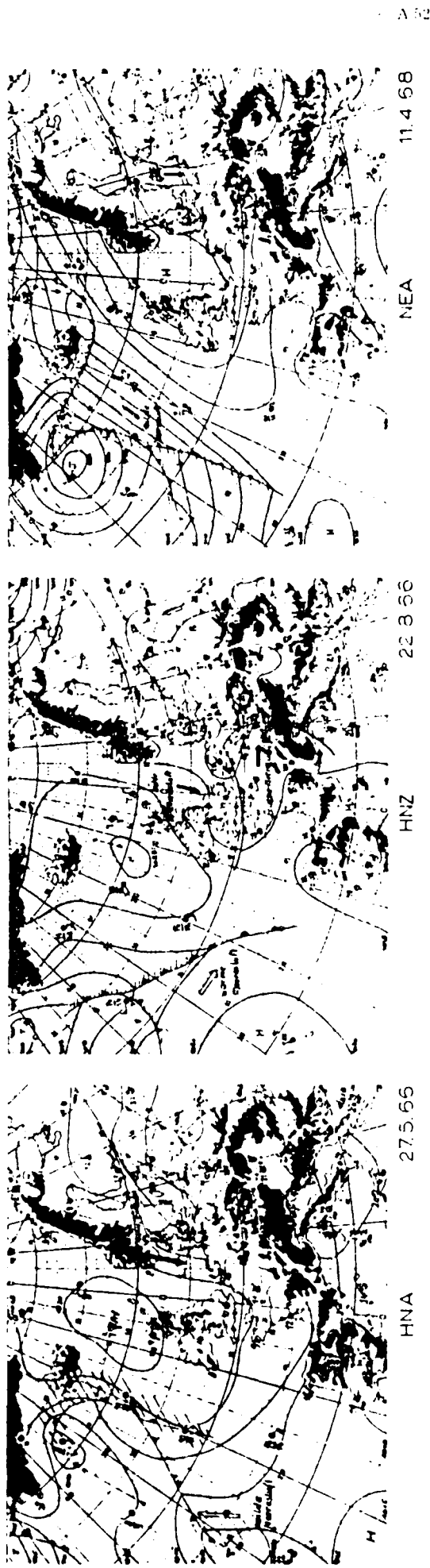
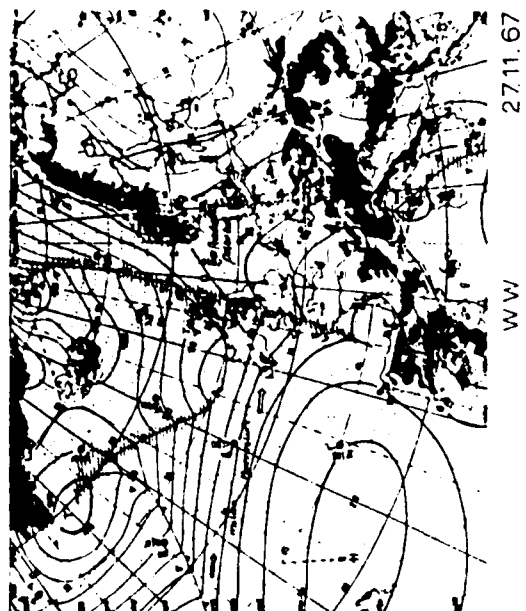
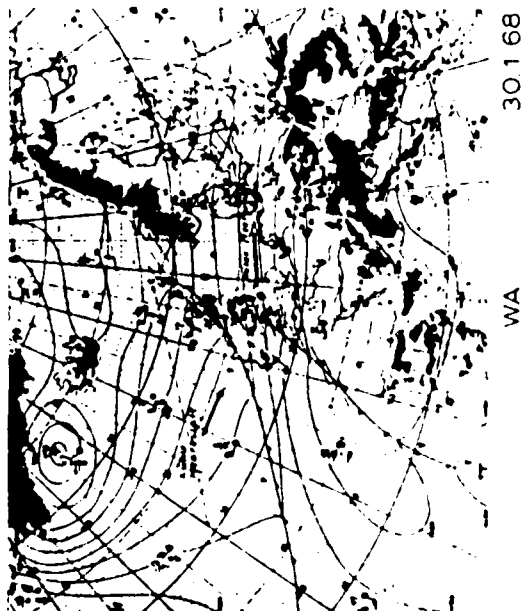
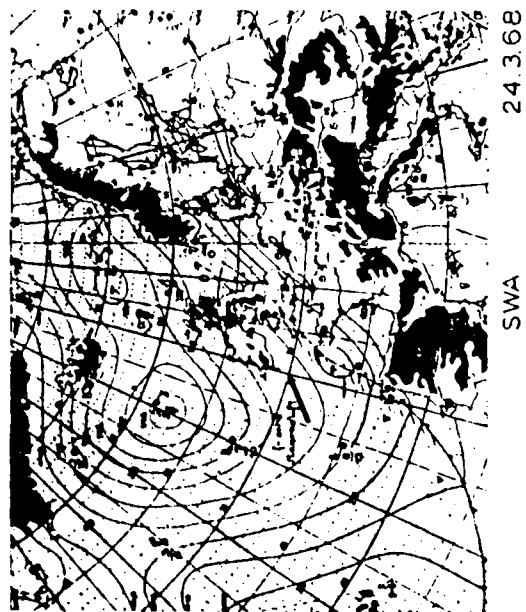
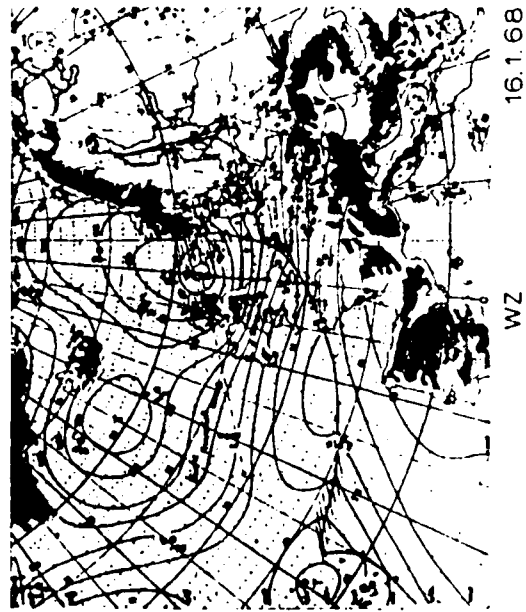
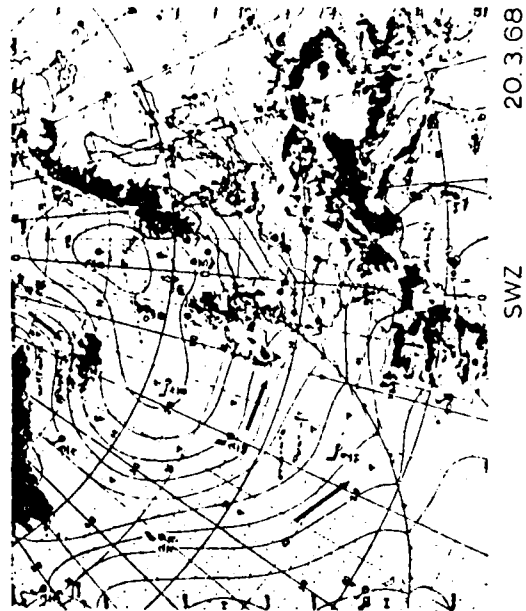
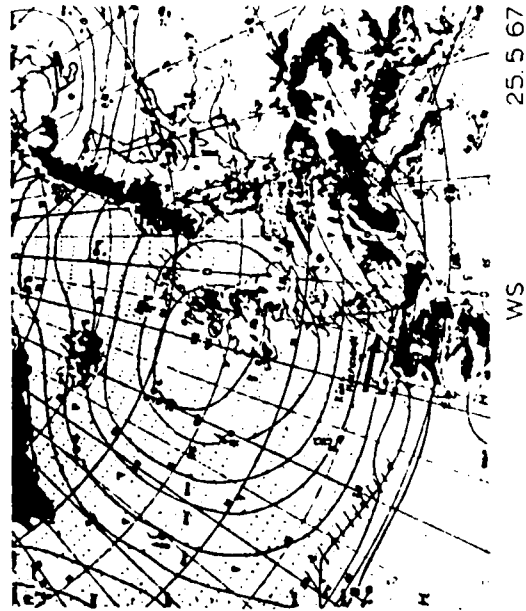


