MIDDLE EAST TECNICAL UNIVERSITY
INSTITUTE OF MARINE SCIENCES, ERDEMLİ/İÇEL

MANAVGAT RIVER WATER SUPPLY PROJECT

ANALYSIS OF WIND AND WAVE DATA

FINAL REPORT

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Acknowledgement

Wave data from the Datawell bouy at Alanya and the time series of significant wave height, period and direction were provided by Prof. Dr. Erdal Ozhan and Dr. Saleh Abdalla, Coastal and Harbor Engineering Laboratory, Middle East Technical University, Ankara. Their assistance is gratefully acknowledged.

Manavgat River Water Supply Project.
Aanalysis of Wind and Wave Conditions.

INTRODUCTION.

The objective of this work was to determine the wind and wave characteristics at Manavgat. For determining the wind characteristics, wind data recorded at Antalya and Alanya meteorological stations were utilised. The wave conditions were evaluated using wave data recorded by a waverider bouy near Alanya.

The Rayleigh distribution was used for determining the 1-year and the 100-year values for both the wind and the waves. This approach is frequently employed in extrapolating data of limited length for obtaining longer term design parameters (Shore protection Manual 1973, Silvester 1974, Khandekar 1990). In practice, the cumulative frequency of exceedance of the parameter of interest (e.g. wave height) are calculated from the available data; these values lie on a straight line, with some scatter, when plotted on probability paper. Alternatively, a plot of the square of the wave height versus the natural logarithm of the cumulative frequency also yields a straight line plot (Shore Protection Manual,1973). Either graph can be extrapolated to determine the values of the parameter corresponding to the desired interval of recurrence. In the present report, the second approach was used (plot of wave height square vs natural log of the cumulative frequency).

WIND

Records of hourly averaged wind speed and direction were obtained for Antalya and Alanya for 1965-1994 from the State Meteorological Office (Devlet Meteoroloji Isleri, Genel Mudurlugu). The winds recorded at Alanya were found to be much weaker than at Antalya, possibly due to difference in exposure as a result of the location of the station. Winds at Alanya did not exceed 16 m/s; there were only 8 instances of winds in the 14-16 m/s range. Therefore, it was decided to base the analysis for maximum winds on the Antalya data.

The recurrence intervals were calculated as follows. First, the occurences of winds in intervals of 1 m/s (1-2 m/s, 2-3 m/s etc) for each direction were determined. Then, the cumulative frequencies for each group were calculated. The data were then plotted, as discussed above, and a best fit line drawn through the data. For a sampling interval of 1 hour, the recurrence interval for a wind with probabilty p is 1/p hours. For a recurrence interval of 1 year (=8760 hours), the probability p=1/8760, or 1.14e-4; the 100-year recurrence interval corresponds to a probability of 1.14e-6. In the plots of cumulative frequency

against the square of the wind speed, the dotted lines indicate the 1-yr and 100-yr recurrence intervals. The results of the computations for the wind are presented in the following Tables.

Table 1. 1-yr and 100-yr winds.
Table 2. Comparison of maximum hourly average wind speed with the 100-yr wind.
Table 3. Comparison of 100-yr average wind to gusts.
Table 4. Average percentage distribution, wind speed.
The cumulative frequency data for wind according to direction and the corresponding plots (Figs.A.1 - A.16) are given in the Appendix.

WAVES

The wave data were obtained from a Datawell Waverider bouy anchored off Alanya in 100 m water depth. The bouy is located at 36 deg 32 min 30 sec N, 31 deg 58 min 30 sec E. It is operated by the Coastal and Harbor Engineering Laboratory of the Middle East Technical University.

The bouy records 20 minutes of data at two hour intervals. The data available for the analysis of significant wave conditions consisted of records of heights, periods, and direction for the period November 1994 - June 1995, while the data for the maximum wave conditions consisted of wave height and period records for the period November 1994- April 1995, with several gaps.

The probability density of a specific wave height implies that it will occur once in (1/p) X recording interval. Even though the actual record length is 20 minutes, it is assumed to represent the wave conditions during the entire 2 hr period, (Silvester,1974). Thus, a wave having a probabilty of 0.001 will occur once every 2/0.001=2000 hrs, or once every three months approximately. The probabilities corresponding to 1 and 100 years recurrence intervals are 2.28e-4 and 2.28e-6 respectively. As for the wind plots, these recurrence intervals are shown in dotted lines on the cumulative frequency plots given in the Appendix.

It should be noted that a similar analysis for wave periods will yield periods which are not necessarily associated with the wave heights corresponding to the respective recurrence intervals. In general, the longer periods correspond to swell, waves which have travelled away from the generation region, and not to the high waves predicted by the Rayleigh distribution. In order to find realistic wave periods for the 1-yr and 100-yr waves, representative curves, fitted to scatter diagrams of height vs periods for significant and maximum waves, were used. The scatter plots for the significant wave is shown in Fig.1, and that for the maximum wave in Fig.2

The maximum 1-yr and 100-yr waves were assumed to have the direction SW, which is the predominant wave direction from the data. The maximum wave height from the other directions was found assuming the ratio of the significant wave from those directions to the significant wave hight from SW was the same for the maximum wave.

Plots of the significant wave height, wave period and direction for each month are given in Figs.3-Figs.9.

The results of the wave computations are presented in the following Tables.
Table 5. 1-yr and 100-yr significant and maximum wave conditions.
Table 6. Monthly highest significant wave heights,largest average periods.
Table 7. Monthly maximum wave heights,periods.
Table 8. Average percentage distribution, significant wave height.

The cumulative frequency data for significant wave heights according to direction and the corresponding plots (Figs.A17-A19) are given in the Appendix. The cumulative frequency data for the maximum wave and the plot (Fig.A-20) are also given in the Appendix.

REFERENCES.

Khandekar, M. L., 1989: Operational Analysis And Prediction Of Ocean Wind Waves. Springer-Verlag, 214 pp.

Shore Protection Manual, Vol.I, 1973. U.S.Army Coastal Engineering Research Center, Wasgington, D.C.

Silvester, R., 1974: Coastal Engineering, Vol.I, Generation, Propagation And Influence Of Waves. Elsevier Scientific Publishing Company, 457 pp.

TABLE 1

ANALYSIS OF ANTALYA WIND DATA

Based on hourly averaged values, 1965-1995.

Direction	1-year wind m/sec	100-year wind m/sec
N	16.5	21.2
NNE	12.2	15.4
NE	9.4	11.3
ENE	10.6	13.4
E	10.0	12.2
ESE	21.4	27.2
SE	21.7	27.2
SSE	21.9	27.6
S	19.5	24.3
SSW	15.8	20.0
SW	11.1	13.8
WSW	11.1	13.8
W	10.1	13.3
WNW	13.8	17.2
NW	15.5	18.7
NNW	15.8	19.5

TABLE 2

COMPARISON OF MAXIMUM HOURLY AVERAGE WIND SPEED WITH THE 100-YR WIND (m/s)

Dir.	Antalya	Alanya	100-yr wind
N	18.1	8.5	21.2
NNE	12.8	11.4	15.4
NE	9.3	11.0	11.3
ENE	11.7	9.2	13.4
E	8.9	11.0	12.2
ESE	22.2	10.0	27.2
SE	20.6	9.6	27.2
SSE	24.2	14.7	27.6
S	19.7	14.2	24.3
SSW	18.6	15.0	20.0
SW	10.3	14.3	13.8
WSW	11.1	12.9	13.8
W	9.2	11.7	13.3
WNW	13.3	12.2	17.2
NW	15.1	8.2	18.7
NNW	16.9	10.4	19.5

TABLE 3

COMPARISON OF THE 100-YR HOURLY AVERAGE WIND SPEED TO MAXIMUM RECORDED GUSTS (m/s).

