BRL

CONTRACT 169

REPORT NO. 2

AD 662203

UPPER ATMOSPHERE WINDS FROM
GUN LAUNCHED VERTICAL PROBES
(Barbados, 20-23 September 1965)

SPACE INSTRUMENTS RESEARCH, INC.

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BRL CONTRACT 169 REPORT 2

UPPER ATMOSPHERE WINDS FROM GUN LAUNCHED VERTICAL PROBES

(Barbados, 20-23 September 1965)

Prepared for

U. S. Army
Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

Contract No. DA-01-009-AMC-169(X)

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INTRODUCTION

A continuing study of upper atmospheric winds over the lower West Indies has been made possible by the firing of high altitude ballistic probes from a sixteen-inch gun located on the Island of Barbados. These firings are being carried out by the U. S. Army Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland, under the direction of Dr. Charles H. Murphy, and by the Space Research Institute of McGill University, Canada, under the direction of Dr. G. V. Bull.

Atmospheric winds are studied by releasing chemical trails from the gun fired probes during the upper portion of their trajectories. To date, the primary chemical which has been released is trimethyl aluminum (TMA). TMA produces a chemiluminescent glow in regions of the atmosphere above 85 kilometers, thus allowing the trails to be photographed while being distorted by upper atmosphere winds. The photographs then can be reduced by Space Instruments Research, using computer techniques to provide wind information.

Although the data reduction given in this report is funded directly by the U. S. Army, it is part of a joint U.S.-Canadian HAFP-McGill program which is supported by the U. S. Army and the Canadian Department of Defense Production.

The purpose of this report is to summarize results of these studies for the period from September 20 through 23, 1965. Previous results are covered in Technical Report No. 1 issued November 1965.

DATA ACQUISITION

The chemical trails are formed almost vertically over the island of Barbados (longitude 59.4°W, latitude 13.0°N) and extend from an altitude of 85 kilometers through apogee. In some firings, TMA is also released on the down leg of the trajectory. To the unaided eye, the chemical release first appears as a straight white trail resembling a jet contrail. Within a minute or so, the trail is distorted into strange shapes by the upper atmospheric winds and fades from view within approximately fifteen minutes after initial release.

Space Instruments Research has established eight photographic triangulation stations on the islands of Barbados, St. Vincnet, Grenada, and Tobago, with two sites per island. These islands are located to the west and south of Barbados at distances of 190 to 290 kilometers. While only one site on each of two islands is required for data reduction purposes, the eight sites have been found necessary because of cloud conditions in the area.

Equipment at each site, built by SIR, consists of a camera unit containing two seven-inch focal length cameras mounted on a concrete pedestal, and an electronic control. Cameras are automatically pulsed to take exposures of 3, 6, and 12 seconds duration every thirty seconds.

Since commercial power is eigher unreliable or unavailable at most site locations, SIR has developed a battery operated 115-volt power supply for the control equipment. The power supply is tuning-fork controlled and provides 60 cycle power with an accuracy of 0.005% for the

camera programmer so that pictures can be taken simultaneously at each site. A data chamber mounted on each camera unit records time, shot number, and site information in the corner of each frame of film.

A short wave radio net connecting all sites and the launch control center has been installed by SIR to enable the launch control officer on Barbados to be informed of weather conditions on the islands and to synchronize picture-taking operations with the firing of the gun. Most sites are operated by local personnel who have been trained by SIR.

During a typical night's operation, the gun is fired at one to two-hour intervals, from sunset to sunrise. Photographs are taken by all sites during the time that the trail is visible. The film is returned to Atlanta for processing and data reduction.

DATA REDUCTION

Several computer programs have been developed which make it possible to calculate upper atmosphere winds from measurements made directly on the photographs of the luminous trails.

Since the method used is basically three-dimensional triangulation using spherical trigonometry, it is necessary to know precisely the direction each camera was pointed during a given firing. The direction is determined by first taking accurate measurements of the locations os several star images on the film, and then computing the azimuth and elevation of the optical axis of the camera by means of a computer program. This computer program makes use of the celestial coordinates of some 6,000 stars which have been stored on magnetic tape.

Wind speeds and directions are then determined from the location of the trail in space at a succession of known times. The location is found, using either a point location program or a trail location program, of both, and depends on the nature of the chemical release.

Point location method. If the chemical release exhibits discrete points (resulting either from turbulence or from the nature of the release mechanism) and these points can be identified on films from two or more islands, the point location program can be used to calculate the position of each point in longitude, latitude, and altitude above sea level.

These calculations are made from data taken at successive times. A wind program is then used to calculate both vertical and horizontal winds from the motion of these points as a function of time.

Trail location method. Most of the chemical releases produce a smooth trail having few, if any, identifiable points. In such cases, film coordinates of a large number of incremental points along the film image of the trail are fed into the computer from data from two or more islands. The trail location program attempts to triangulate each point from one site with many points from another site, finally choosing points from both sites whose optical paths from camera into space form the closest spatial intersection. After doing many hundreds of such calculations, the computer is able to construct coordinates for a mathematical curve in the shape of the trail in space. Then, as with the point location program, winds can be determined from the motion of the curve with time. Here, however, it must be assumed that vertical winds are essentially zero. This assumption is borne out by previous studies which have shown vertical winds in this altitude region to be of the order of a few meters per second compared to horizontal winds ranging up to 150 meters per second.

Corrections for variables, such as atmospheric refraction, rotation of camera about optical axis, and camera focal length, are incorporated into the programs to maintain high accuracy. Focal length and camera rotation are in fact calculated from measurements of the positions of star images on the films.

INTERPRETATION OF DATA

In the remainder of this report, horizontal wind velocities are presented in tabular form and in plots of wind velocity, heading, components, and shear.

Winds were calculated at altitude intervals of one kilometer. Points on the various plots show the actual computed result, as listed in the table preceding the plot. A curve has been fitted to each set of points to aid in detecting wind patterns and to indicate reliability of the plotted results. Each curve has been drawn with a knowledge of intermediate results leading to the wind calculations and of the consistency of the winds as calculated between each of the five or six time intervals used. In cases where point-to-point curve fitting was not thought to reflect actual variations in wind velocity, heading, components, or shear, a more appropriate smooth curve has been drawn. Otherwise, the curves are fitted directly to the data points. Results of certain portions of the trails are at times less accurate than others due to the spacial orientation of those trail segments relative to the available photographic stations. Less accurate data also can result from photographs obscured by haze and clouds and from trails of short duration.

Wind velocity plot. This plot shows the velocity of the wind vector in meters per second as a function of height in kilometers above sea level.

Wind heading plot. The wind vector is considered to point in the direction toward which the wind is moving. The heading plot shows the DIRECTION OF THIS VECTOR IN DEGREES CLOCKWISE FROM NORTH AS SEEN FROM

direction of this vector in degrees clockwise from north as seen from above. Thus a wind heading toward the east would be ninety degrees.

Wind components plot. While plots of wind heading and velocity do completely describe the wind vector, it has been found helpful in studying wind patterns to present the north-south and east-west velocity components of the vector. In the north-south plot, north is positive; south is negative. In the east-west plot, east is positive, west negative. Components are plotted in meters per second versus height in kilometers.

Wind shear plot. Of considerable interest in upper atmospheric wind studies is the wind shear, or rate of change of velocity with altitude. Shear is plotted in component form showing north-south and east-west shears in meters per second per kilometer versus height in kilometers. The shear components are not listed in tabular form as they are calculated from the curves fitted to the plots of wind velocity components rather than from the points themselves. This approach was found necessary to provide realistic values of wind shear.

SYNOPSIS OF RESULTS

The following comments may be helpful in interpreting the data contained in this report. Only those shots with unusual characteristics are discussed.

Belair. A trail was formed on both the up and down legs of the trajectory which permits two independent studies of the wind profile.

Differences in wind profiles for the up and down trails are shown at some altitudes. These differences have been carefully checked, and it has been found in many cases that the possible errors in velocities are less than the differences in velocity between the up and down trails. Hence, the observed variations are assumed to be primarily due to a change in wind velocity during either the time interval or the spatial separation of the up and down trails. Further study is being planned on the spatial and time variations. On shot Belair, as well as some other shots, plots have been broken into two parts by altitude (with some overlap) due to the long length of the trail.

Magnolia. Original film data for this shot was poor due to weather conditions. One section of trail between 103 and 107 km executed some rather intricate maneuvers which were viewed end-on by one of the two photographic sites, and it was not possible to determine the winds in this region.

Nanticoke. This shot also had poor photographic data due to weather. Results were not as accurate as for most shots, and a smooth curve was fitted to the data points. While data points at 124 km and 125 km were not obtained, the dotted curves are thought to approximate winds in this region.

TABLE OF TRAIL INFORMATION

Trail No.	Name	Date	Time (AST)	Altitudes (Km)
19	Belair	20 Sept. 1965	19:30:00	108-132
20	Conowingo	20 Sept. 1965	20:52:00	88-136
21	Edgewood	21 Sept. 1965	00:24:00	90-123
22	Fountain Green	21 Sept. 1965	02:21:00	88-128
23	Galena	21 Sept. 1965	03:35:00	91-138
24	Havre de Grace	21 Sept. 1965	05:00:00	90-123
25	Linthicum	22 Sept. 1965	19:24:00	91-127
26	Magnolia	23 Sept. 1965	01:50:00	94-126
27	Nanticoke	23 Sept. 1965	03:15:00	98-133
28	Olney	23 Sept. 1965	04:07:00	88-126
29	Perryman	23 Sept. 1965	05:05:00	98-124

TABULATIONS AND PLOTS

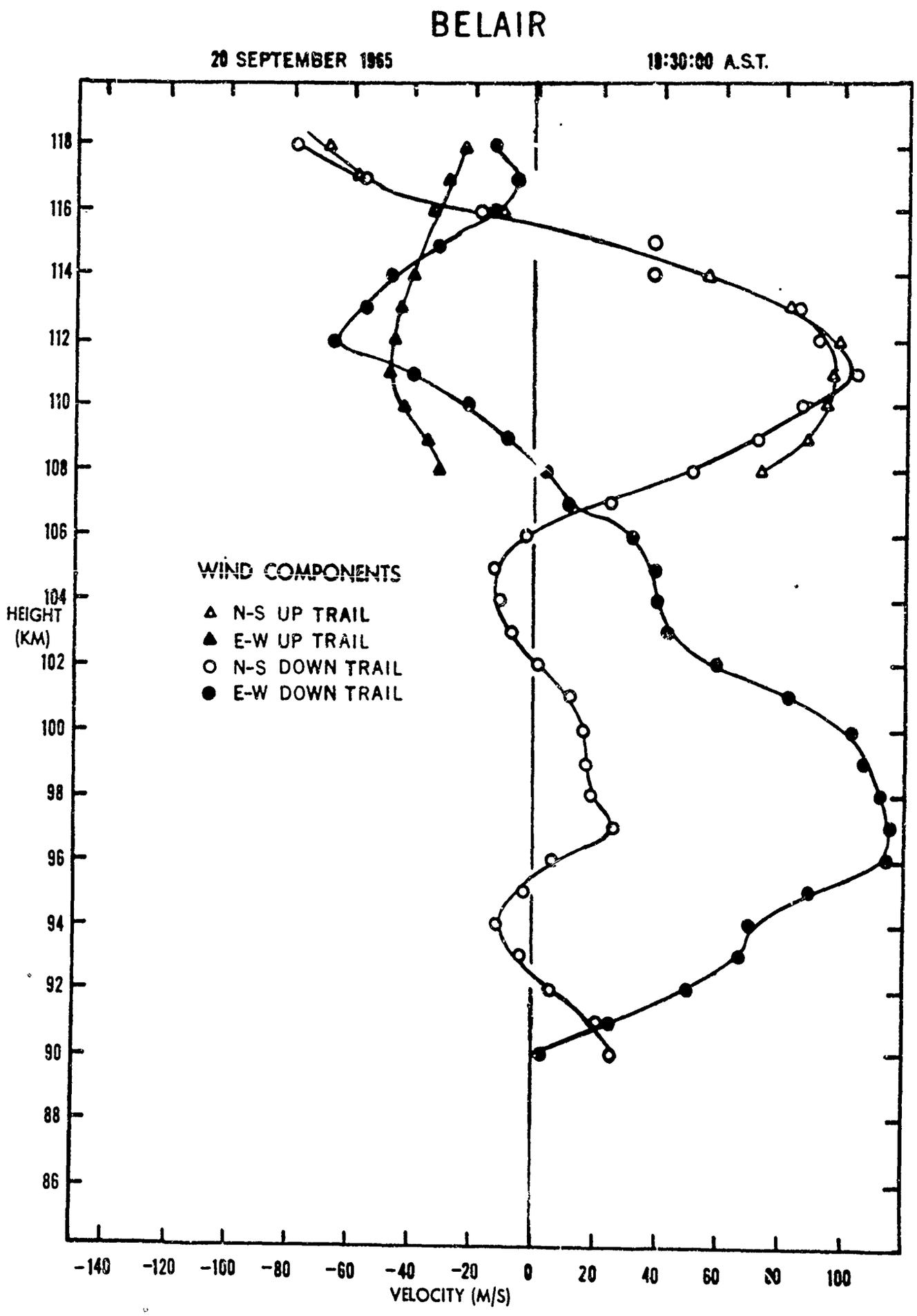
Eleven Trail Releases - September 20-23, 1965

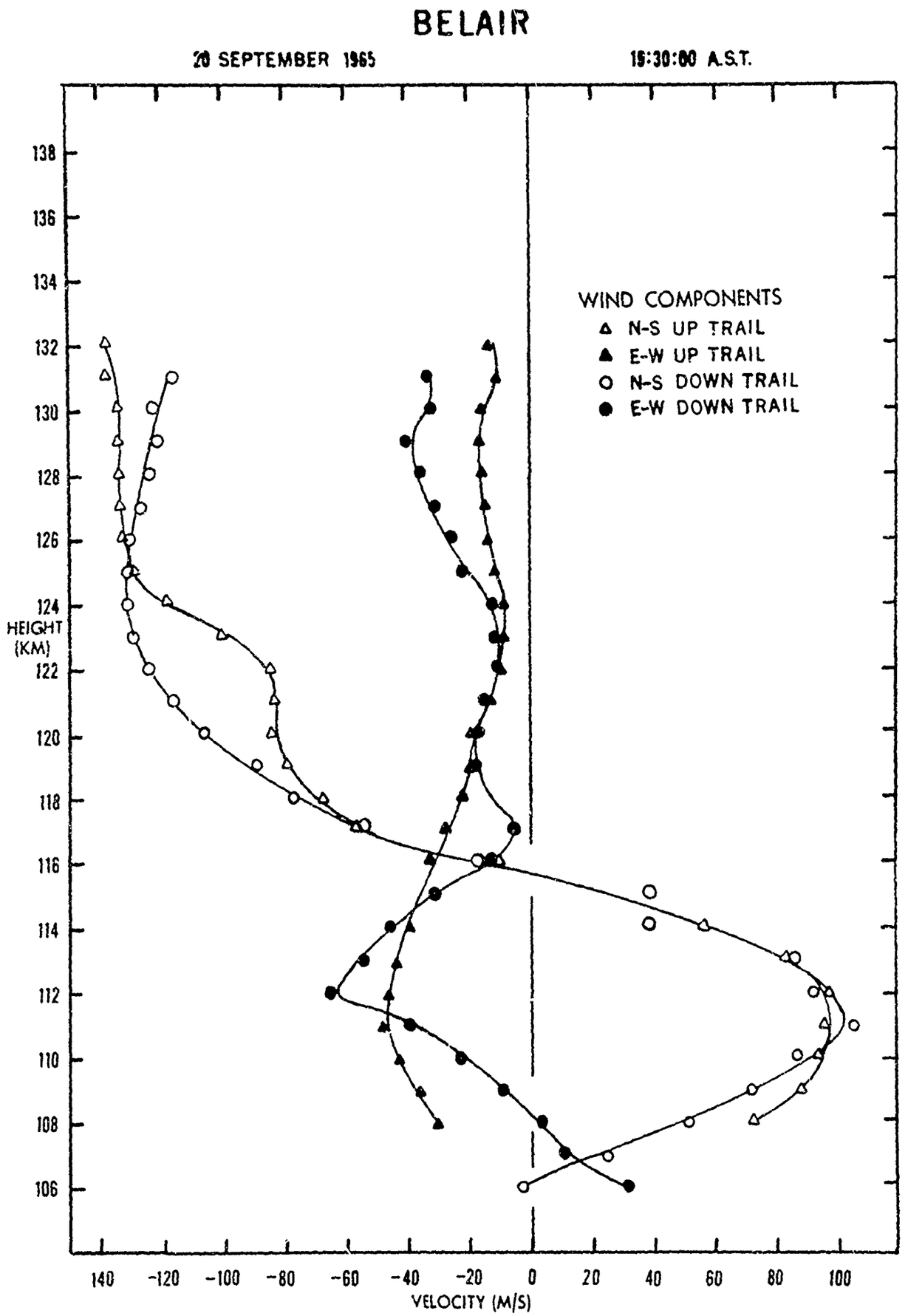
SHOT BELAIR 20 SEPTEMBER 1965 19-30-00 AST
UP TRAIL

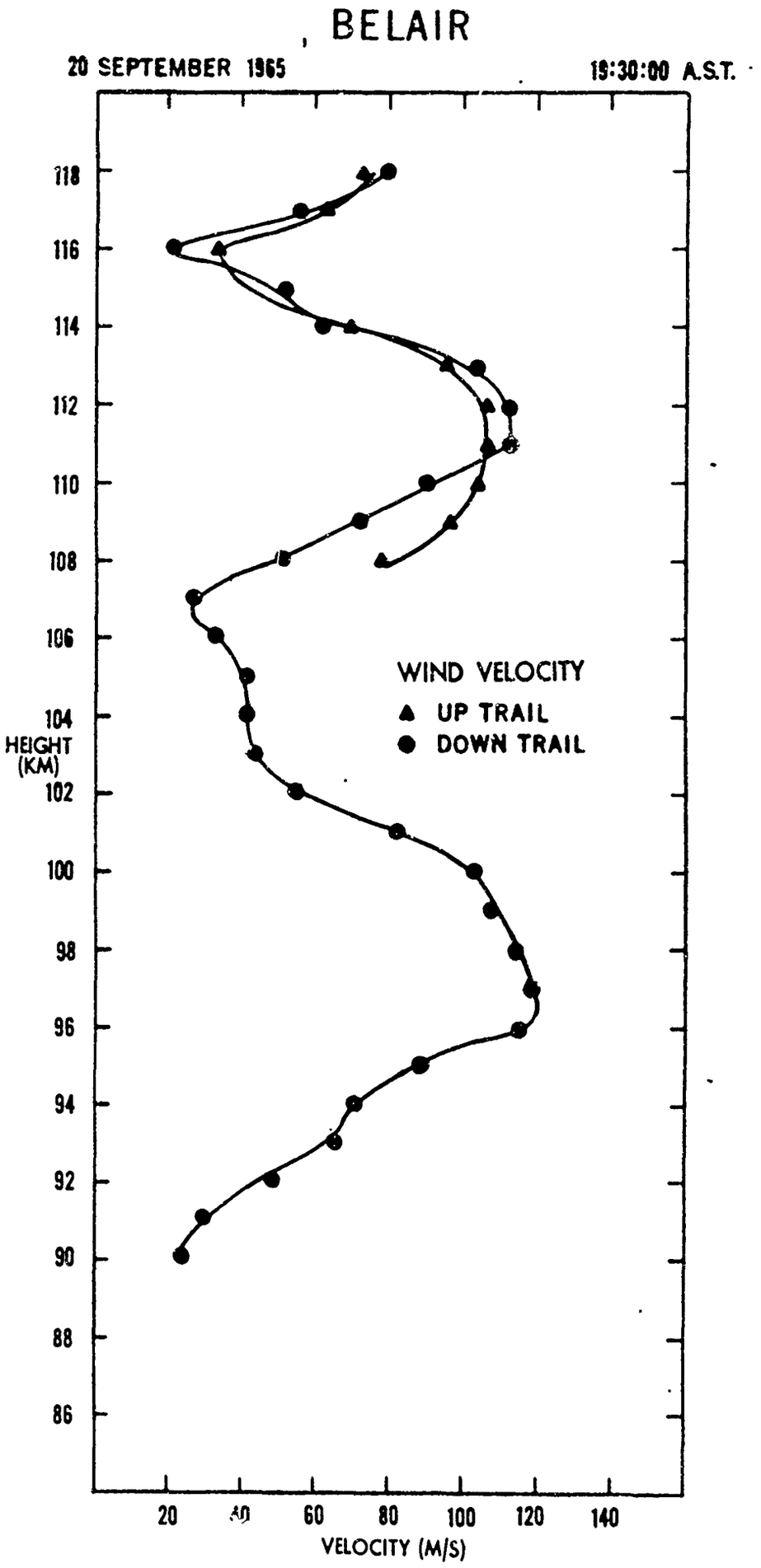
ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
108.0	337.7	79.0	73.1	-30.1
109.0	337.5	96.4	89.1	-36.8
110.0	335.6	103.6	94.3	-42.8
111.0	333.6	107.5	96.3	-47.8
112.0	334.8	107.3	97.1	-45.7
113.0	332.7	94.4	83.8	-43.3
114.0	325.7	69.1	57.1	-38.9
116.0	252.6	34.0	-10.2	-32.4
117.0	206.3	62.9	-56.4	-27.8
118.0	198.4	71.0	-67.3	-22.4
119.0	194.8	81.9	-79.2	-20.9
120.0	192.8	86.3	-84.1	-19.1
121.0	189.3	84.6	-83.5	-13.6
122.0	187.4	84.8	-84.1	-10.9
123.0	185.6	101.4	-100.9	-9.9
124.0	183.8	118.9	-118.6	-7.9
125.0	184.9	129.9	-129.5	-11.1
126.0	185.6	134.2	-133.6	-13.0
127.0	186.3	134.0	-133.2	-14.6
128.0	186.5	135.0	-134.1	-15.3
129.0	186.8	135.8	-134.8	-16.0
130.0	186.6	134.9	-134.0	-15.4
131.0	184.4	138.4	-138.0	-10.6
132.0	185.4	137.5	-136.8	-13.0

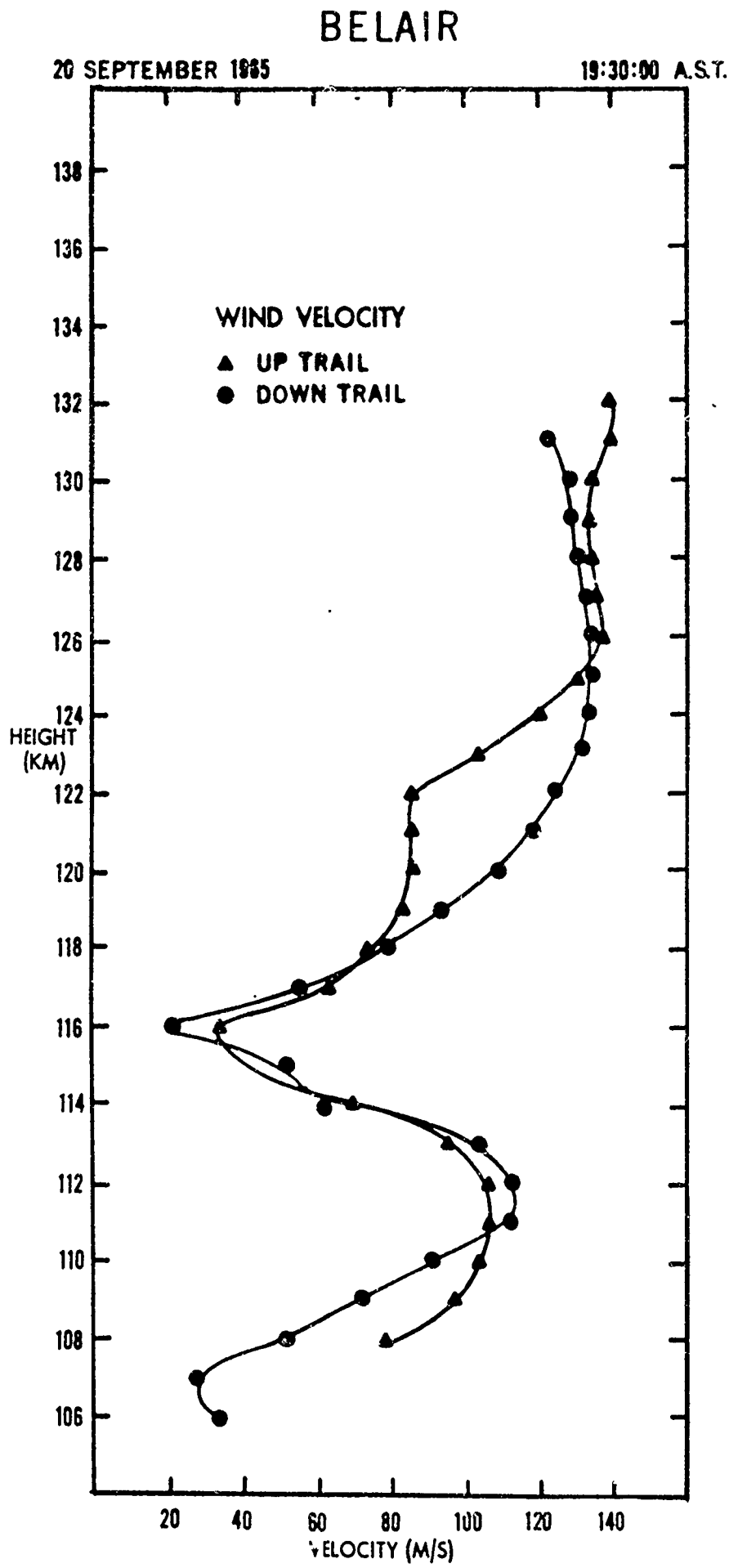
SHOT BELAIR 20 SEPTEMBER 1965 19-30-00 AST
DOWN TRAIL

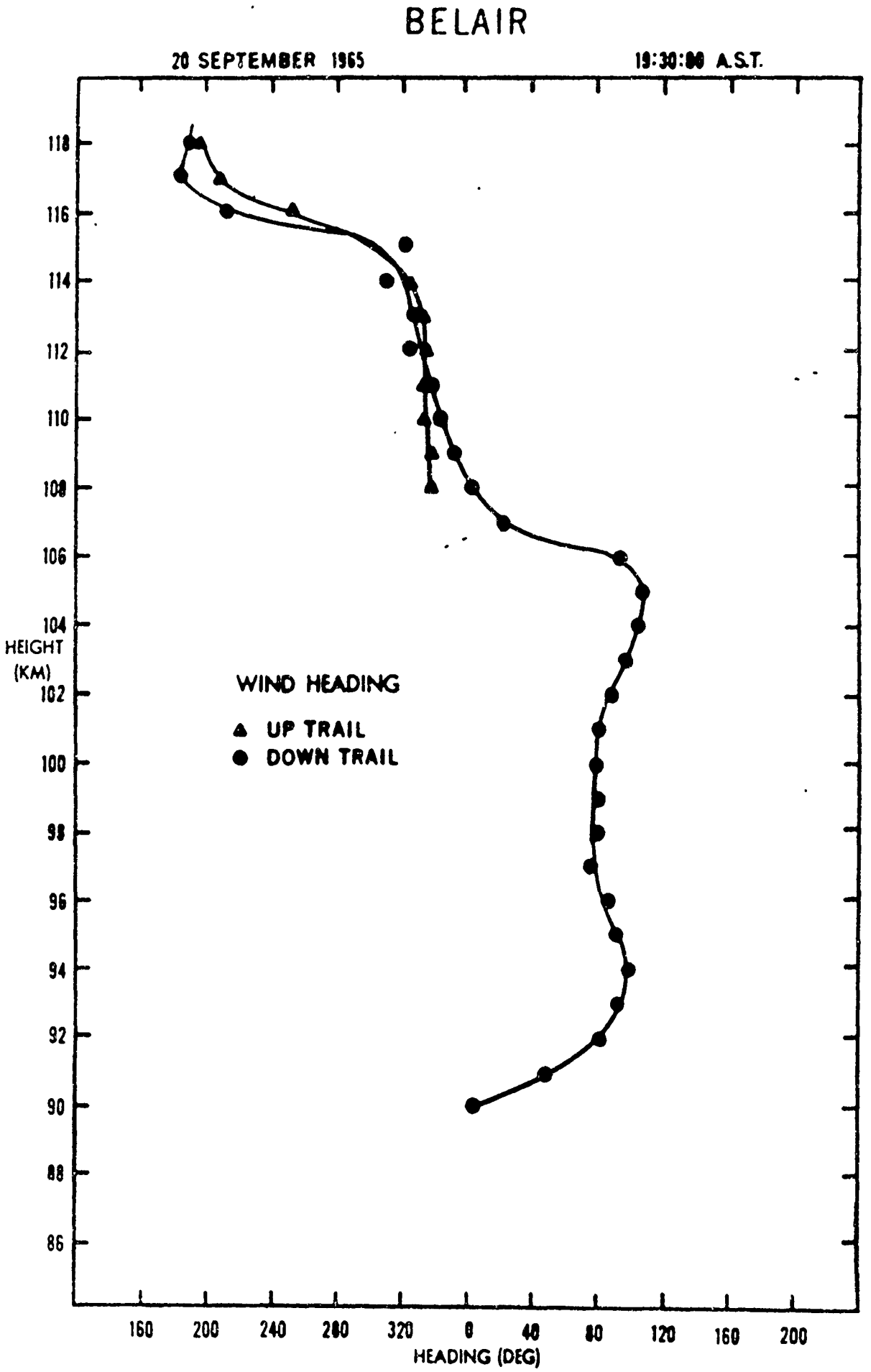
ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
90.0	6.0	26.3	26.2	2.8
91.0	49.9	32.7	21.1	25.0
92.0	82.5	50.6	6.6	50.2
93.0	94.0	67.9	-4.7	67.7
94.0	100.3	72.1	-12.9	70.9
95.0	92.3	89.3	-3.6	89.2
96.0	86.9	115.6	6.2	115.4
97.0	77.0	119.5	27.0	116.5
98.0	80.2	115.3	19.6	113.6
99.0	80.4	109.2	18.1	107.6
100.0	80.4	104.8	17.5	103.4
101.0	81.1	83.1	12.9	82.1
102.0	88.1	55.2	1.9	55.2
103.0	98.0	44.4	-6.2	43.9
104.0	106.0	42.3	-11.7	40.7
105.0	107.9	42.0	-12.9	40.0
106.0	94.1	33.0	-2.4	32.9
107.0	23.4	27.8	25.6	11.0
108.0	5.3	51.5	51.3	4.8
109.0	352.7	72.9	72.3	-9.3
110.0	345.3	90.3	87.3	-22.9
111.0	339.6	112.0	105.0	-39.0
112.0	324.8	112.8	92.3	-65.0
113.0	328.1	103.5	87.8	-54.7
114.0	310.0	61.0	39.2	-46.8
115.0	322.0	50.6	39.9	-31.2
116.0	212.8	20.9	-17.6	-11.3
117.0	184.7	55.5	-55.3	-4.6
118.0	189.7	78.7	-77.6	-13.2
119.0	191.7	92.9	-90.9	-18.8
120.0	189.6	108.1	-106.6	-18.0
121.0	186.8	117.3	-116.5	-14.0
122.0	185.0	123.7	-123.3	-10.8
123.0	185.0	130.4	-129.9	-11.4
124.0	185.4	132.3	-131.7	-12.4
125.0	189.6	133.7	-131.8	-22.3
126.0	191.5	133.0	-130.3	-26.5
127.0	194.1	131.2	-127.2	-31.9
128.0	195.7	129.5	-124.6	-35.1
129.0	198.6	127.7	-121.1	-40.6
130.0	194.5	126.8	-122.7	-31.8
131.0	196.2	120.9	-116.1	-33.7

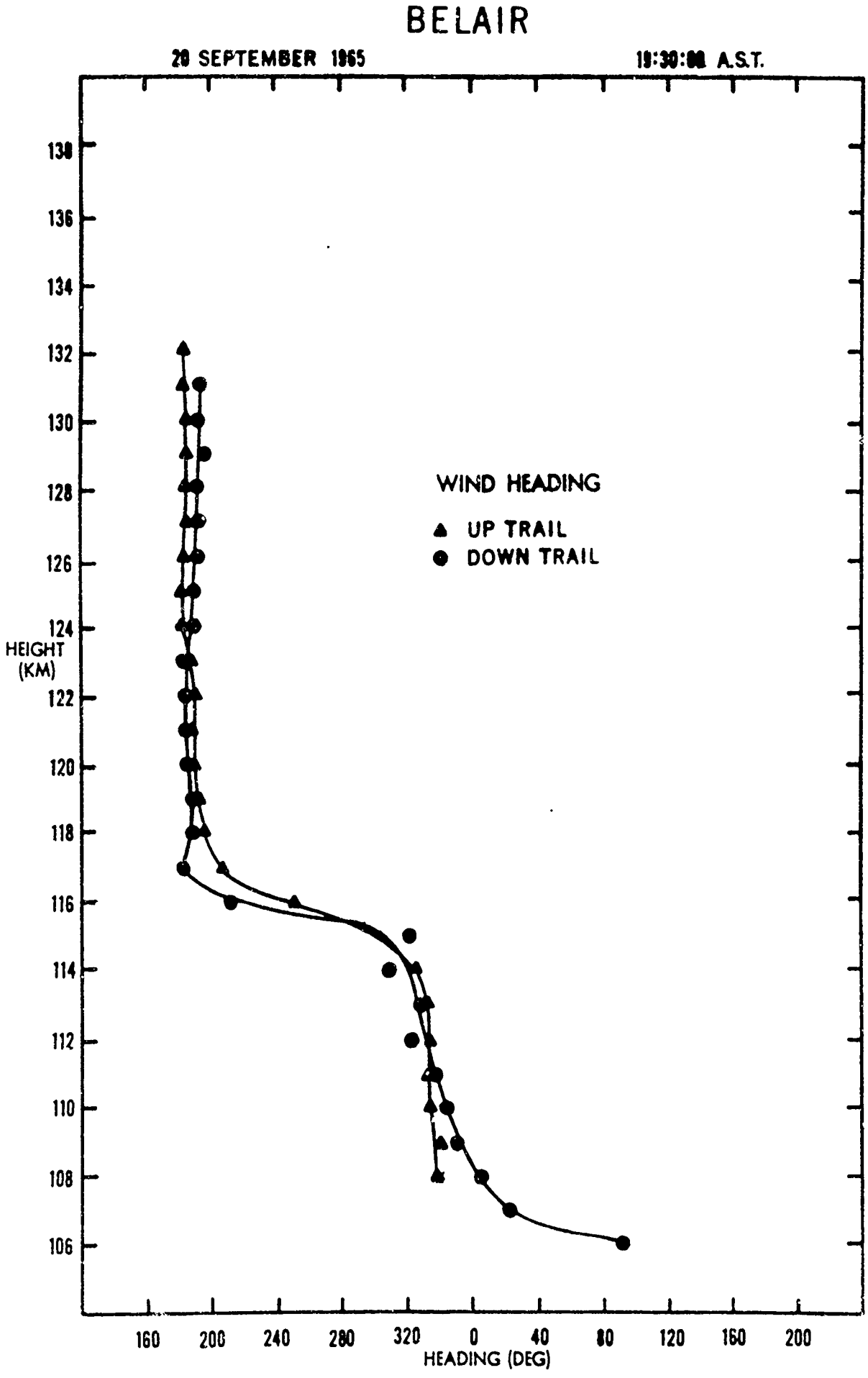

BELAIR
20 SEPTEMBER 1965
18:30:00 A.S.T.
WIND COMPONENTS
N-S UP TRAIL
E-W UP TRAIL
N-S DOWN TRAIL
E-W DOWN TRAIL
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)

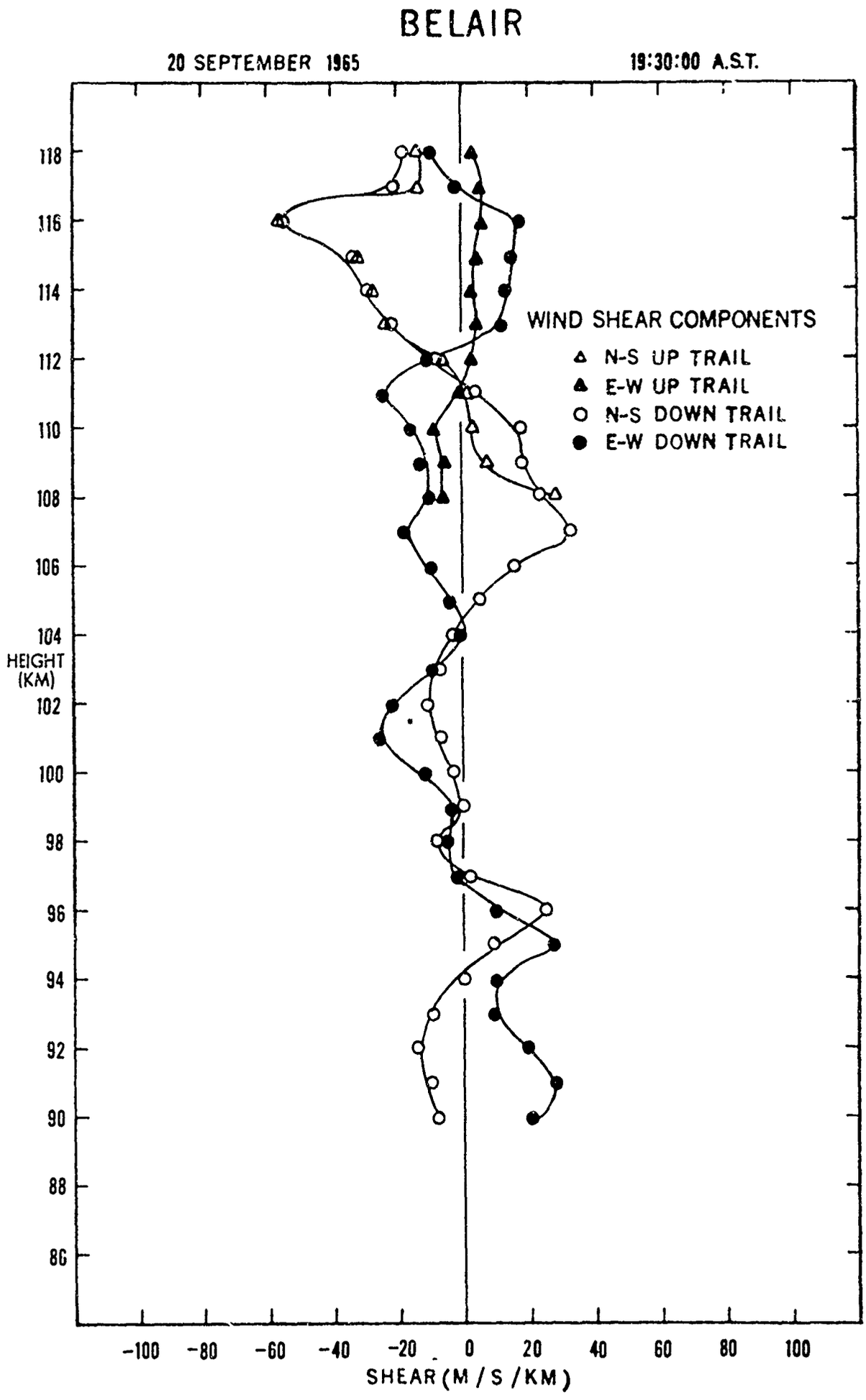

BELAIR
20 SEPTEMBER 1965
19:30:00 A.S.T.
WIND COMPONENTS
N-S UP TRAIL
E-W UP TRAIL
N-S DOWN TRAIL
E-W DOWN TRAIL
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)