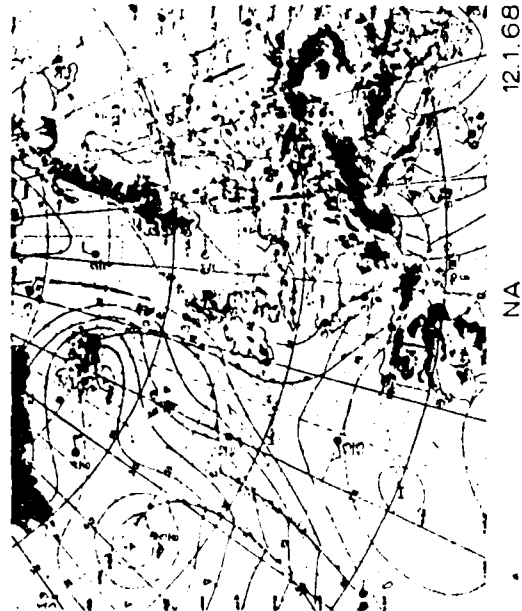
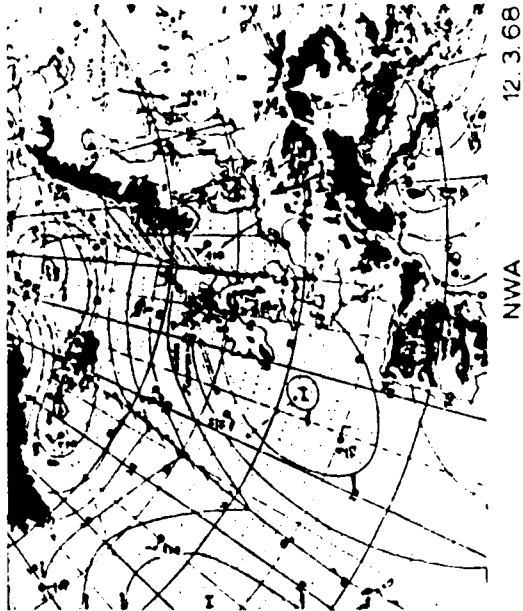
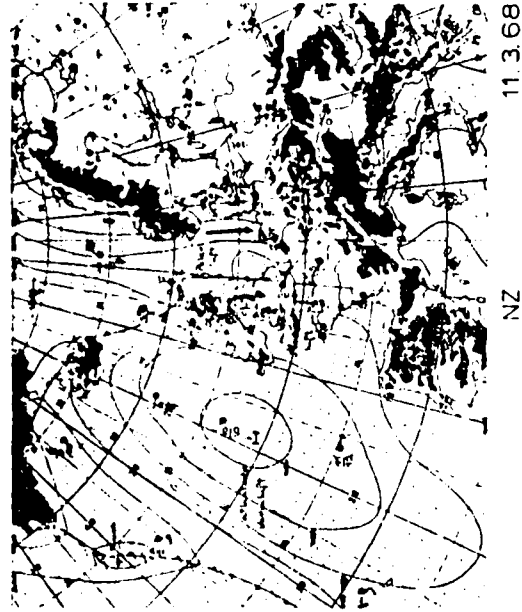
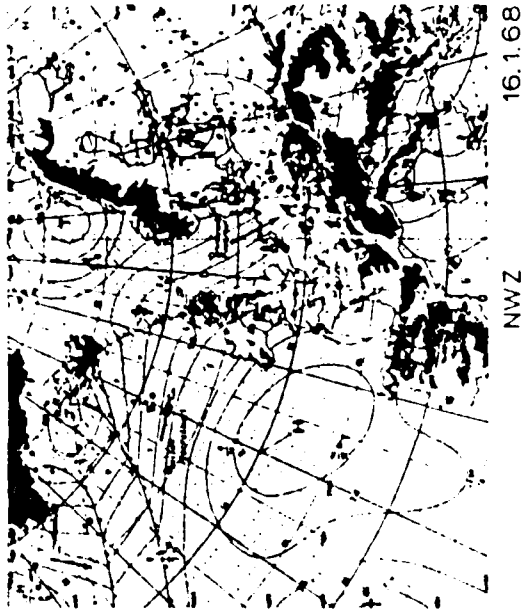
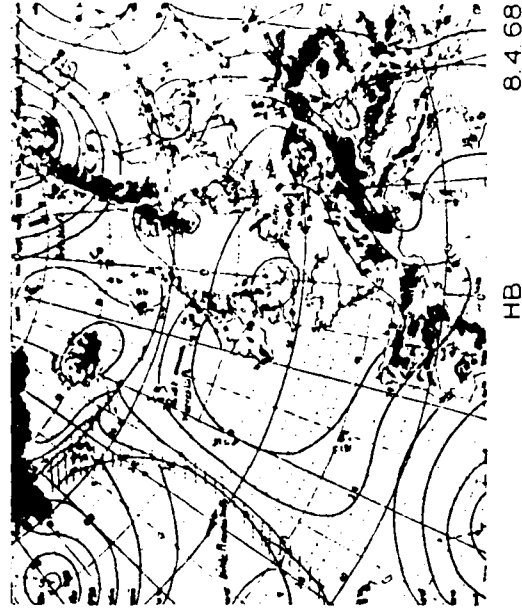
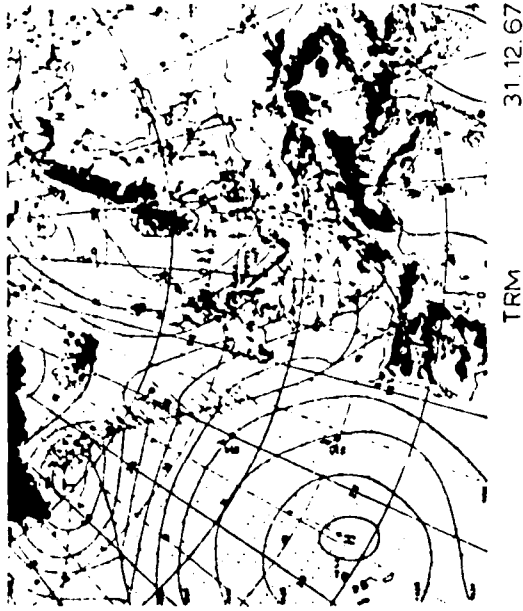
Fig.18. Mean temperature (°C) in July, 1931-1960.