Dir.	Antalya	Alanya	Mnvgt	100-yr wind
N	22.1	23.8	15.5	21.2
NNE		25.2		15.4
NE				11.3
ENE			5.6	13.4
E				12.2
ESE				27.2
SE	37.0			27.2
SSE	35.6			27.6
S	38.7	30.8	18.9	24.3
SSW			6.2	20.0
SW	24.0		9.1	13.8
WSW		30.0		13.8
W		29.4	18.9	13.3
WNW	25.2			17.2
NW	20.6			18.7
NNW	26.7			19.5

TABLE 4

AVERAGE PERCENTAGE OF WIND SPEED AT ANTALYA (1965-1995)

Wind speed groups:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
N	5.29	4.61	1.56	.39	.10	.01	.00	.00	.00	11.96
NNE	5.84	3.65	.54	.10	.01	.00	.00	.00	.00	10.14
NE	2.32	.74	.04	.00	.00	.00	.00	.00	.00	3.10
ENE	2.35	.94	.10	.01	.00	.00	.00	.00	.00	3.40
E	1.03	.34	.06	.00	.00	.00	.00	.00	.00	1.43
ESE	1.89	1.12	.21	.07	.03	.01	.00	.01	.00	3.34
SE	1.48	1.75	.41	.14	.06	.04	.02	.01	.00	3.91
SSE	3.23	4.90	.90	.21	.10	.06	.04	.01	.00	9.45
S	2.70	3.90	.90	.18	.07	.04	.01	.00	.00	7.80
SSW	2.79	2.48	.81	.07	.03	.00	.00	.00	.00	6.18
SW	.91	.30	.05	.00	.00	.00	.00	.00	.00	1.26
WSW	1.02	.15	.03	.00	.00	.00	.00	.00	.00	1.20
W	.80	.08	.01	.00	.00	.00	.00	.00	.00	.89
WNW	2.56	1.16	.22	.08	.02	.00	.00	.00	.00	4.04
NW	5.13	3.16	1.43	.50	.12	.02	.00	.00	.00	10.36
NNW	9.82	7.87	2.70	.87	.23	.05	.00	.00	.00	21.54
Total	49.16	37.15	9.97	2.62	.77	.23	.07	.03	.00	100.00

Speed range of groups:

(1) 0 - 2.4
(2) 2.4 - 4.9
(3) 5.0 - 7.4
(4) 7.5 - 9.9
(5) 10.0 - 12.4
(6) 12.5 - 14.9
(7) 15.0 - 17.4
(8) 17.5 - 19.9
(9) 20 plus

TABLE 5

1-yr AND 100-yr SIGNIFICANT AND MAXIMUM WAVE CONDITIONS.

1-yr recurrence:

	West	Southwest	South
Hs (m)	2.23	4.00	3.20
Ts (s)	8.00	9.10	8.60
Hmax (m)	3.50	6.50	5.00
Tmax (s)	7.20	9.10	8.00

100-yr recurrence:

	West	Southwest	South
Hs (m)	2.70	5.10	4.10
Ts (s)	8.40	9.60	9.20
Hmax (m)	4.58	8.30	6.40
Tmax (s)	7.70	10.00	8.90

TABLE 6

MONTHLY HIGHEST SIGNIFICANT HEIGHT AND PERIODS.

	West		Southwest		South	
	H	T	H	T	H	T
Nov94	1.2	5.6	2.0	6.3	2.6	7.0
Dec94	1.0	5.2	2.6	6.7	2.1	5.9
Jan95	1.5	5.8	3.6	7.6	0.9	4.2
Feb95	0.3	4.0	1.5	6.6	1.1	4.9
Mar95	1.1	5.5	2.3	6.8	1.8	5.3
Apr95	1.2	4.4	3.3	6.9	1.3	4.8
May95	0.2	3.6	1.2	5.7	0.7	4.4
Jun95	0.8	4.8	1.3	5.5	0.3	2.9

TOTAL NO OF OBSERVATIONS:

	West	Southwest	South	Total
Nov94	22	171	123	316
Dec94	26	204	127	357
Jan95	92	253	6	351
Feb95	2	284	58	344
Mar95	4	351	49	404
Apr95	9	342	41	392
May95	10	460	21	491
Jun95	9	285	20	314
Total	174	2350	445	2969

TABLE 7

MONTHLY MAXIMUM WAVE HEIGHTS, PERIODS.

	H(m)	T(s)
Nov94	4.2	9.3
Dec94	4.5	11.3
Jan95	5.7	9.5
Feb95	1.7	9.9
Mar94	3.8	8.4
Apr95	5.5	9.7

TABLE 8.

AVERAGE PERCENT DISTRIBUTION OF SIGNIFICANT WAVE HEIGHT.

There are waves from west, southwest and south only.
No waves from other directions.

Wave height Groups (m)	S	SW	W	Total
0 - 0.4	8.49	41.80	1.82	52.11
0.5 - 0.9	4.18	26.34	3.26	33.78
1.0 - 1.4	1.62	6.26	0.71	8.59
1.5 - 1.9	0.54	2.90	0.07	3.51
2.0 - 2.4	0.10	0.90	0.00	1.0
2.5 - 2.9	0.07	0.54	0.00	0.61
3.0 - 3.4	0.00	0.37	0.00	0.31
3.5 - 3.9	0.00	0.03	0.00	0.03
Total	15.00	79.14	5.86	100.00