BELAIR
20 SEPTEMBER 1965
19:30:00 A.S.T.
118
116
114
112
110
108
106
104
HEIGHT (KM)
102
100
98
96
94
92
90
88
86
WIND VELOCITY
UP TRAIL
DOWN TRAIL
20
40
60
80
100
120
140
VELOCITY (M/S)


BELAIR
20 SEPTEMBER 1965
19:30:00 A.S.T.
WIND VELOCITY
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
20
40
60
80
100
120
140
VELOCITY (M/S)


BELAIR
20 SEPTEMBER 1965
19:30:00 A.S.T.
118
116
114
112
110
108
106
104
HEIGHT
(KM)
102
100
98
96
94
92
90
88
86
WIND HEADING
UP TRAIL
DOWN TRAIL
160
200
240
280
320
0
40
80
120
160
200
HEADING (DEG)


BELAIR
20 SEPTEMBER 1965
19:30:00 A.S.T.
WIND HEADING
UP TRAIL
DOWN TRAIL
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
160
200
240
280
320
0
40
80
120
160
200
HEADING (DEG)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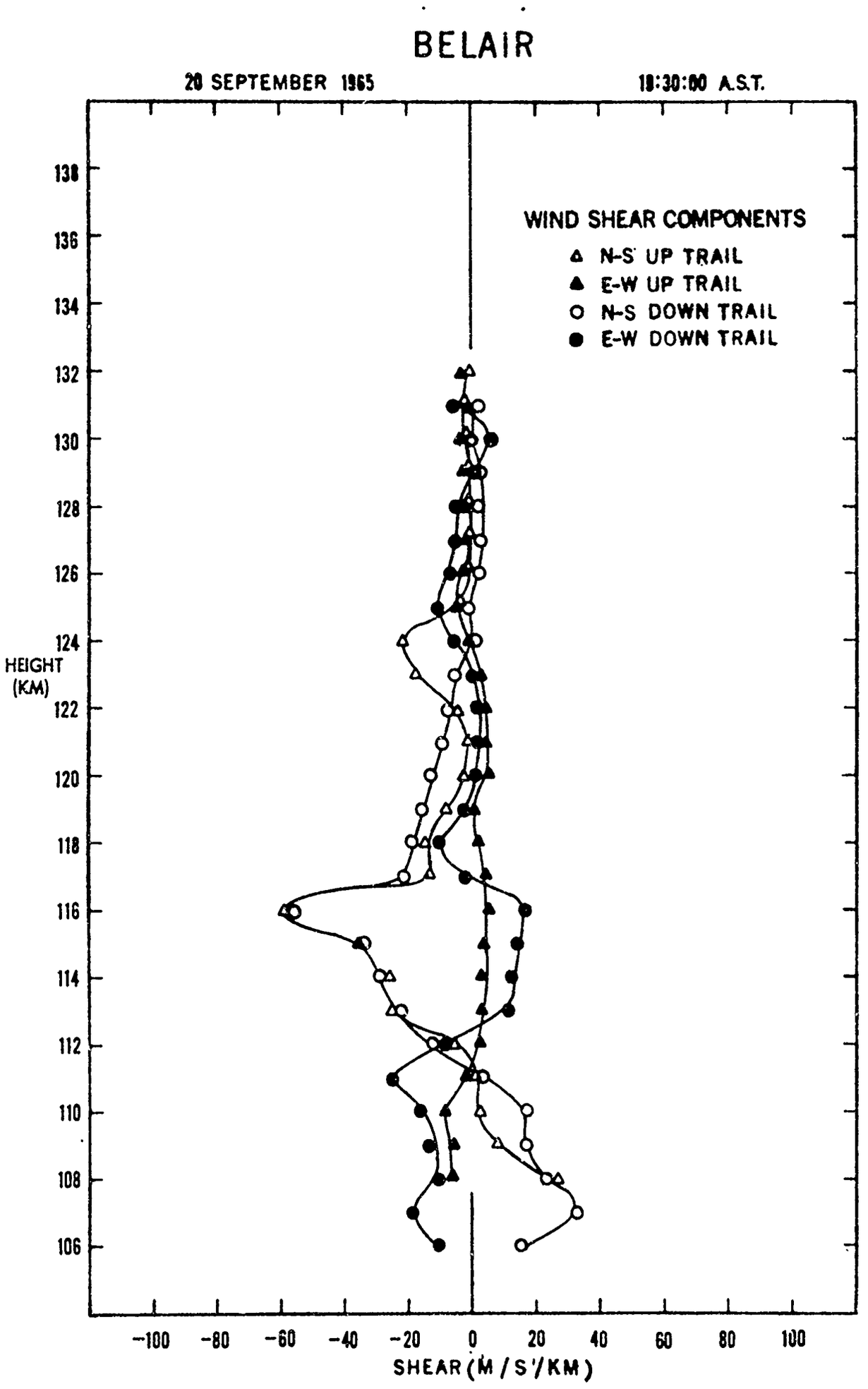
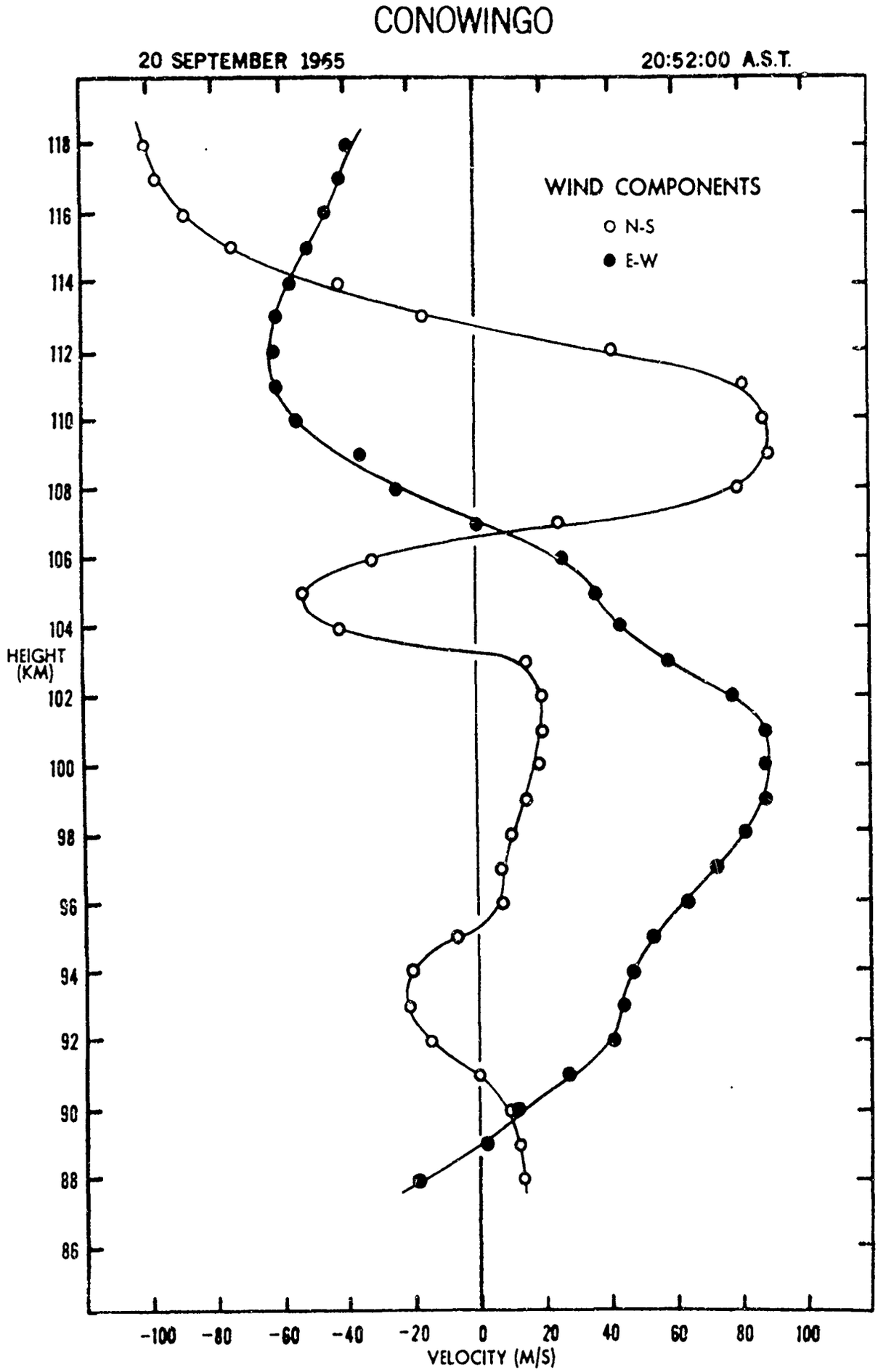
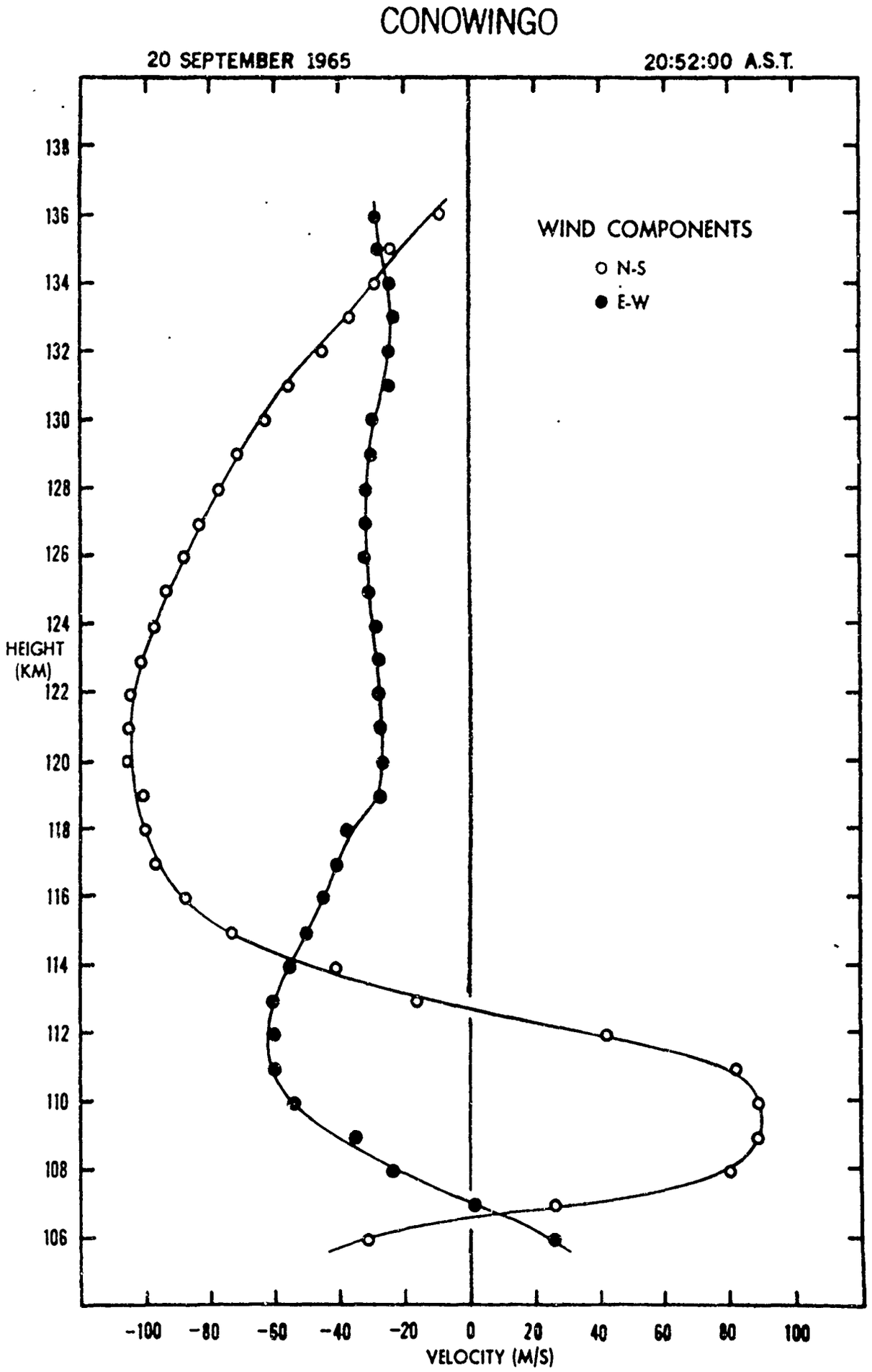
20 SEPTEMBER 1965
19:30:00 A.S.T.
WIND SHEAR COMPONENTS
N-S UP TRAIL
E-W UP TRAIL
N-S DOWN TRAIL
E-W DOWN TRAIL
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M / S / KM)

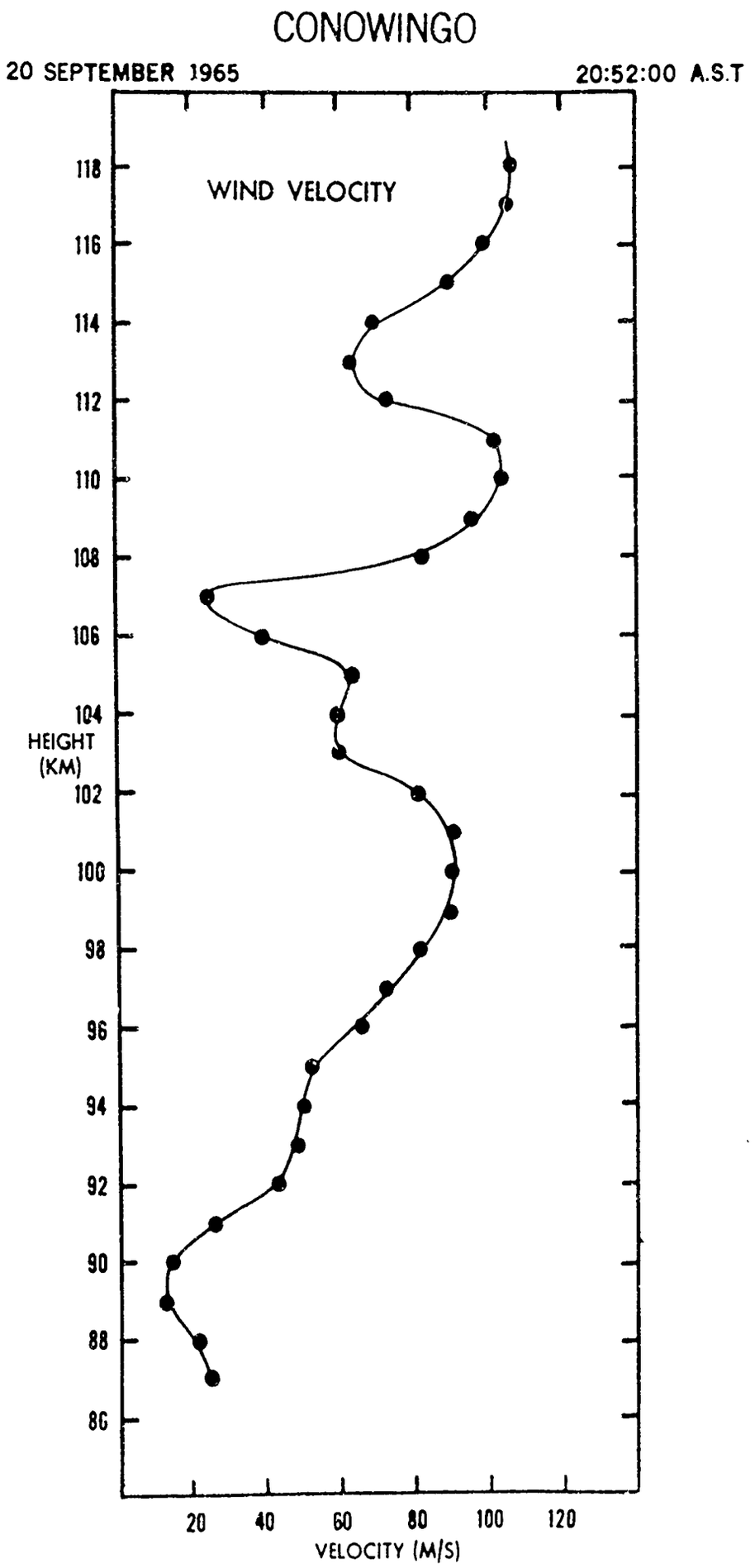

BELAIR
20 SEPTEMBER 1965
18:30:00 A.S.T.
WIND SHEAR COMPONENTS
N-S UP TRAIL
E-W UP TRAIL
N-S DOWN TRAIL
E-W DOWN TRAIL
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M/S/KM)

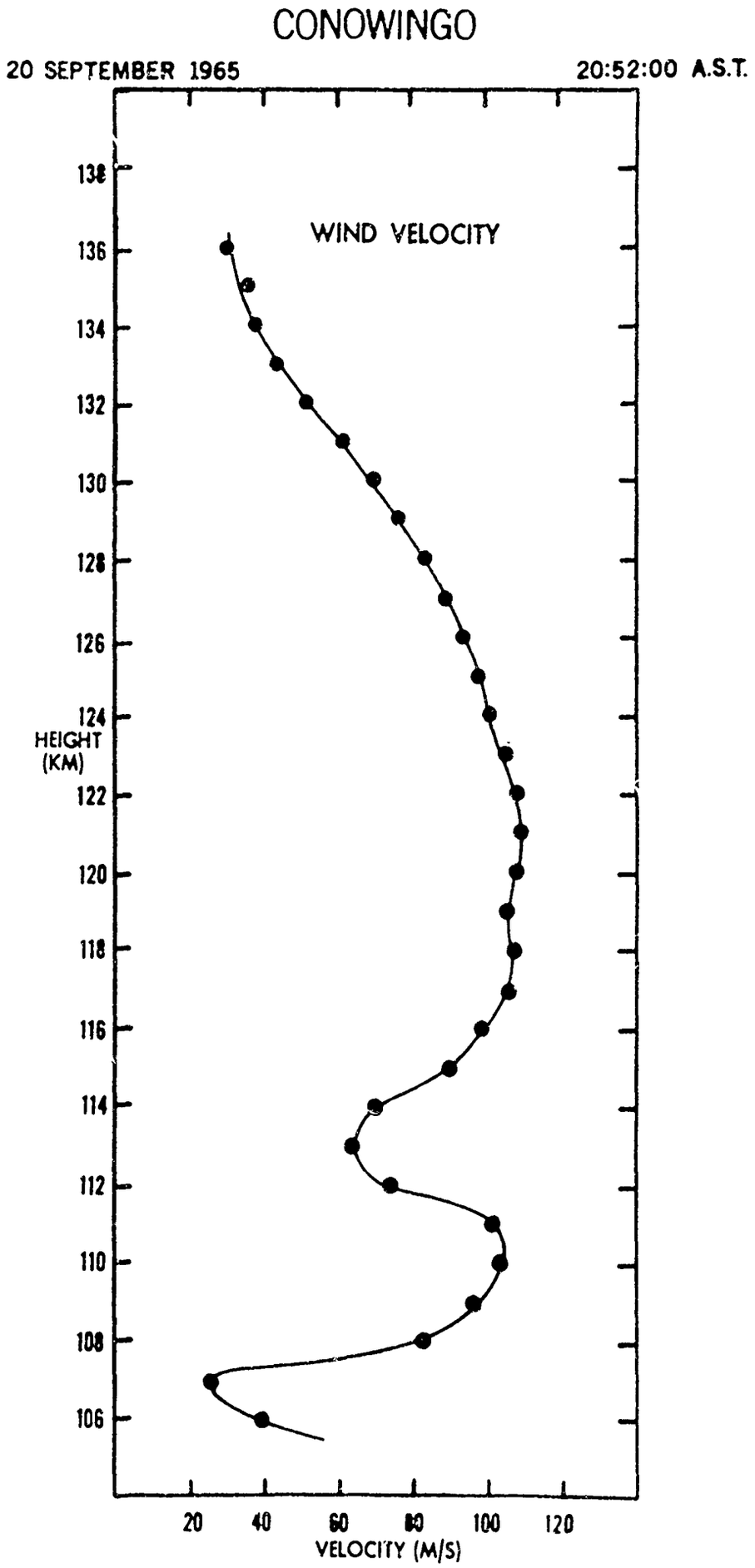
SHOT CONOWINGO 20 SEPTEMBER 1965 20-52-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
88.0	304.2	22.7	12.7	-18.8
89.0	9.6	13.5	13.3	2.3
90.0	46.8	15.6	10.7	11.4
91.0	87.8	27.5	1.0	27.4
92.0	109.3	44.0	-14.5	41.5
93.0	116.0	49.0	-21.4	44.0
94.0	113.9	50.7	-20.6	46.4
95.0	96.9	53.7	-6.5	53.4
96.0	82.8	66.0	8.3	65.5
97.0	84.0	73.8	7.7	73.4
98.0	82.9	82.5	10.2	81.9
99.0	79.9	90.2	15.8	88.8
100.0	77.9	90.2	19.0	88.2
101.0	76.7	91.2	21.0	88.8
102.0	75.6	82.5	20.6	79.9
103.0	75.3	60.5	15.3	58.5
104.0	133.2	60.1	-41.2	43.8
105.0	143.9	64.4	-52.0	37.9
106.0	139.8	40.6	-31.0	26.2
107.0	1.6	25.7	25.7	0.7
108.0	343.1	83.3	79.7	-24.2
109.0	338.4	96.1	89.3	-35.4
110.0	328.6	104.1	88.8	-54.3
111.0	323.5	102.1	82.1	-60.7
112.0	303.9	74.5	41.5	-61.8
113.0	254.7	64.0	-16.9	-61.8
114.0	233.5	70.2	-41.7	-56.4
115.0	214.8	90.3	-74.1	-51.5
116.0	206.9	99.7	-88.9	-45.0
117.0	203.0	106.2	-97.7	-41.5
118.0	200.7	107.7	-100.8	-38.1
119.0	195.9	105.4	-101.4	-28.8
120.0	194.6	108.6	-105.1	-27.5
121.0	195.1	109.5	-105.7	-28.5
122.0	194.9	108.8	-105.1	-28.0
123.0	195.7	105.9	-101.9	-28.7
124.0	196.6	101.8	-97.5	-29.1
125.0	198.4	98.6	-93.5	-31.1
126.0	199.9	94.2	-88.5	-32.1
127.0	201.6	89.4	-83.2	-32.9
128.0	202.9	84.2	-77.6	-32.7
129.0	203.0	77.7	-71.5	-30.4
130.0	205.2	70.5	-63.8	-30.1
131.0	204.0	62.0	-56.6	-25.2
132.0	208.8	52.3	-45.8	-25.2
133.0	211.5	44.4	-37.8	-23.2
134.0	221.7	38.8	-29.0	-25.8
135.0	229.5	37.8	-24.5	-28.7
136.0	252.9	30.7	-9.0	-29.3


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND COMPONENTS
O N-S
● E-W
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T
WIND VELOCITY
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
20
40
60
80
100
120
VELOCITY (M/S)


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
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118
116
114
112
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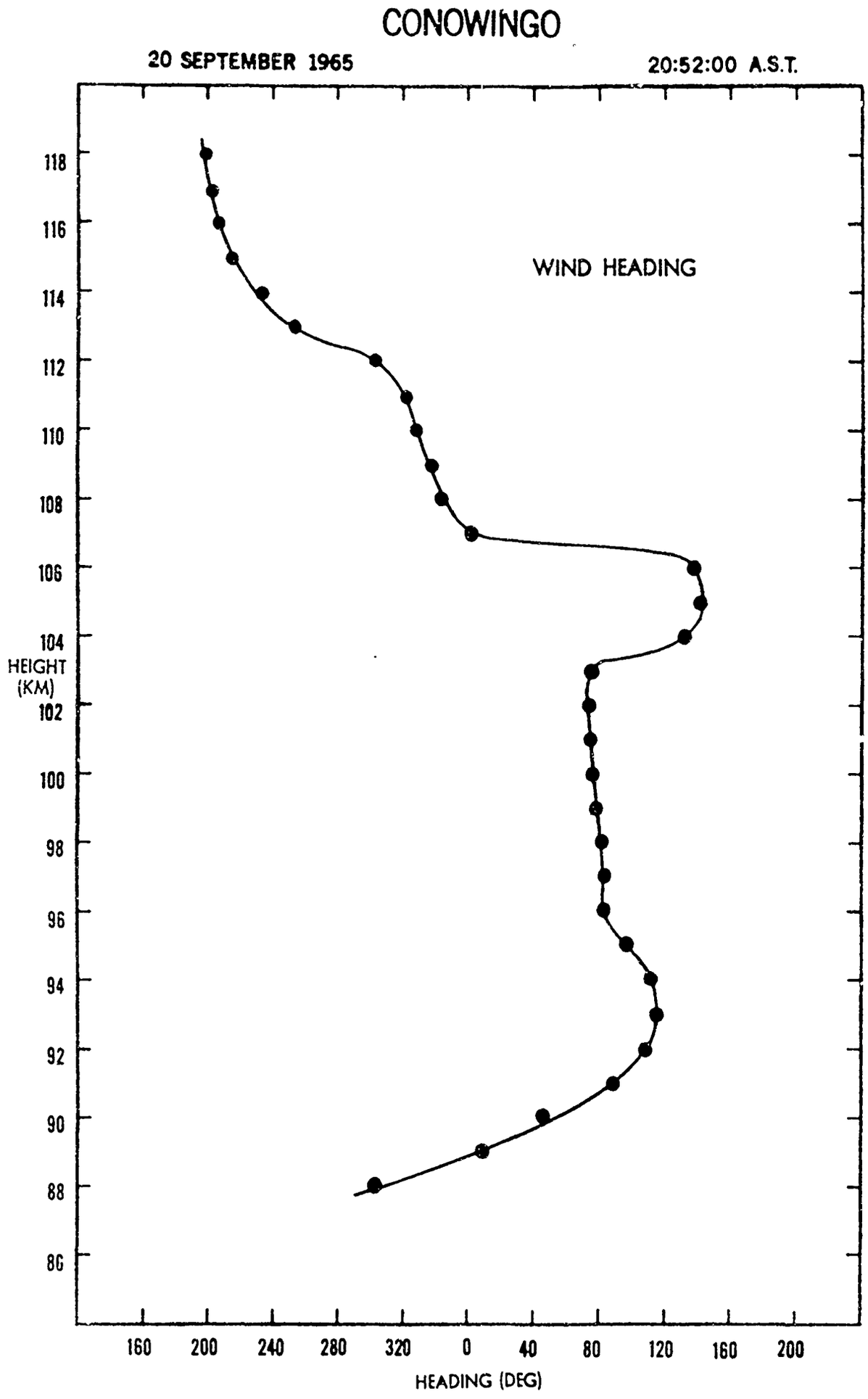
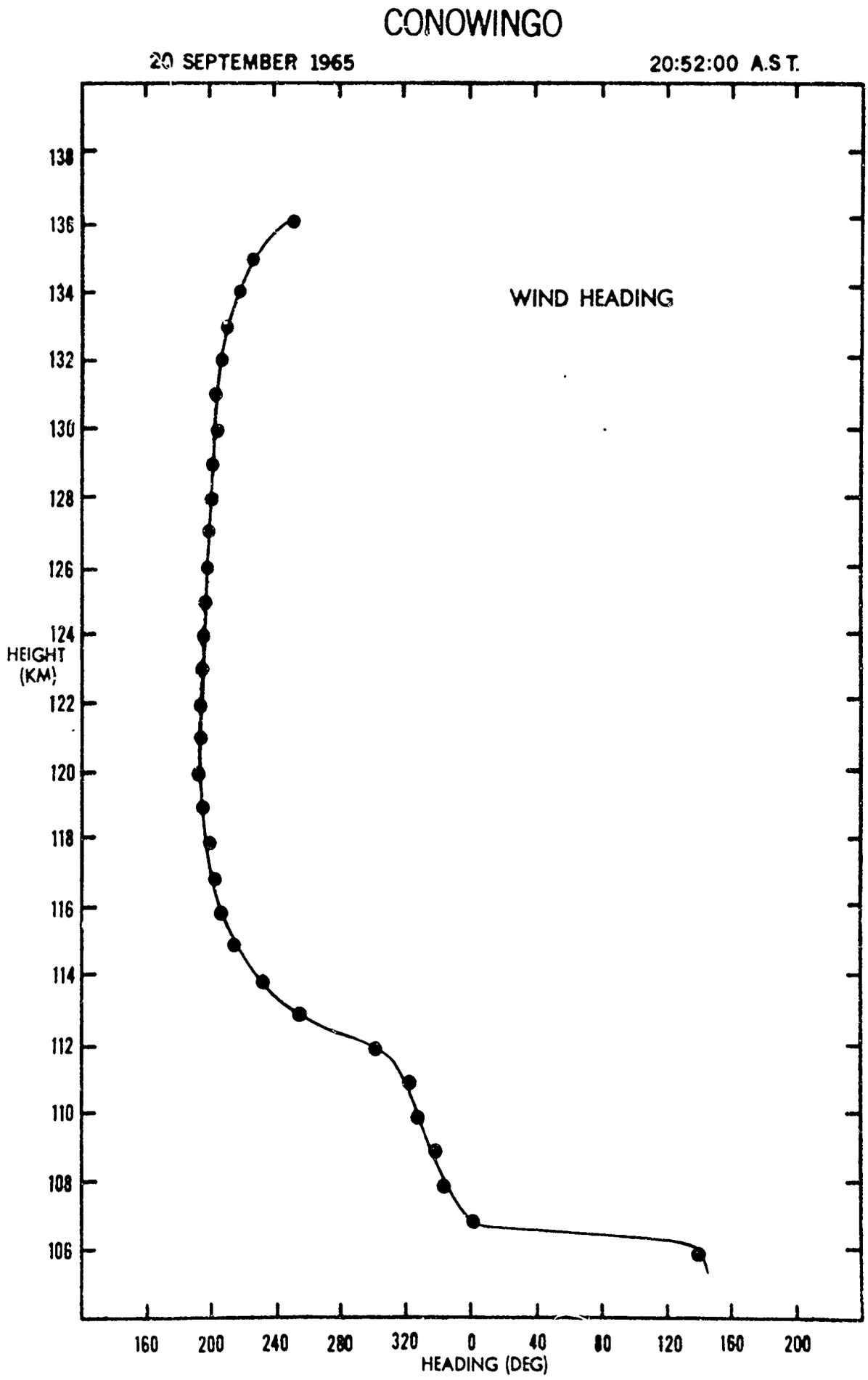
108
106
20
40
60
80
100
120
VELOCITY (M/S)


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND HEADING
118
116
114
112
110
108
106
104
HEIGHT
(KM)
102
100
98
96
94
92
90
88
86
160
200
240
280
320
0
40
80
120
160
200
HEADING (DEG)


CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND HEADING
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
160
200
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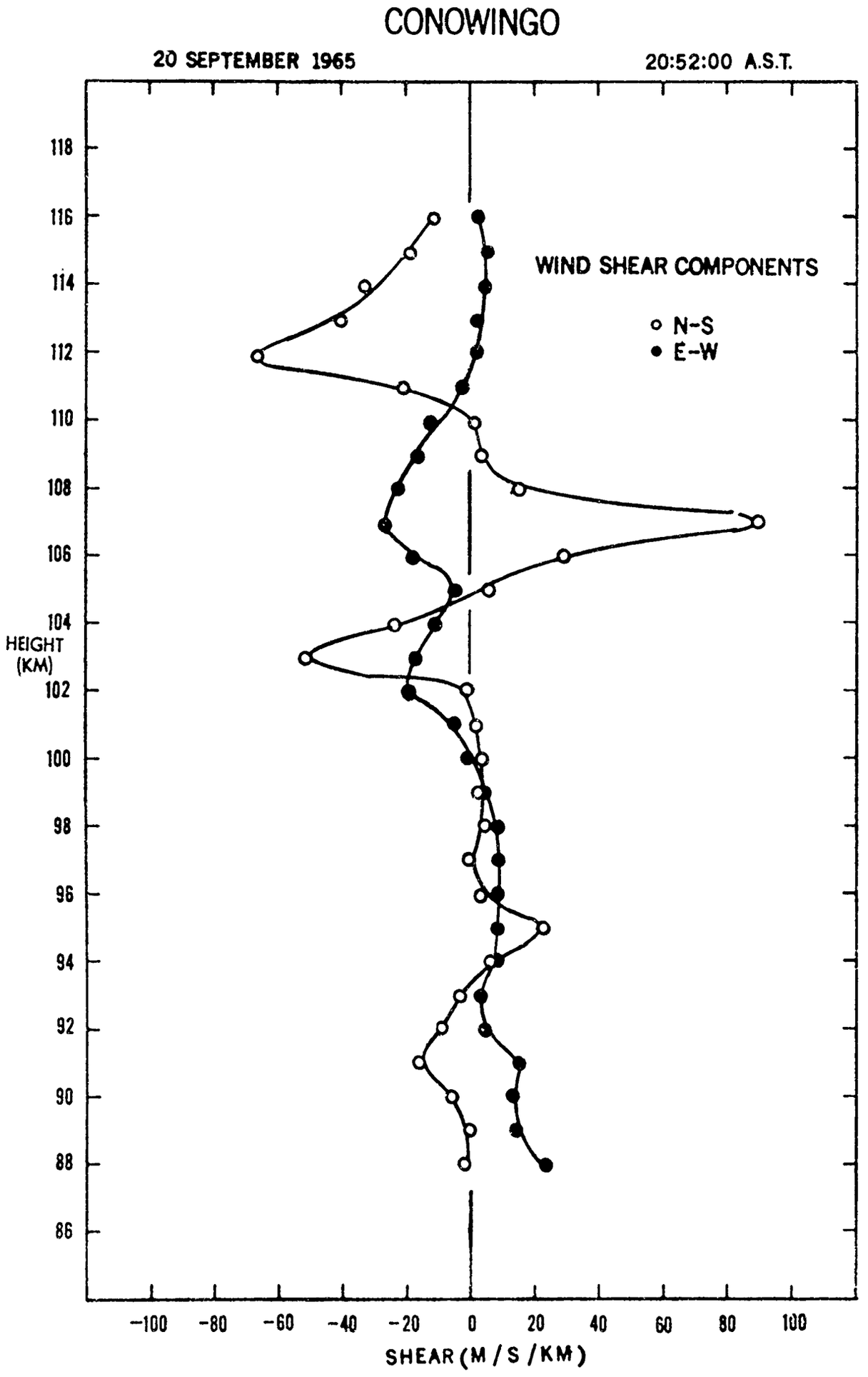
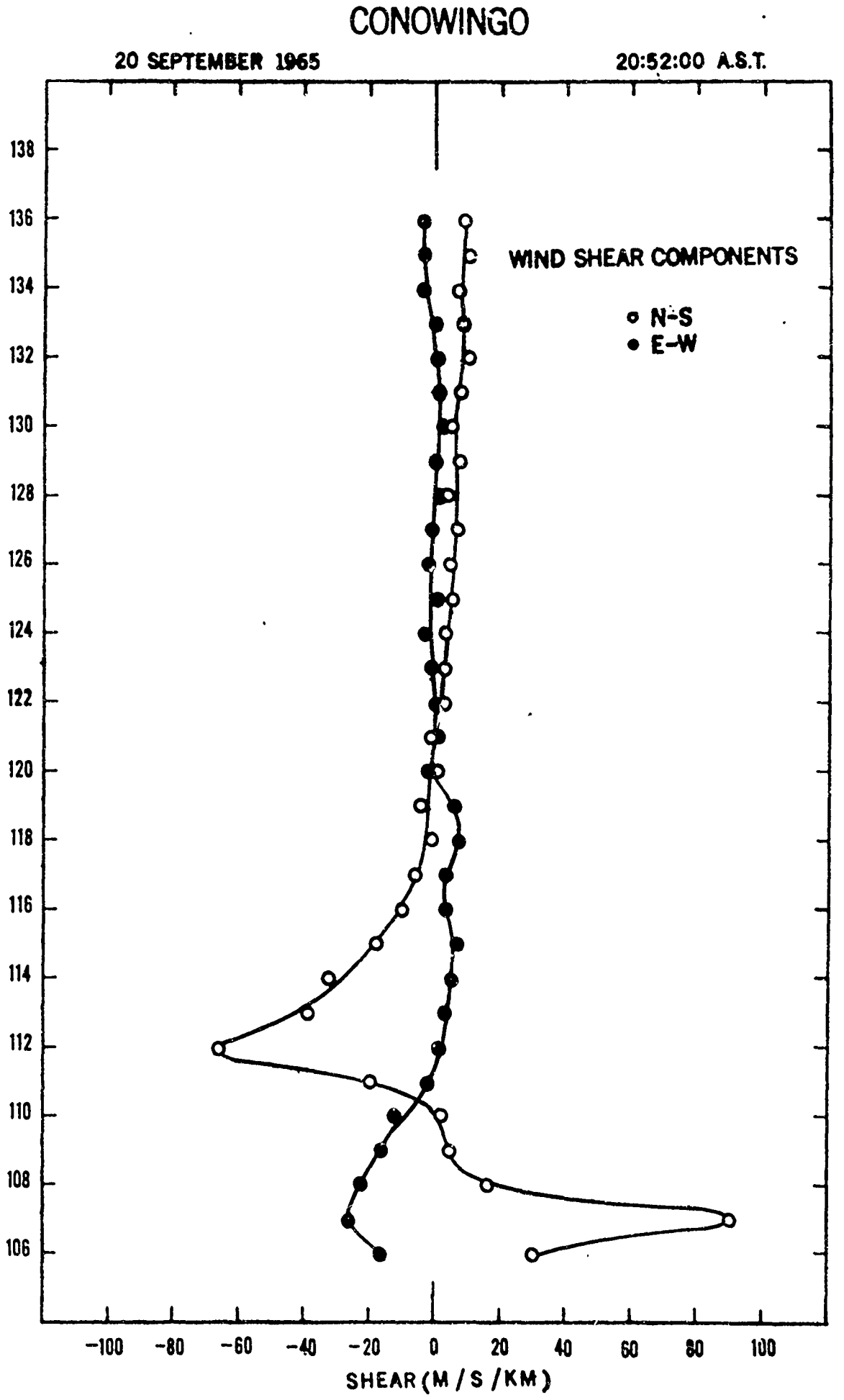
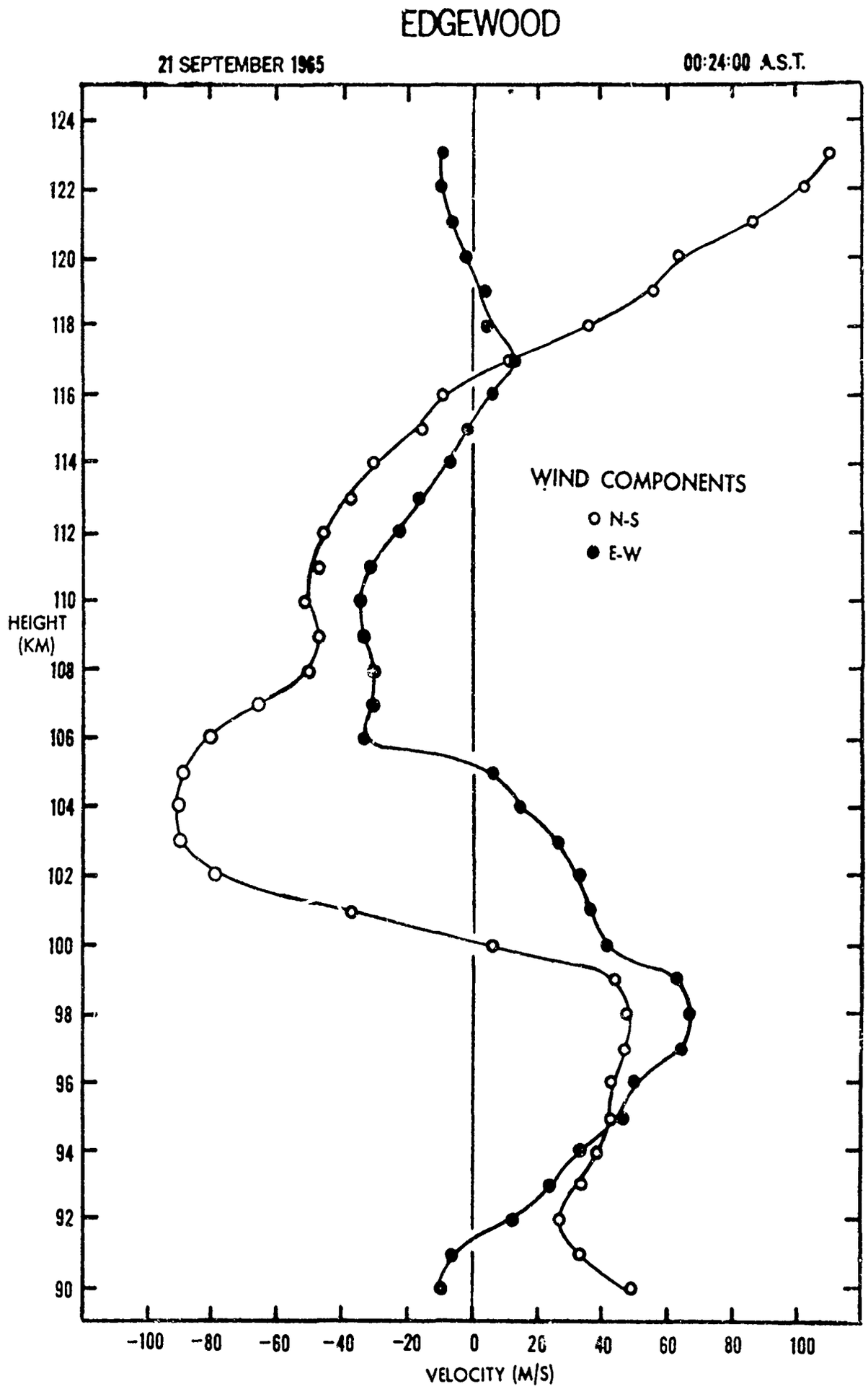
320
0
40
80
120
160
200
HEADING (DEG)