7 Typical Examples of European Main-Weather-Types



5 Typical Examples of European Main-Weather-Typs



4 Typical Examples of European Main-Weather-Typs

Amtsblatt des Deutschen Wetterdienstes

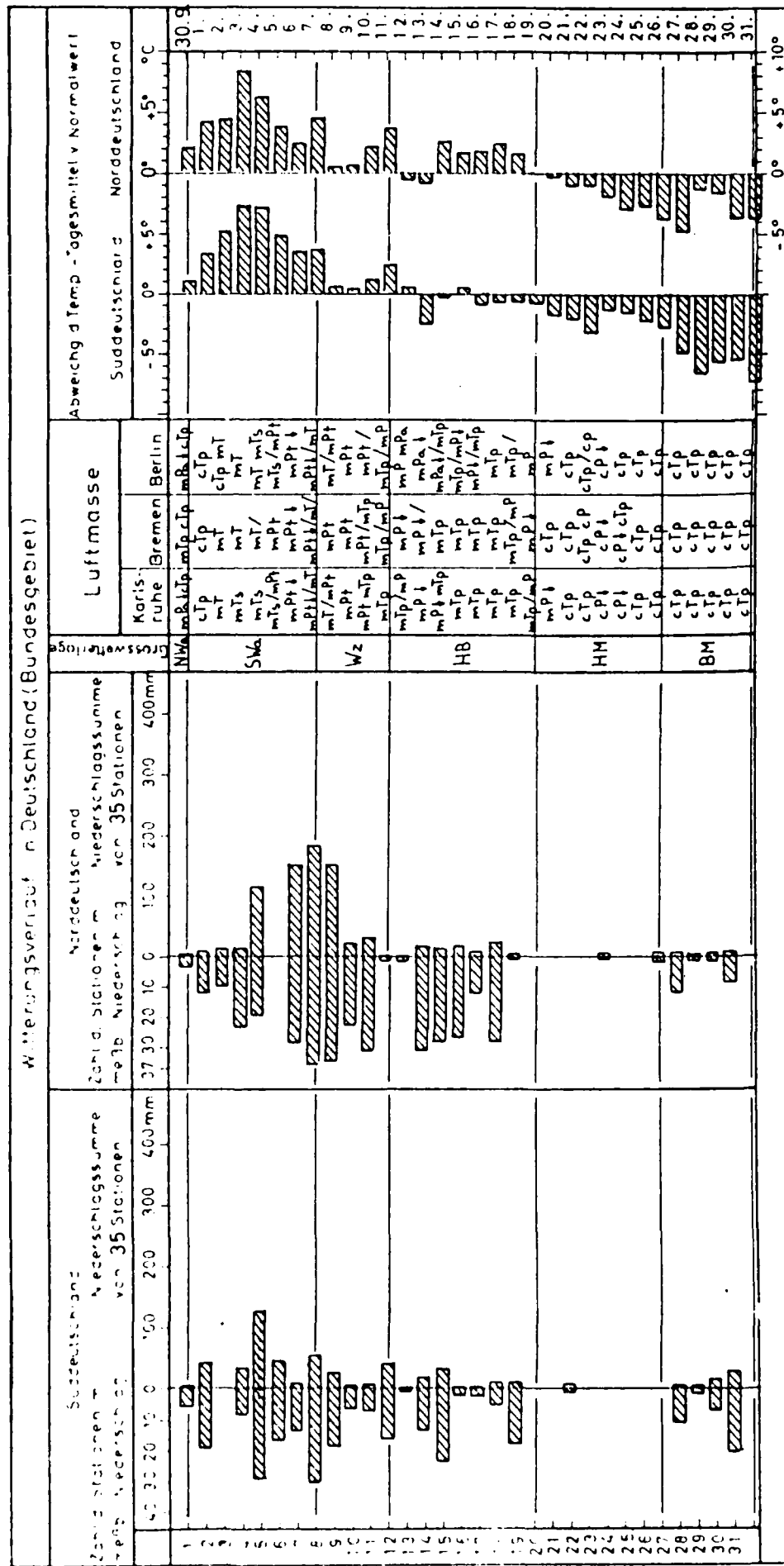
Verlagsges. Offenbach a. M. Norddruck-Verlag
Erscheinung monatlich, bezugspreis jährlich 60,- DM, 1980
ISSN 0017 - 4645
Druck und Verlag: Deutscher Wetterdienst — Zentralamt —
D 6050 Offenbach am Main, Frankfurter Straße 135, Tel.: (069) 80620