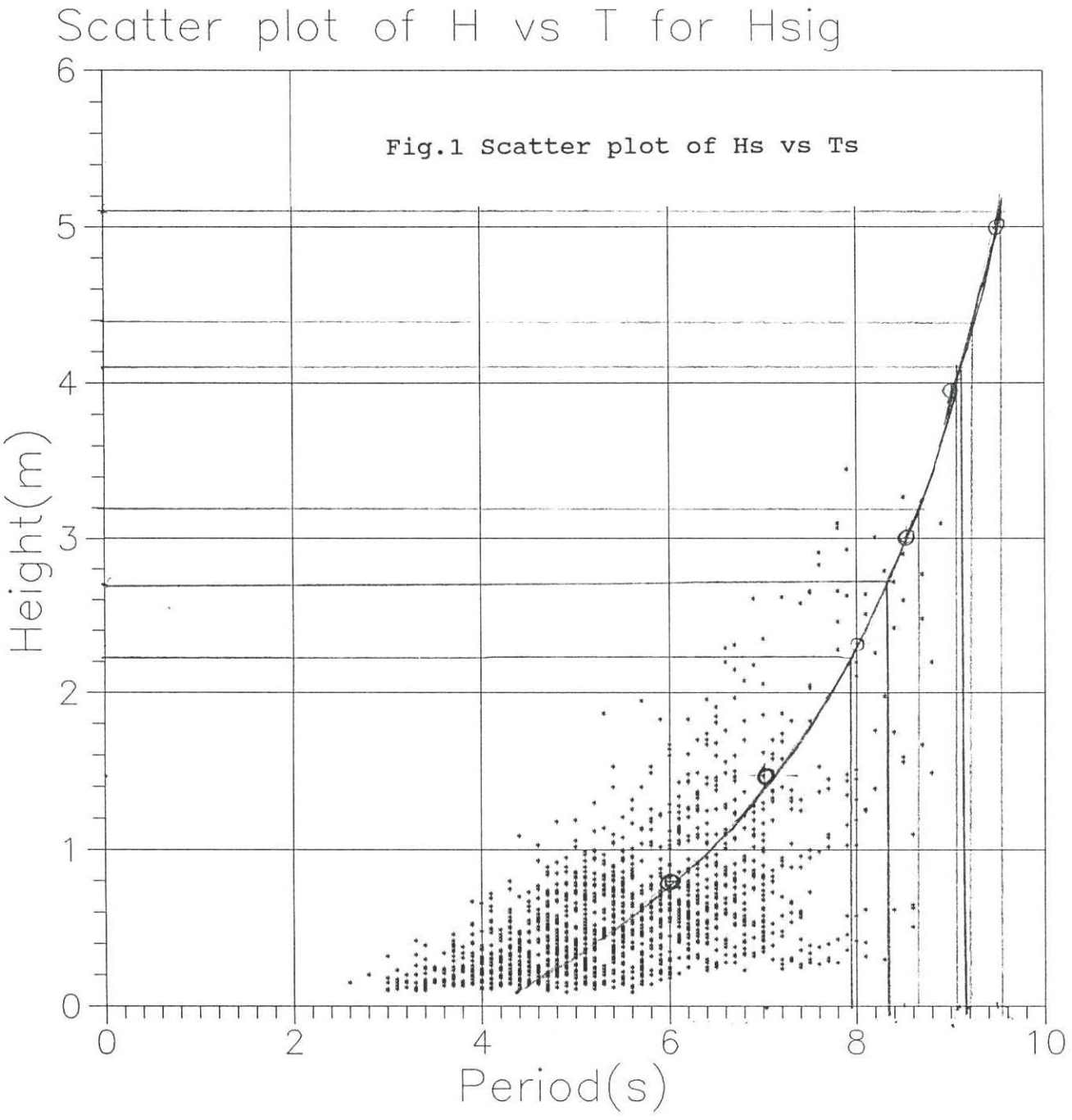

Fig.1 Scatter plot of Hs vs Ts

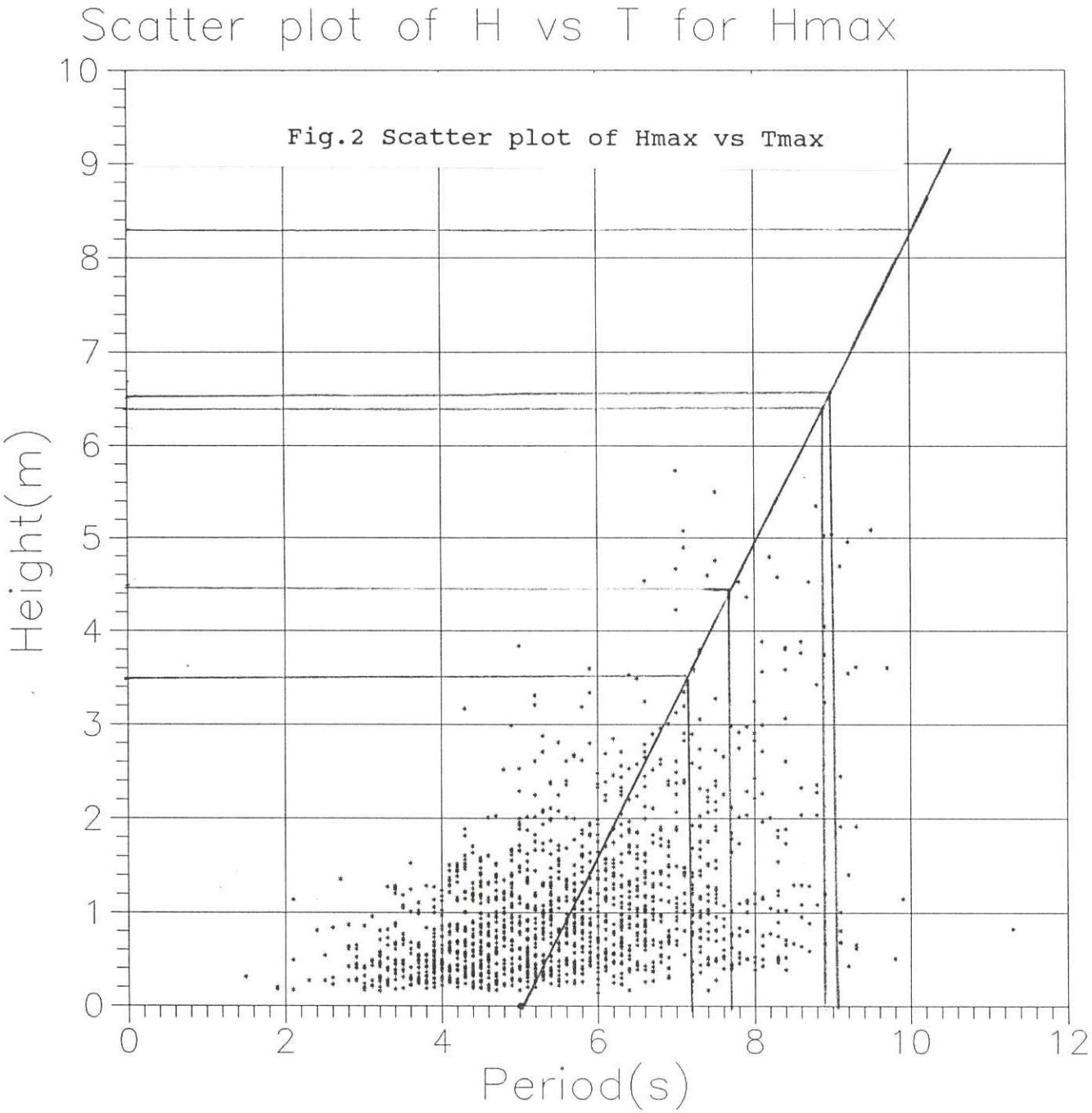

Fig.2 Scatter plot of Hmax vs Tmax