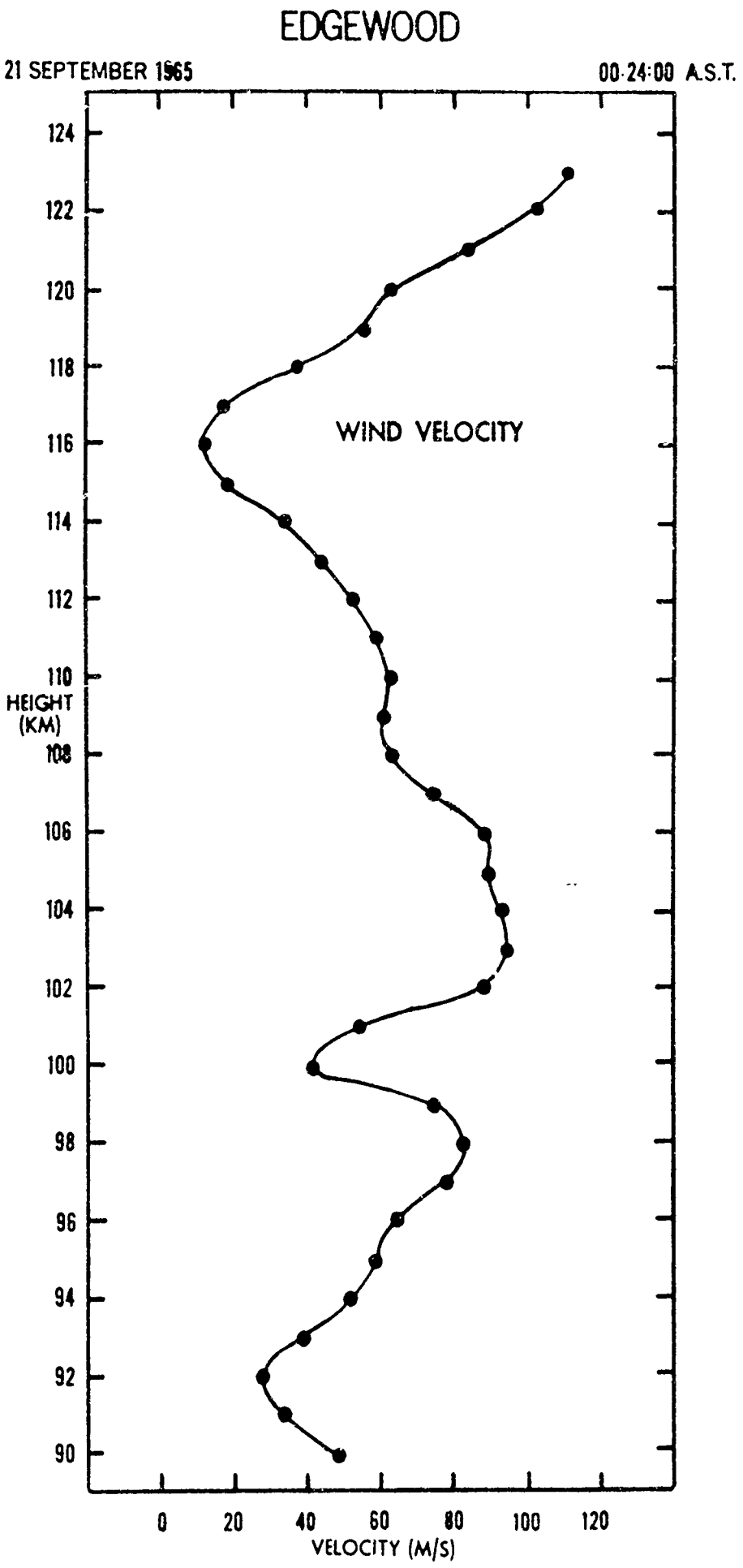

CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M / S / KM)

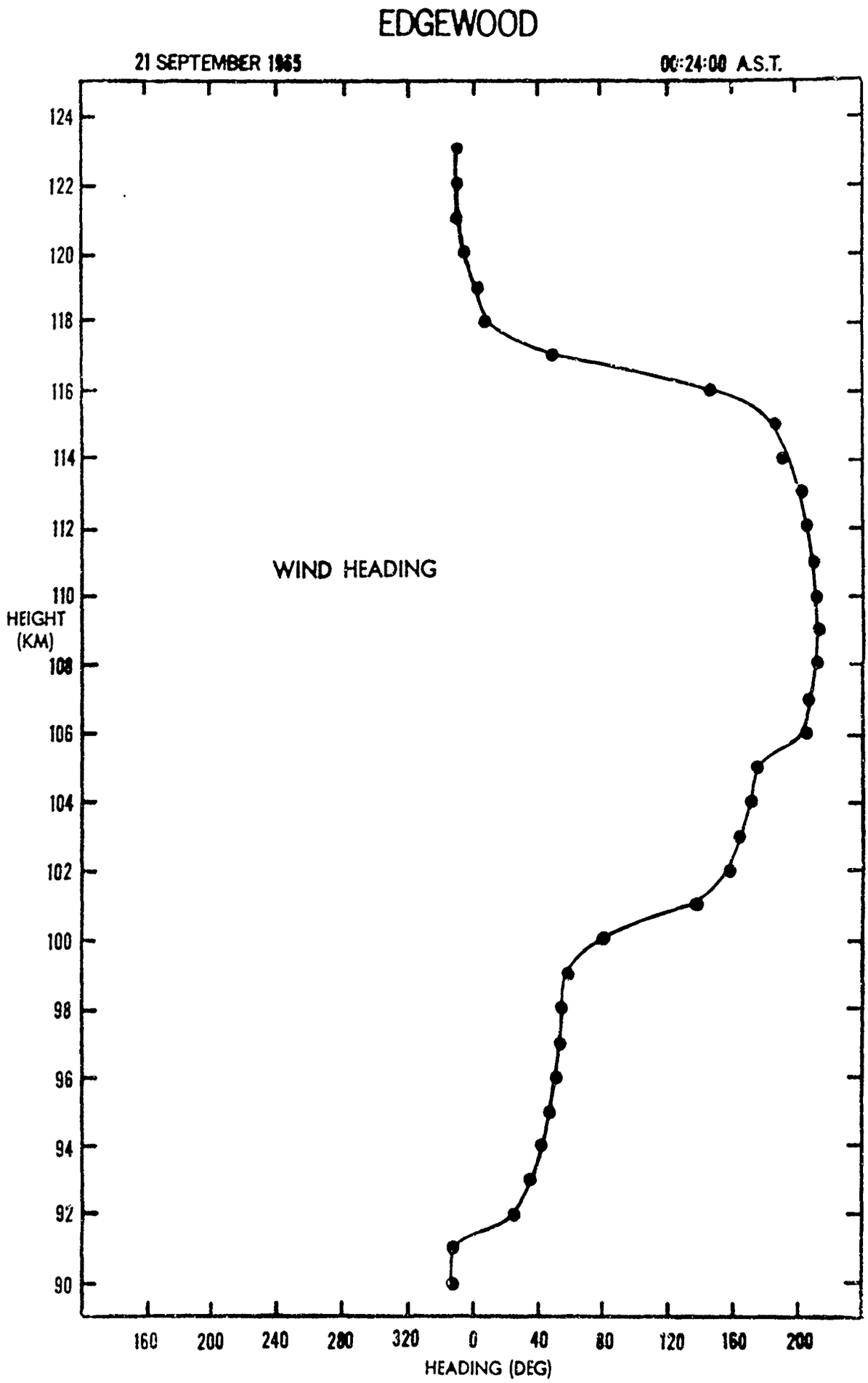

CONOWINGO
20 SEPTEMBER 1965
20:52:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M / S / KM)

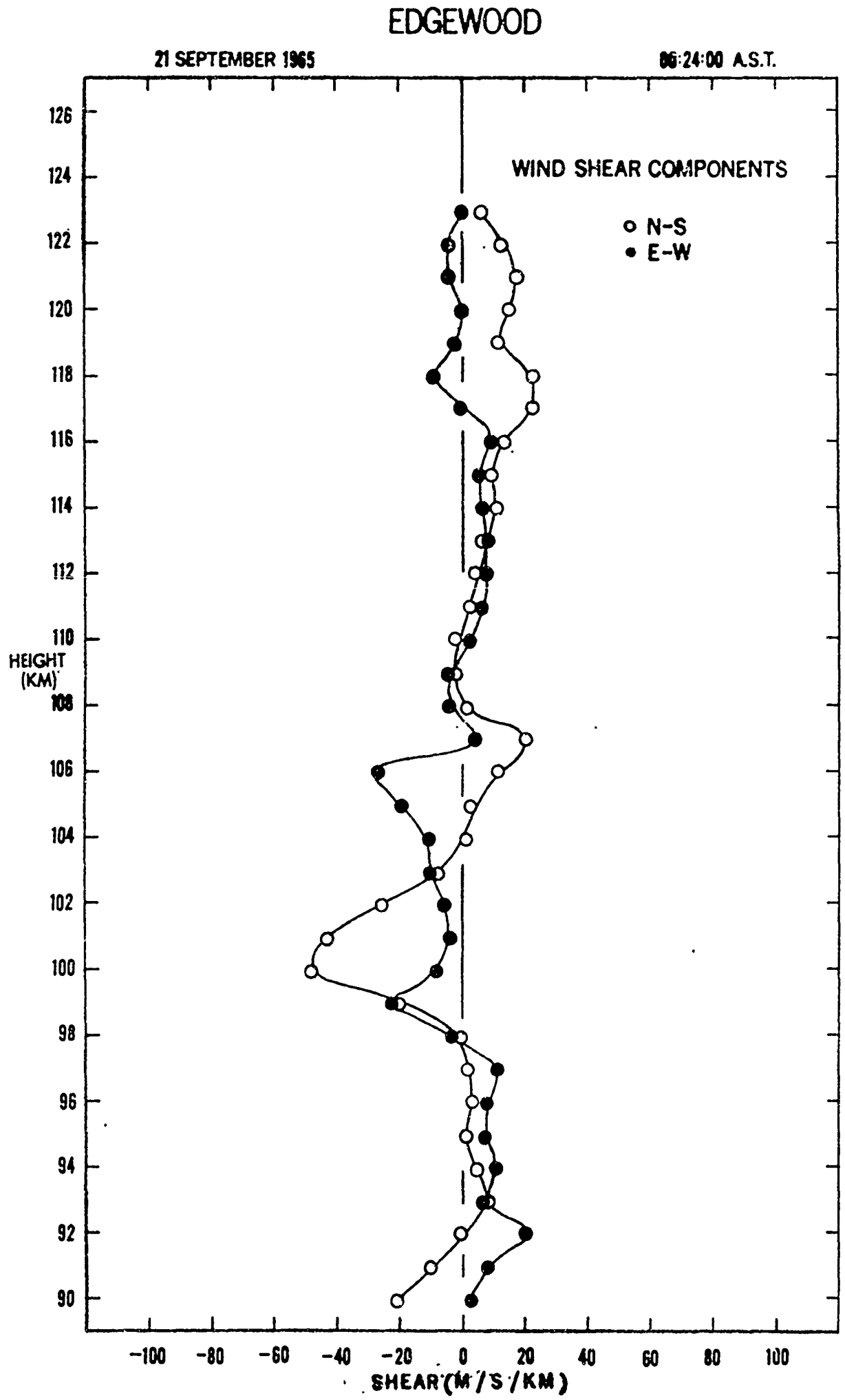
SHOT EDGEWOOD 21 SEPTEMBER 1965 00-24-00 AS.

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
90.0	348.2	49.0	48.0	-10.0
91.0	348.8	33.4	32.8	-6.5
92.0	26.0	28.5	25.6	12.5
93.0	36.9	39.8	31.8	23.9
94.0	42.8	51.4	37.7	34.9
95.0	46.3	59.7	41.2	43.1
96.0	50.2	64.6	41.4	49.6
97.0	53.8	78.6	46.4	63.4
98.0	55.5	82.0	46.5	67.6
99.0	55.3	74.9	42.6	61.6
100.0	81.7	40.3	5.8	39.9
101.0	136.4	53.4	-38.7	36.9
102.0	158.0	87.0	-80.6	32.6
103.0	163.6	93.8	-90.0	26.5
104.0	170.2	91.9	-90.6	15.7
105.0	175.9	89.7	-89.5	6.4
106.0	203.9	88.2	-80.7	-35.8
107.0	205.5	74.0	-66.8	-31.8
108.0	211.0	61.0	-52.3	-31.4
109.0	215.9	60.5	-49.0	-35.5
110.0	212.9	62.7	-52.6	-34.0
111.0	212.6	58.9	-49.7	-31.7
112.0	206.0	51.3	-46.1	-22.4
113.0	203.1	43.2	-39.8	-17.0
114.0	197.1	33.2	-31.7	-9.8
115.0	186.0	17.7	-17.6	-1.8
116.0	148.5	12.4	-10.6	6.5
117.0	52.1	16.9	10.4	13.3
118.0	10.2	37.2	36.6	6.6
119.0	5.8	55.8	55.5	5.6
120.0	358.1	61.9	61.9	-2.0
121.0	354.6	83.5	83.2	-7.9
122.0	354.3	101.3	100.8	-10.1
123.0	354.3	110.5	109.9	-10.9


EDGEWOOD
21 SEPTEMBER 1965
00:24:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)

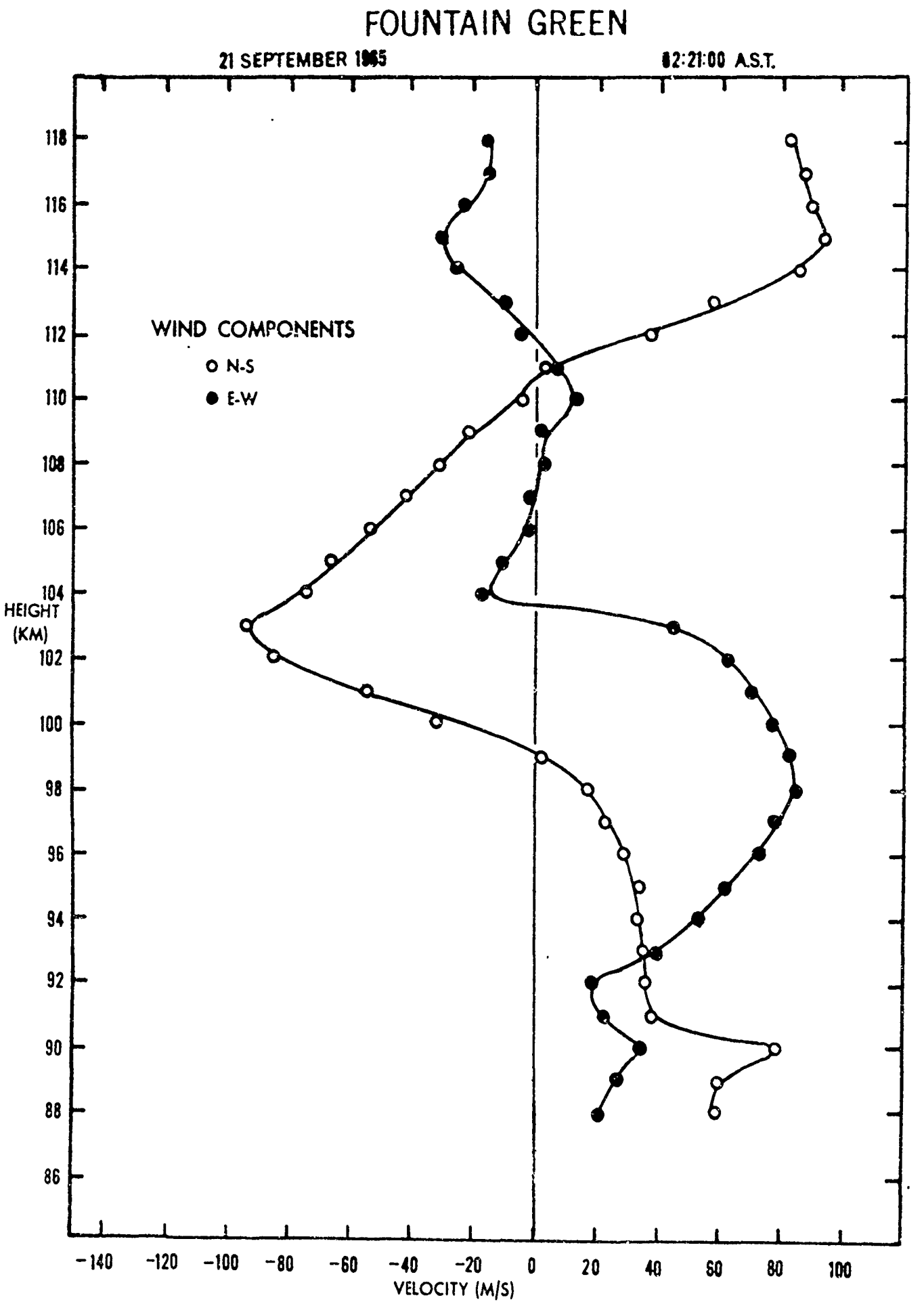

EDGEWOOD
21 SEPTEMBER 1965
00:24:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
0
20
40
60
80
100
120
VELOCITY (M/S)

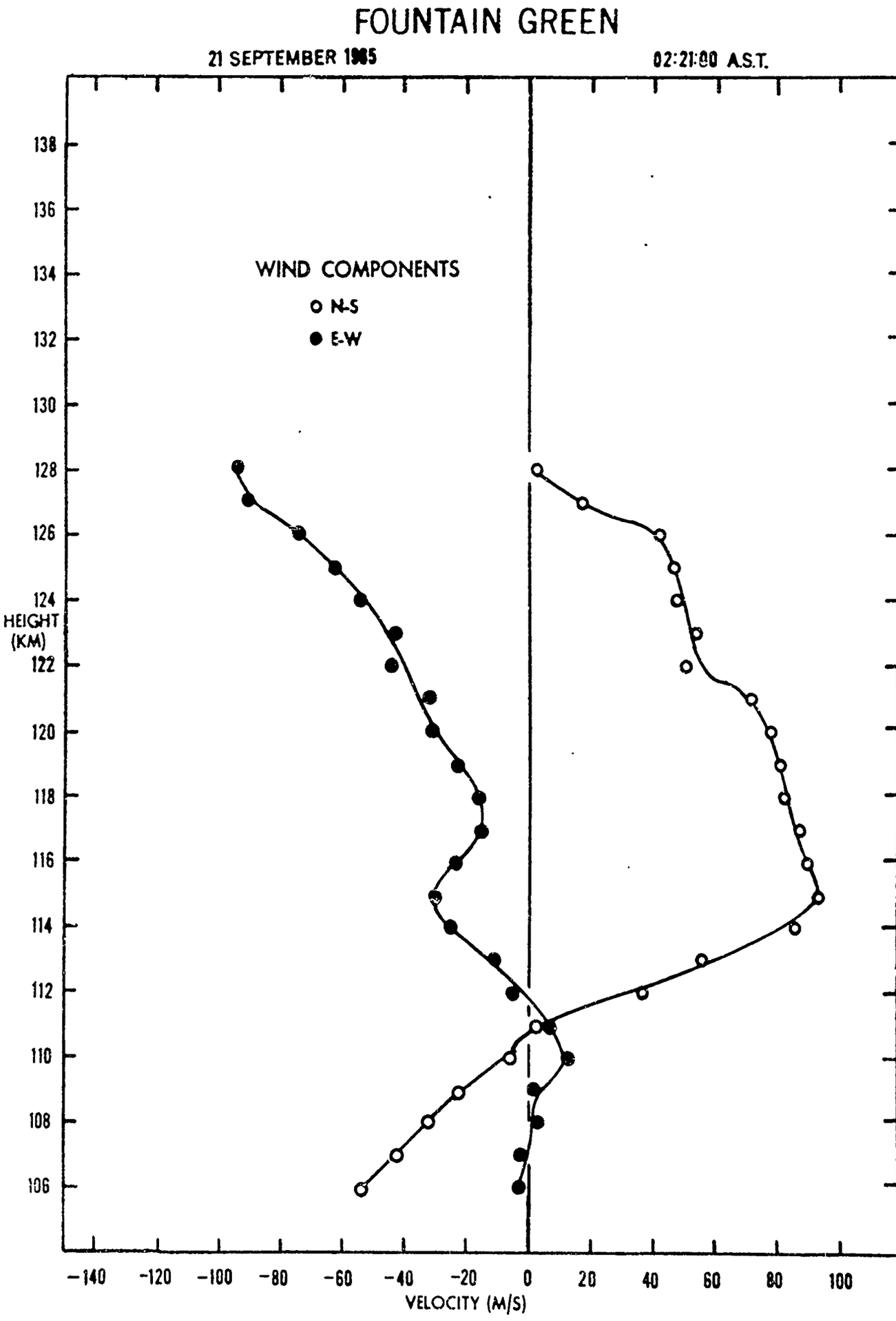

EDGEWOOD
21 SEPTEMBER 1965
00:24:00 A.S.T.
WIND HEADING
HEIGHT (KM)
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
160
200
240
280
320
0
40
80
120
160
200
HEADING (DEG)

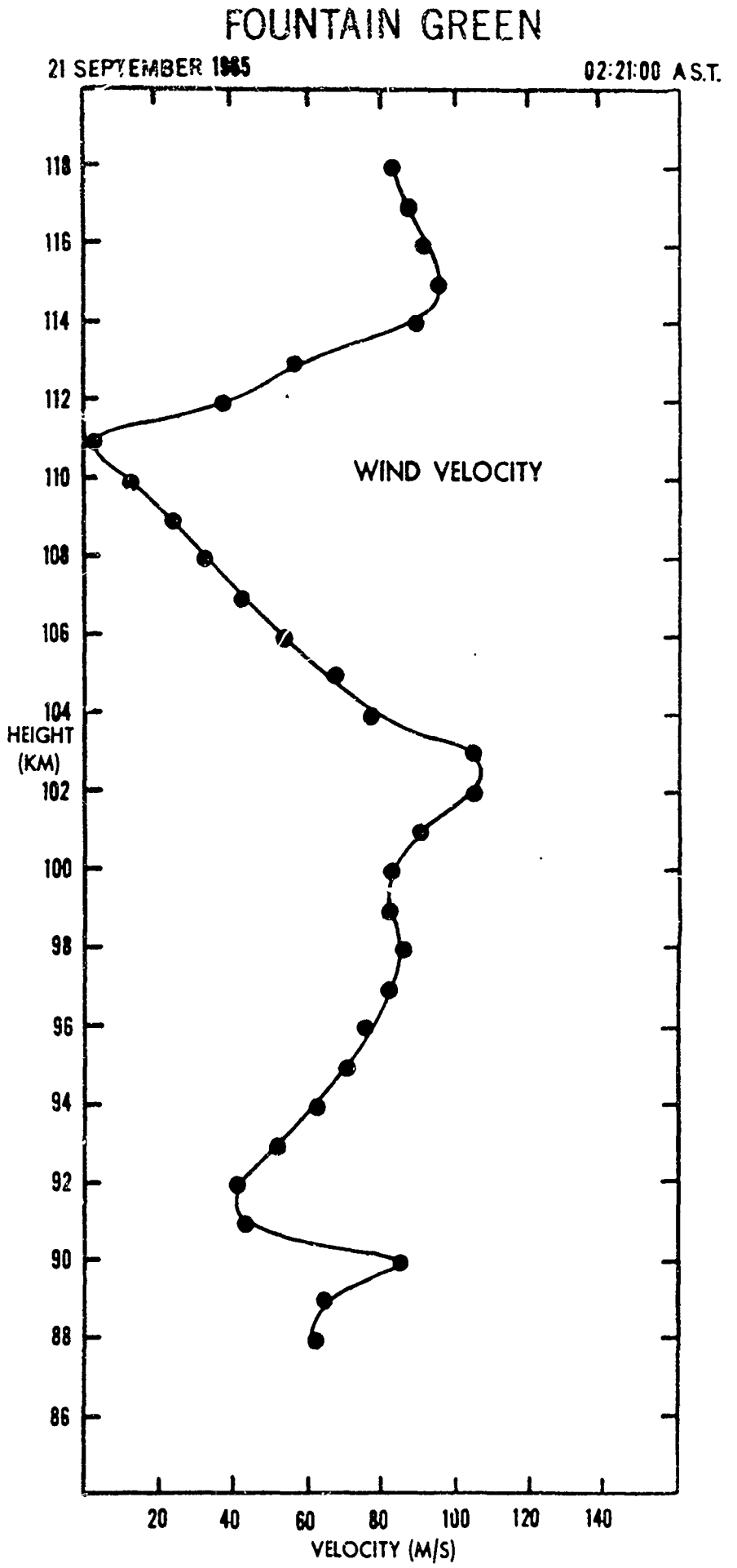

EDGEWOOD
21 SEPTEMBER 1965
06:24:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
126
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M/S/KM)

SHOT FOUNTAIN GREEN 21 SEPTEMBER 1965 02-21-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
88.0	19.1	61.8	58.4	20.2
89.0	25.5	64.9	58.6	27.9
90.0	23.5	85.3	78.2	34.0
91.0	29.4	43.9	38.3	21.6
92.0	28.0	40.9	36.1	19.2
93.0	48.0	52.8	35.4	39.2
94.0	57.0	62.8	34.2	52.7
95.0	61.9	70.1	33.0	61.8
96.0	67.8	76.6	28.9	71.0
97.0	74.0	82.0	22.6	78.8
98.0	79.2	86.3	16.2	84.7
99.0	88.7	82.3	1.9	82.3
100.0	112.5	83.5	-32.0	77.1
101.0	128.4	90.6	-56.3	70.9
102.0	143.8	106.6	-86.1	62.9
103.0	155.4	105.2	-95.6	43.9
104.0	194.6	78.8	-76.2	-19.8
105.0	189.3	68.1	-67.2	-11.0
106.0	182.9	55.4	-55.3	-2.8
107.0	186.4	42.5	-42.3	-4.8
108.0	177.9	33.2	-33.1	1.2
109.0	179.8	24.4	-24.4	0.1
110.0	121.4	13.4	-7.0	11.5
111.0	70.1	3.3	1.1	3.1
112.0	349.5	38.5	37.8	-7.0
113.0	349.0	57.9	56.9	-11.1
114.0	342.8	90.9	86.8	-27.0
115.0	340.9	96.8	91.5	-31.8
116.0	344.0	91.5	88.0	-25.2
117.0	347.5	88.0	86.0	-19.0
118.0	346.0	82.5	80.0	-19.9
119.0	343.7	83.4	80.1	-23.4
120.0	337.1	83.7	77.1	-32.5
121.0	335.6	77.5	70.5	-32.1
122.0	318.0	67.1	49.9	-44.9
123.0	318.9	69.9	52.7	-45.9
124.0	310.1	74.3	47.9	-56.9
125.0	304.9	78.8	45.1	-64.7
126.0	297.9	86.7	40.6	-76.6
127.0	280.5	93.0	17.0	-91.4
128.0	271.1	95.9	1.9	-95.9


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND COMPONENTS
O N-S
● E-W
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)