38. Jahrgang

OKTOBER 1985

Nummer 10

Wahlkreisverteilung in Deutschland (Bundesgebiet)



DIE GROSSWETTERLAGEN EUROPAS

Amteblatt des Deutschen Wetterdienstes

Verlagsort Offenbach a. M. Nachdruck verboten.

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**Druck und Verlag: Deutscher Wetterdienst — Zentralamt —
D 6050 Offenbach am Main, Frankfurter Straße 135, Tel.: (06 9) 806 20**

38. Jahrgang

JUL 1985

Nummer 7

Witterungsverlauf in Deutschland (Bundesgebiet)																
Süddeutschland Zahl d. Stationen m. meßb. Niederschlag				Norddeutschland Zahl d. Stationen m. meßb. Niederschlag				Luftmasse		Abweichung d Temp.-Tagesmittel v. Normalwert						
Niederschlagssumme von 35 Stationen				Niederschlagssumme von 35 Stationen				Karlsruhe	Bremen	Berlin	Süddeutschland	Norddeutschland				
40 30 20 10 0 100 200 300 400 mm				37 30 20 10 0 100 200 300 400 mm				Wa	HM	Wa	HM	Wz	HM	TB	Wz	
1.									Wa	HM	Wa	HM	Wz	HM	TB	Wz
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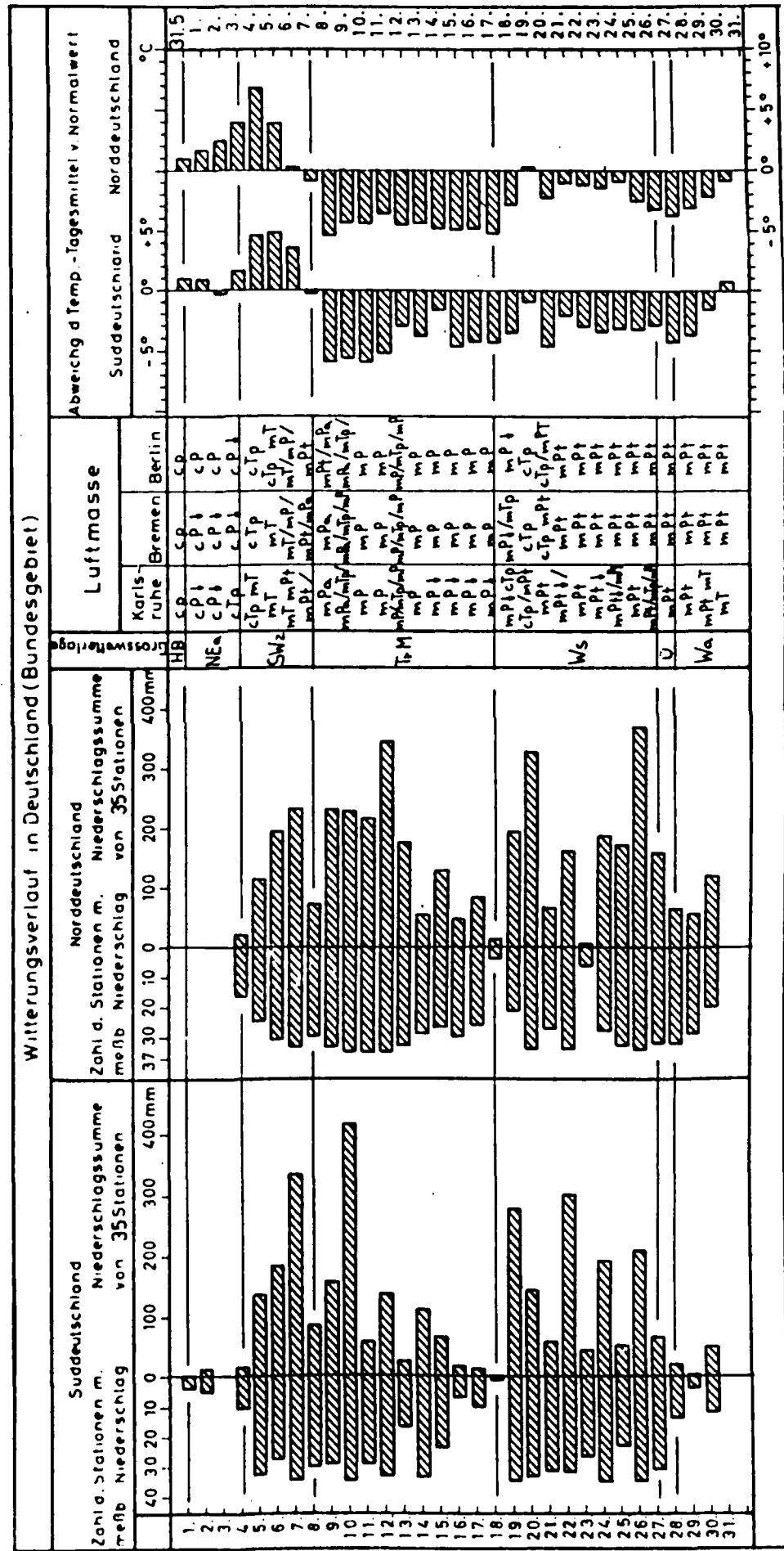
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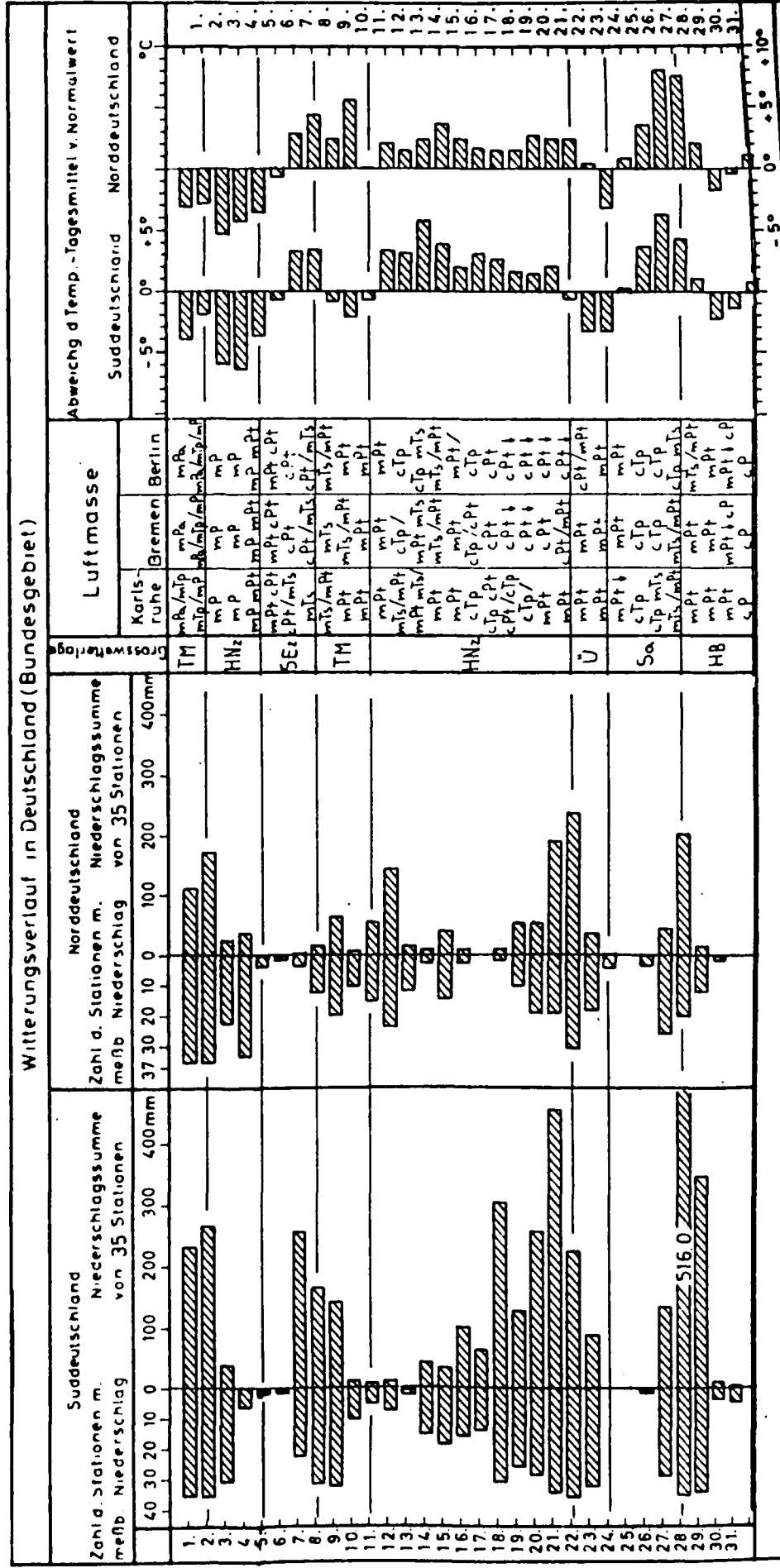