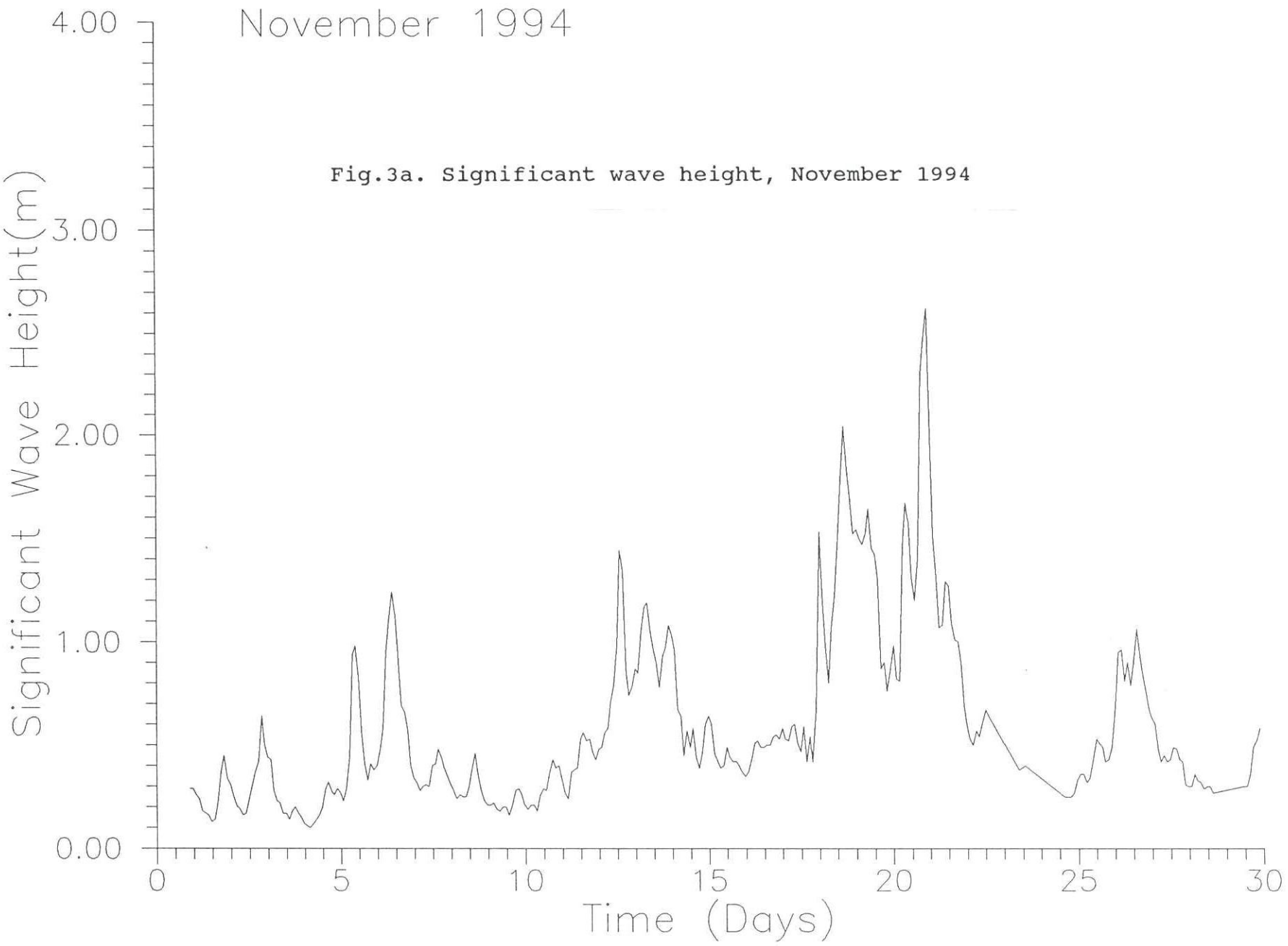

Fig.3a. Significant wave height, November 1994

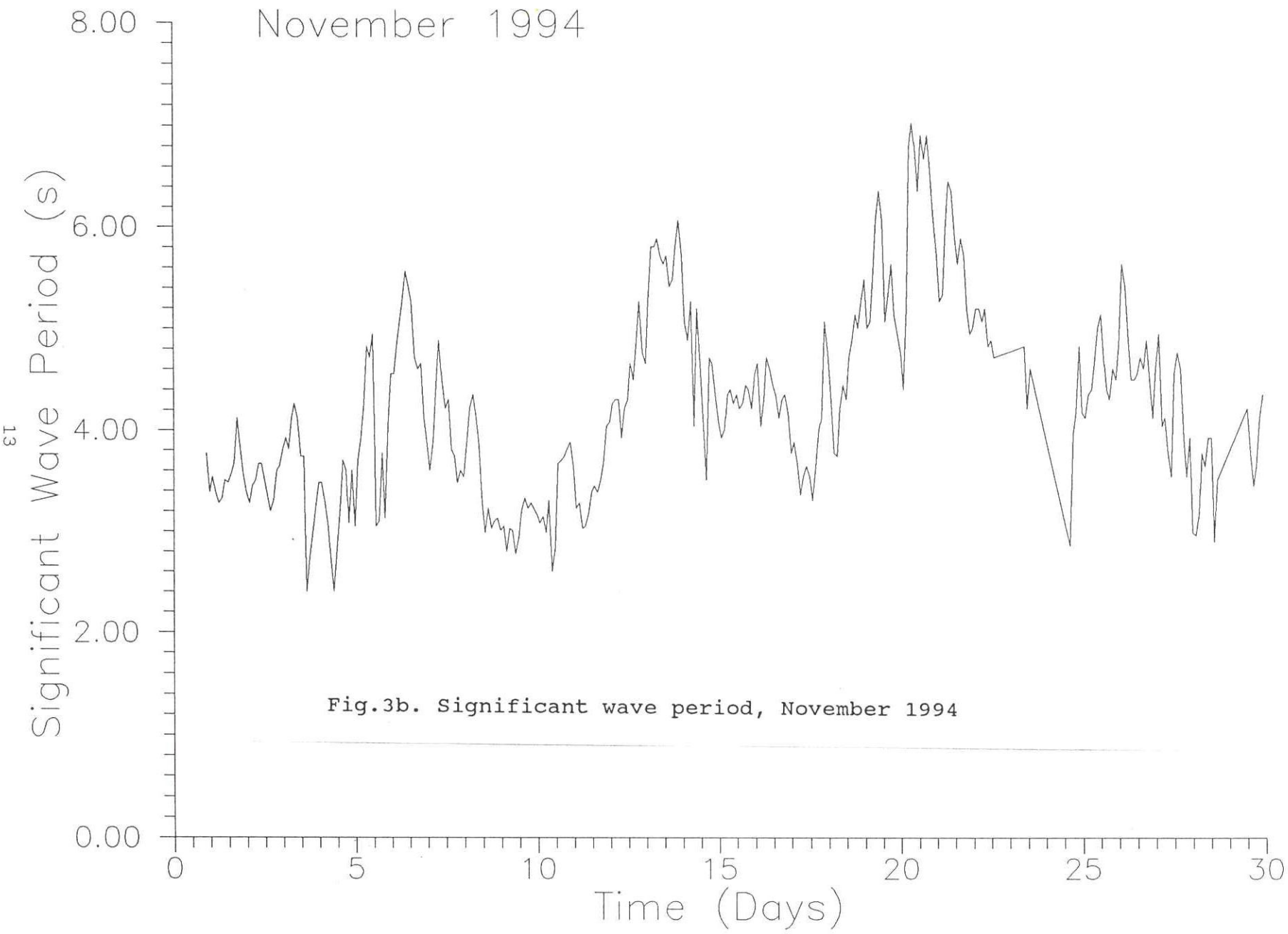

Fig.3b. Significant wave period, November 1994