FOUNTAIN GREEN
21 SEPTEMBER 1985
02:21:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
120
118
116
114
112
110
108
106
-140
-120
-100
-80
-60
-40
-20
0
20
40
60
80
100
VELOCITY (M/S)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
118
116
114
112
110
108
106
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102
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94
92
90
88
86
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40
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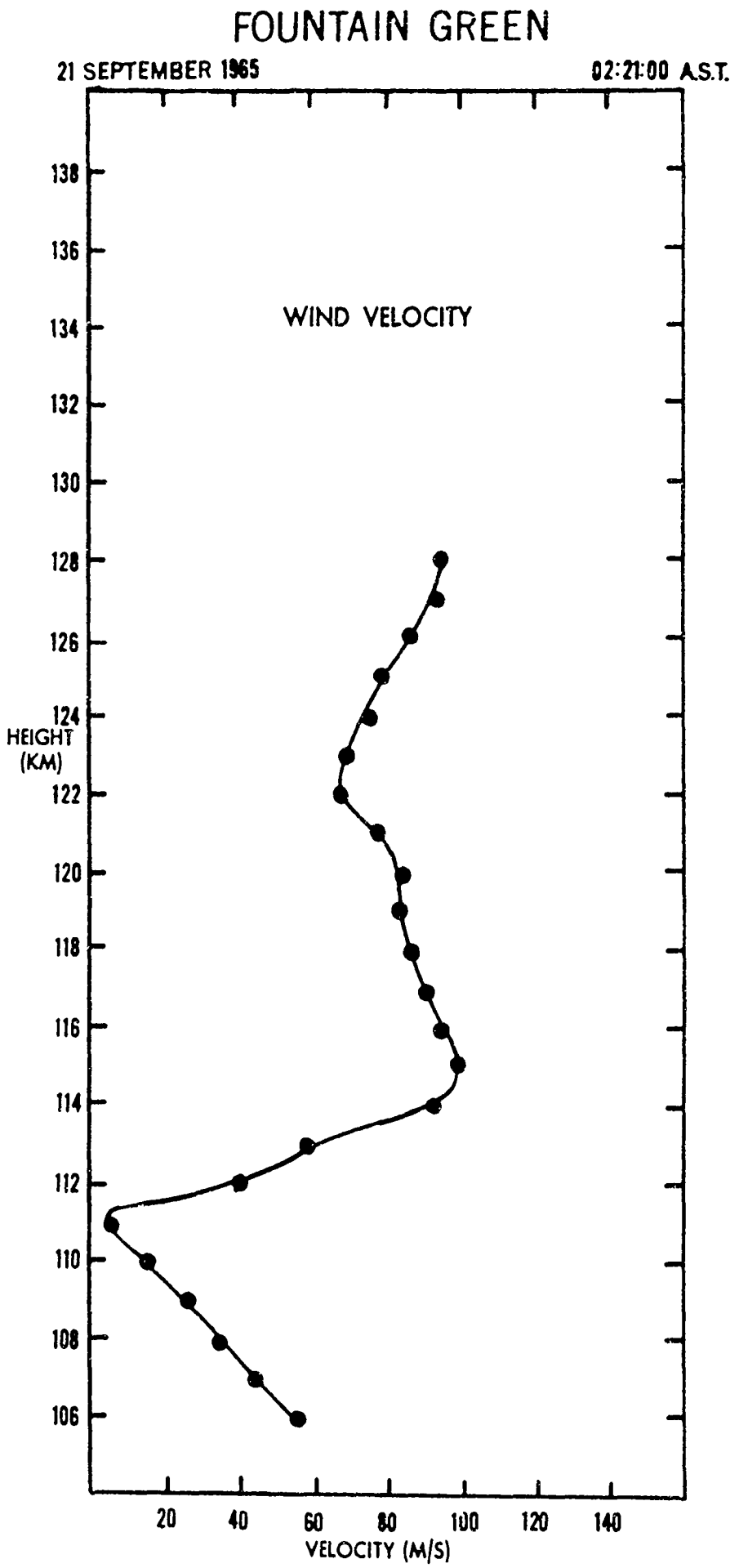
100
120
140
VELOCITY (M/S)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
138
136
134
132
130
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40
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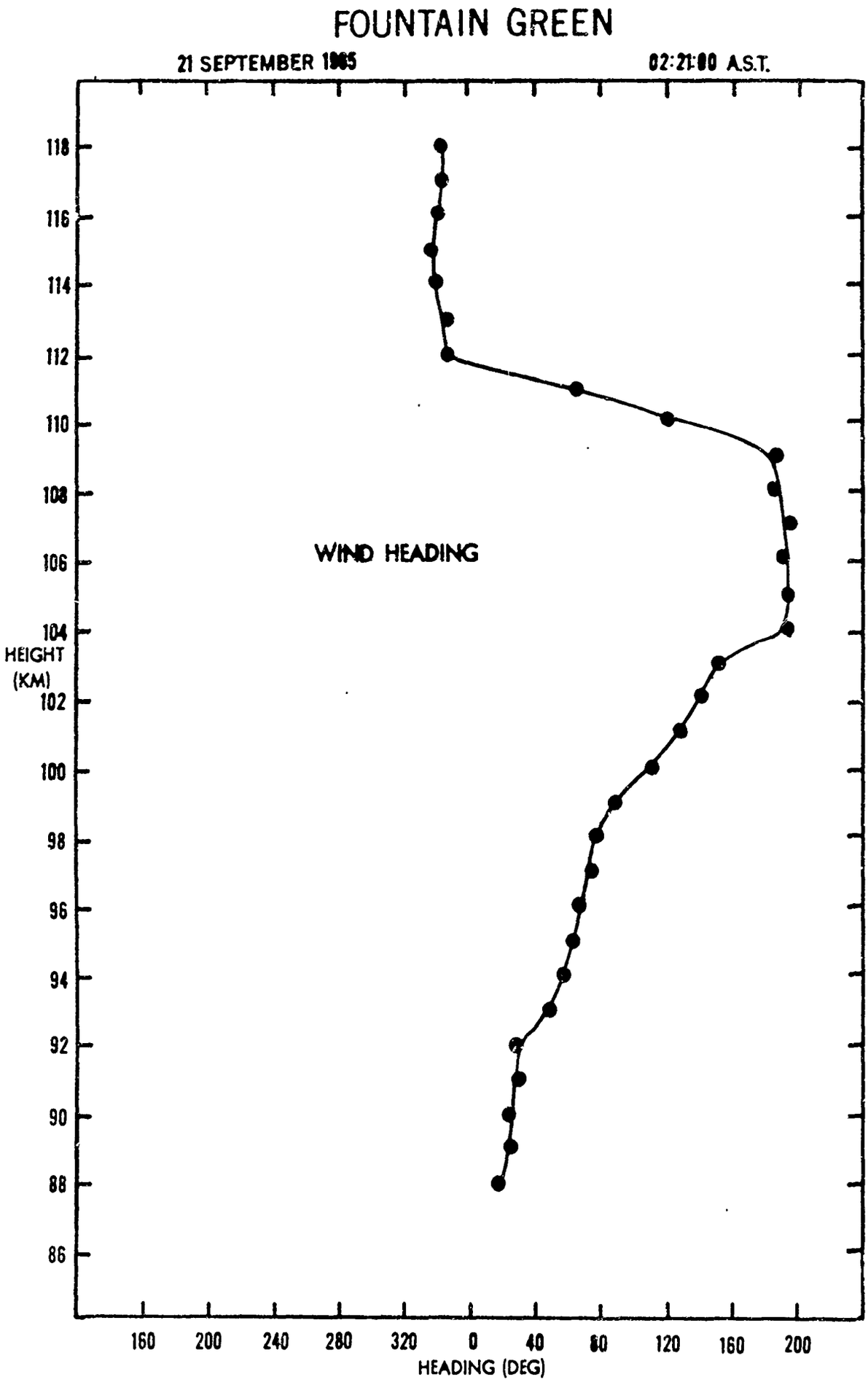
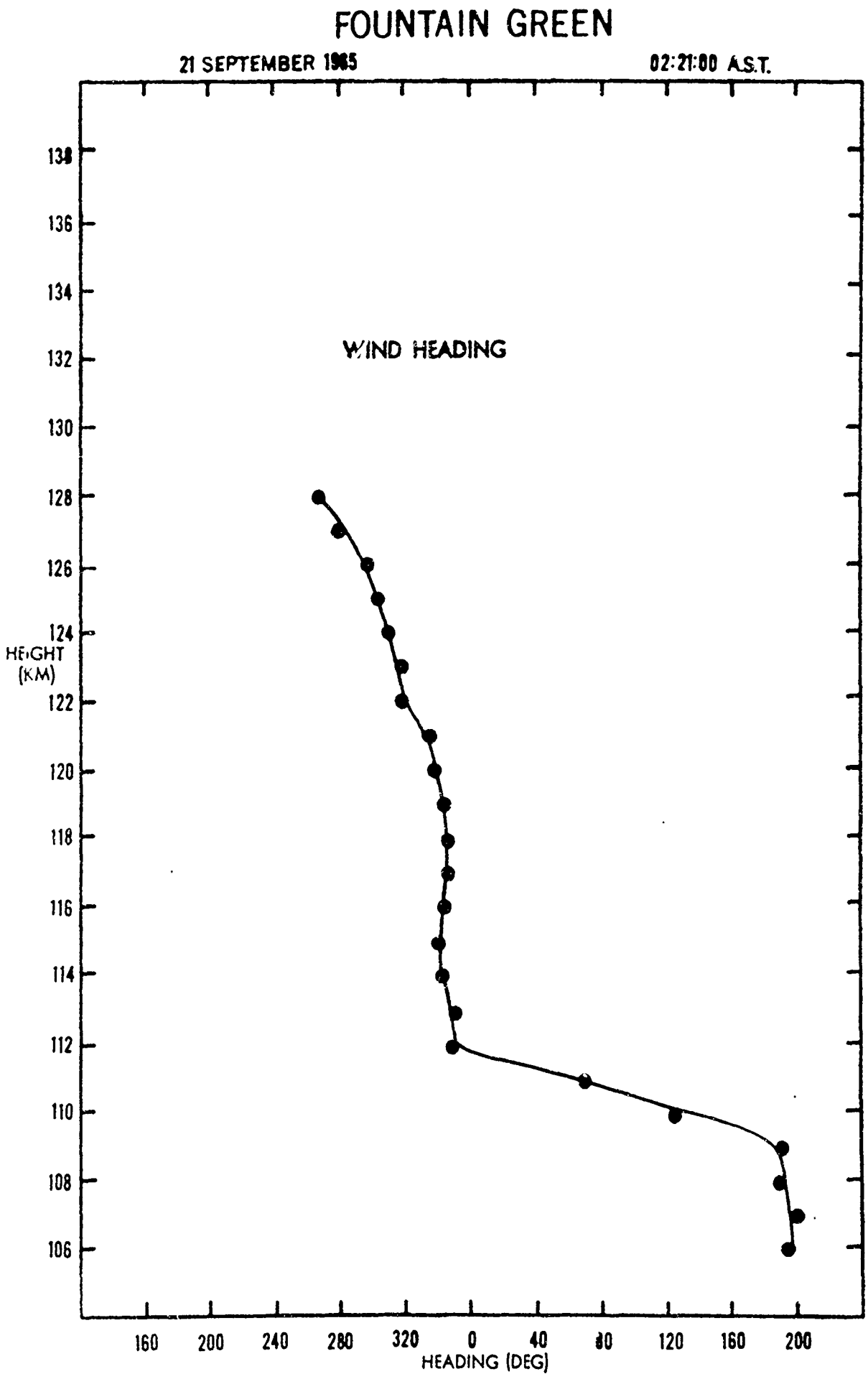
80
100
120
140
VELOCITY (M/S)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND HEADING
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
96
94
92
90
88
86
160
200
240
280
320
0
40
80
120
160
200
HEADING (DEG)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND HEADING
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
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118
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160
200
240
280
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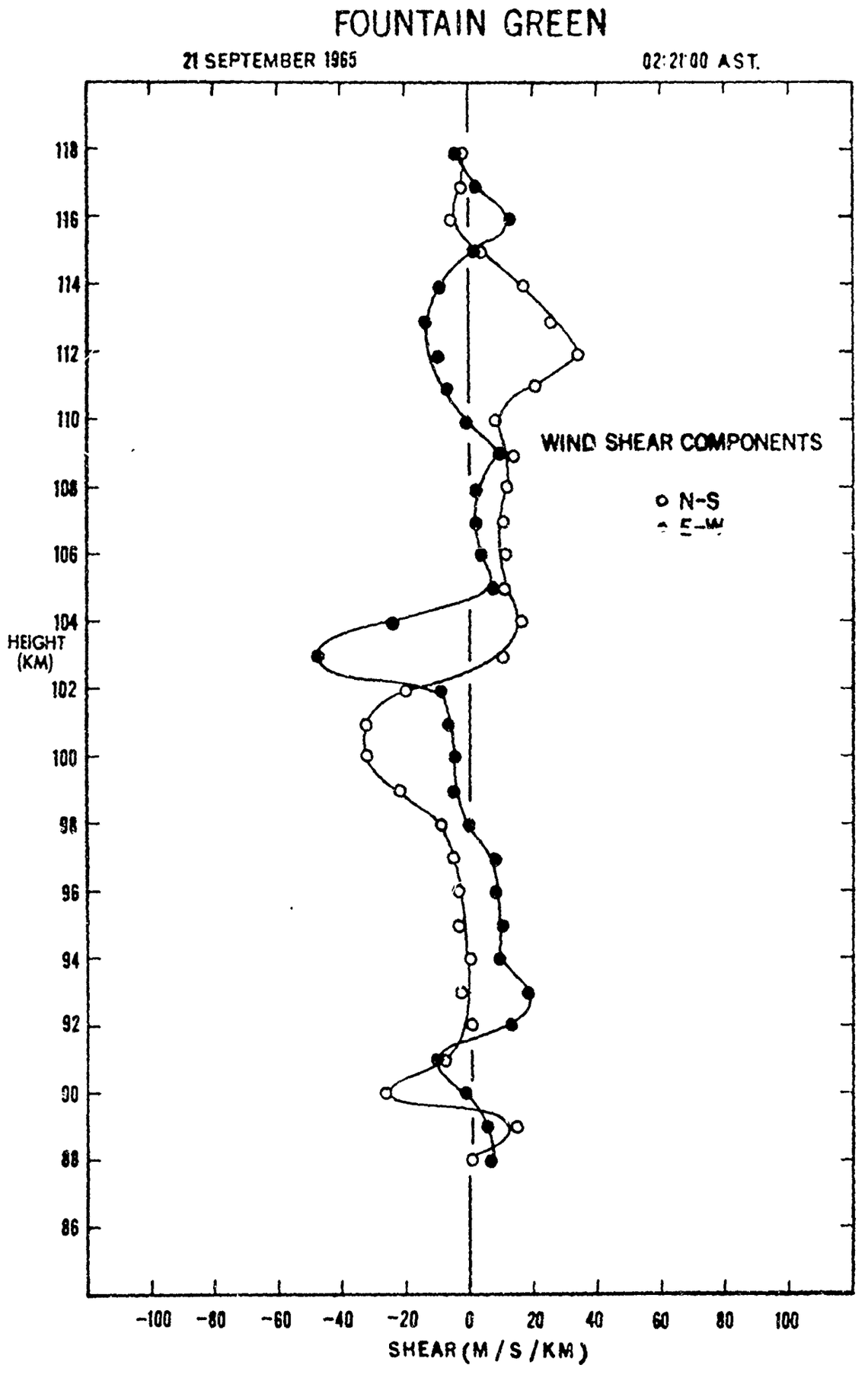
160
200
HEADING (DEG)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 AST.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
98
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94
92
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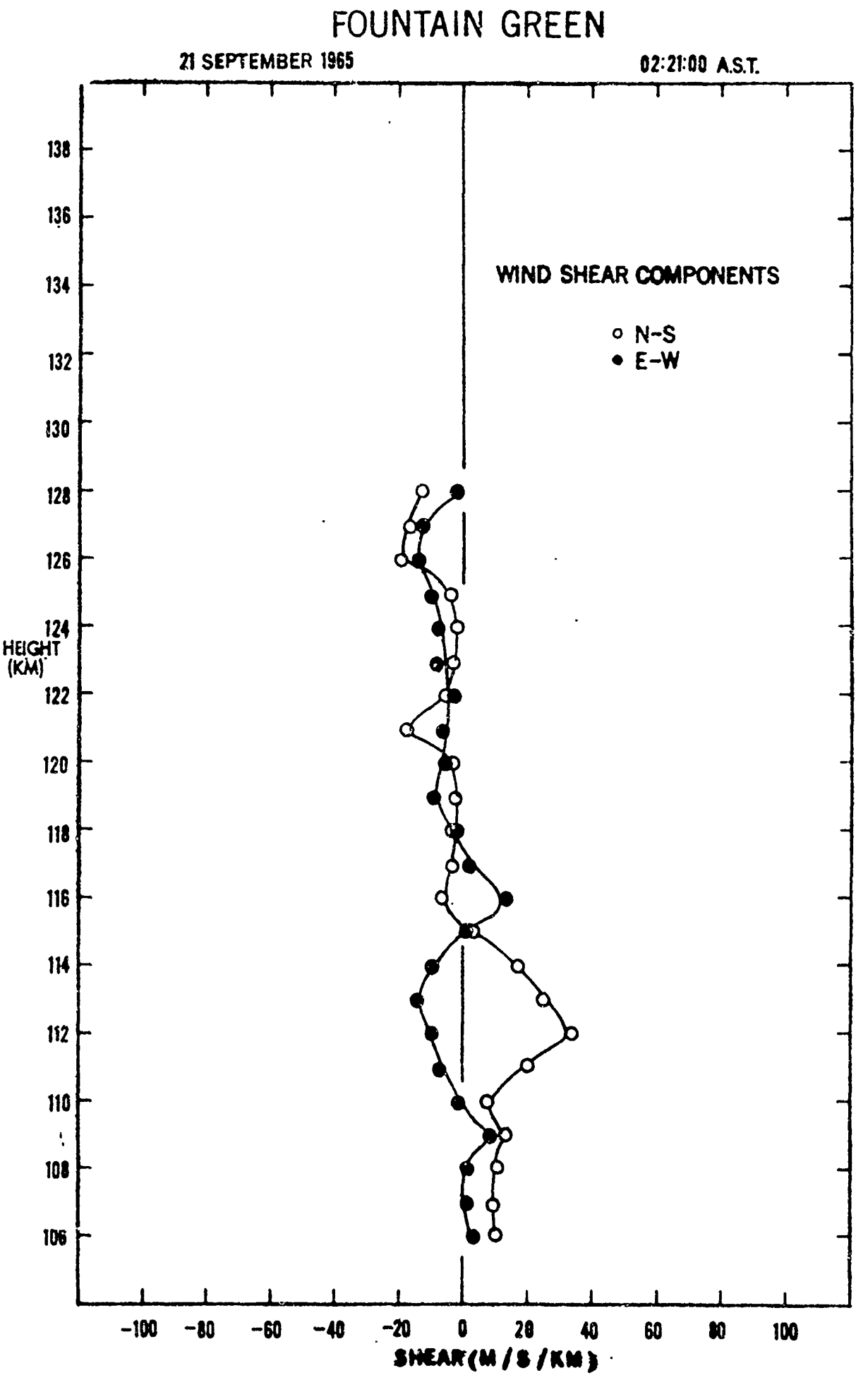
88
86
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M/S/KM)


FOUNTAIN GREEN
21 SEPTEMBER 1965
02:21:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
138
136
134
132
130
128
126
124
122
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118
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114
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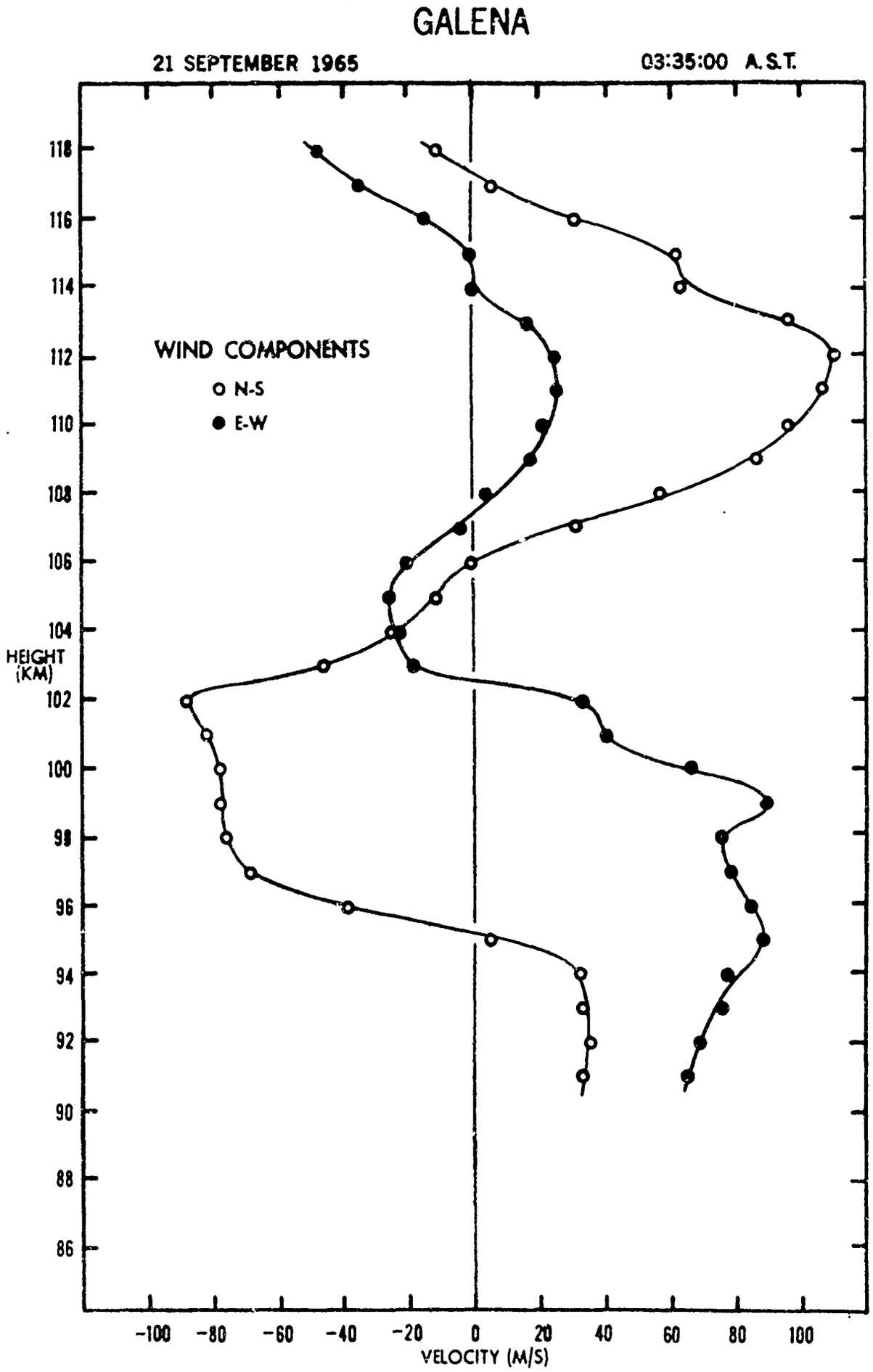
108
106
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M/S/KM)

SHOT GALENA 21 SEPTEMBER 1965 03-35-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
91.0	63.1	73.2	33.1	65.3
92.0	63.2	77.8	35.1	69.5
93.0	66.2	82.7	33.3	75.7
94.0	67.5	84.0	32.1	77.7
95.0	86.4	89.1	5.5	88.9
96.0	115.2	92.9	-39.6	84.1
97.0	131.7	104.2	-69.3	77.9
98.0	135.3	108.1	-76.9	76.0
99.0	132.0	117.5	-78.6	87.3
100.0	139.2	103.8	-78.6	67.7
101.0	154.1	92.1	-82.8	40.2
102.0	159.1	94.4	-88.2	33.6
103.0	201.9	50.6	-46.9	-18.9
104.0	221.2	34.0	-25.6	-22.4
105.0	244.0	28.9	-12.7	-26.0
106.0	268.8	20.9	-0.4	-20.9
107.0	352.6	31.3	31.1	-4.1
108.0	4.0	57.3	57.2	4.0
109.0	11.9	87.8	85.9	18.1
110.0	12.2	98.2	96.0	20.8
111.0	13.5	108.9	105.9	25.3
112.0	13.0	112.9	109.9	25.4
113.0	10.1	96.6	95.1	17.0
114.0	0.1	63.7	63.7	0.2
115.0	359.3	61.8	61.8	-0.8
116.0	333.7	35.5	31.8	-15.7
117.0	279.3	35.8	5.8	-35.3
118.0	256.4	49.2	-11.6	-47.8
119.0	244.5	63.4	-27.3	-57.2
120.0	237.9	71.2	-37.8	-60.3
121.0	231.6	81.7	-50.7	-64.0
122.0	228.4	85.0	-56.4	-63.6
123.0	224.7	88.0	-62.6	-61.9
124.0	222.2	87.8	-65.0	-59.0
125.0	219.8	85.6	-65.7	-54.8
126.0	214.3	78.2	-64.6	-44.1
127.0	209.9	77.5	-67.2	-38.6
128.0	205.1	76.8	-69.6	-32.7
129.0	190.3	76.2	-73.1	-21.4
130.0	190.3	75.8	-74.6	-13.6
131.0	183.8	75.4	-75.3	-5.1
132.0	176.9	75.3	-75.2	4.1
133.0	169.5	75.6	-74.3	13.8
134.0	161.9	76.4	-72.6	23.7
135.0	154.5	77.7	-70.1	33.4
136.0	149.1	79.3	-68.1	40.7
137.0	145.1	82.5	-67.7	47.2
138.0	142.8	85.8	-68.4	51.9


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
118
116
114
112
110
108
106
104
102
100
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-100
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-40
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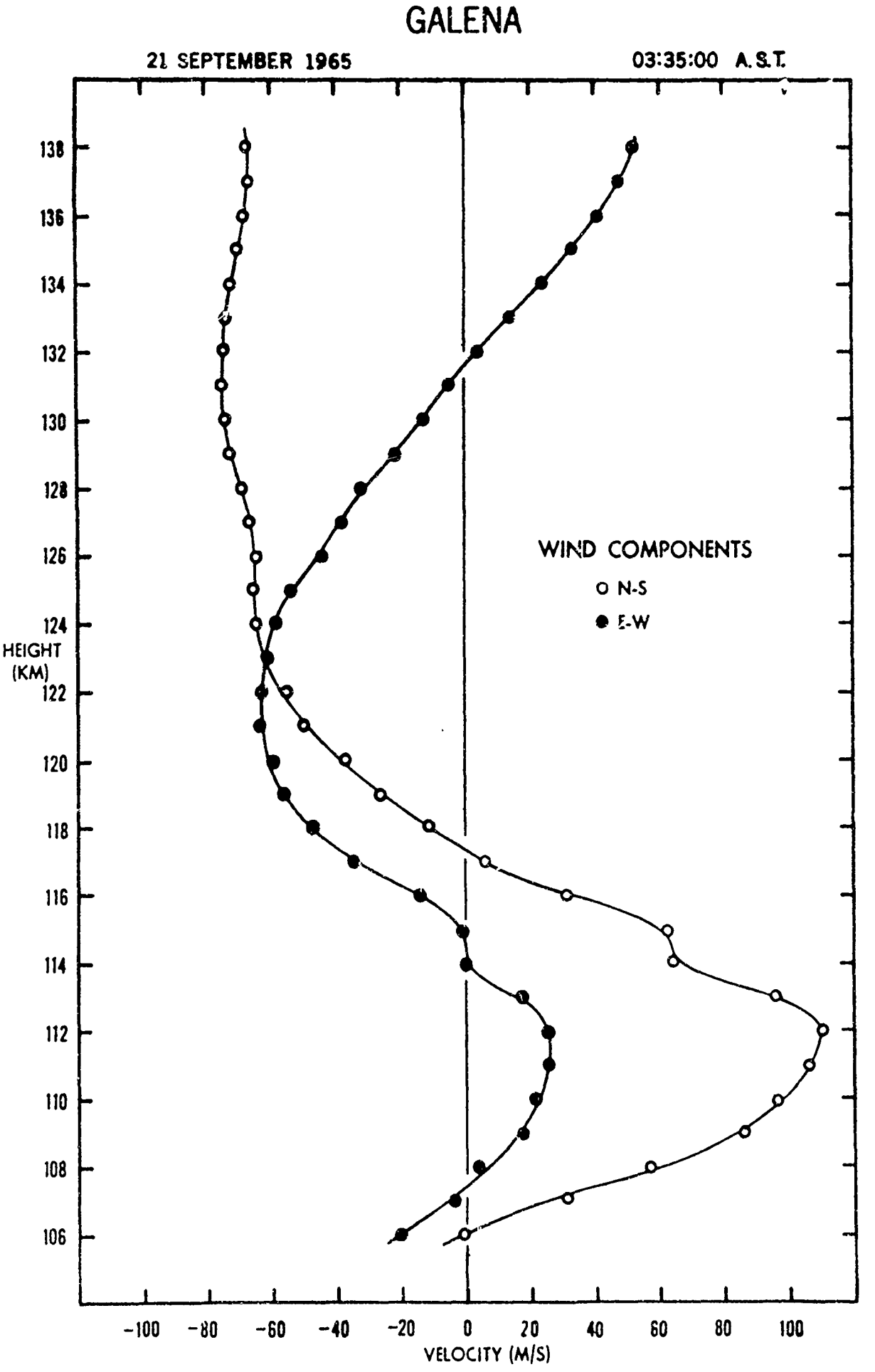
100
VELOCITY (M/S)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
138
136
134
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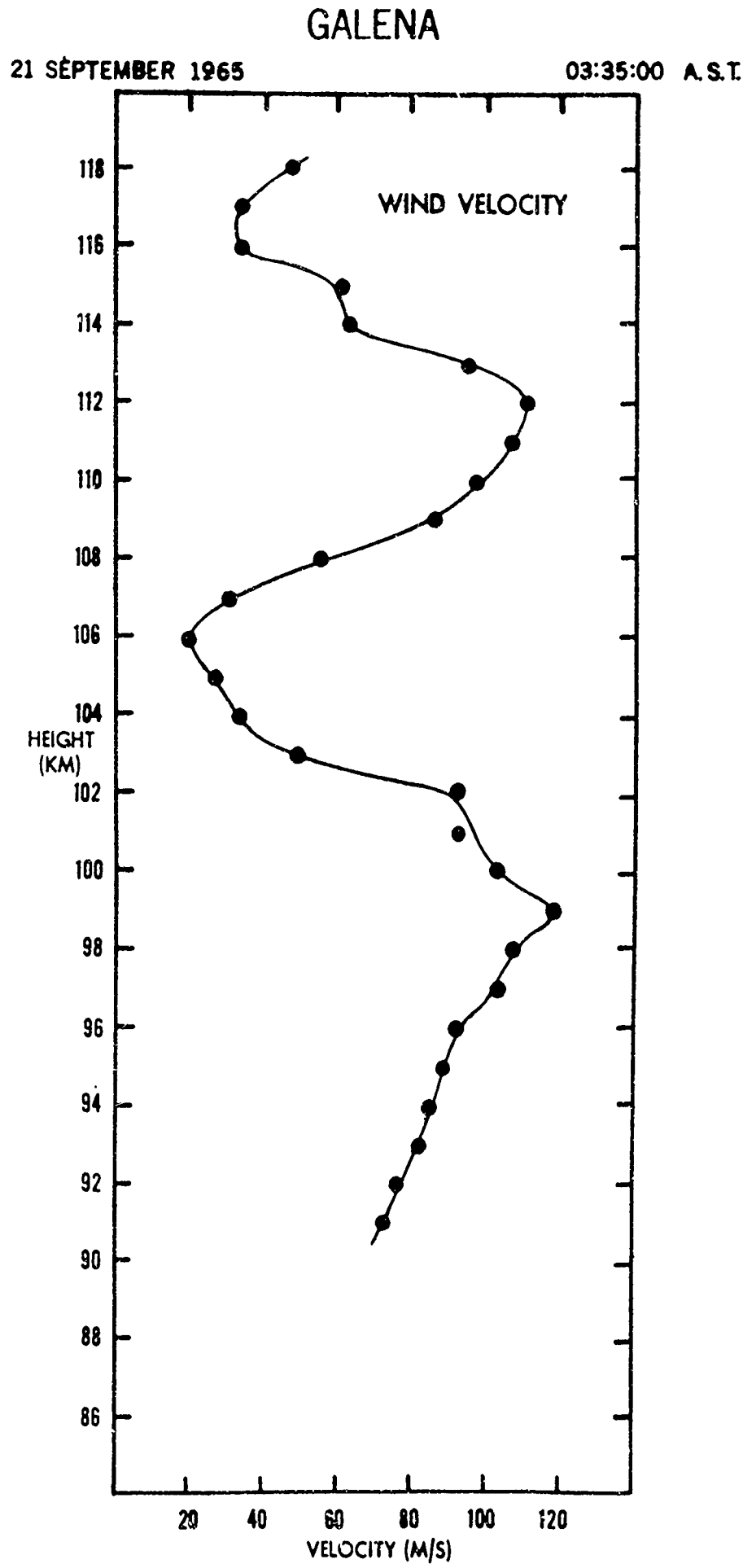
VELOCITY (M/S)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
118
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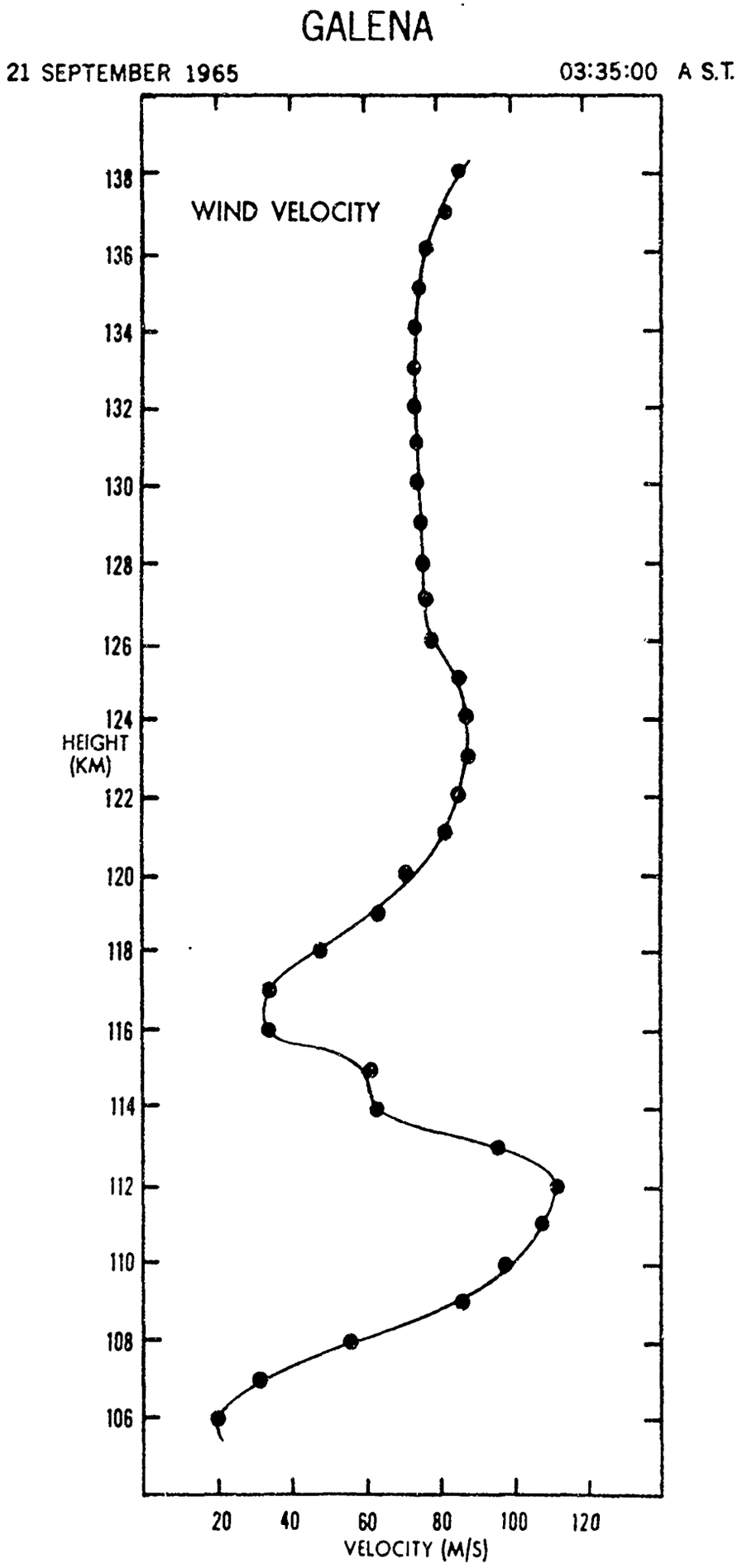
VELOCITY (M/S)


GALENA
21 SEPTEMBER 1965
03:35:00 A S.T.
WIND VELOCITY
138
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HEIGHT
(KM)
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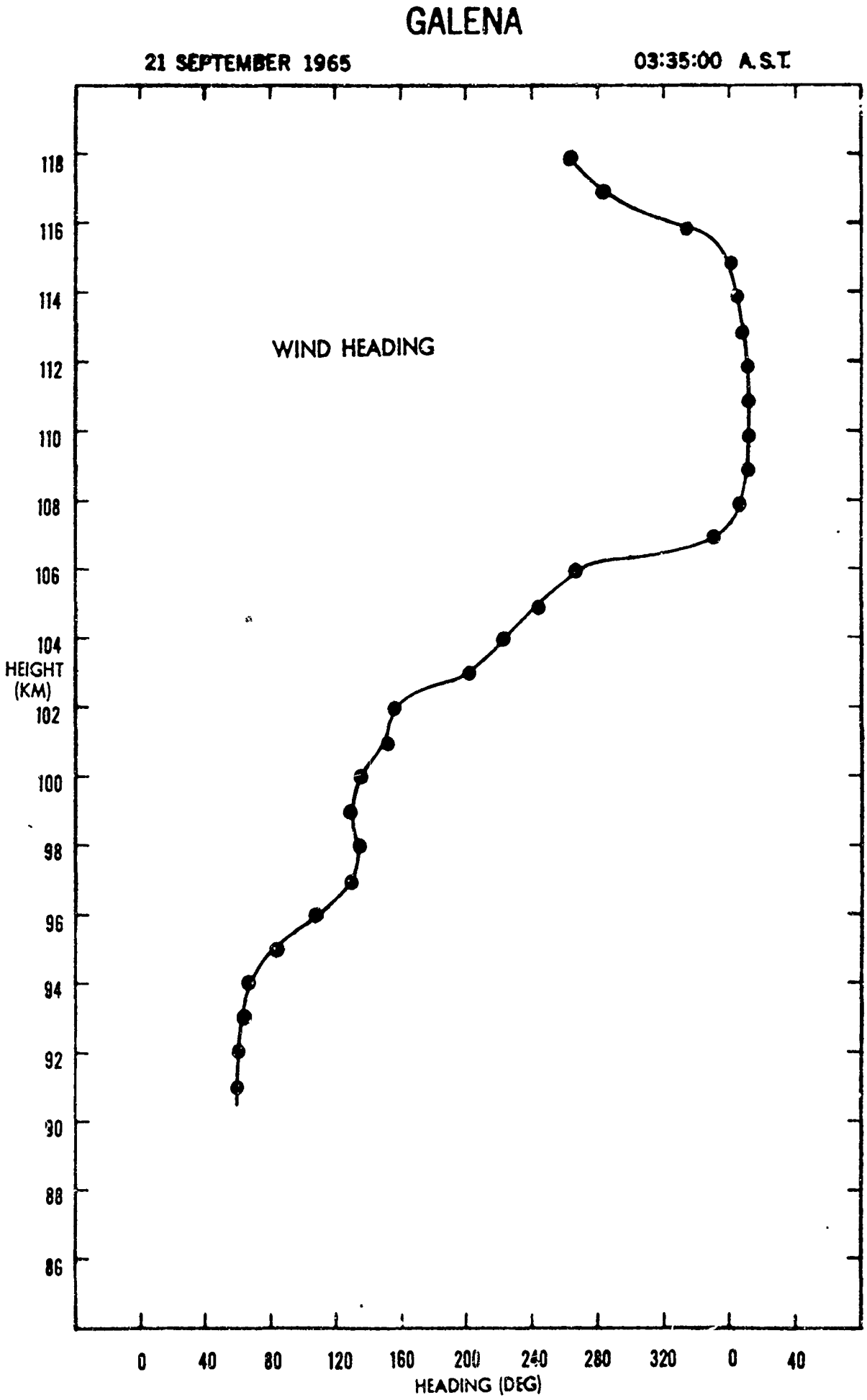
VELOCITY (M/S)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND HEADING
118
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HEIGHT
(KM)
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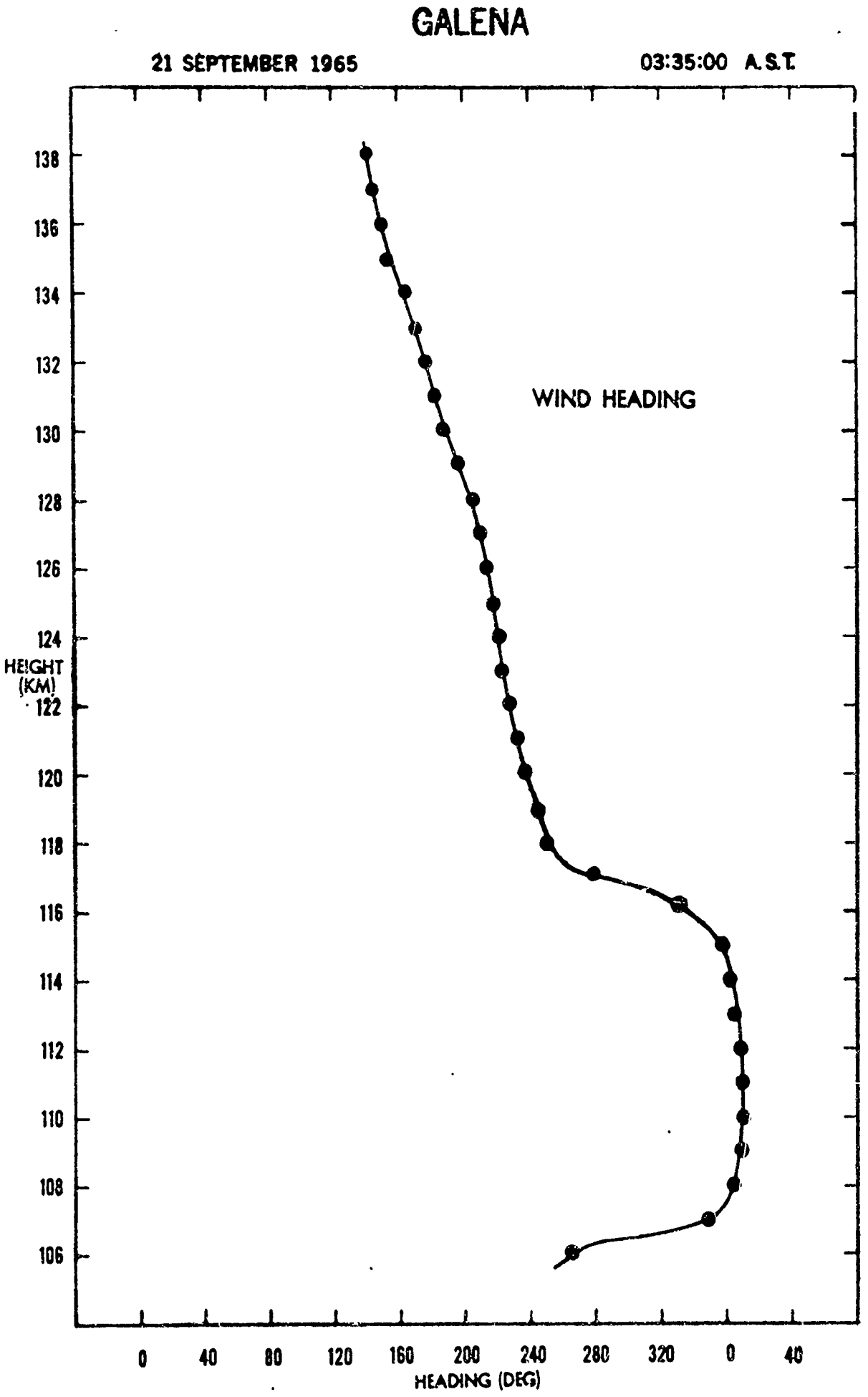
HEADING (DEG)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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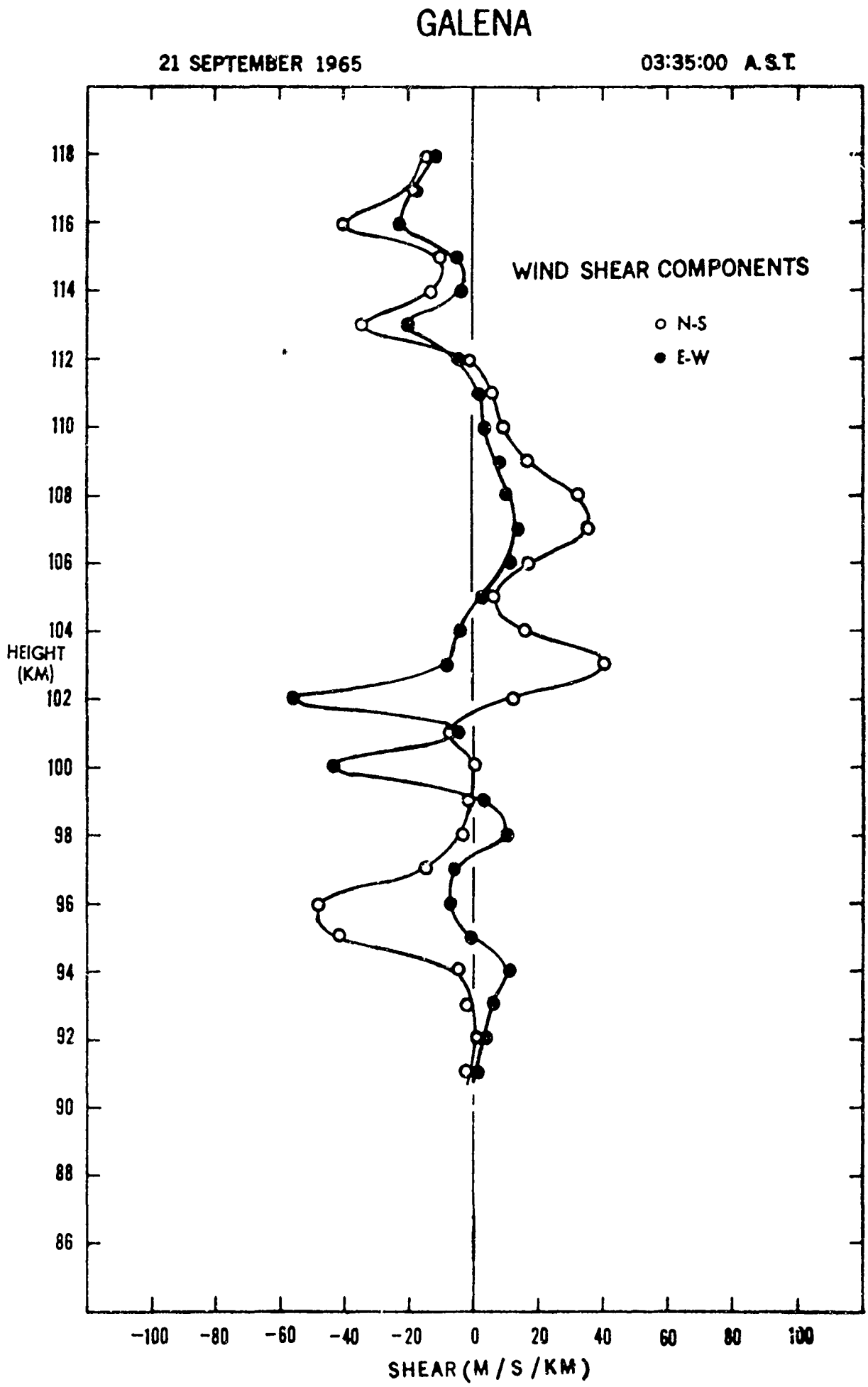
HEADING (DEG)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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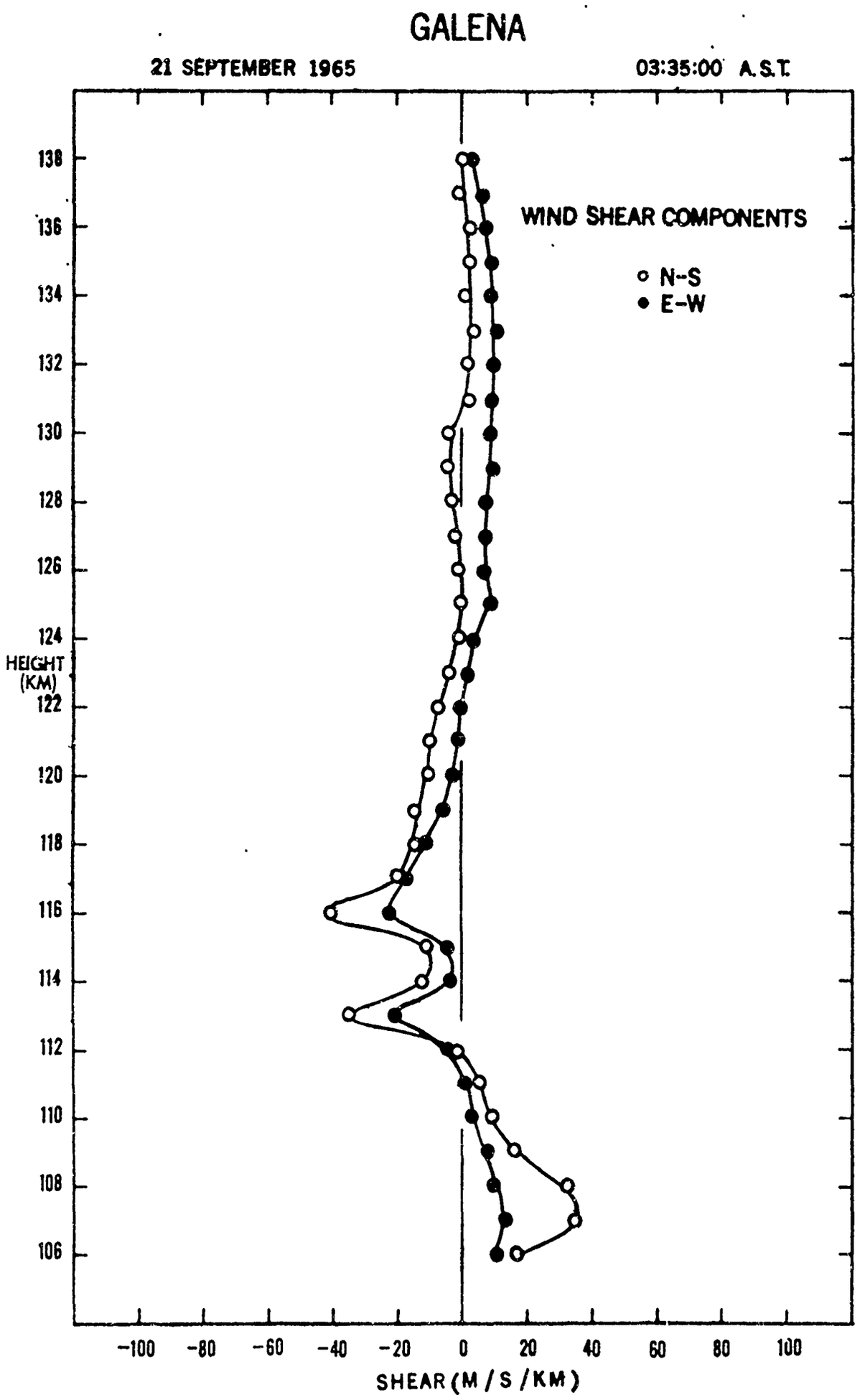
SHEAR (M / S / KM)