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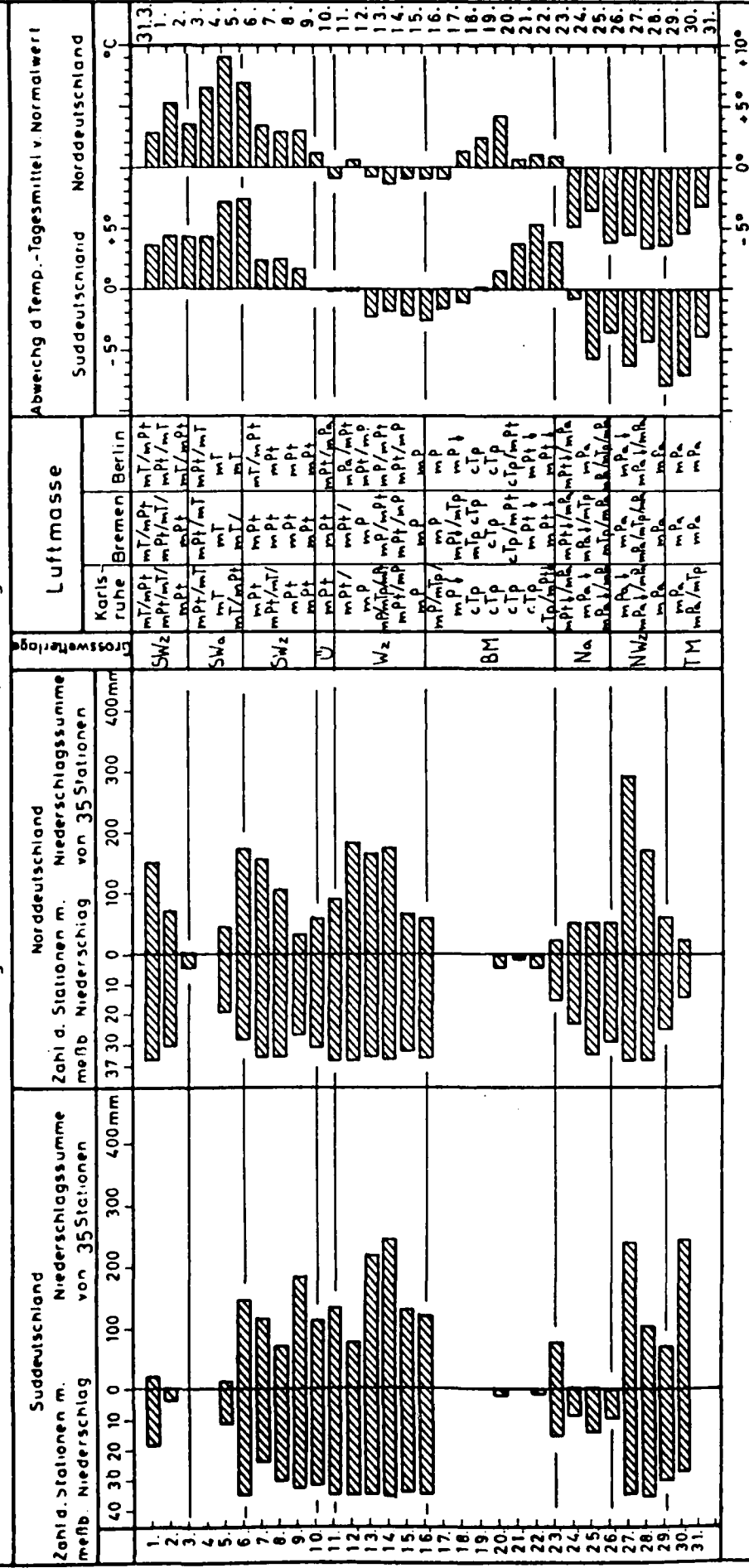
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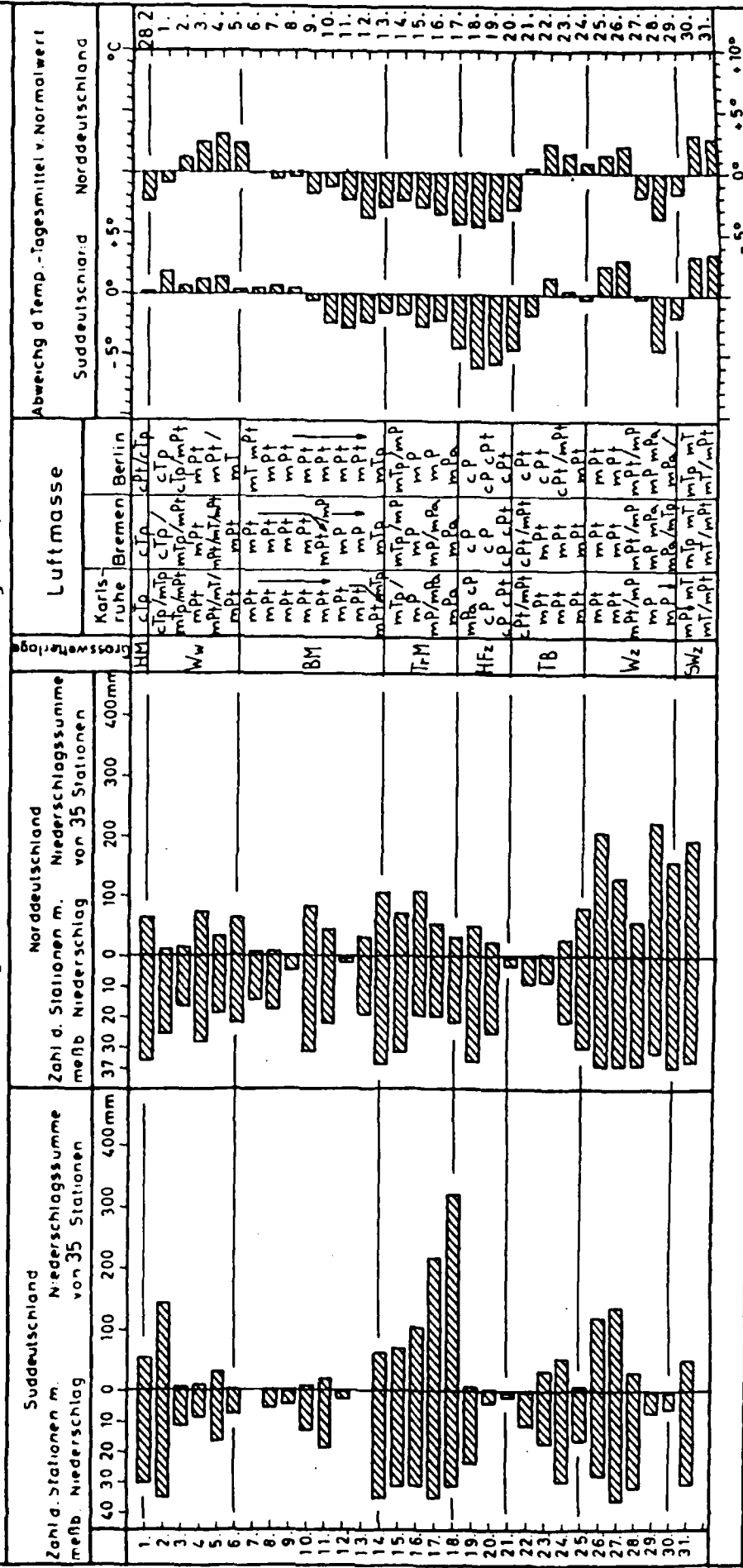
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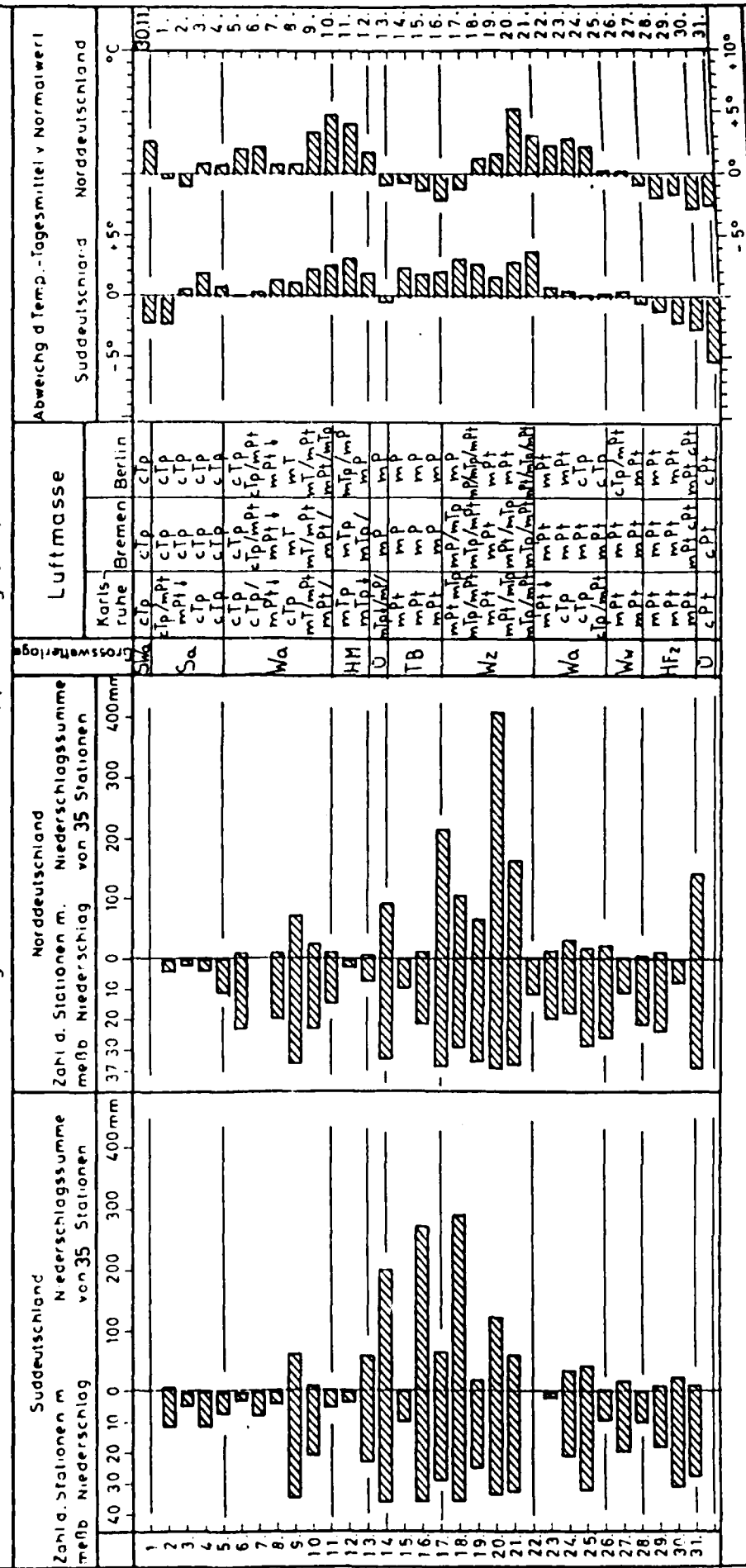
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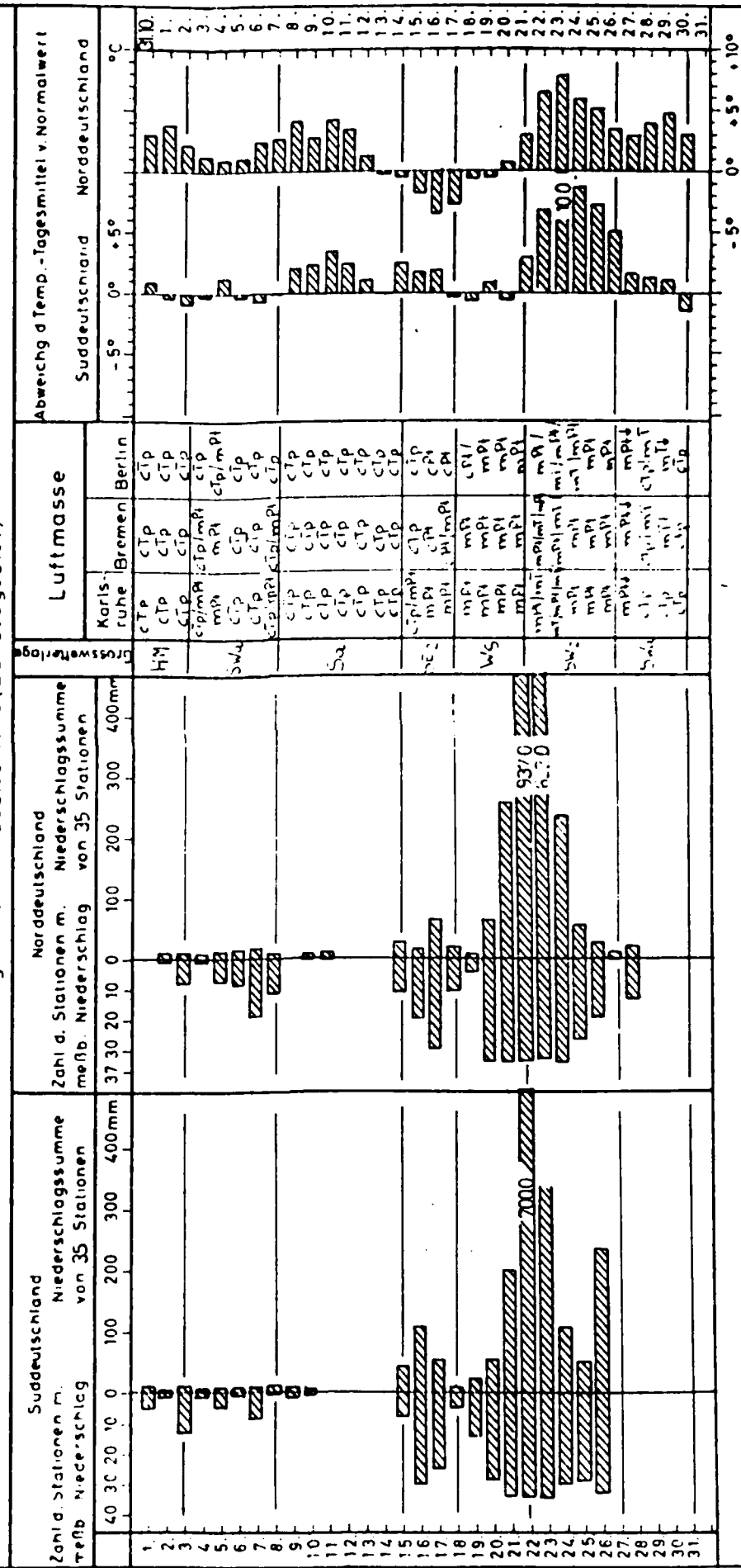
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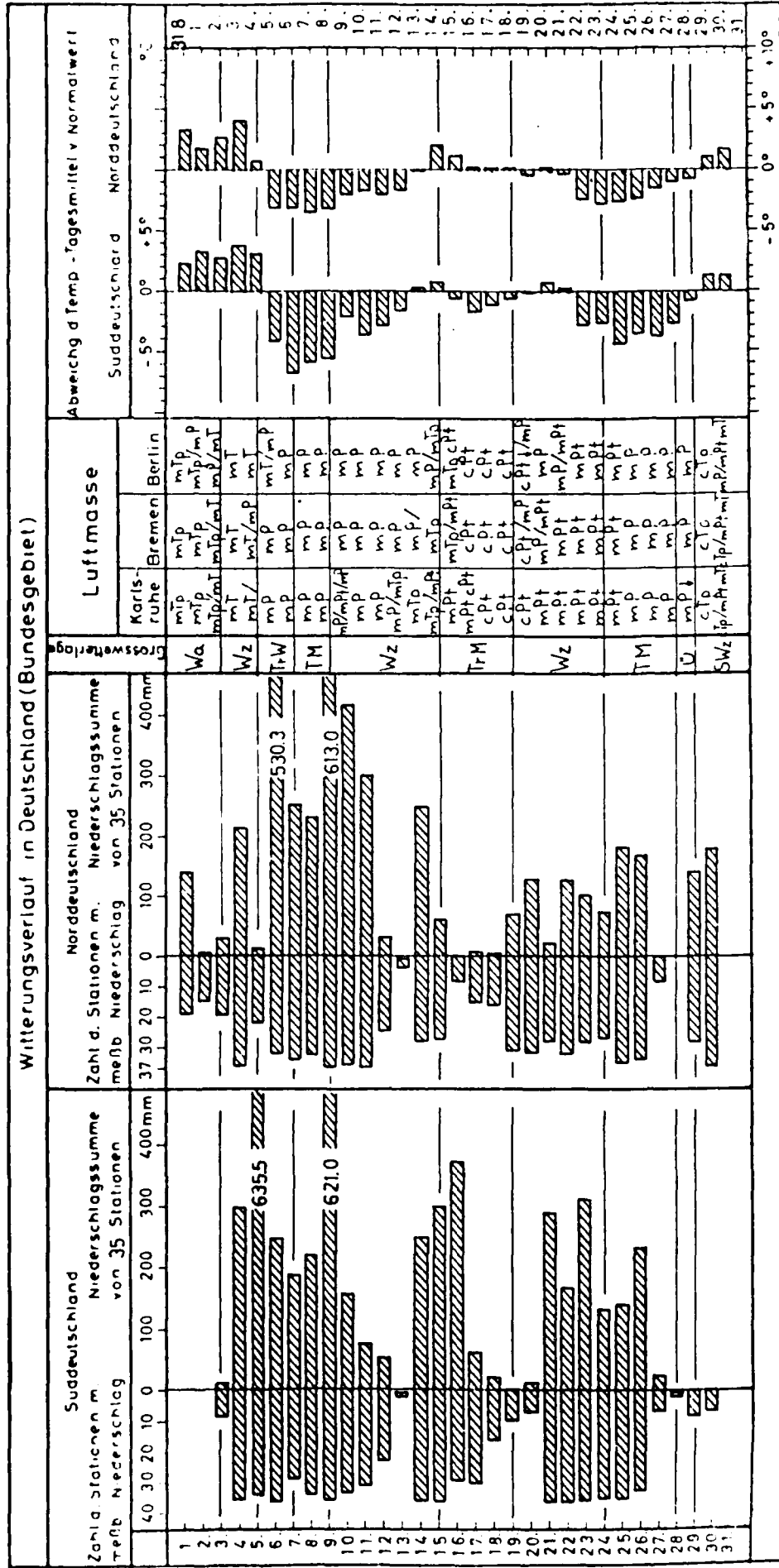
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Table(s) 3.

Main-Weather-Situations (Groß-Wetterlagen) für Europe

and

Air-Mass (Luftmasse) 1. Karlsruhe: representative for STEINBACH

2. Bremen: representative for BREMEN

from September 1984 to October 1985 (November not yet available)

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