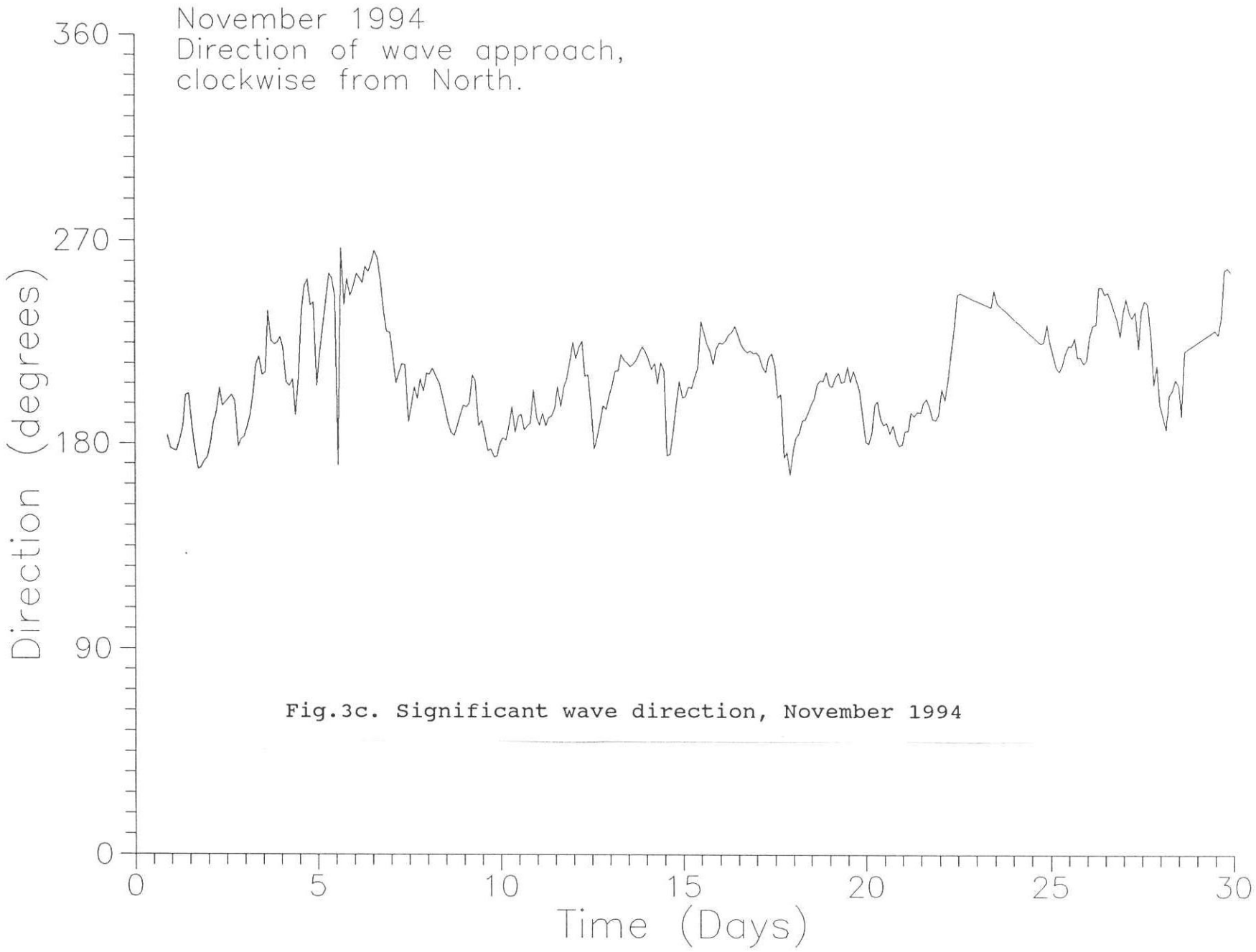

Fig.3c. Significant wave direction, November 1994

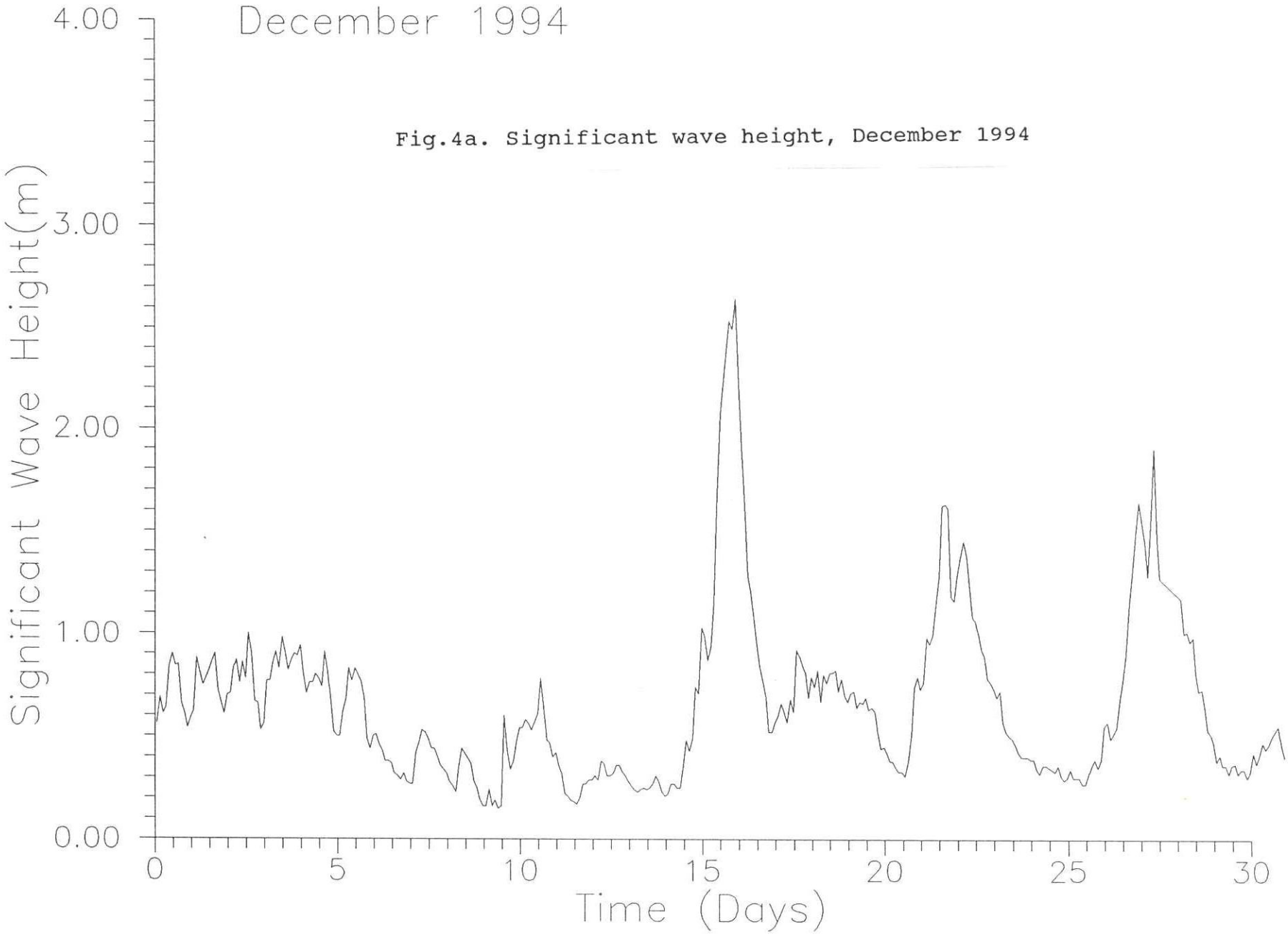