GALENA
21 SEPTEMBER 1965
03:35:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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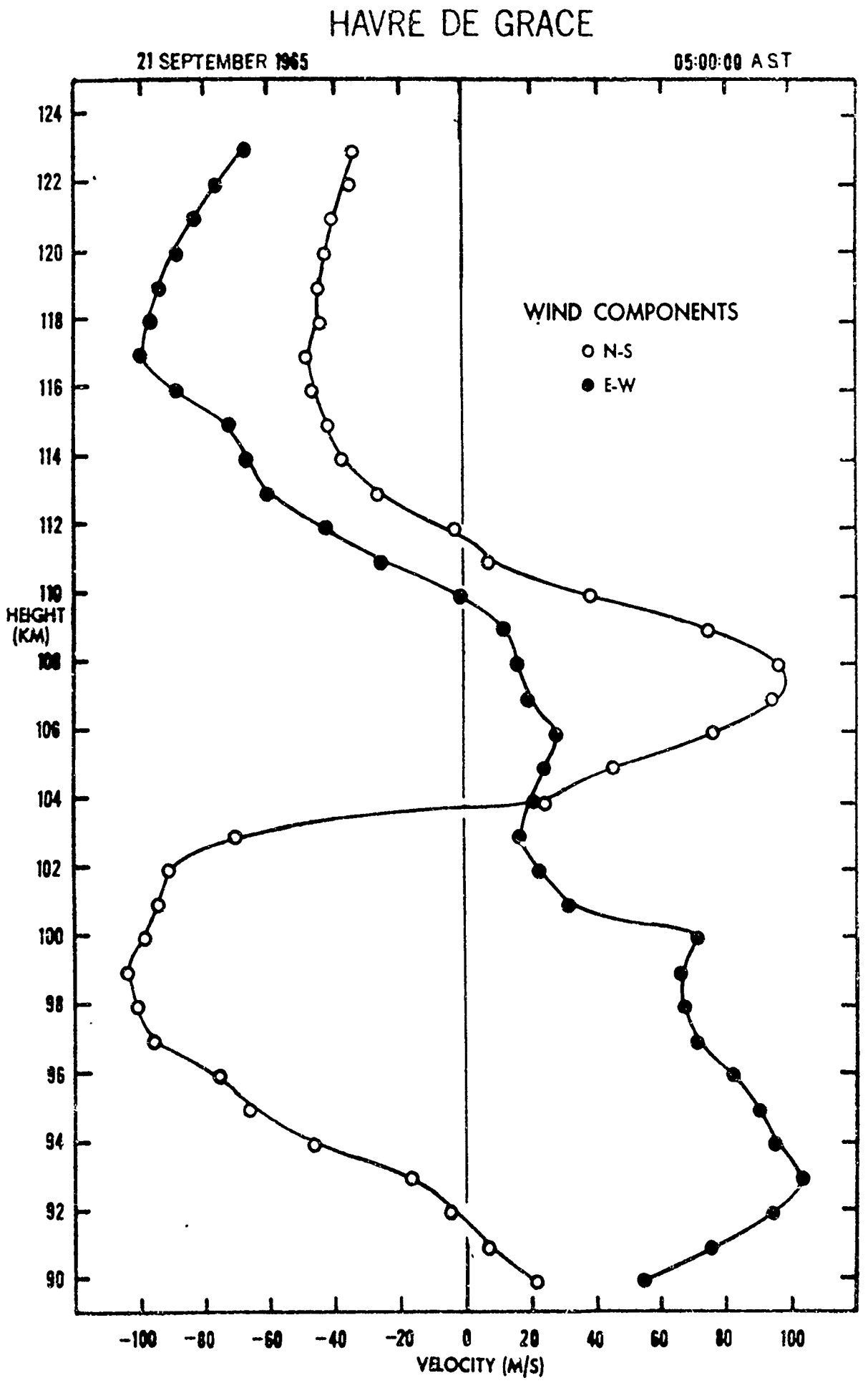
SHEAR (M/S/KM)

SHOT HAVRE DE GRACE 21 SEPTEMBER 1965 05-00-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
90.0	68.7	60.6	22.0	56.5
91.0	84.0	76.4	8.0	76.0
92.0	92.1	95.0	-3.5	94.9
93.0	98.3	106.2	-15.4	105.1
94.0	115.8	106.9	-46.5	96.3
95.0	125.8	111.7	-65.3	90.6
96.0	132.4	112.6	-75.9	83.2
97.0	143.1	119.3	-95.3	71.7
98.0	145.6	121.0	-99.9	68.3
99.0	146.9	123.3	-103.3	67.3
100.0	143.8	121.3	-97.9	71.6
101.0	160.5	99.9	-94.2	33.4
102.0	165.2	93.3	-90.2	23.8
103.0	166.6	71.4	-69.5	16.6
104.0	41.1	33.4	25.1	21.9
105.0	28.2	51.9	45.8	24.5
106.0	20.6	81.9	76.7	28.9
107.0	11.6	97.8	95.8	19.7
108.0	9.9	98.1	96.6	16.9
109.0	9.3	76.1	75.1	12.3
110.0	359.4	39.0	39.0	-0.4
111.0	287.1	26.5	7.8	-25.3
112.0	266.7	42.2	-2.4	-42.1
113.0	246.5	64.9	-25.9	-59.5
114.0	240.7	76.1	-37.2	-66.3
115.0	240.4	82.6	-40.9	-71.8
116.0	242.4	99.7	-46.2	-88.3
117.0	244.1	109.8	-48.0	-98.7
118.0	245.1	105.3	-44.4	-95.5
119.0	244.6	103.6	-44.5	-93.5
120.0	244.7	97.0	-41.4	-87.8
121.0	248.7	87.8	-31.9	-81.8
122.0	245.3	83.3	-34.8	-75.7
123.0	244.0	74.4	-32.6	-66.9


HAVRE DE GRACE
21 SEPTEMBER 1965
05:00:00 AST
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
124
122
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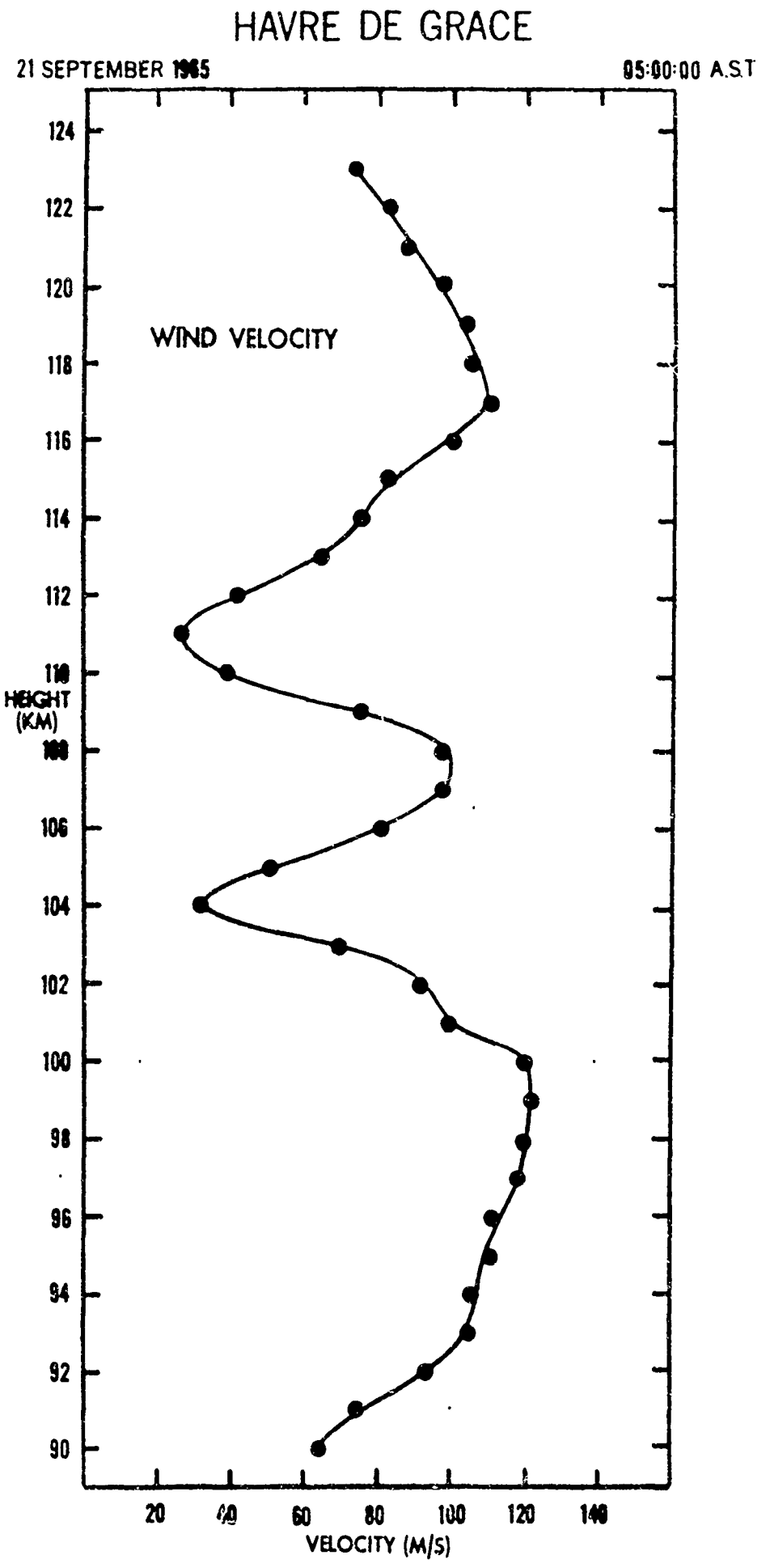
VELOCITY (M/S)


HAVRE DE GRACE
21 SEPTEMBER 1965
05:00:00 A.S.T
WIND VELOCITY
HEIGHT (KM)
124
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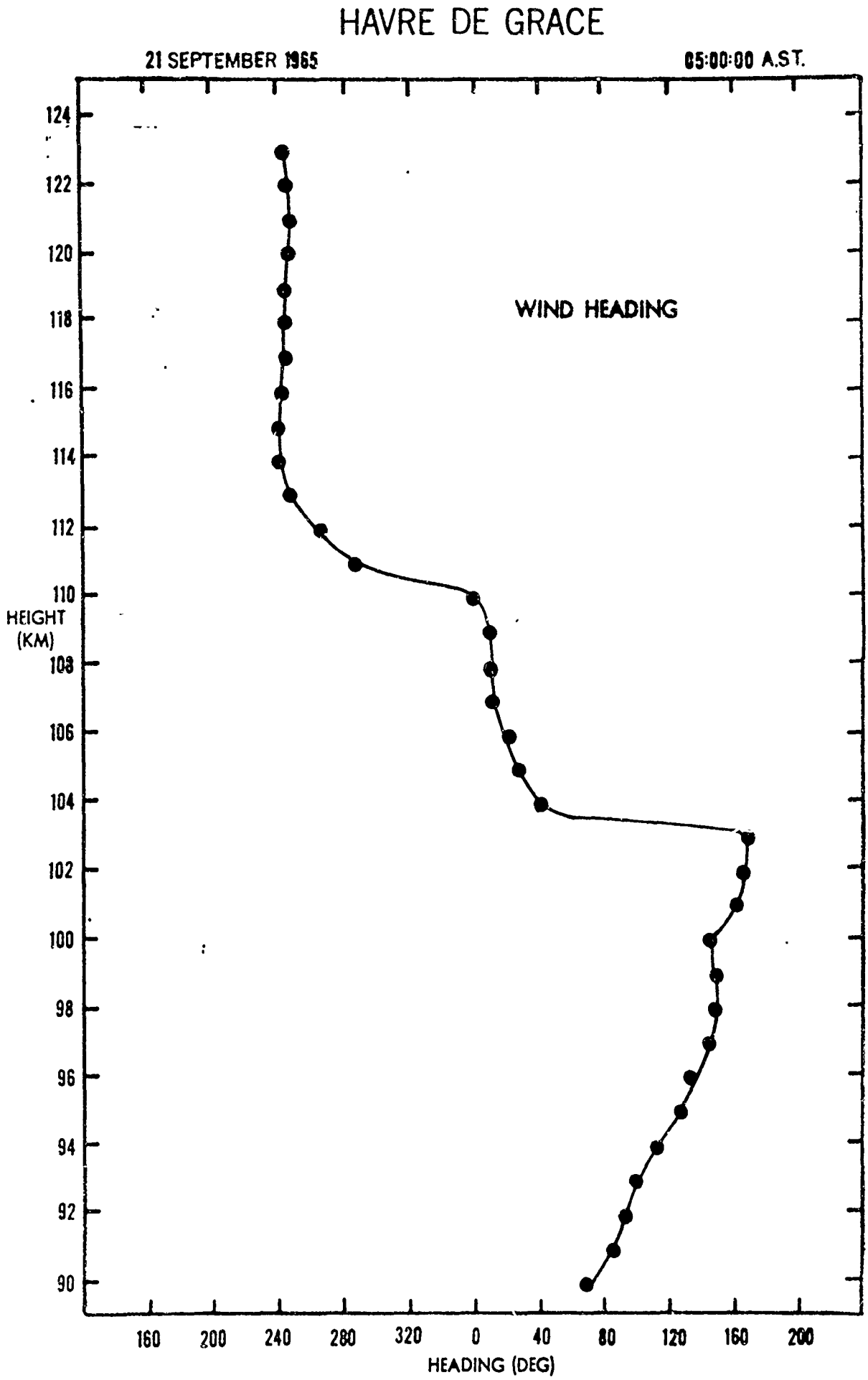
VELOCITY (M/S)


HAVRE DE GRACE
21 SEPTEMBER 1965
05:00:00 A.S.T.
WIND HEADING
HEIGHT (KM)
124
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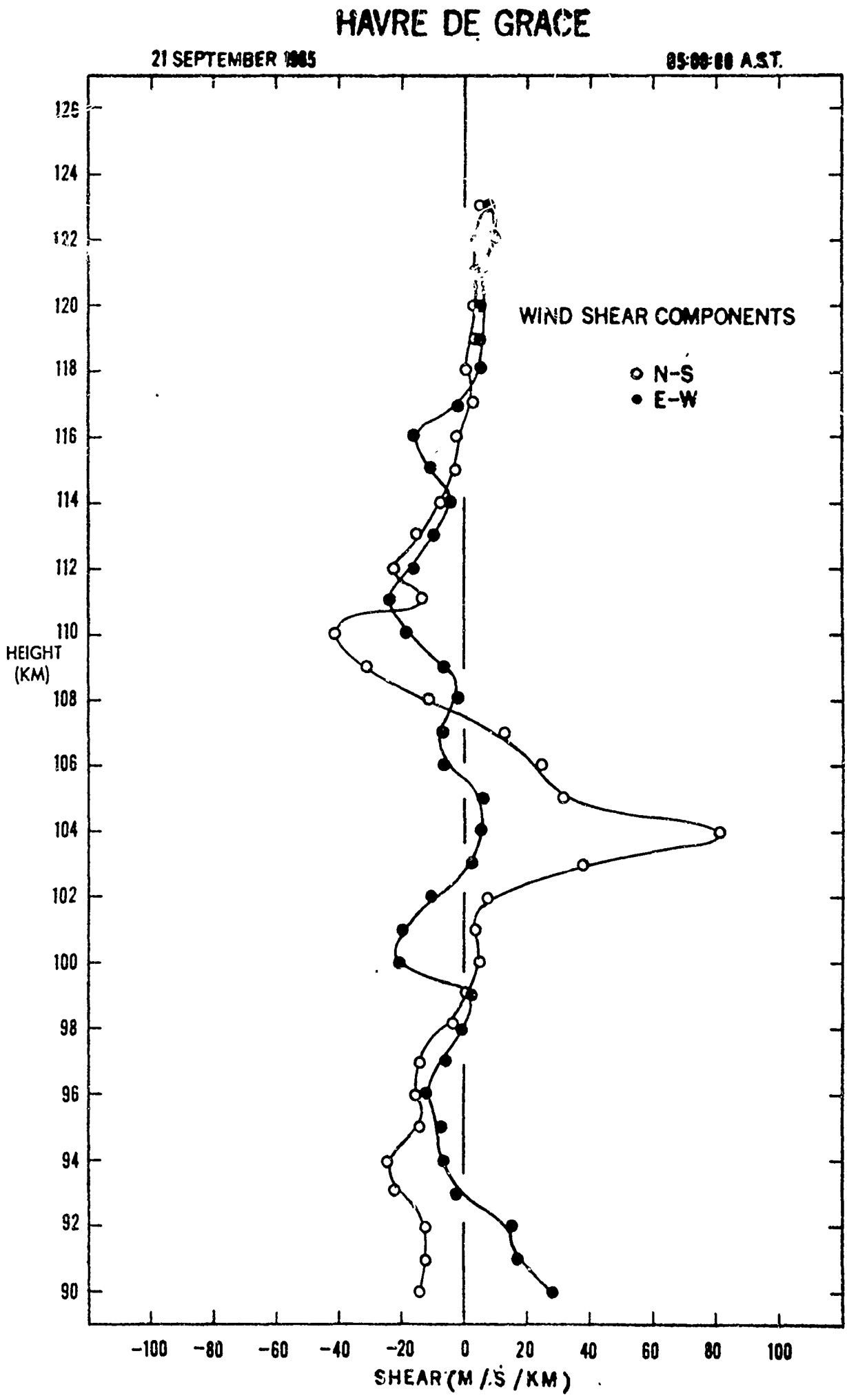
160
200
HEADING (DEG)


HAVRE DE GRACE
21 SEPTEMBER 1985
05:00:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
126
124
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-100
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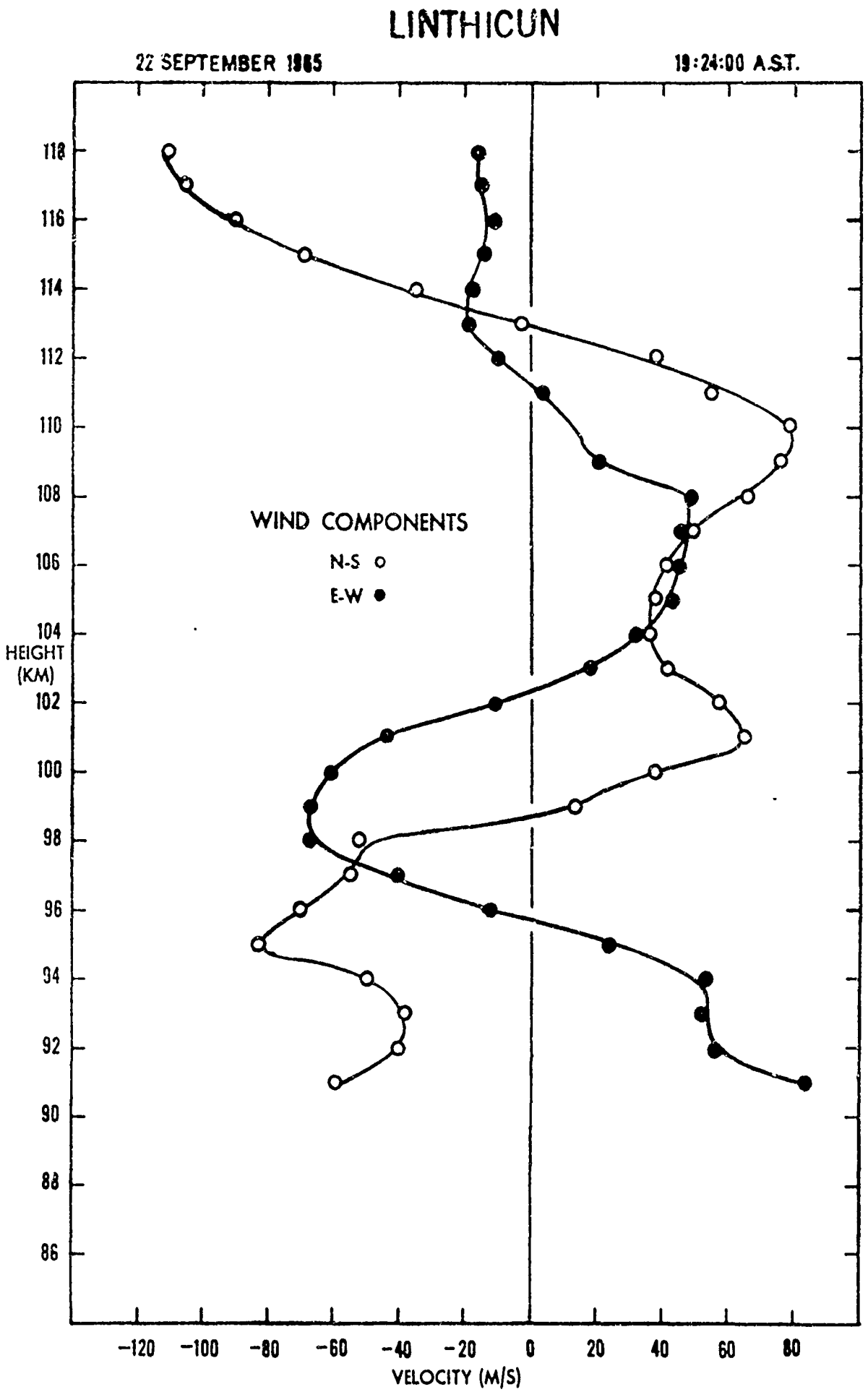
100
SHEAR (M/S/KM)

SHOT LINTHICUN 22 SEPTEMBER 1965 19-24-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
91.0	125.4	101.4	-58.8	82.7
92.0	125.8	68.5	-40.1	55.6
93.0	126.5	64.3	-38.2	51.7
94.0	134.0	72.5	-50.3	52.2
95.0	164.5	87.1	-83.9	23.3
96.0	190.1	72.2	-71.1	-12.7
97.0	215.3	70.1	-57.3	-40.5
98.0	232.0	85.5	-52.7	-67.3
99.0	281.3	68.5	13.4	-67.2
100.0	301.2	71.7	37.1	-61.4
101.0	325.5	78.3	64.5	-44.3
102.0	348.1	57.5	56.3	-11.9
103.0	23.5	44.7	41.0	17.8
104.0	41.5	47.5	35.6	31.5
105.0	48.5	56.4	37.4	42.2
106.0	48.0	60.3	40.3	44.9
107.0	43.0	66.8	48.8	45.5
108.0	36.4	81.4	65.5	48.4
109.0	15.1	78.4	75.8	20.4
110.0	9.4	79.9	78.8	13.1
111.0	3.8	54.6	54.5	3.7
112.0	344.9	39.2	37.9	-10.2
113.0	259.1	20.1	-3.8	-19.7
114.0	207.3	39.9	-35.4	-18.3
115.0	191.7	70.8	-69.3	-14.3
116.0	187.0	91.1	-90.5	-11.1
117.0	188.2	106.8	-105.7	-15.2
118.0	188.0	114.3	-113.1	-16.0
119.0	187.2	117.3	-116.4	-14.7
120.0	190.5	118.9	-116.9	-21.7
121.0	192.6	118.4	-115.6	-25.8
122.0	193.6	117.5	-114.2	-27.6
123.0	194.2	116.4	-112.8	-28.6
124.0	202.8	116.4	-107.3	-45.2
125.0	207.2	112.8	-100.3	-51.6
126.0	208.1	104.0	-91.8	-48.9
127.0	201.0	99.7	-93.1	-35.7


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND COMPONENTS
N-S o
E-W ●
HEIGHT (KM)
118
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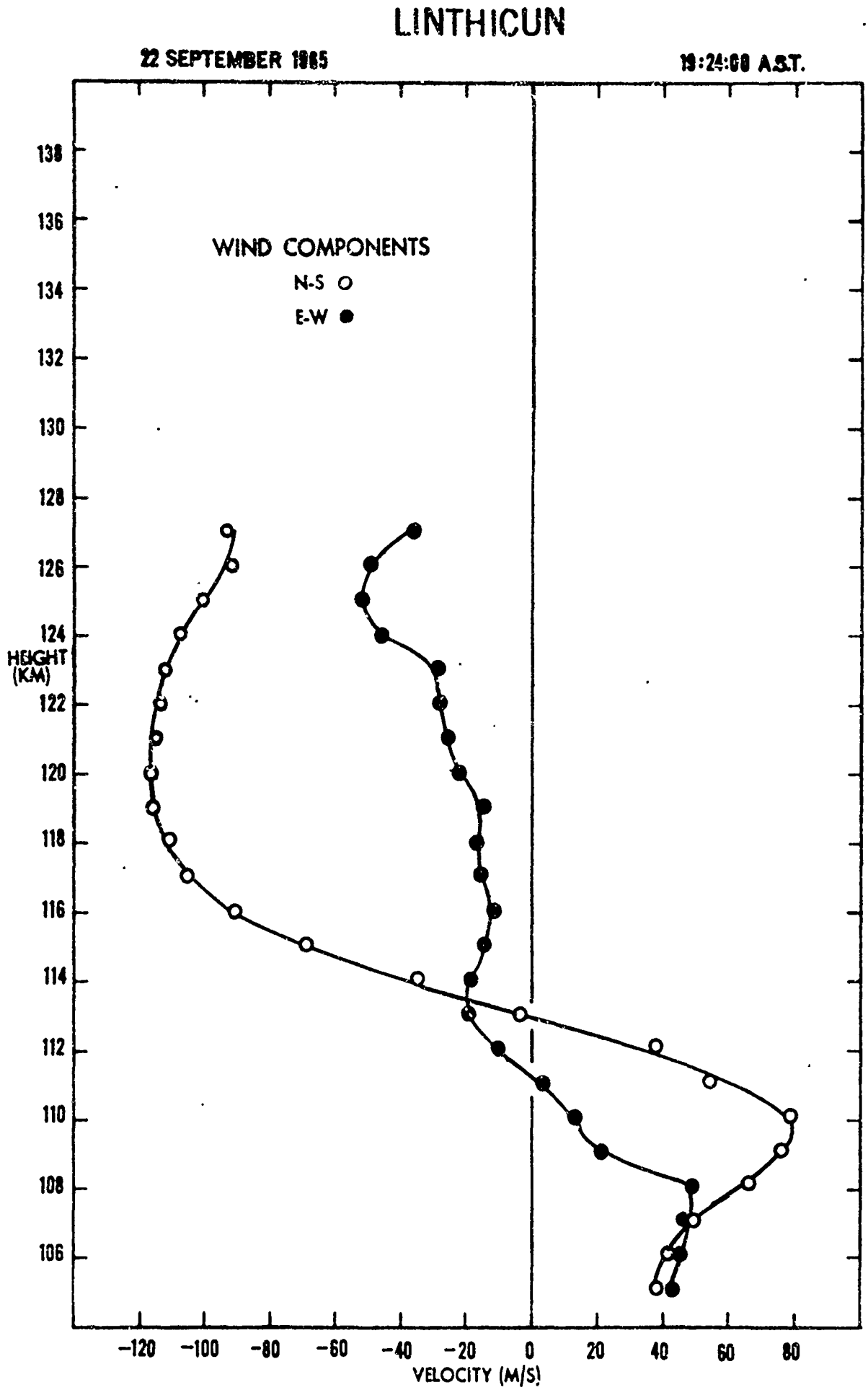
VELOCITY (M/S)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND COMPONENTS
N-S O
E-W ●
HEIGHT (KM)
138
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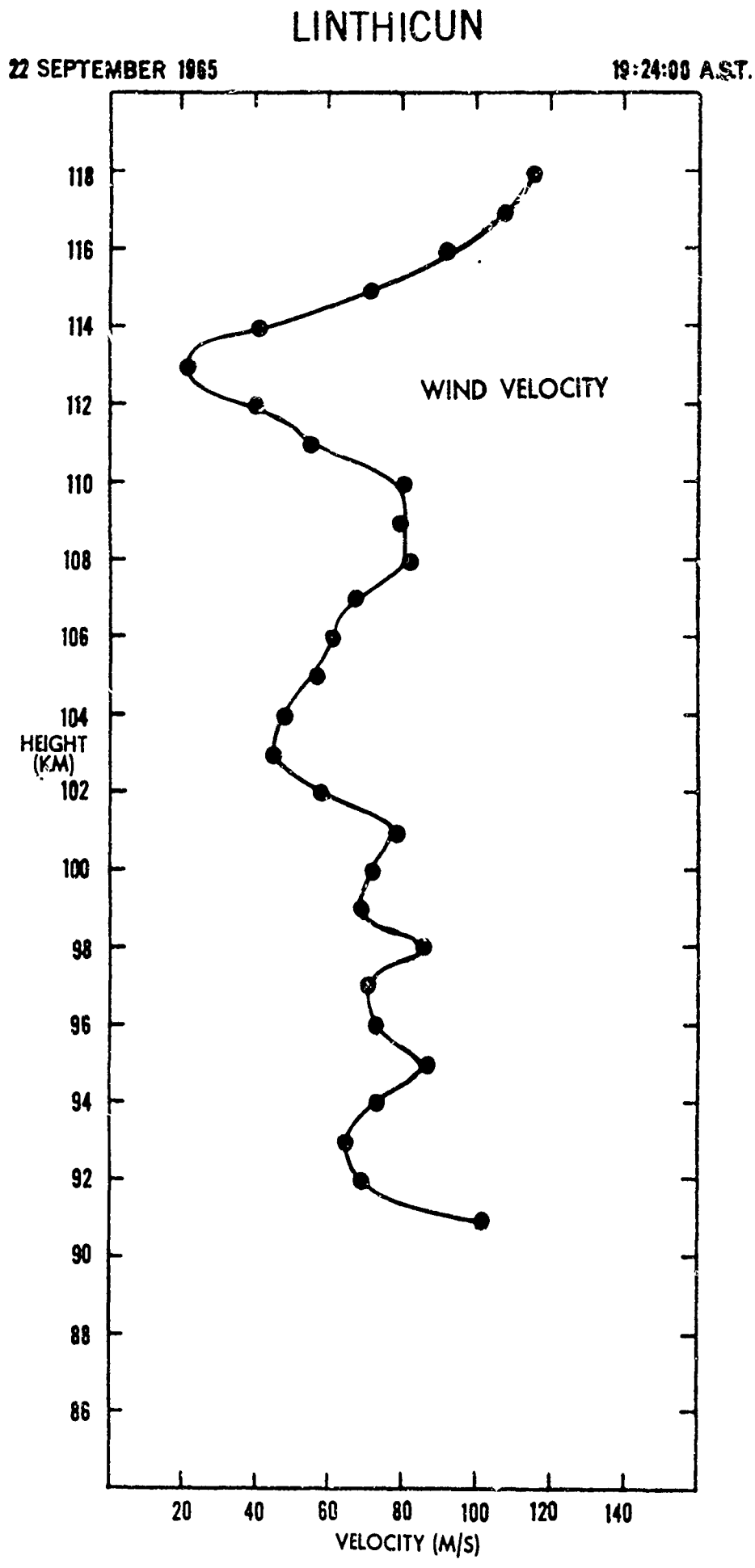
VELOCITY (M/S)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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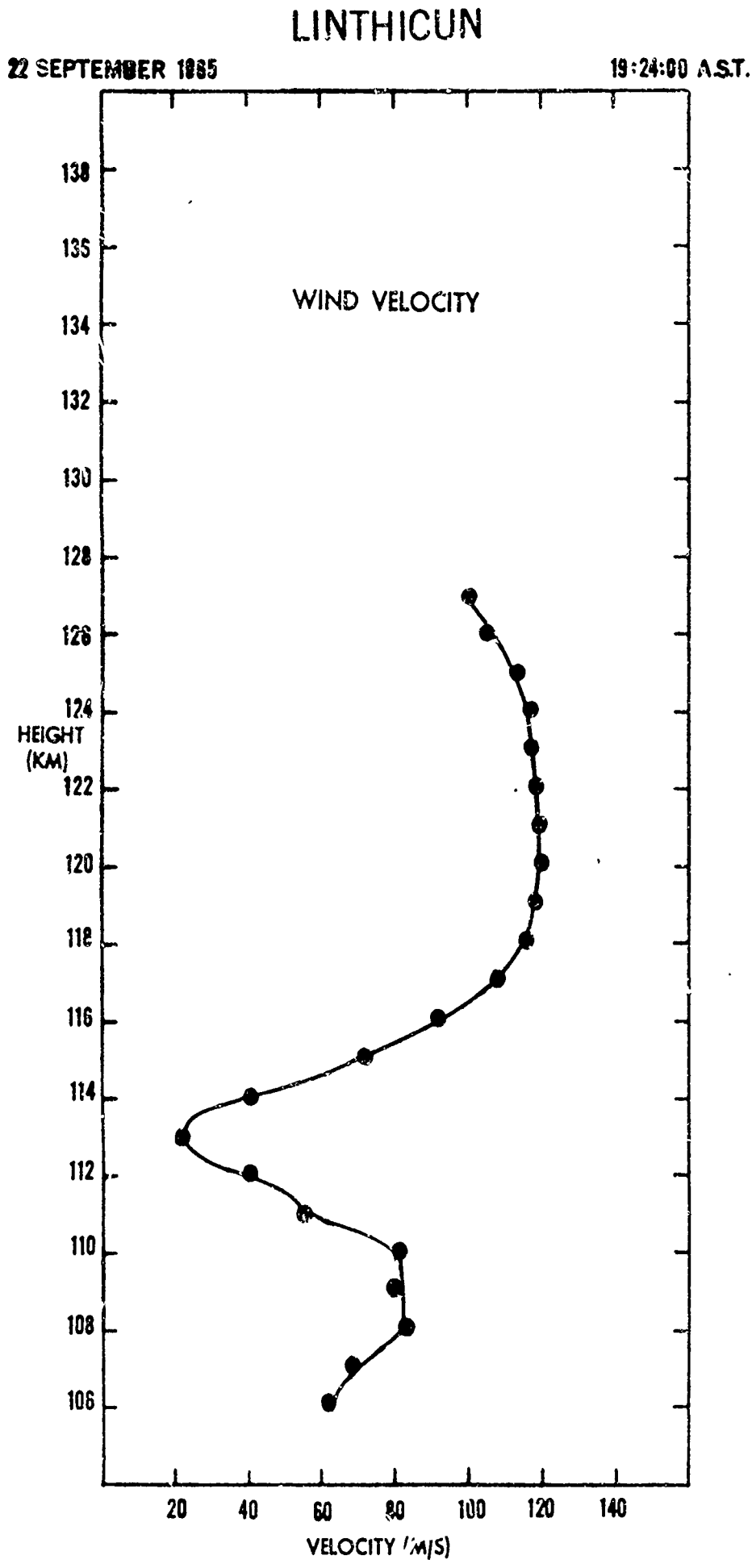
VELOCITY (M/S)