Fig.4a. Significant wave height, December 1994

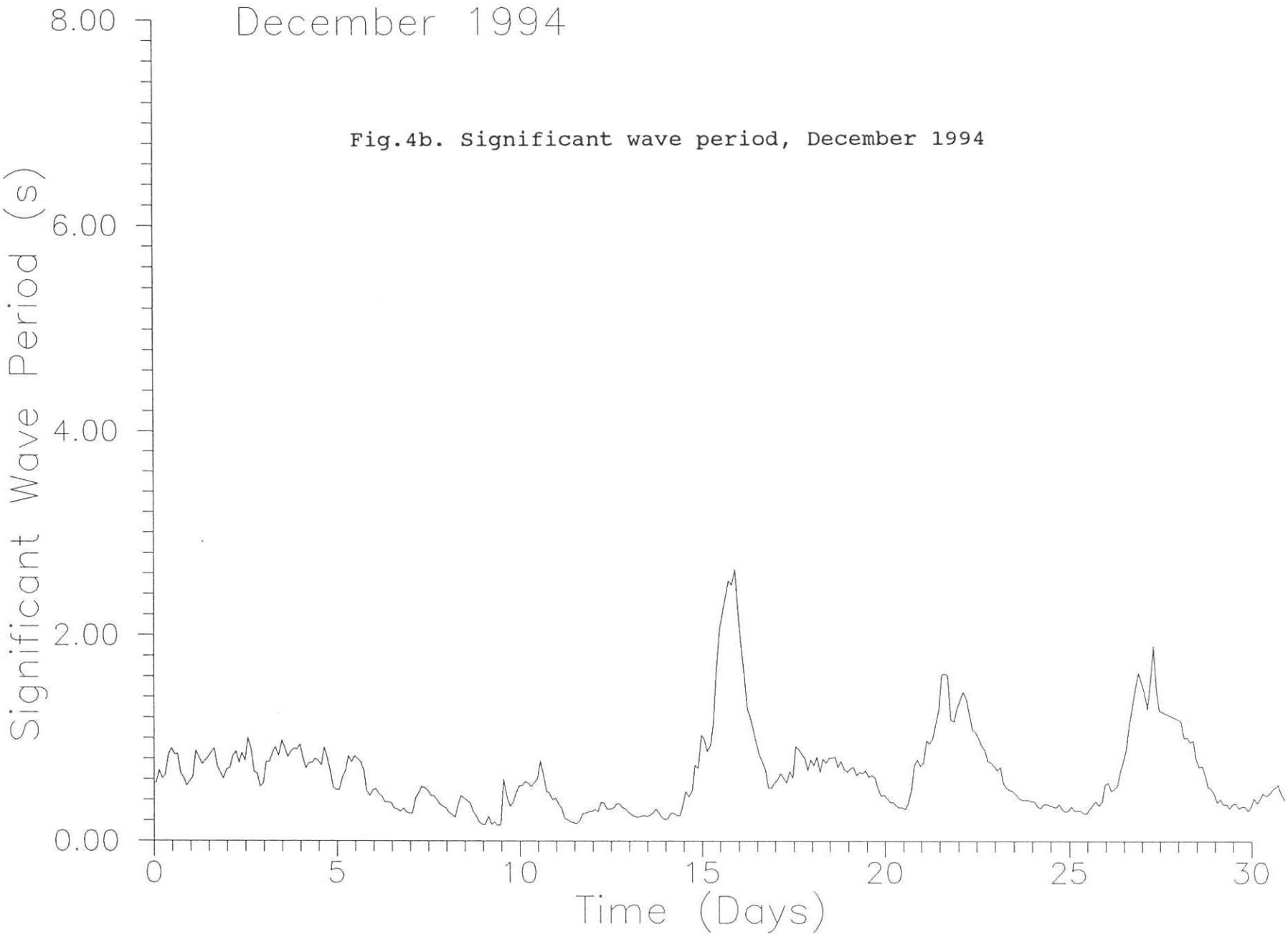

Fig.4b. Significant wave period, December 1994

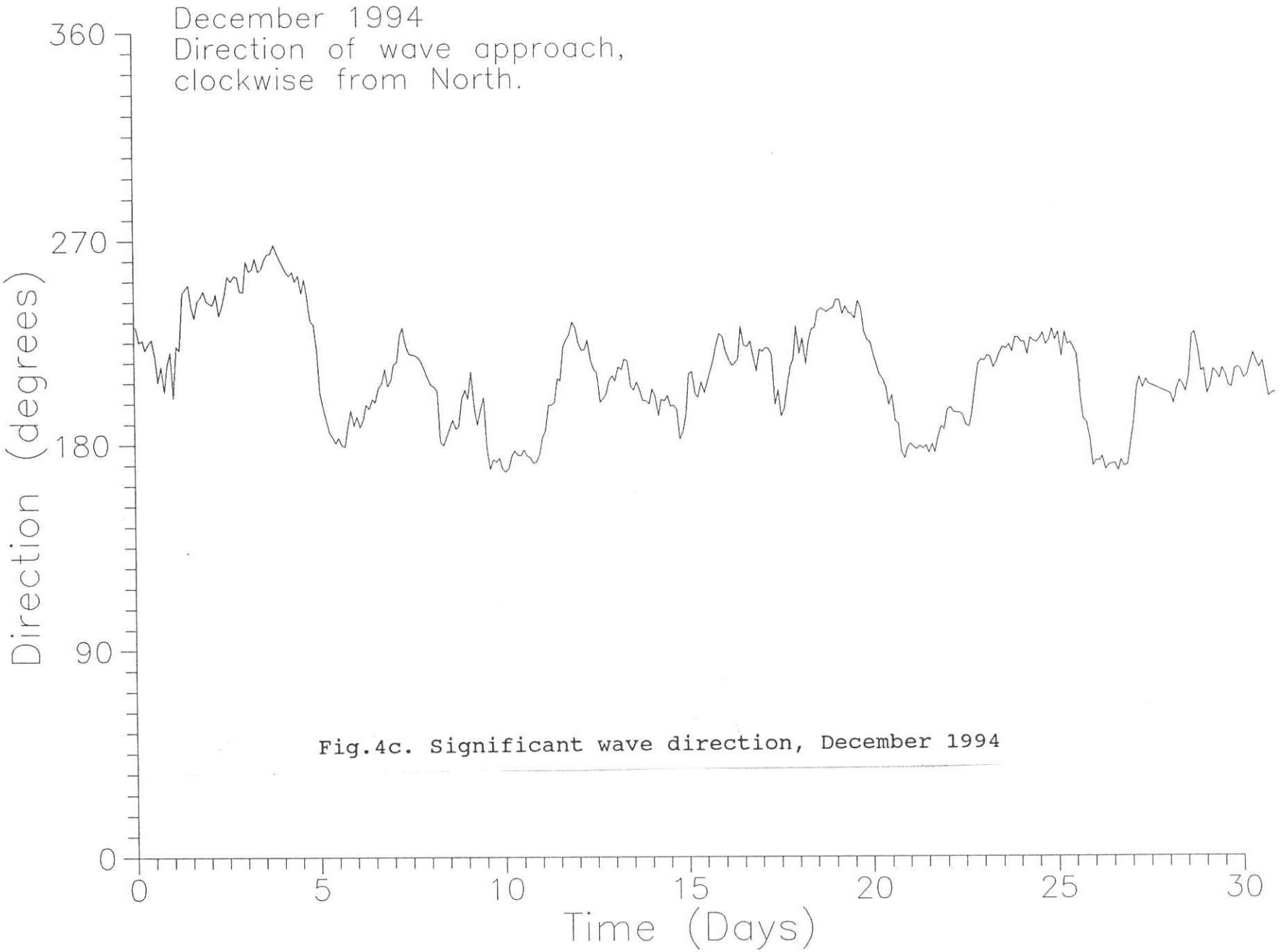

Fig.4c. Significant wave direction, December 1994

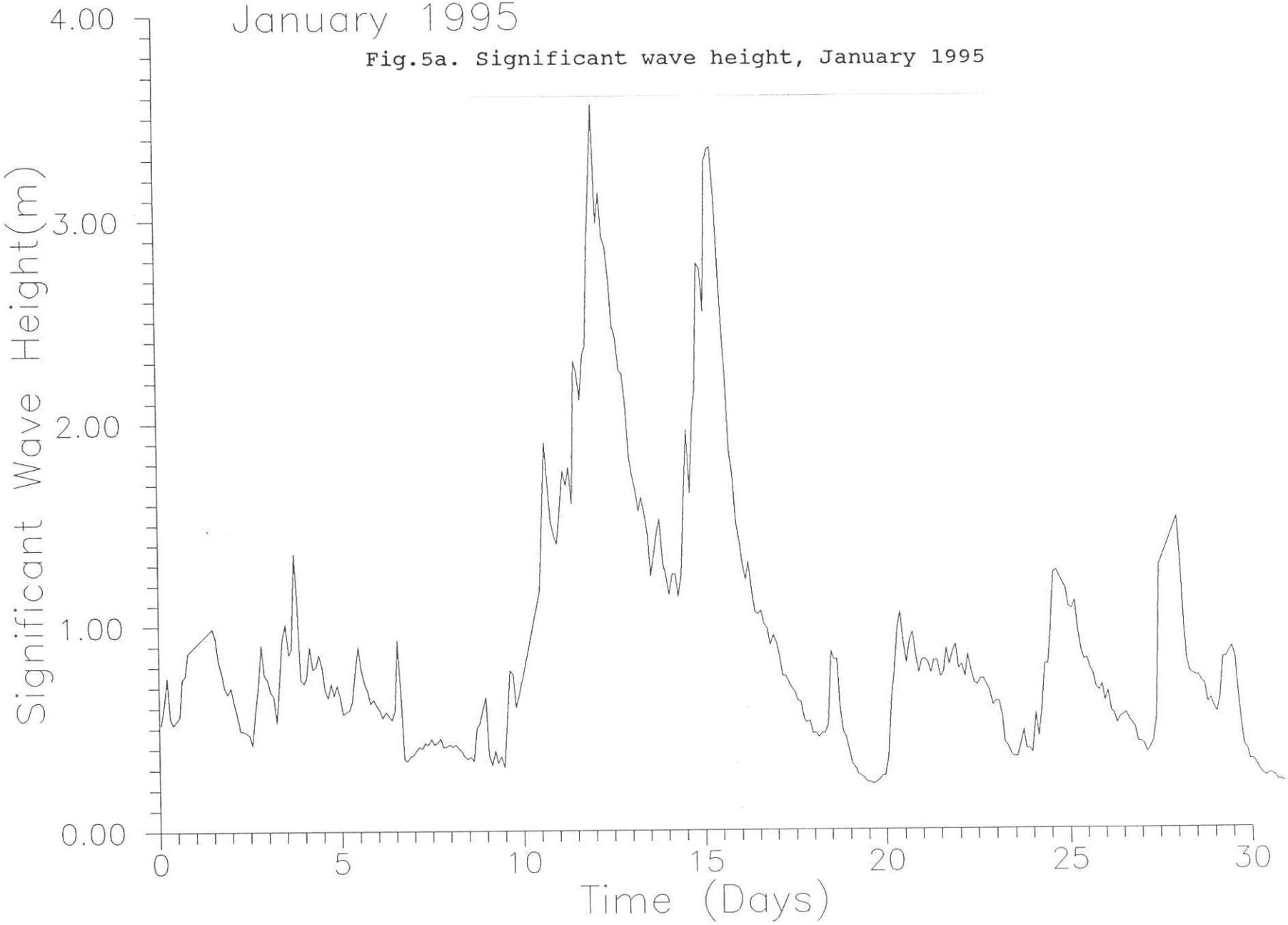

Fig.5a. Significant wave height, January 1995