LINTHICUN
22 SEPTEMBER 1985
19:24:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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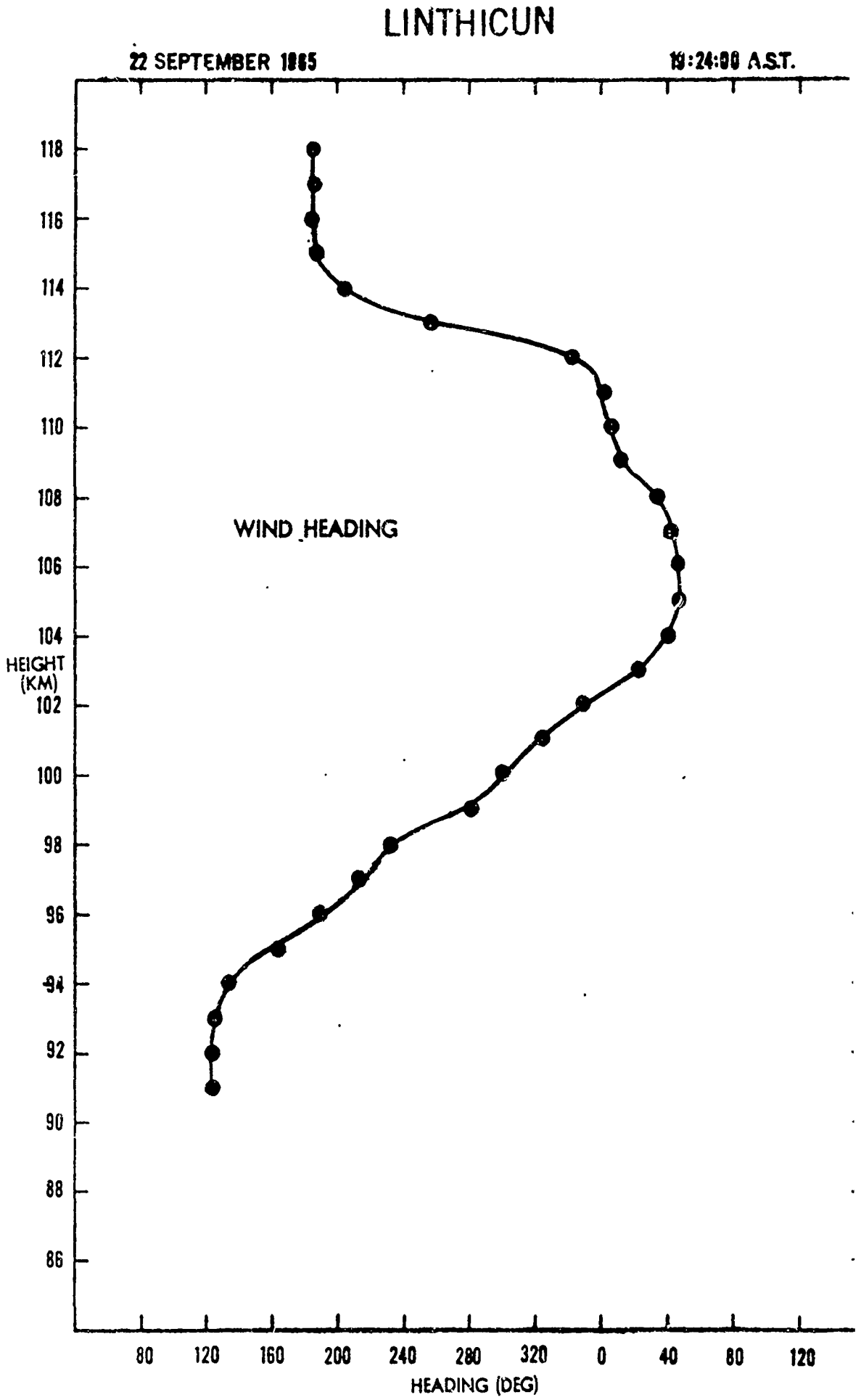
VELOCITY (M/S)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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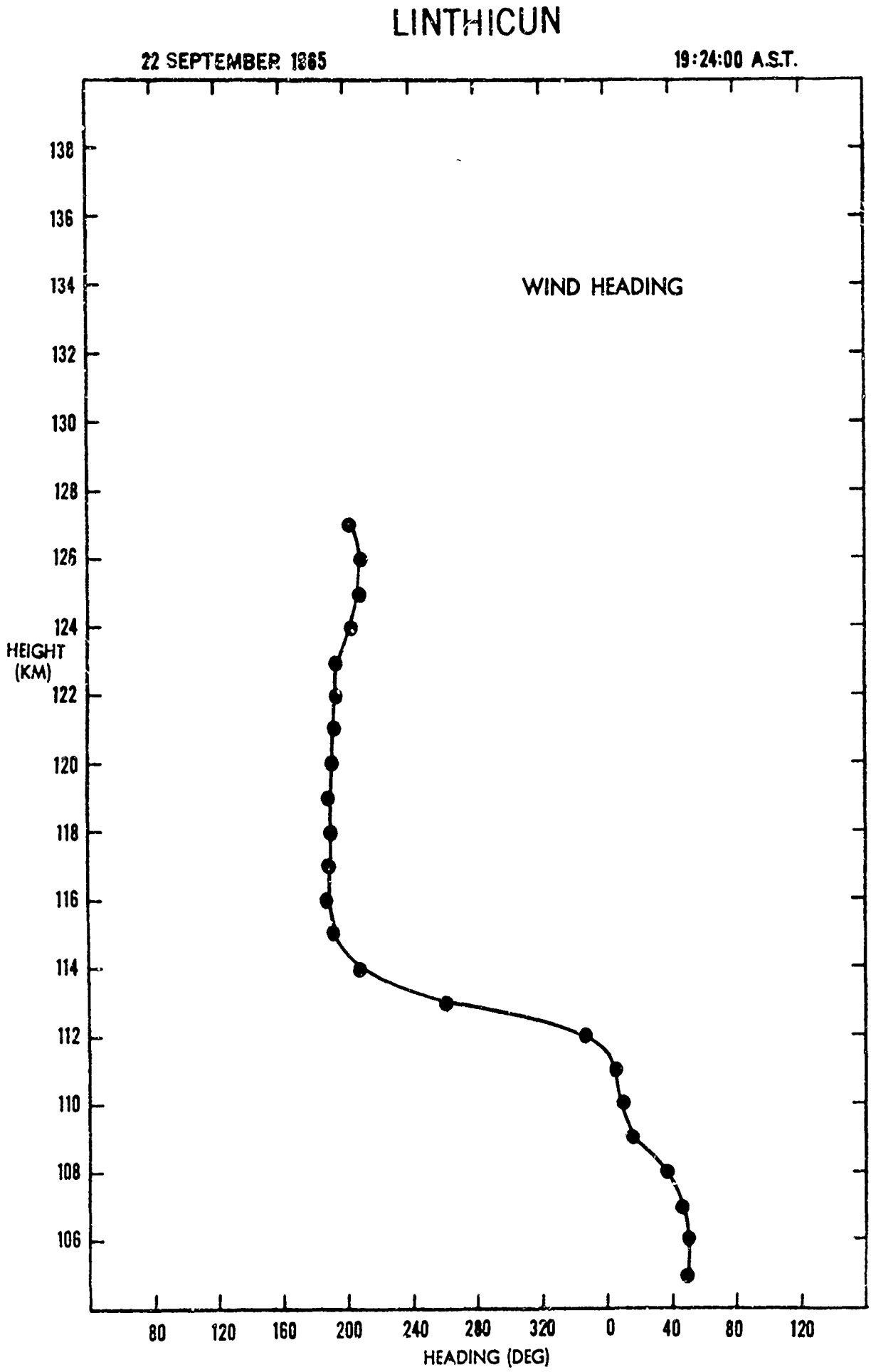
HEADING (DEG)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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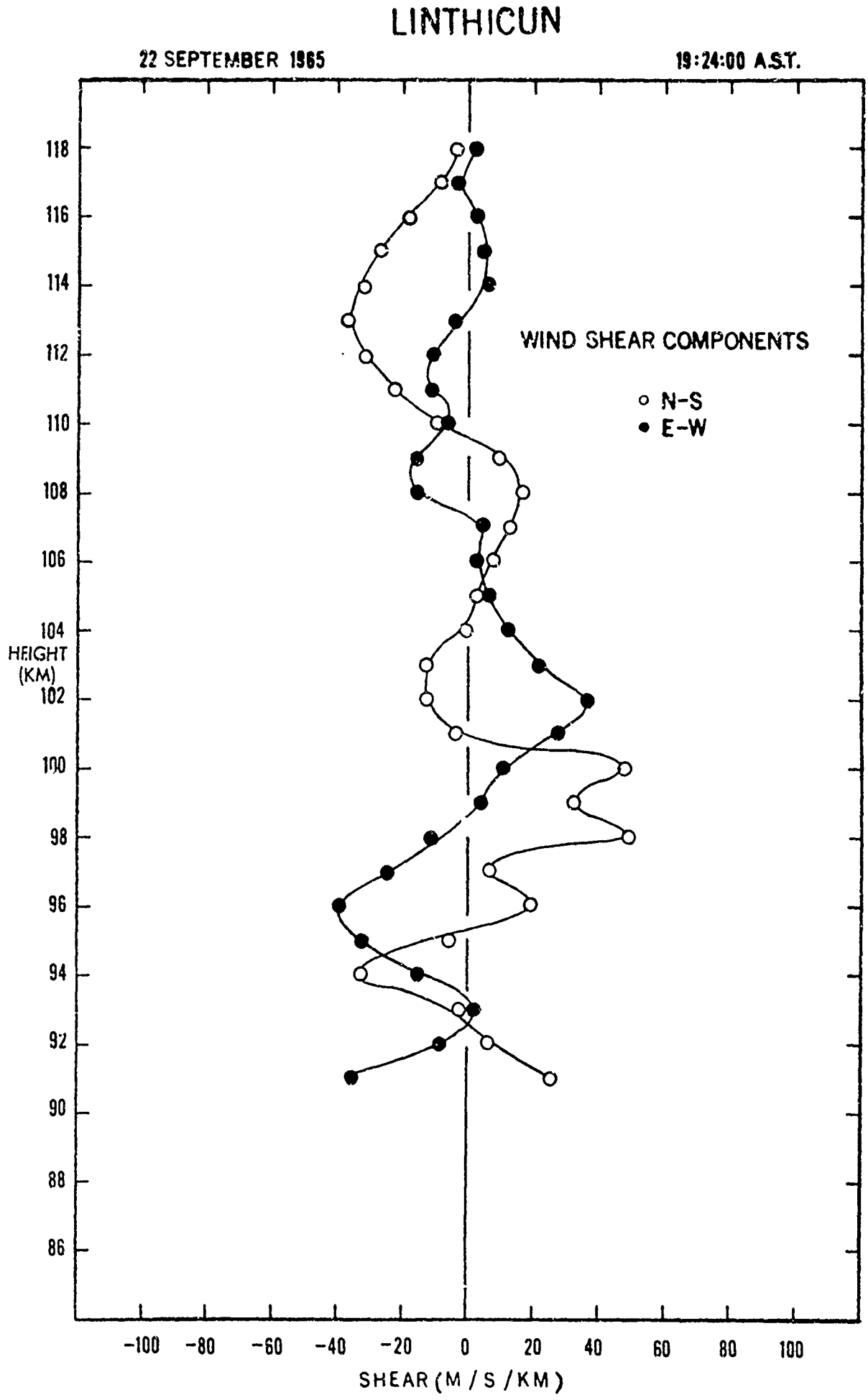
HEADING (DEG)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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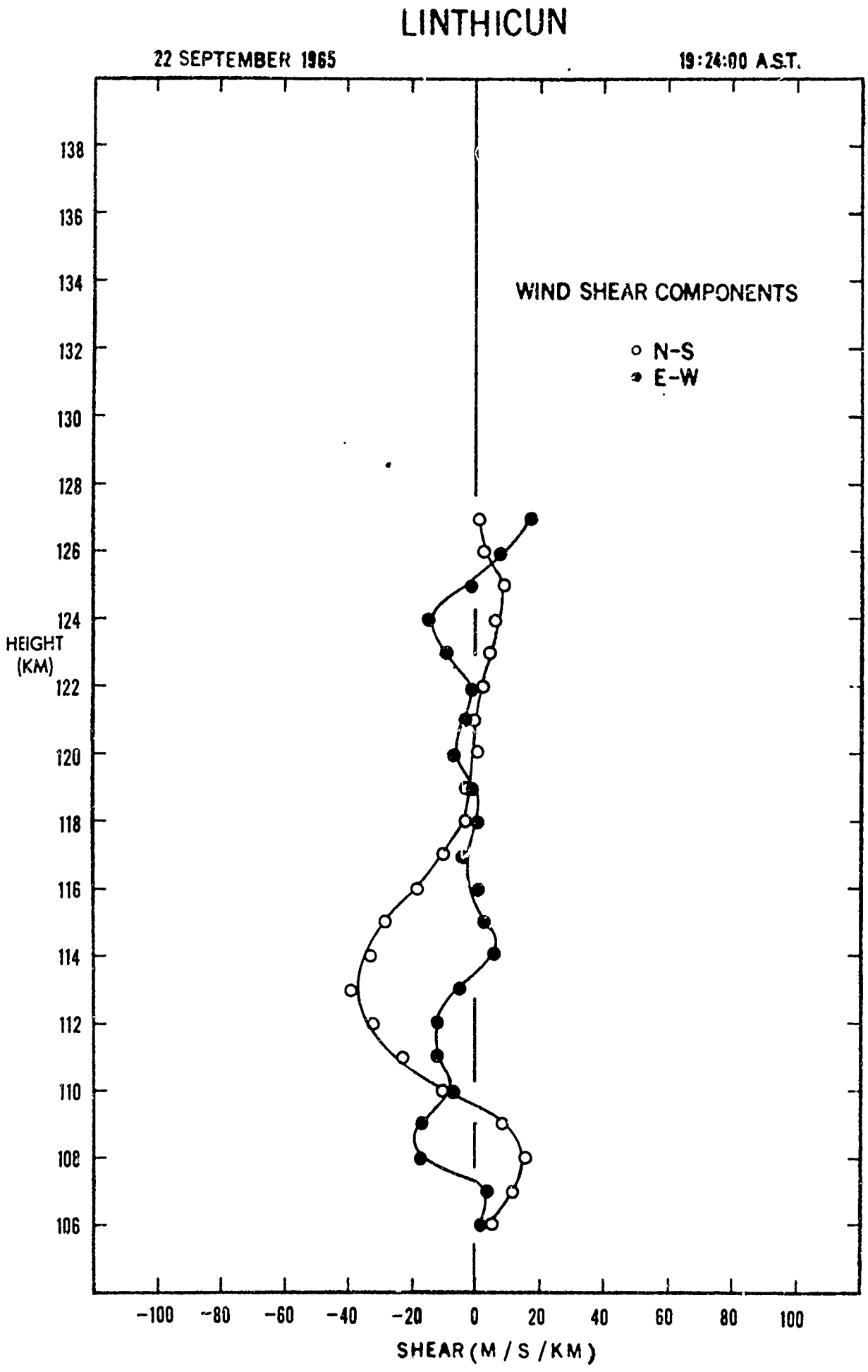
SHEAR (M / S / KM)


LINTHICUN
22 SEPTEMBER 1965
19:24:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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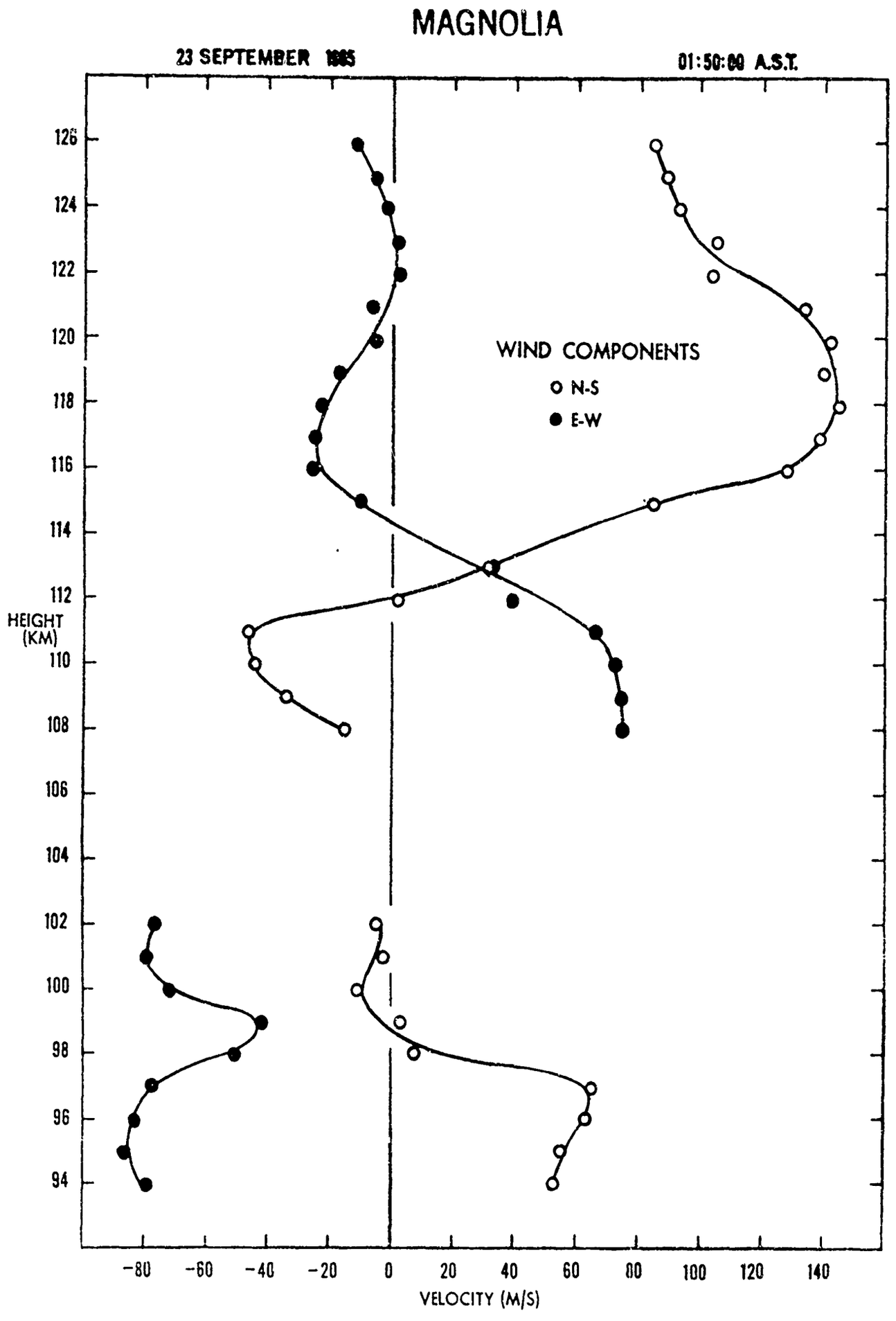
100
SHEAR (M / S / KM)

SHOT MAGNOLIA 23 SEPTEMBER 1965 01-50-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
94.0	303.9	95.7	53.3	-79.5
95.0	302.8	102.4	55.5	-86.0
96.0	307.2	104.4	63.1	-83.1
97.0	310.3	101.0	65.4	-77.0
98.0	279.3	50.8	8.2	-50.1
99.0	275.1	41.9	3.8	-41.7
100.0	259.8	72.1	-12.7	-71.0
101.0	268.7	79.3	-1.8	-79.3
102.0	266.4	76.6	-4.7	-76.4
108.0	101.8	77.5	-15.8	75.8
109.0	114.9	81.8	-34.4	74.2
110.0	121.2	85.5	-44.3	73.1
111.0	125.0	81.2	-46.6	66.6
112.0	88.4	39.5	1.1	39.5
113.0	46.3	44.4	30.7	32.1
115.0	352.9	85.1	84.5	-10.5
116.0	349.2	130.5	128.2	-24.5
117.0	350.0	141.0	138.8	-24.5
118.0	351.3	146.8	145.1	-22.2
119.0	353.1	141.8	140.7	-17.1
120.0	357.8	141.9	141.8	-5.3
121.0	357.5	135.6	135.5	-6.0
122.0	1.4	104.5	104.5	2.5
123.0	1.1	105.2	105.2	2.0
124.0	359.4	93.5	93.5	-1.0
125.0	356.8	89.8	89.7	-5.0
126.0	352.0	86.2	85.3	-12.0


MAGNOLIA
23 SEPTEMBER 1985
01:50:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
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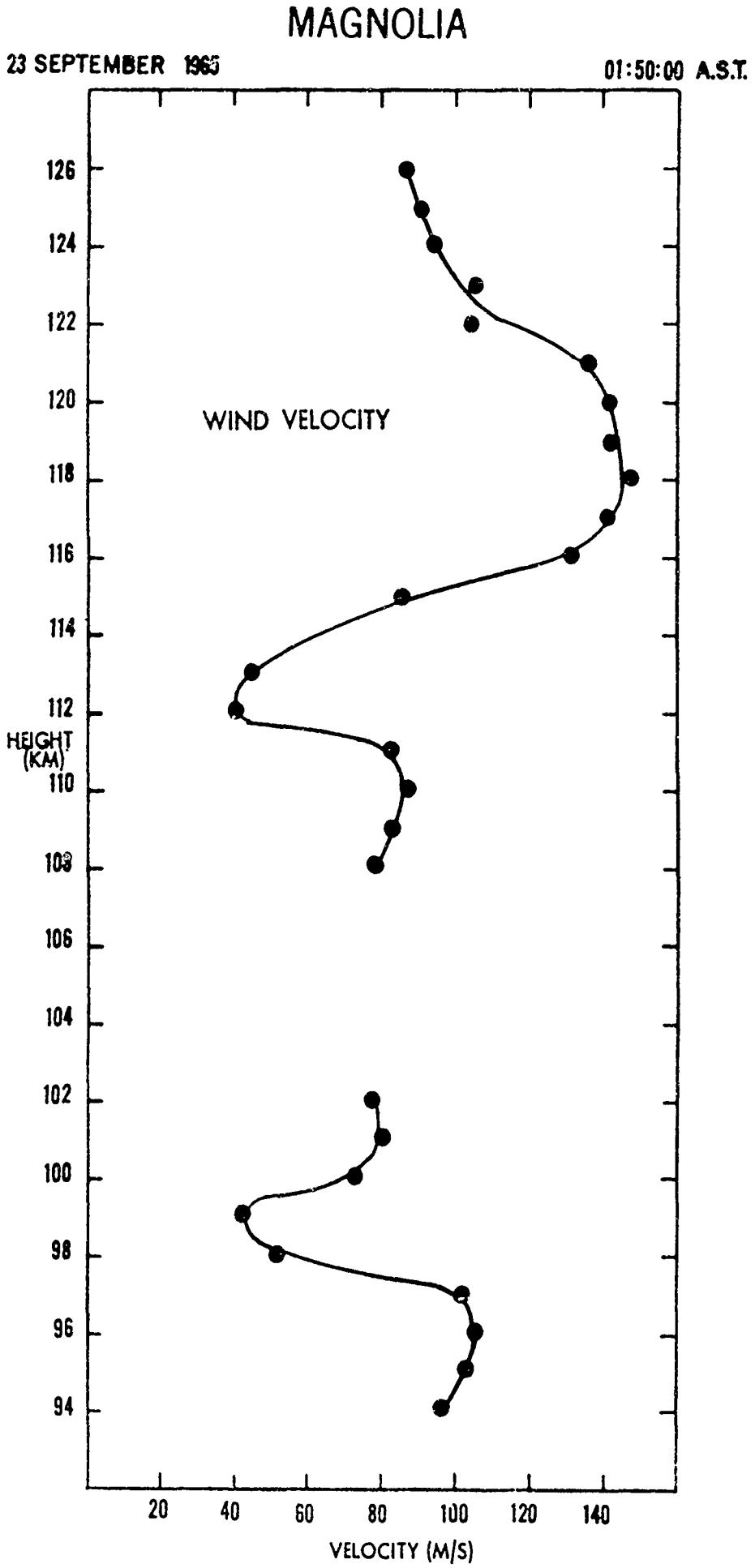
VELOCITY (M/S)


MAGNOLIA
23 SEPTEMBER 1965
01:50:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
126
124
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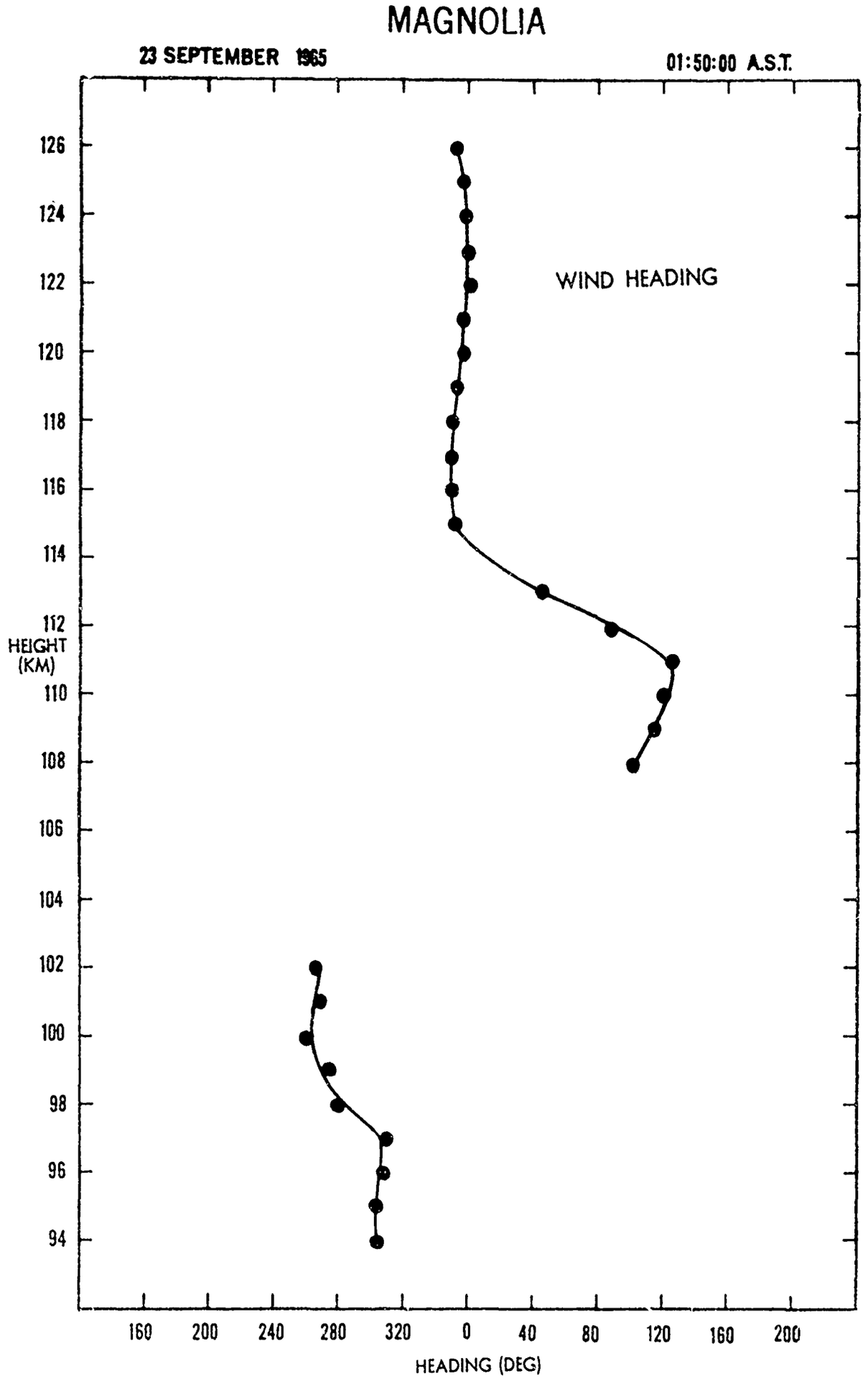
140
VELOCITY (M/S)


MAGNOLIA
23 SEPTEMBER 1965
01:50:00 A.S.T.
WIND HEADING
HEIGHT (KM)
126
124
122
120
118
116
114
112
110
108
106
104
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98
96
94
160
200
240
280
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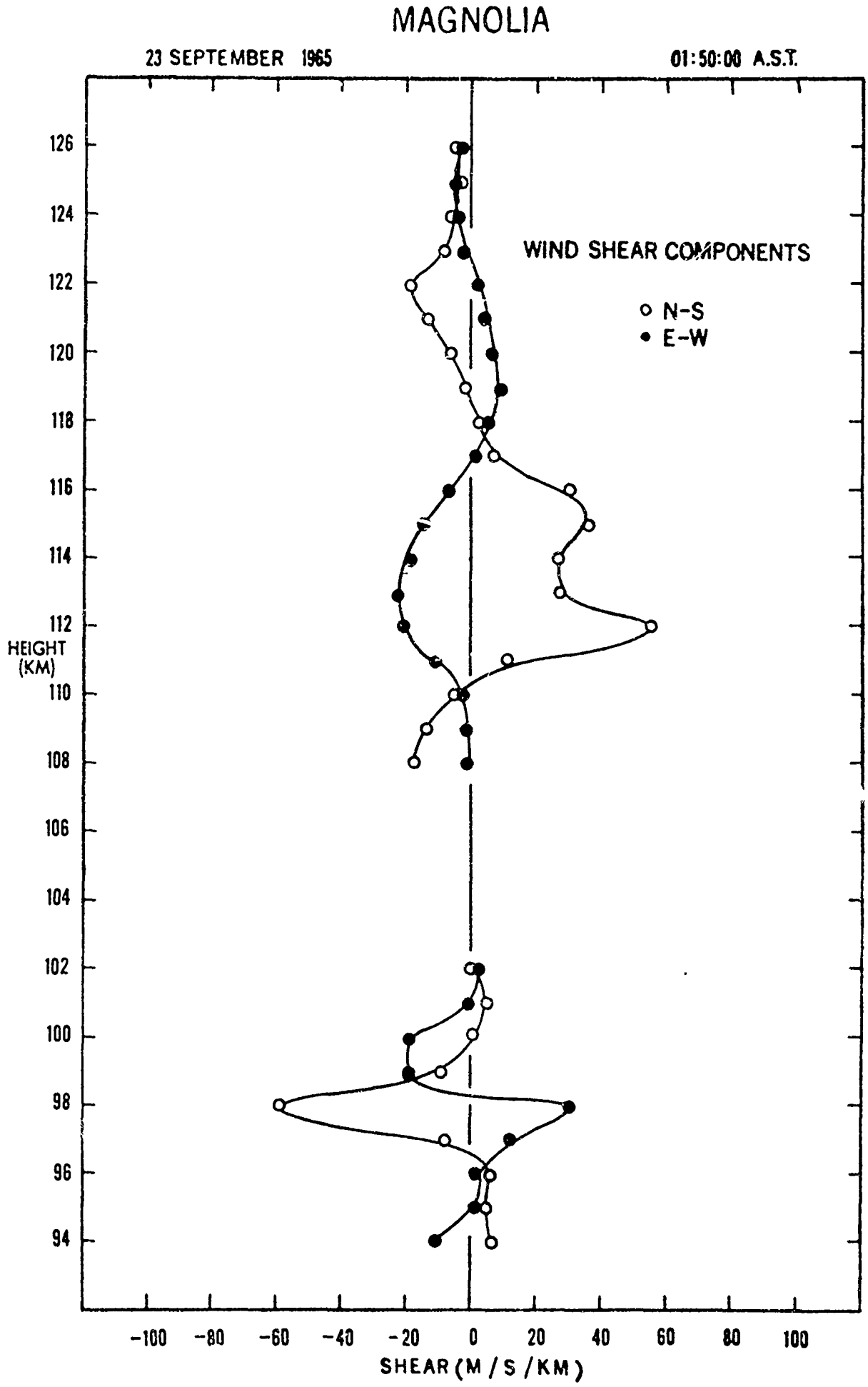
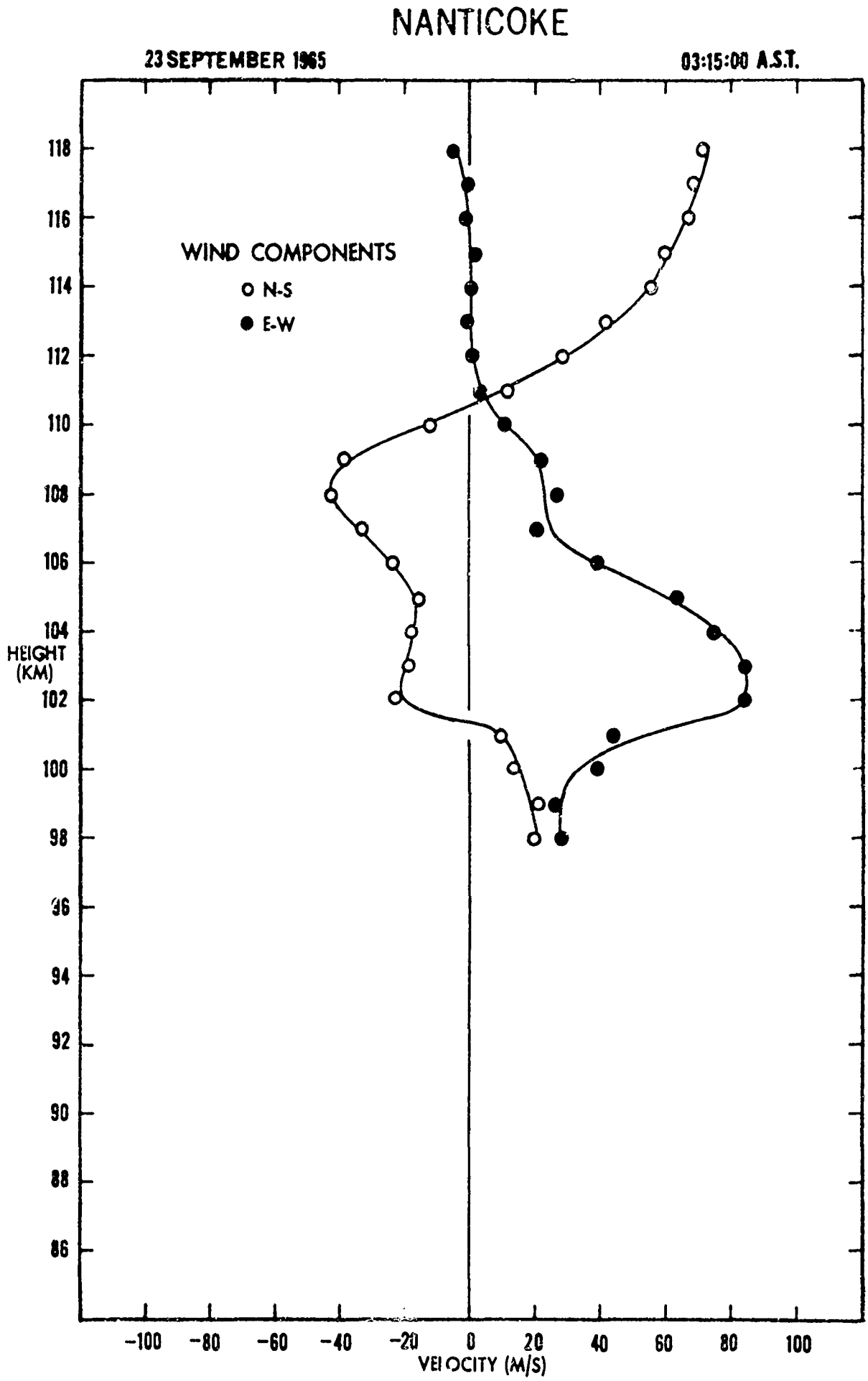
0
40
80
120
160
200
HEADING (DEG)


MAGNOLIA
23 SEPTEMBER 1965
01:50:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
126
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M / S / KM)

SHOT NANTICOKE 23 SEPTEMBER 1965 03-15-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
98.0	55.6	34.0	19.2	28.1
99.0	51.7	32.8	20.3	25.8
100.0	72.0	40.9	12.7	38.9
101.0	78.8	44.3	8.6	43.5
102.0	105.0	87.2	-22.6	84.3
103.0	102.8	86.2	-19.1	84.0
104.0	103.5	77.5	-18.2	75.3
105.0	103.9	64.8	-15.6	62.9
106.0	121.5	46.0	-24.0	39.2
107.0	149.8	39.0	-33.7	19.7
108.0	147.5	50.7	-42.8	27.3
109.0	150.8	45.1	-39.4	22.0
110.0	141.9	16.1	-12.7	10.0
111.0	16.4	11.7	11.3	3.3
112.0	359.9	28.2	28.2	0.0
113.0	358.5	41.4	41.4	-1.1
114.0	359.9	54.5	54.5	-0.1
115.0	1.1	58.8	58.8	1.1
116.0	358.2	66.4	66.4	-2.1
117.0	359.0	68.1	68.1	-1.2
118.0	355.1	71.4	71.1	-6.1
119.0	354.9	77.9	77.6	-7.0
120.0	354.2	76.5	76.2	-7.7
121.0	352.3	75.8	75.1	-10.2
122.0	347.9	73.9	72.2	-15.5
123.0	347.5	77.5	75.7	-16.8
126.0	235.4	61.4	-34.8	-50.6
127.0	238.7	67.9	-35.3	-58.0
128.0	237.4	76.0	-40.9	-64.1
129.0	237.2	82.0	-44.4	-68.9
130.0	236.9	88.9	-48.6	-74.5
131.0	235.5	95.8	-54.2	-78.9
132.0	236.4	102.2	-56.6	-85.2
133.0	237.2	108.8	-58.9	-91.5


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
118
116
114
112
110
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100
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-100
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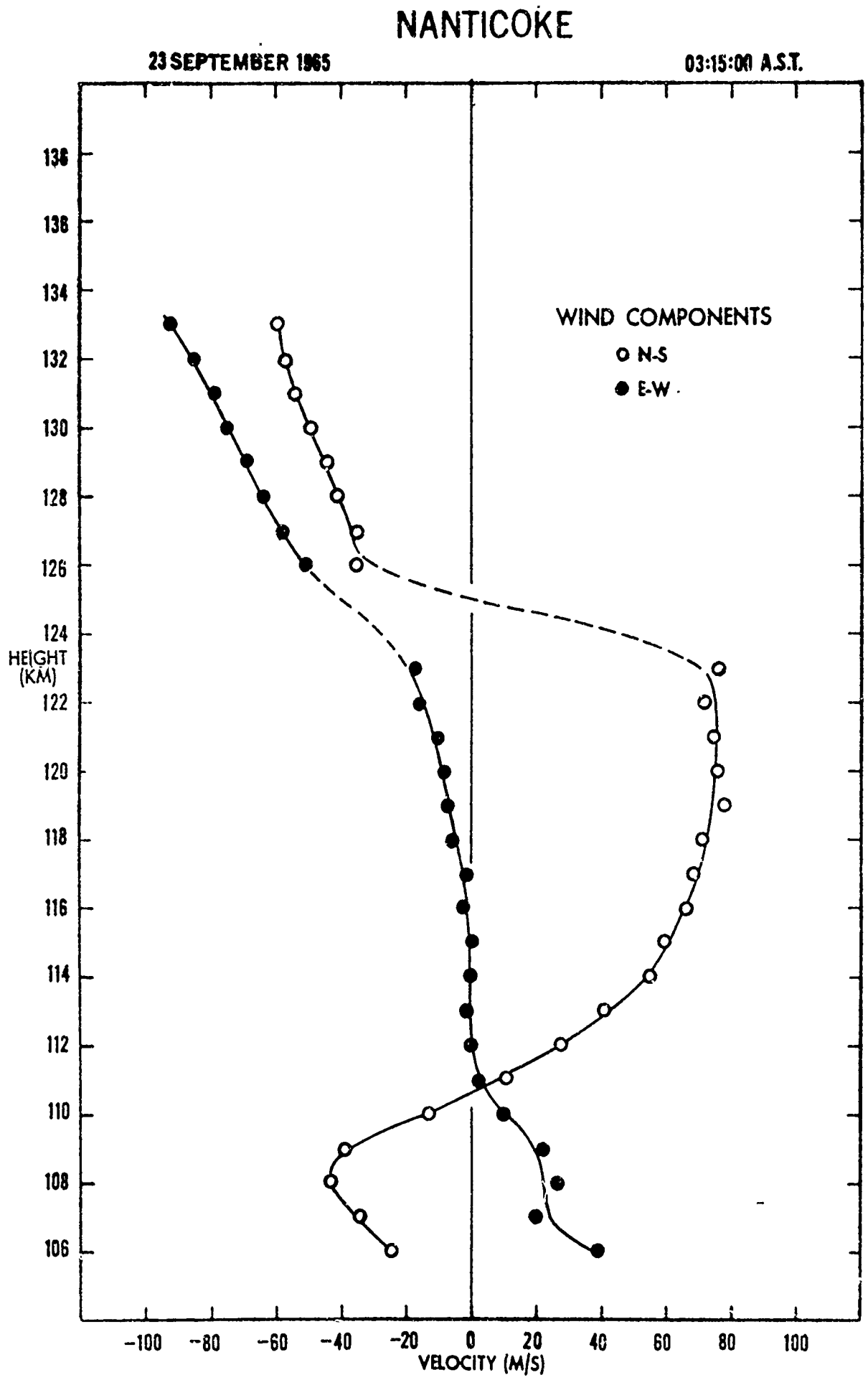
100
VELOCITY (M/S)


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
VELOCITY (M/S)
136
138
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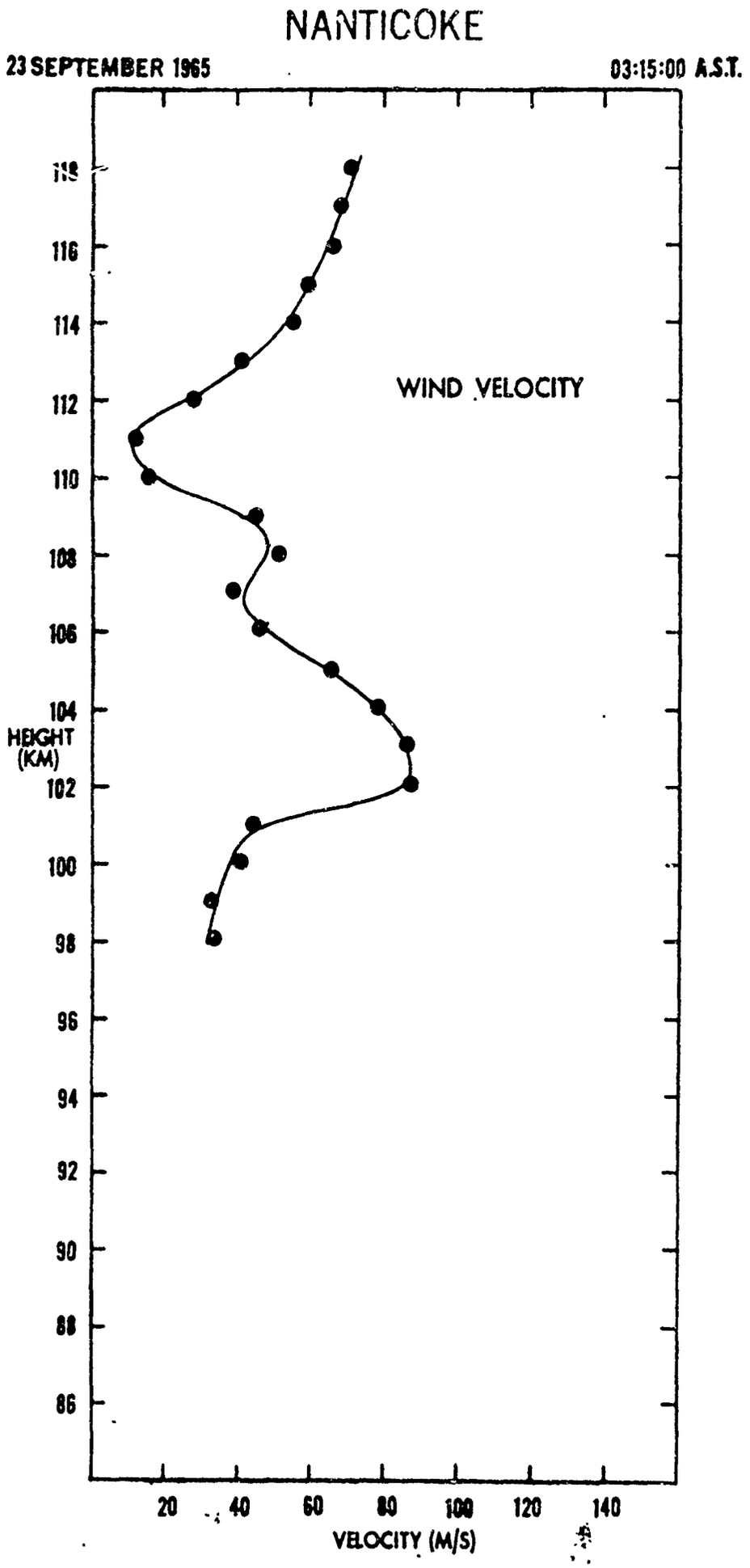
NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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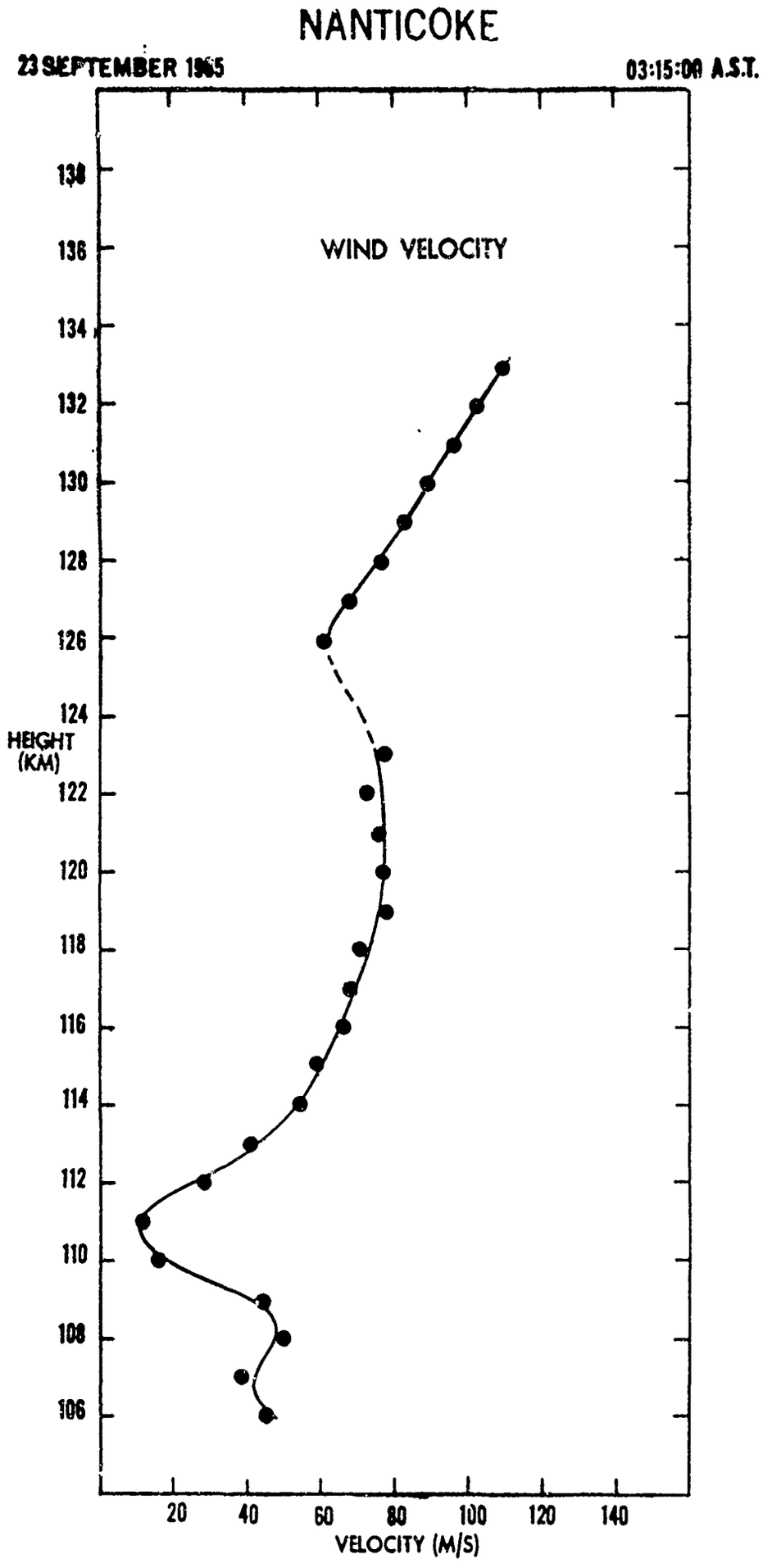
VELOCITY (M/S)


NANTICOKE
23 SEPTEMBER 1965
03:15:09 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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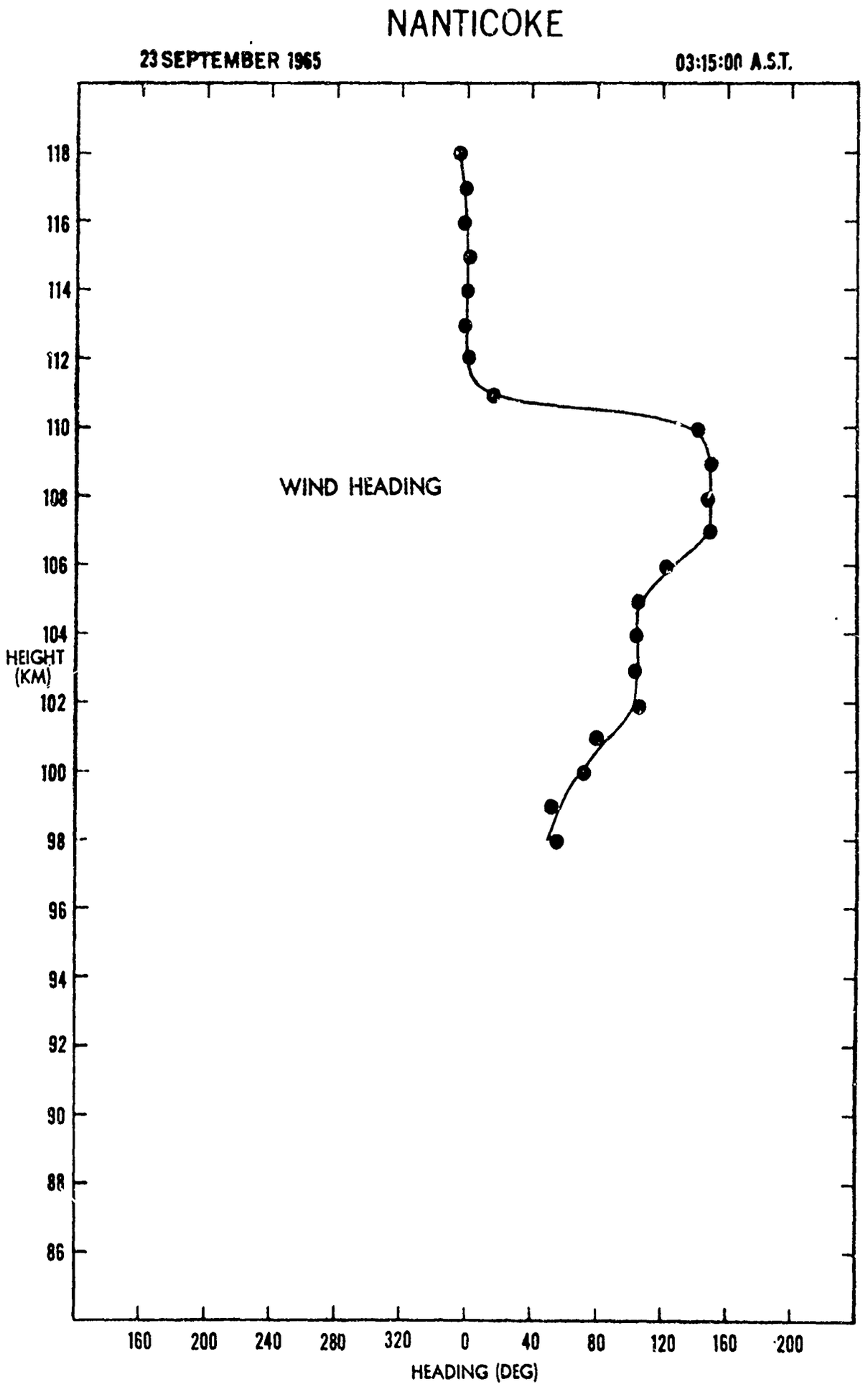
VELOCITY (M/S)


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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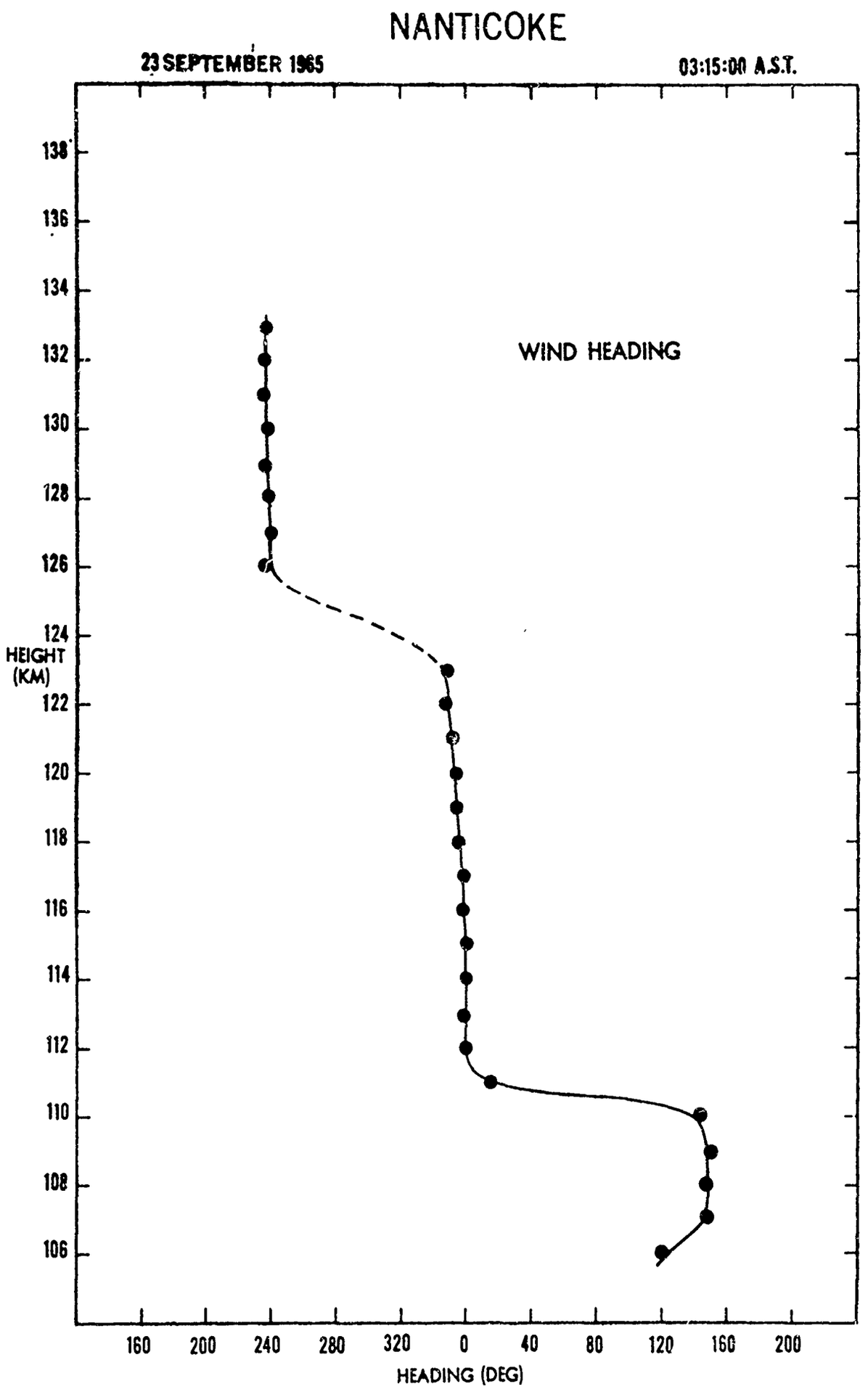
HEADING (DEG)


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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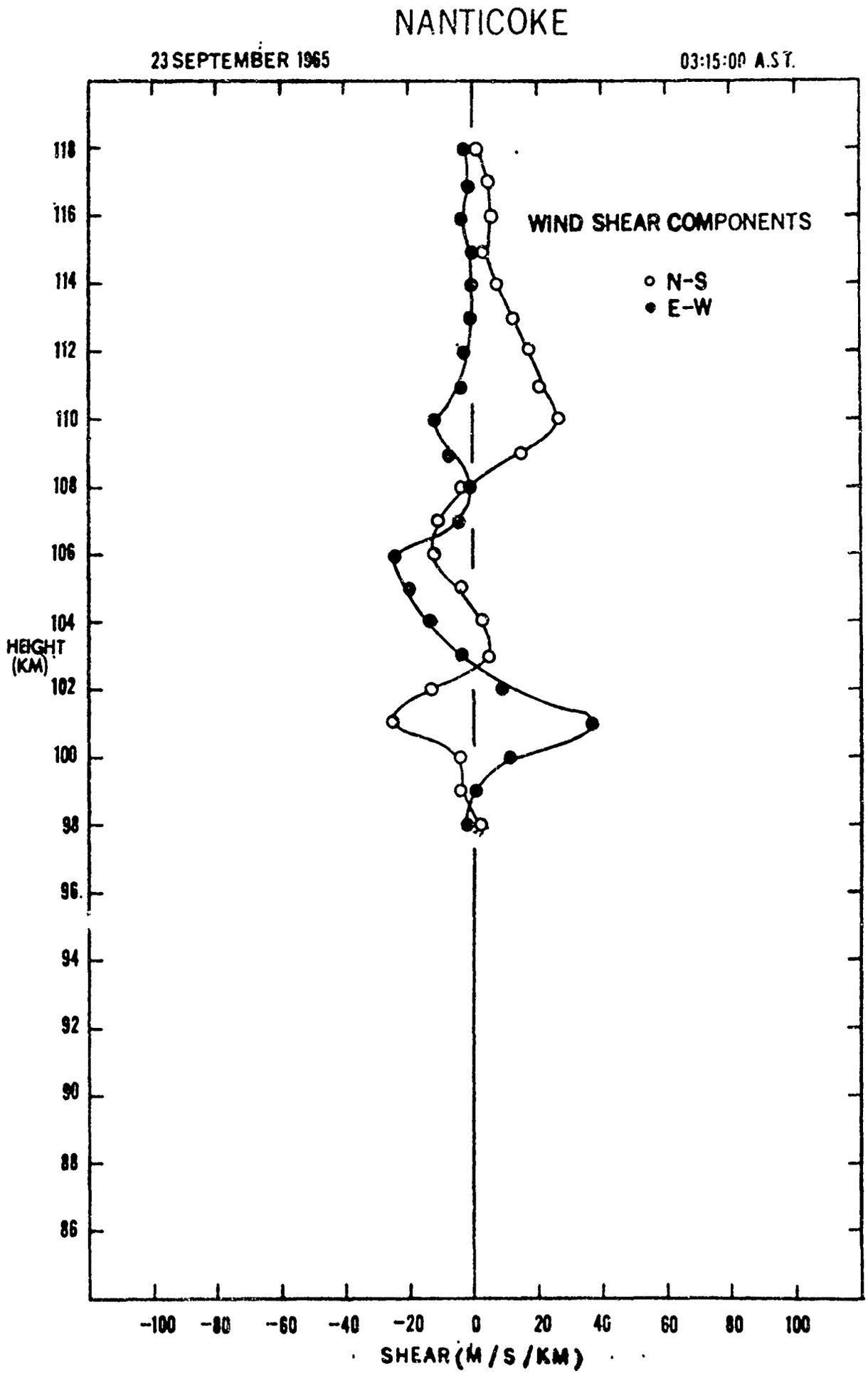
HEADING (DEG)


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
118
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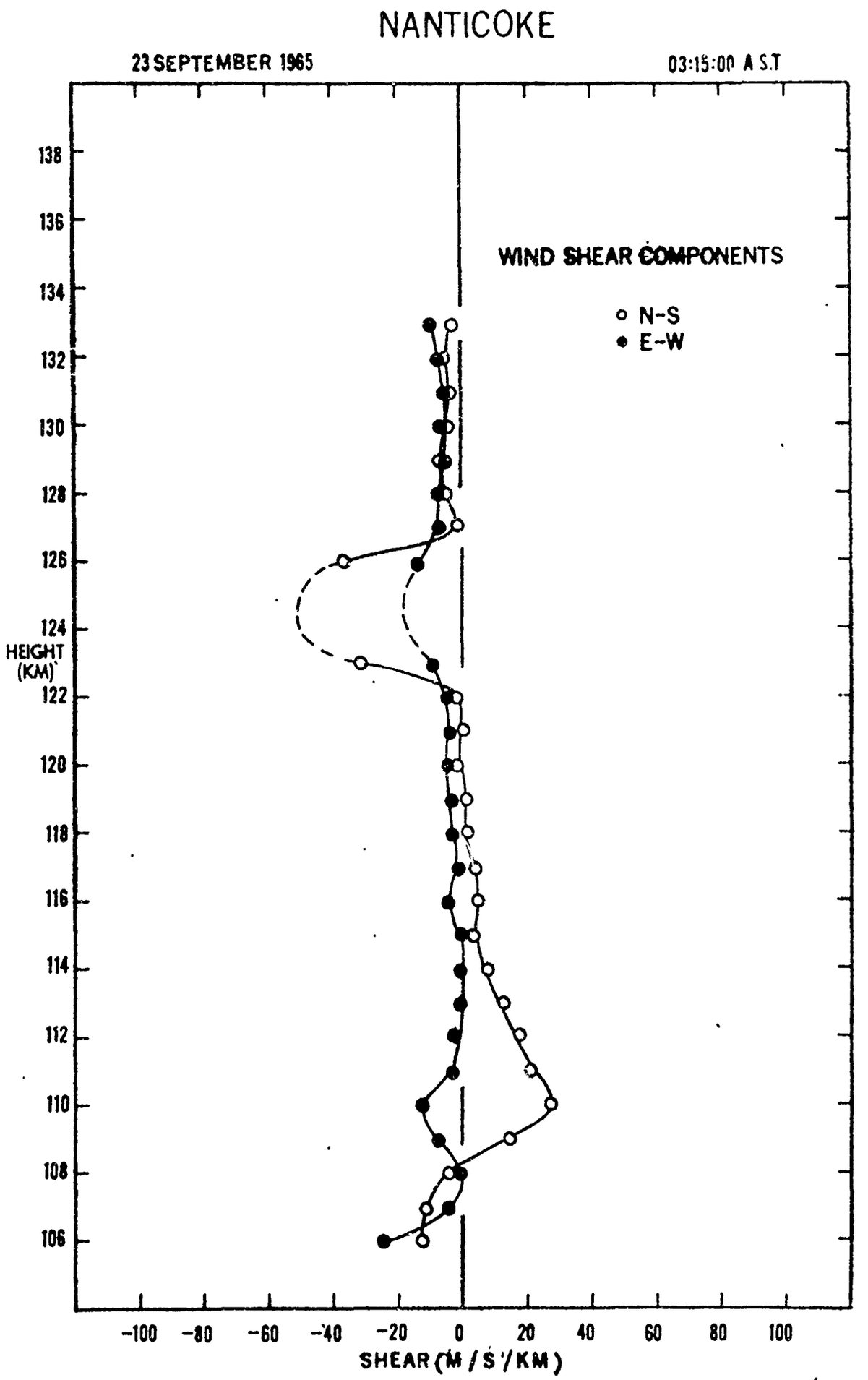
100
SHEAR (M/S/KM)


NANTICOKE
23 SEPTEMBER 1965
03:15:00 A.S.T
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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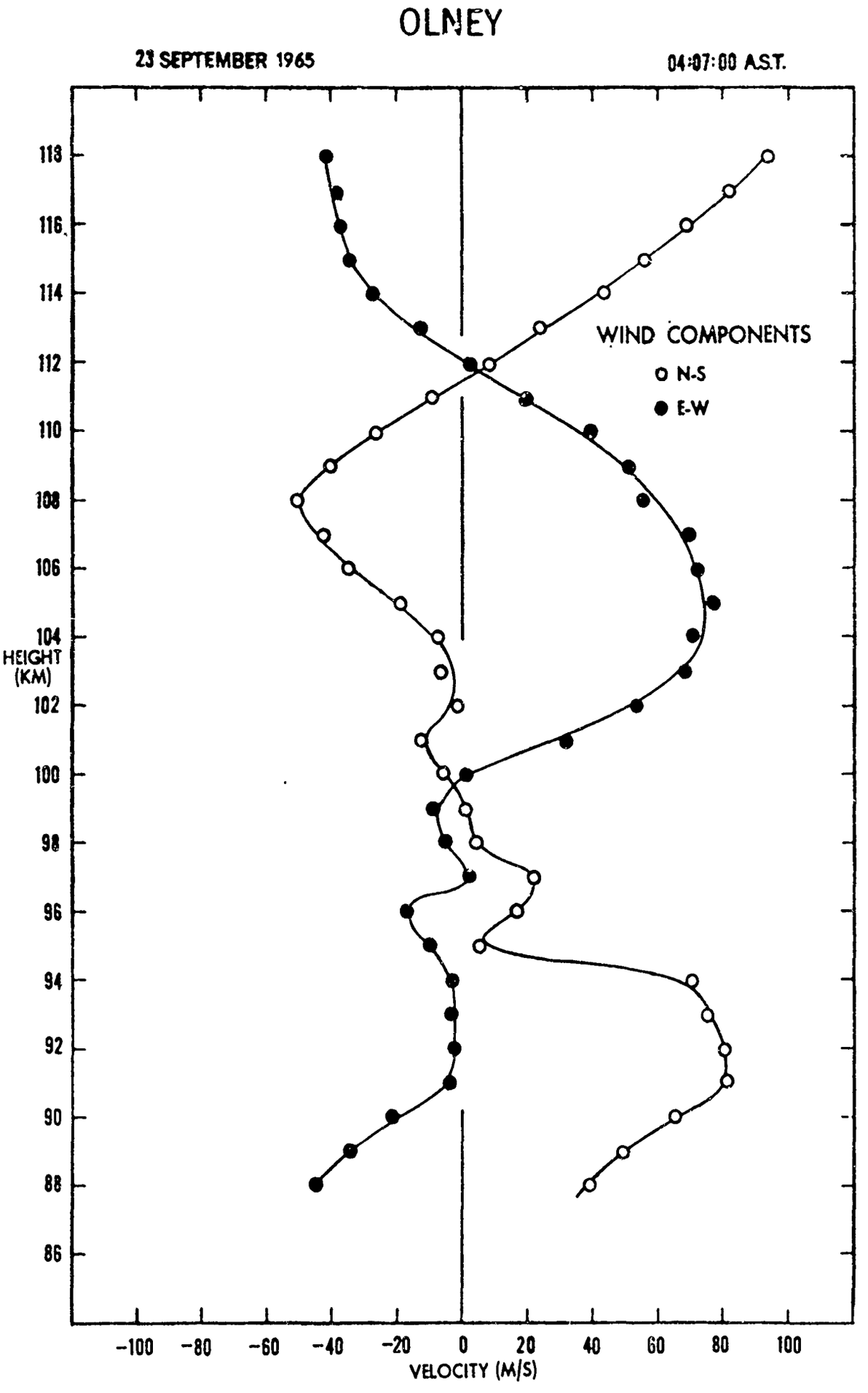
SHEAR (M/S/KM)

SHOT OLNEY 23 SEPTEMBER 1965 04-07-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
88.0	310.9	59.1	38.7	-44.7
89.0	325.5	59.7	49.2	-33.8
90.0	341.9	68.0	64.7	-21.2
91.0	357.4	81.0	80.9	-3.7
92.0	358.5	80.0	80.0	-2.0
93.0	357.5	75.4	75.3	-3.3
94.0	357.2	70.0	69.9	-3.4
95.0	297.5	11.2	5.2	-10.0
96.0	314.8	23.8	16.8	-16.9
97.0	4.9	22.5	22.4	1.9
98.0	307.9	6.4	3.9	-5.0
99.0	277.9	9.1	1.2	-9.0
100.0	167.0	6.0	-5.8	1.3
101.0	111.9	34.0	-12.7	31.5
102.0	91.6	53.0	-1.5	53.0
103.0	96.2	68.2	-7.4	67.8
104.0	96.7	70.0	-8.1	69.5
105.0	103.5	79.5	-18.6	77.3
106.0	116.0	79.9	-35.0	71.8
107.0	121.9	81.5	-43.0	69.2
108.0	132.7	74.8	-50.8	54.9
109.0	129.4	65.1	-41.3	50.3
110.0	123.9	46.8	-26.1	38.8
111.0	116.7	21.5	-9.7	19.3
112.0	14.5	8.0	7.8	2.0
113.0	329.9	26.3	22.8	-13.2
114.0	326.3	51.1	42.5	-28.3
115.0	327.7	65.2	55.2	-34.8
116.0	330.8	77.9	68.0	-38.0
117.0	334.0	89.9	80.8	-39.4
118.0	335.7	101.9	92.8	-41.9
119.0	335.5	105.3	95.8	-43.7
120.0	329.7	87.9	75.9	-44.4
121.0	325.4	85.6	70.5	-48.6
122.0	296.1	65.2	28.7	-58.6
124.0	261.8	82.4	-11.8	-81.5
125.0	258.6	94.2	-18.6	-92.4
126.0	254.7	100.8	-26.6	-97.2


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
118
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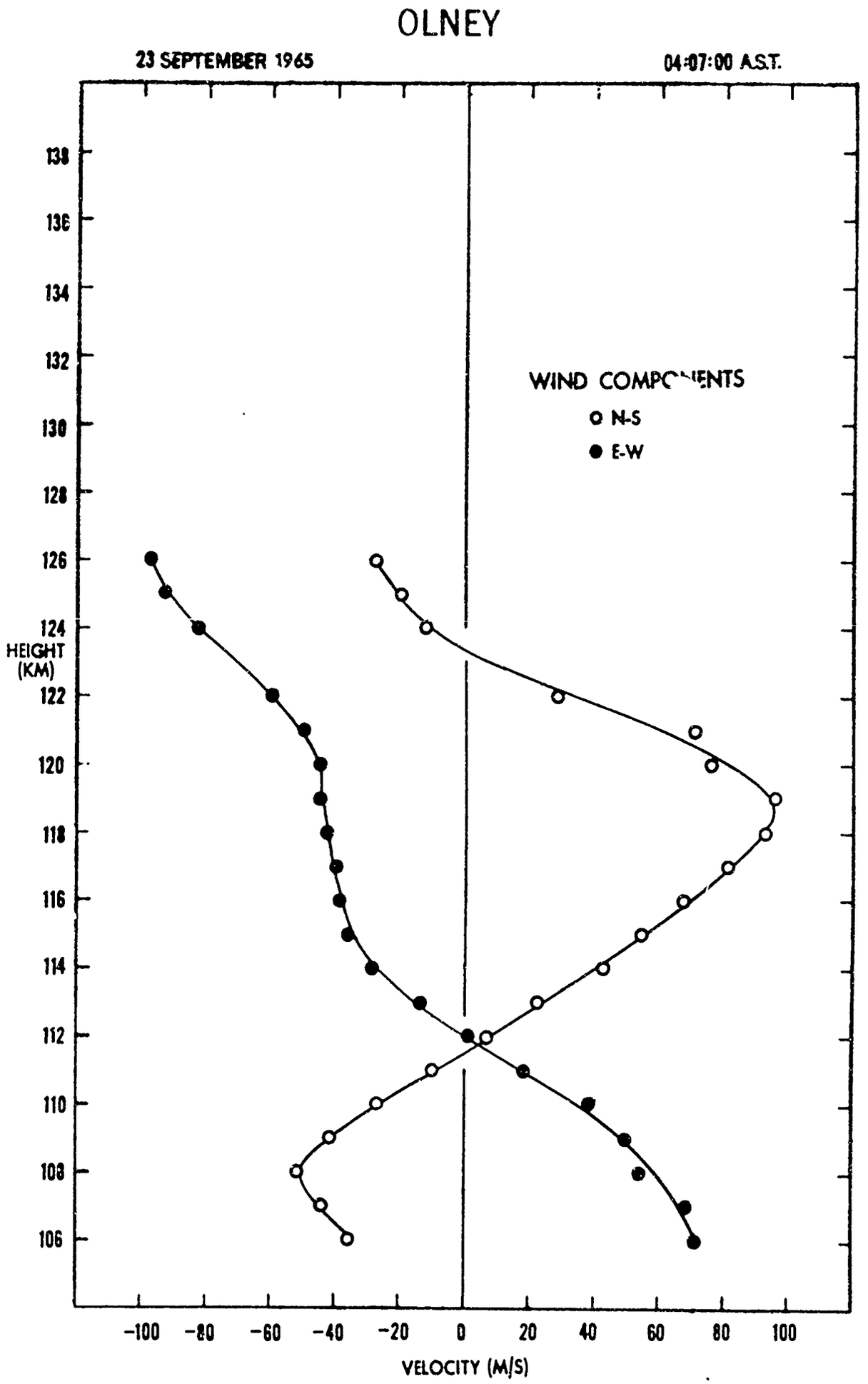
VELOCITY (M/S)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
138
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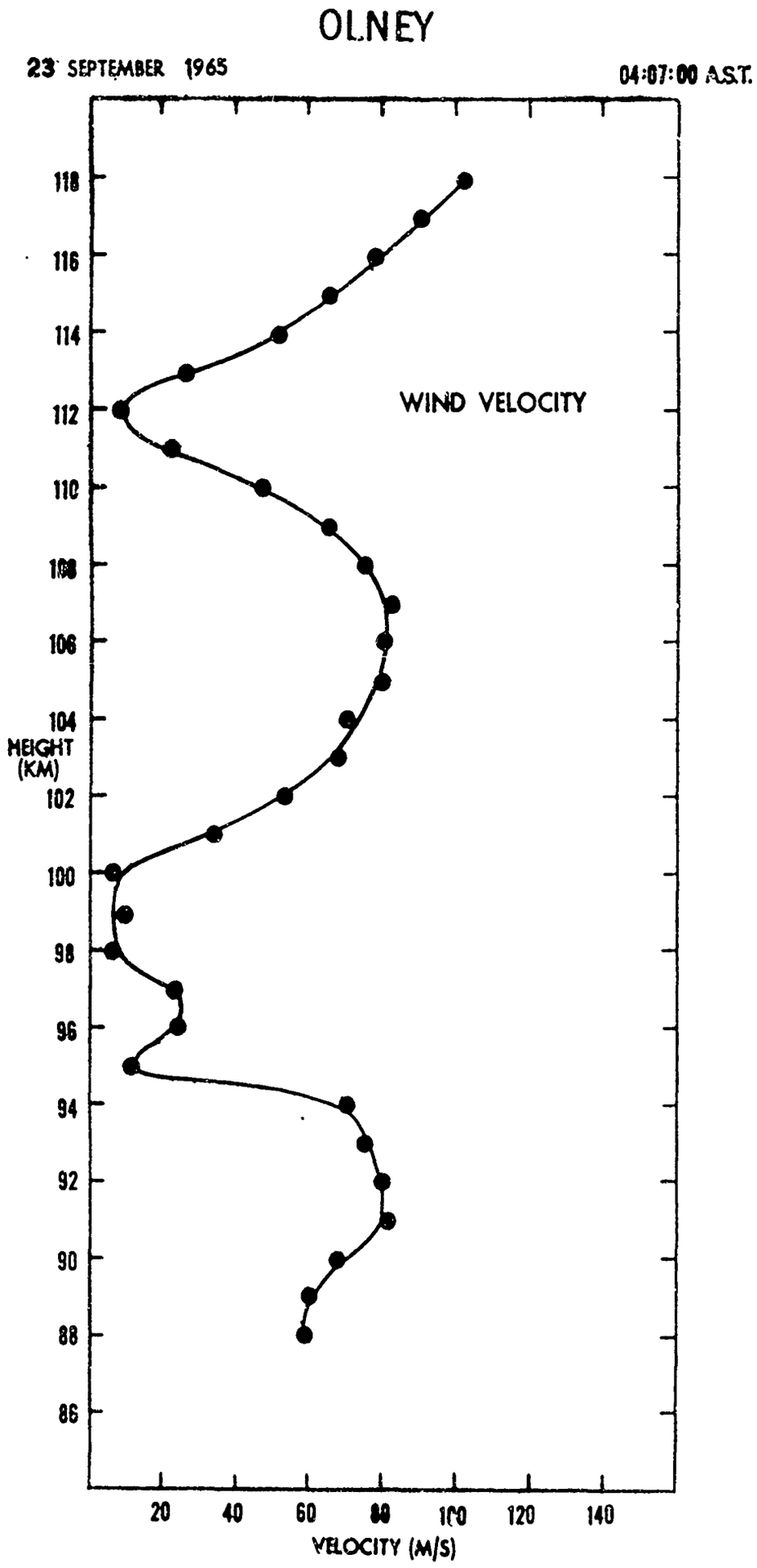
VELOCITY (M/S)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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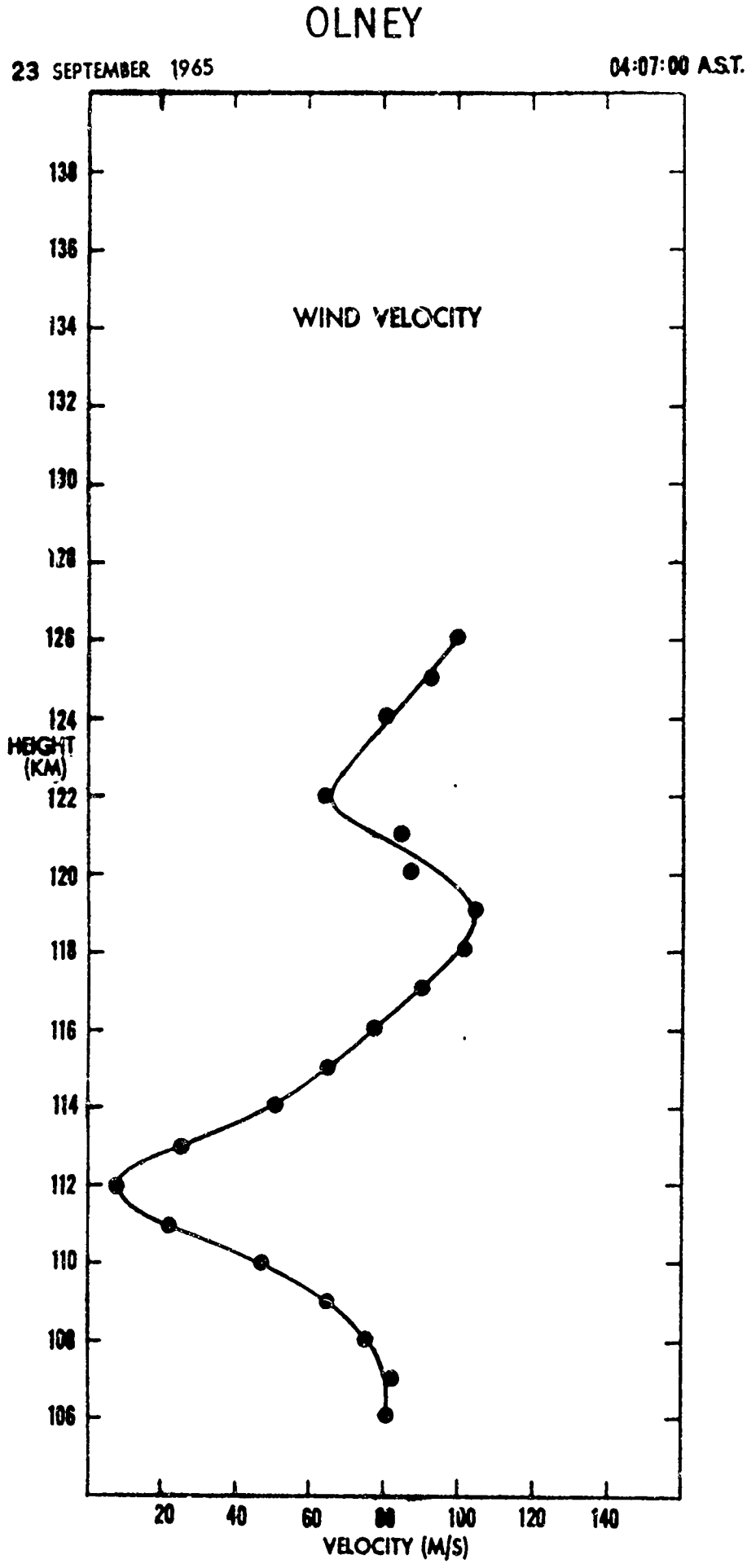
VELOCITY (M/S)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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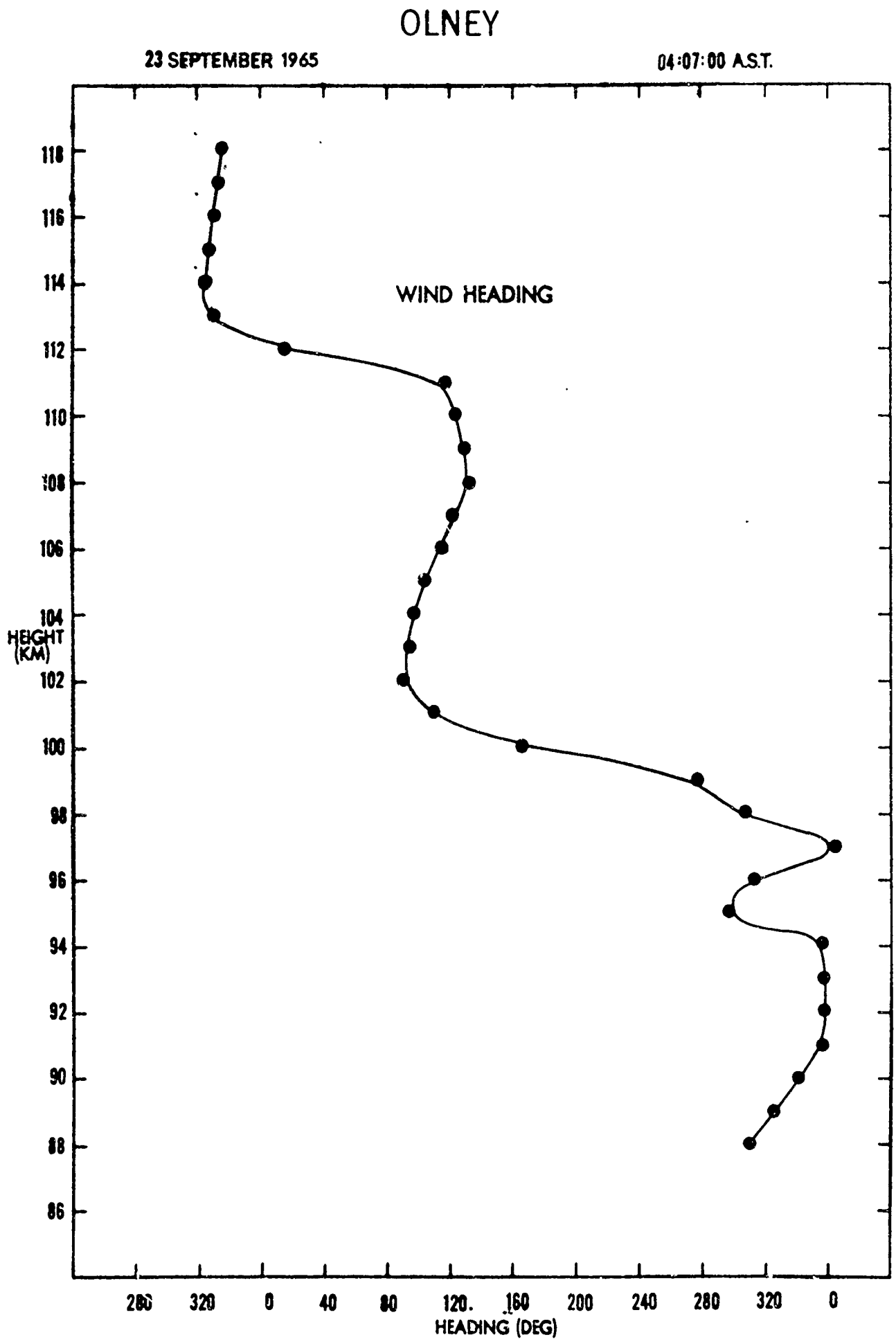
VELOCITY (M/S)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND HEADING
HEIGHT (KM)
118
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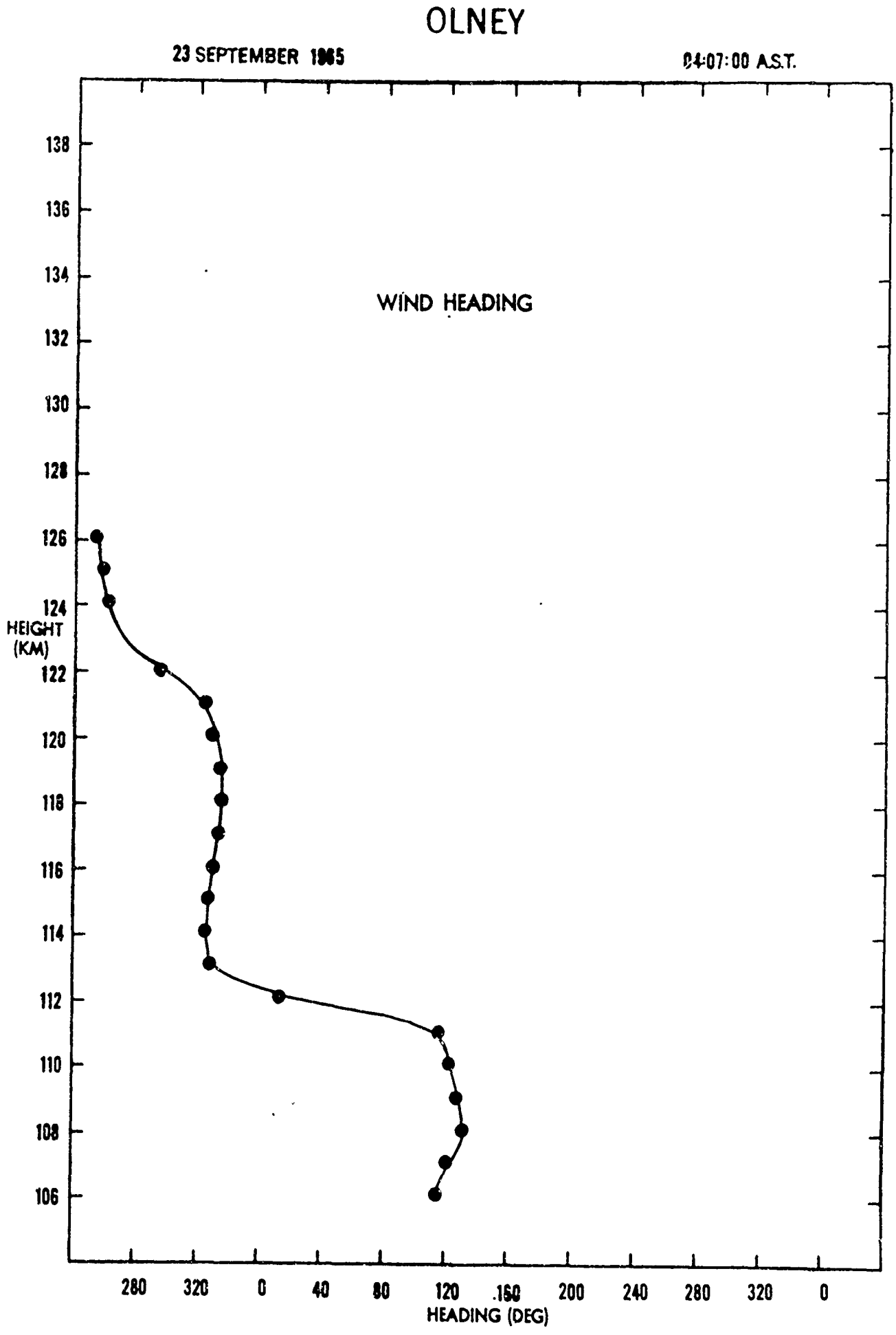
HEADING (DEG)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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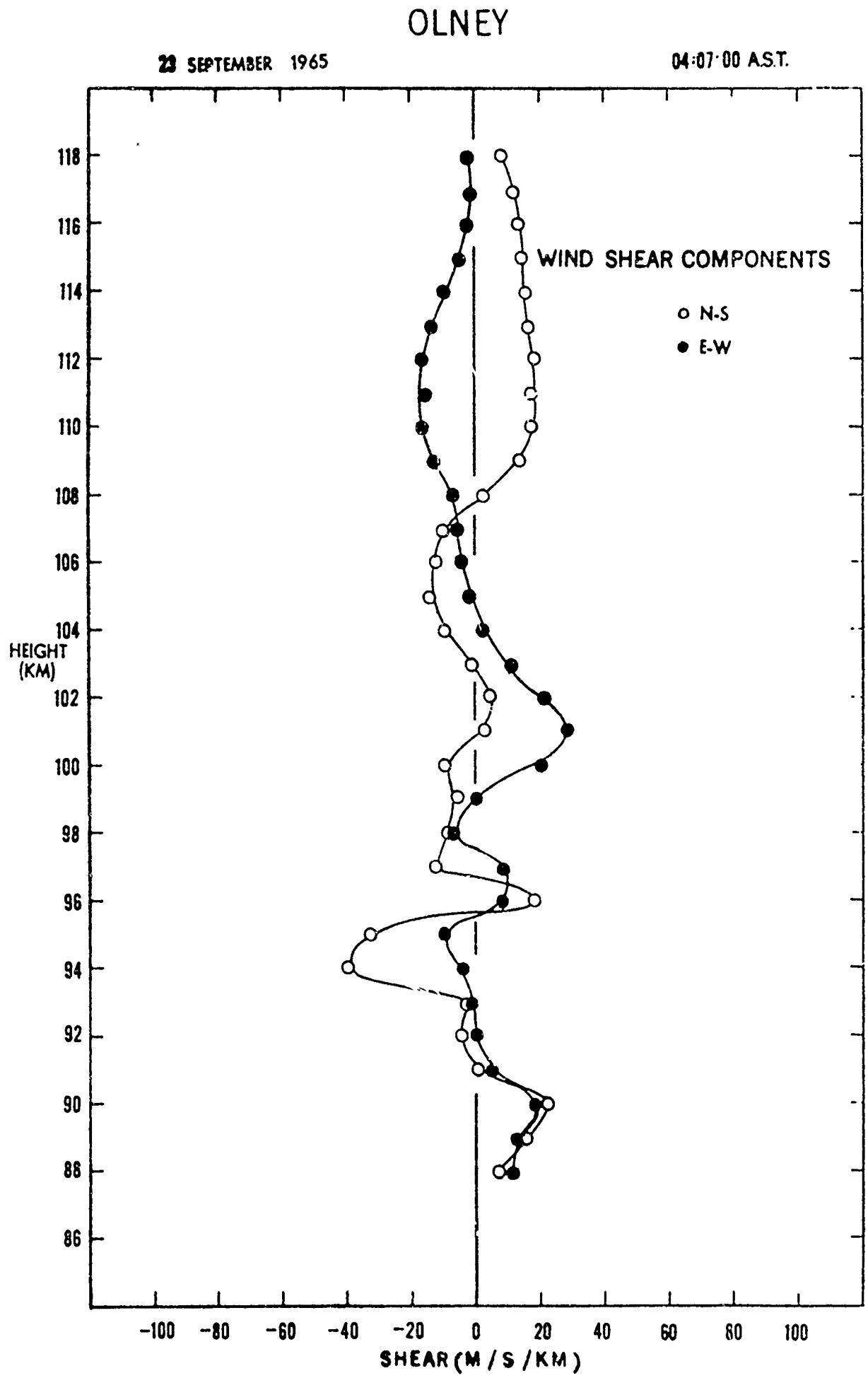
0
HEADING (DEG)


OLNEY
23 SEPTEMBER 1965
04:07:00 A.S.T.
WIND SHEAR COMPONENTS
o N-S
● E-W
HEIGHT (KM)
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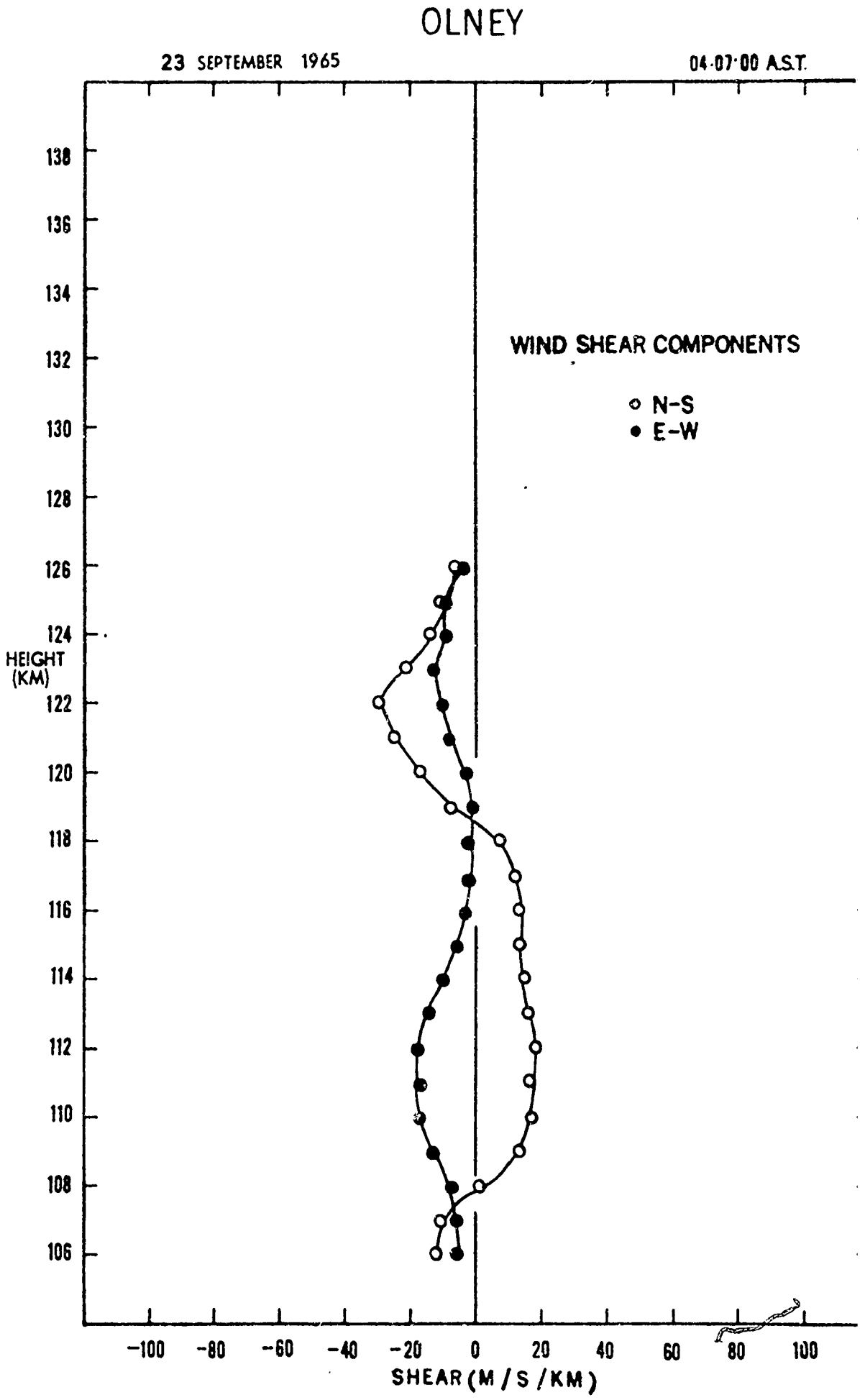
100
SHEAR (M / S / KM)


OLNEY
23 SEPTEMBER 1965
04·07·00 A.S.T.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
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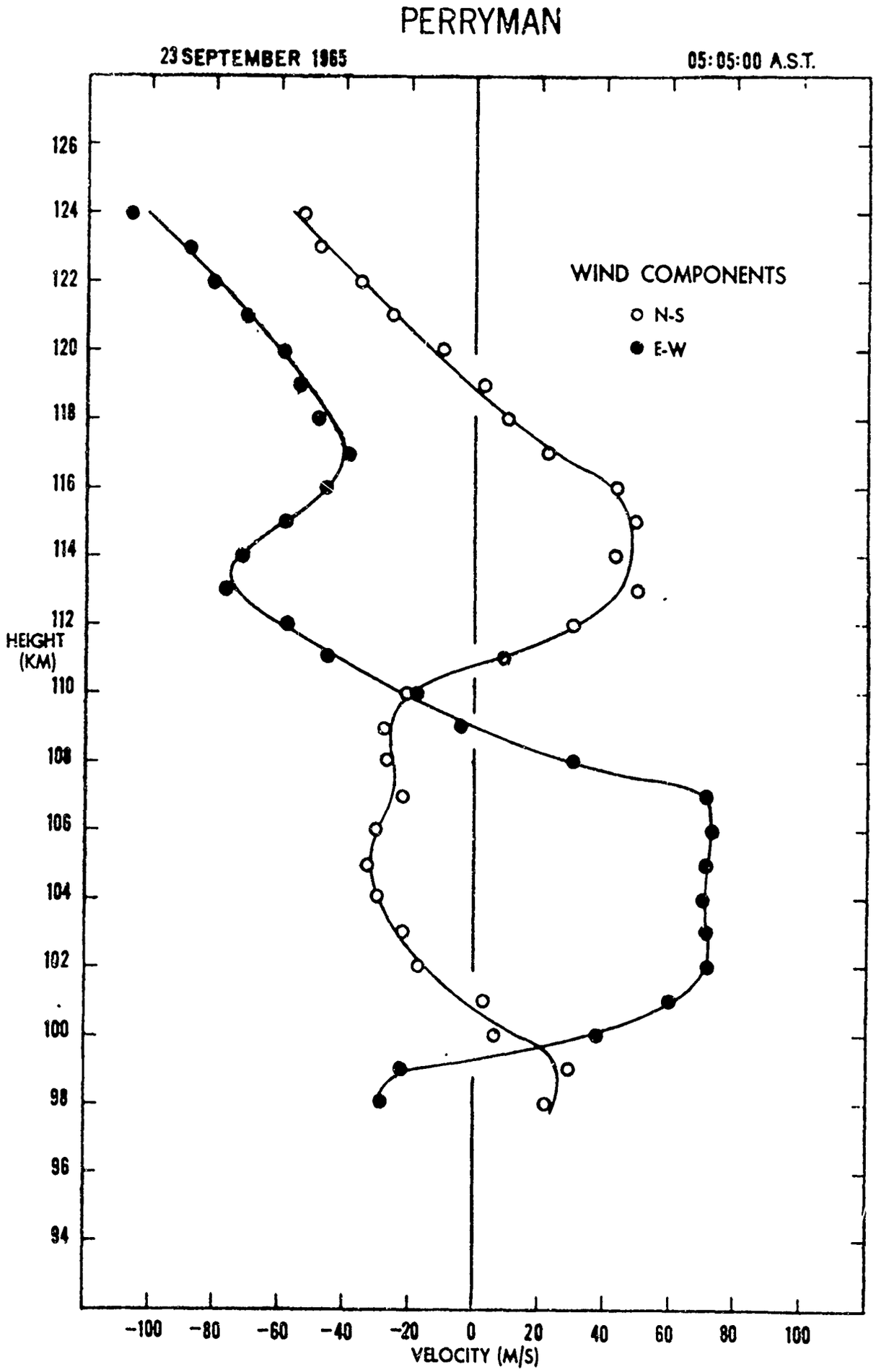
100
SHEAR (M / S / KM)

SHOT PERRYMAN 23 SEPTEMBER 1965 05-05-00 AST

ALTITUDE (KM)	WIND HEADING (DEG)	WIND VELOCITY (M/S)	WIND COMPONENTS (M/S) N-S	E-W
97.0	175.2	83.0	-82.7	7.0
98.0	308.0	36.3	22.4	-28.6
99.0	322.9	36.5	29.1	-22.0
100.0	80.1	38.5	6.6	38.0
101.0	86.8	59.6	3.4	59.5
102.0	103.5	73.9	-17.2	71.8
103.0	106.9	74.5	-21.7	71.3
104.0	113.0	76.0	-29.8	70.0
105.0	114.5	78.3	-32.5	71.2
106.0	112.6	78.7	-30.3	72.7
107.0	107.4	74.6	-22.3	71.2
108.0	131.3	40.8	-26.9	30.7
109.0	188.8	28.2	-27.9	-4.3
110.0	219.9	27.8	-21.3	-17.9
111.0	280.7	46.3	8.6	-45.5
112.0	297.8	65.0	30.3	-57.5
113.0	302.7	91.6	49.5	-77.0
114.0	300.9	84.2	43.2	-72.3
115.0	310.3	76.7	49.6	-58.5
116.0	313.3	63.5	43.6	-46.2
117.0	299.8	45.3	22.5	-39.3
118.0	281.7	48.9	9.9	-47.9
119.0	273.4	54.7	3.3	-54.6
120.0	260.2	59.7	-10.1	-58.9
121.0	249.9	75.3	-25.8	-70.7
122.0	246.0	88.8	-36.1	-81.1
123.0	241.0	100.0	-48.4	-87.5
124.0	243.3	118.7	-53.3	-106.0
125.0	203.5	31.3	-28.7	-12.5


PERRYMAN
23 SEPTEMBER 1965
05:05:00 A.S.T.
WIND COMPONENTS
N-S
E-W
HEIGHT (KM)
126
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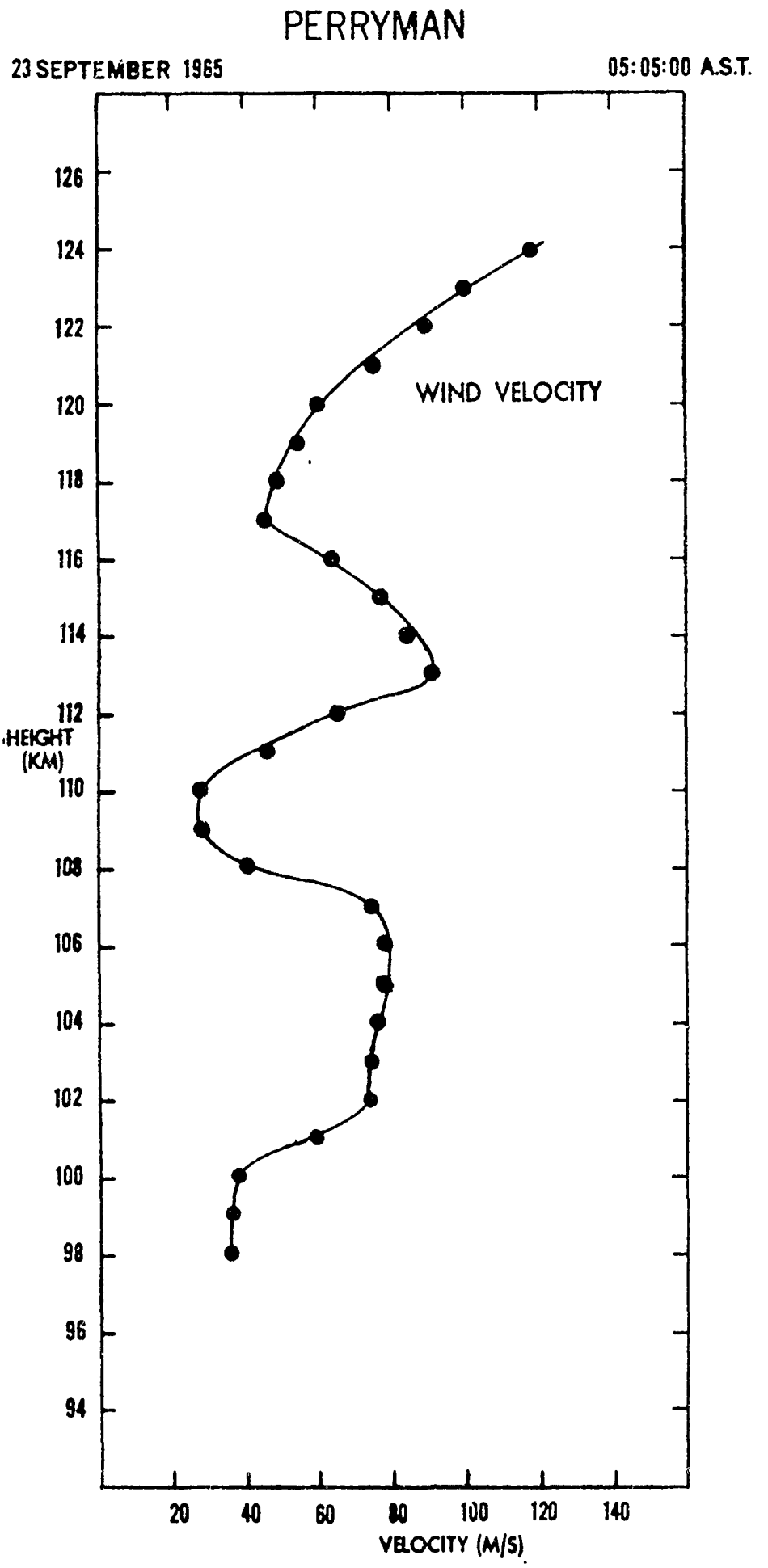
VELOCITY (M/S)


PERRYMAN
23 SEPTEMBER 1965
05:05:00 A.S.T.
WIND VELOCITY
HEIGHT (KM)
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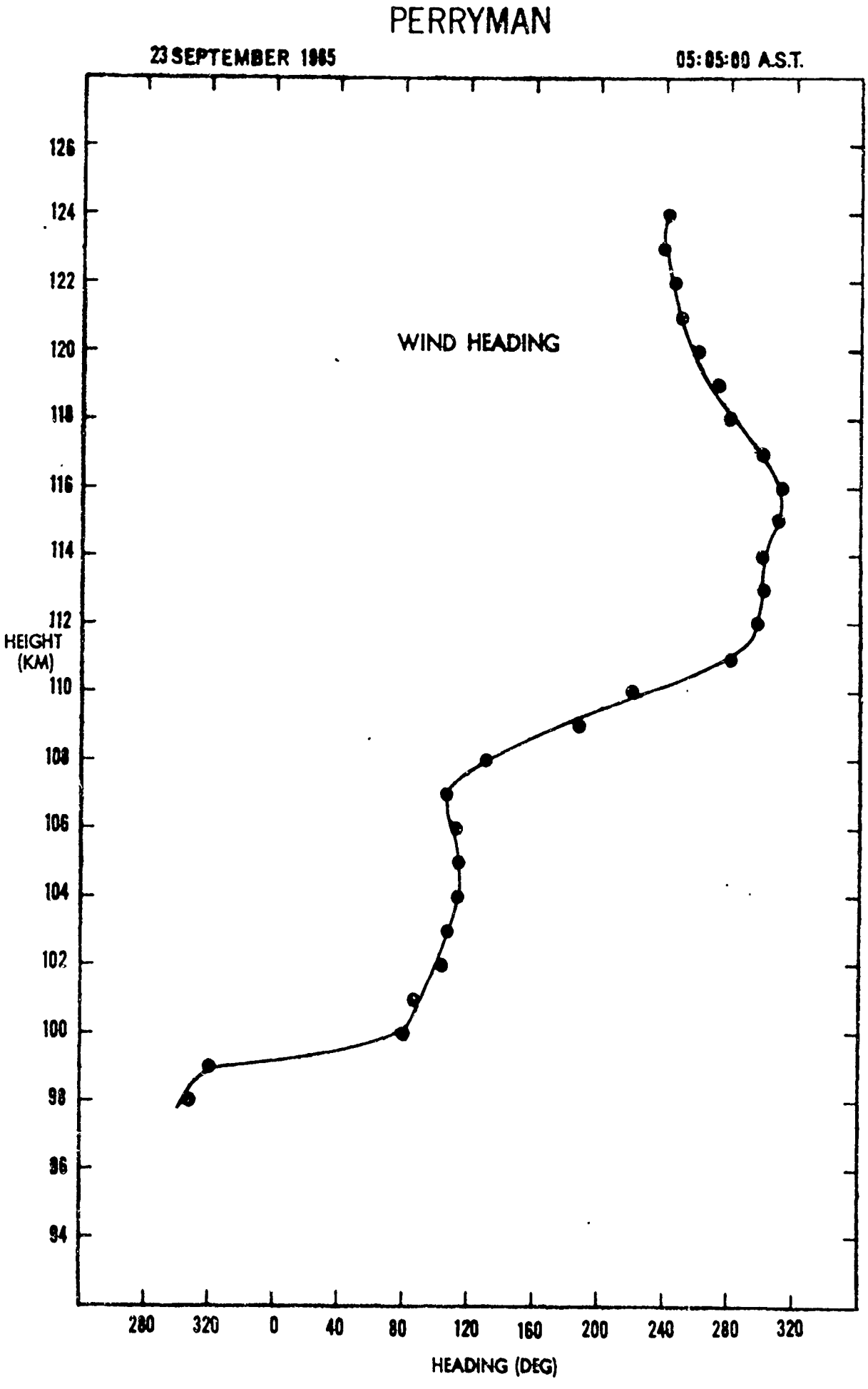
VELOCITY (M/S)


PERRYMAN
23 SEPTEMBER 1965
05:05:00 A.S.T.
WIND HEADING
HEIGHT (KM)
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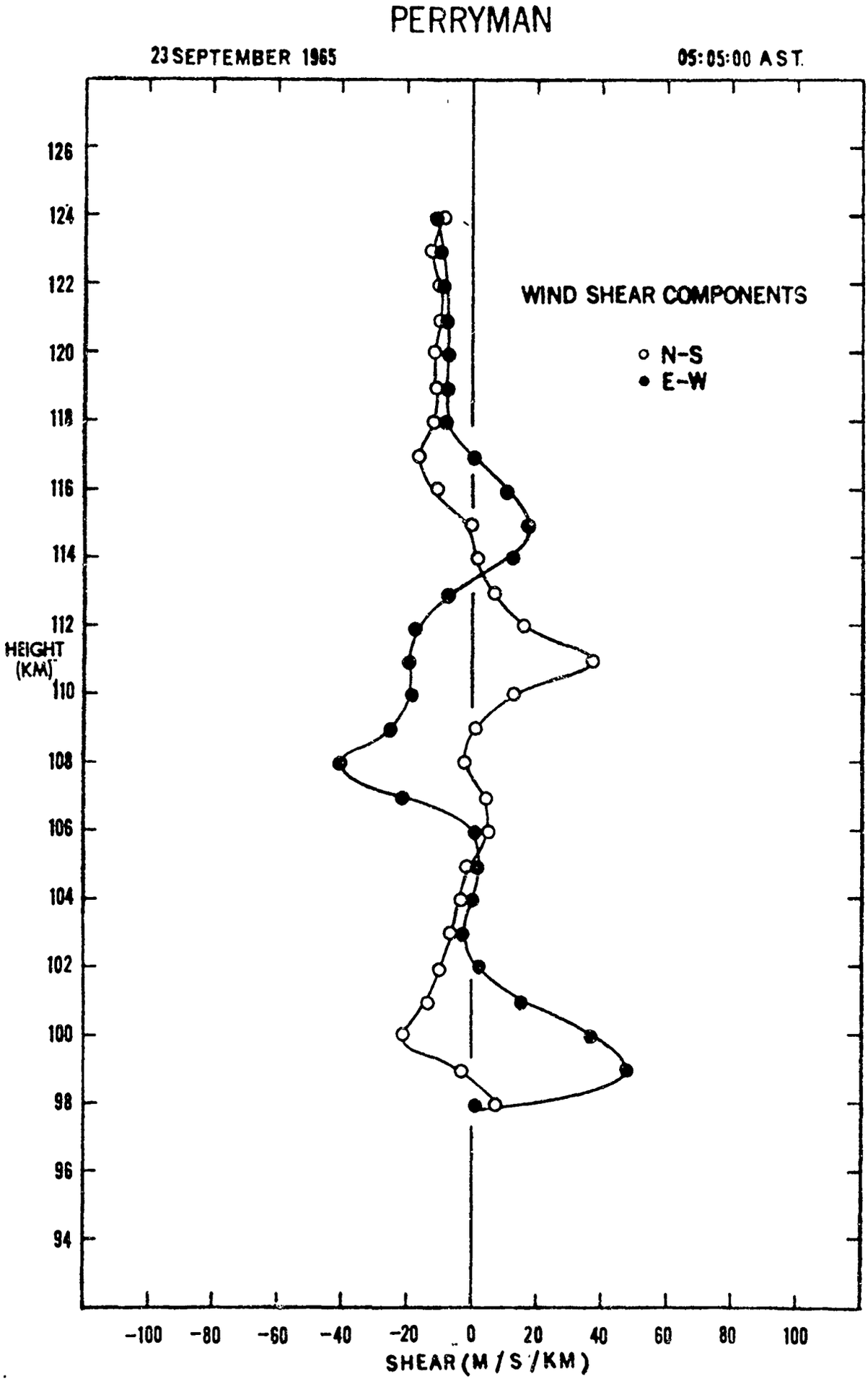
HEADING (DEG)


PERRYMAN
23 SEPTEMBER 1965
05:05:00 AST.
WIND SHEAR COMPONENTS
N-S
E-W
HEIGHT (KM)
126
124
122
120
118
116
114
112
110
108
106
104
102
100
98
96
94
-100
-80
-60
-40
-20
0
20
40
60
80
100
SHEAR (M/S/KM)

UNCLASSIFIED
Security Classification

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13. ABSTRACT
On the night of 20-21 September 1965, six luminous trails were produced between 88km and 136km by the release of tri-methyl-aluminum from projectiles fired from a smoothbore sixteen-inch gun located on the West Indian island of Barbados (57.5°W, 13.1°N). An additional five trails were produced during the night of 22-23 September 1965. These trails were photographed from neighboring islands and analyzed to yield wind profiles. This report contains the tabulated wind data from all eleven trails together with plots versus altitude of wind components, wind speed, wind heading, and wind shear components.

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