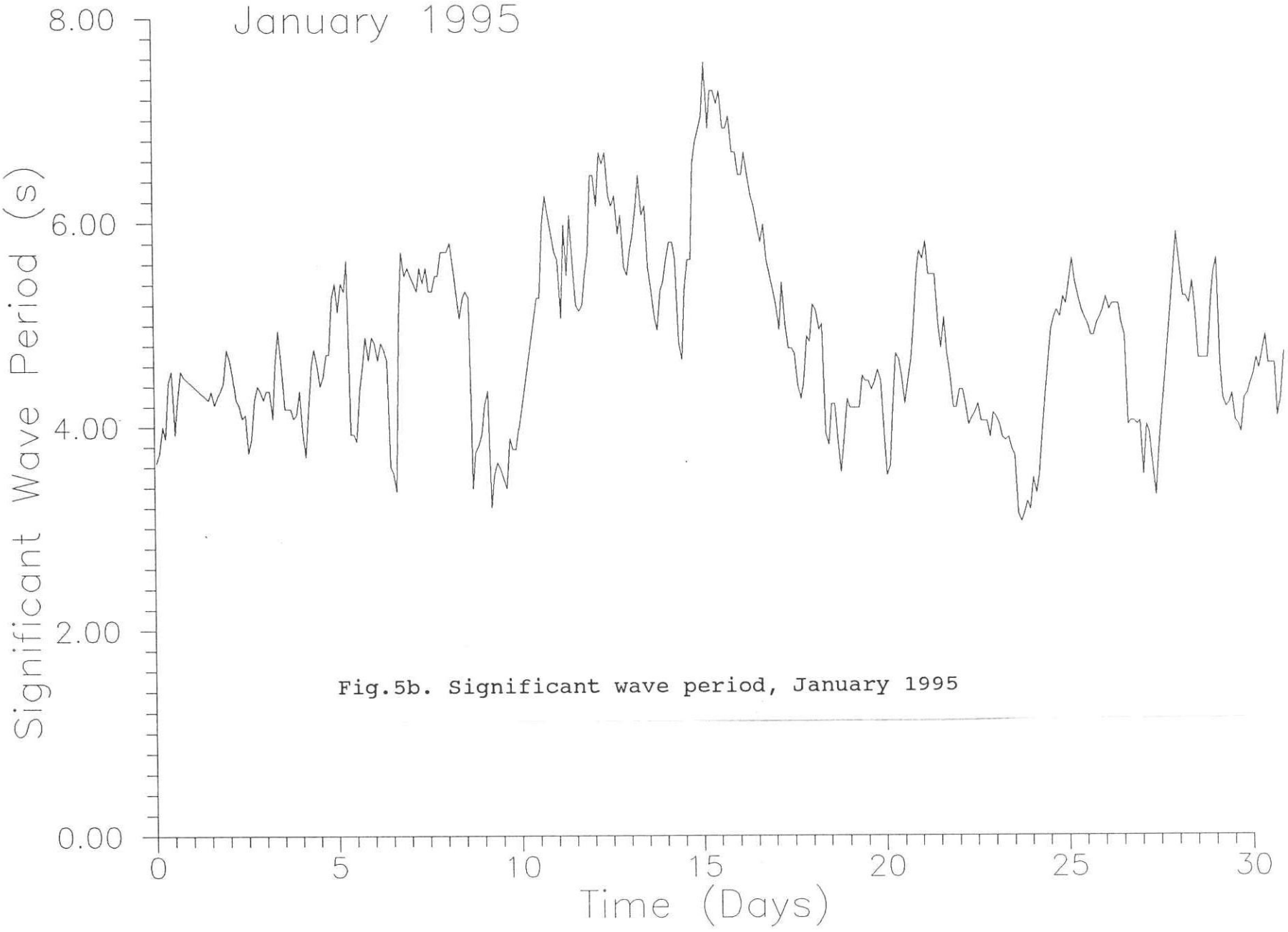

Fig.5b. Significant wave period, January 1995

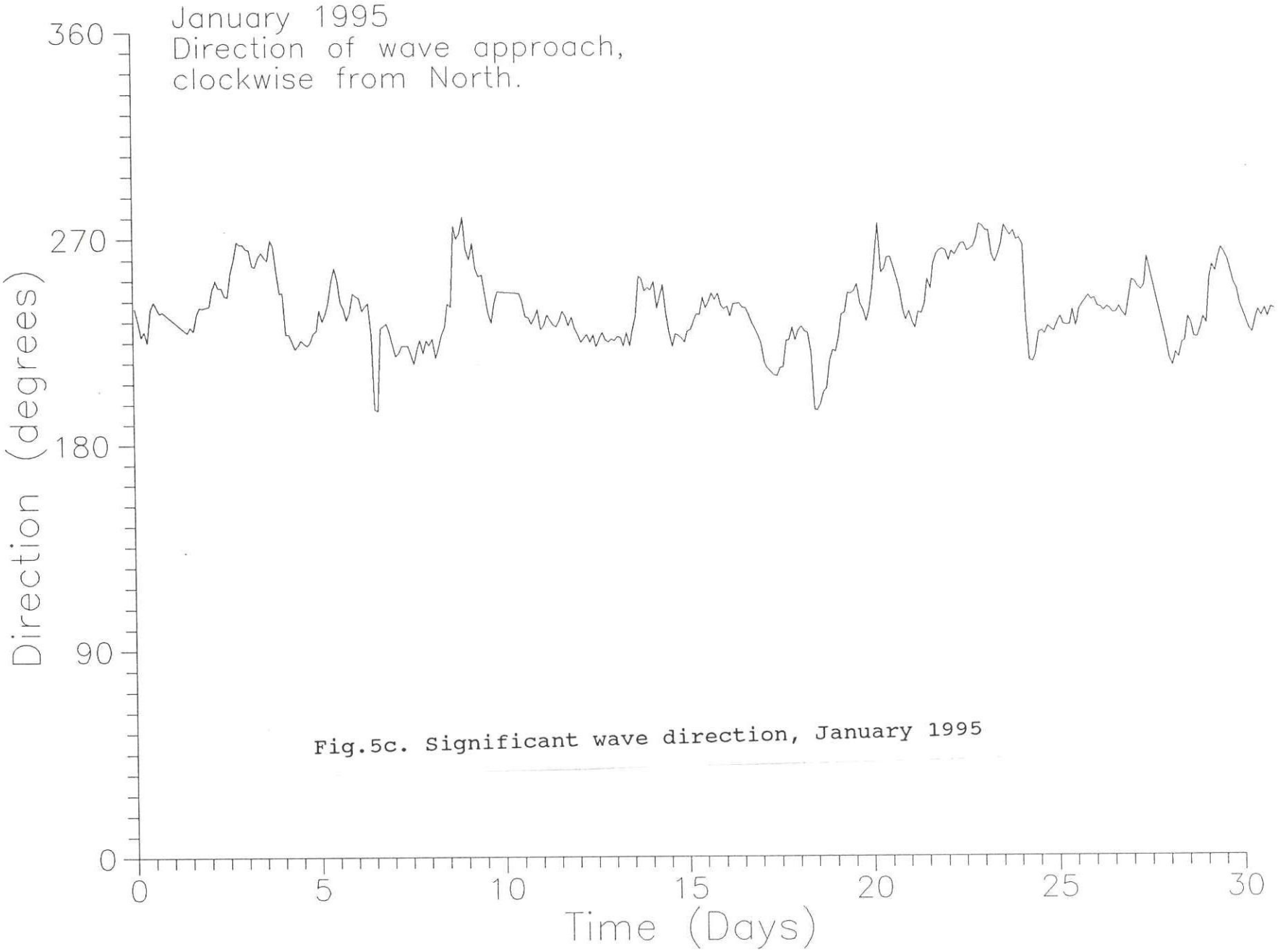

Fig.5c. Significant wave direction, January 1995

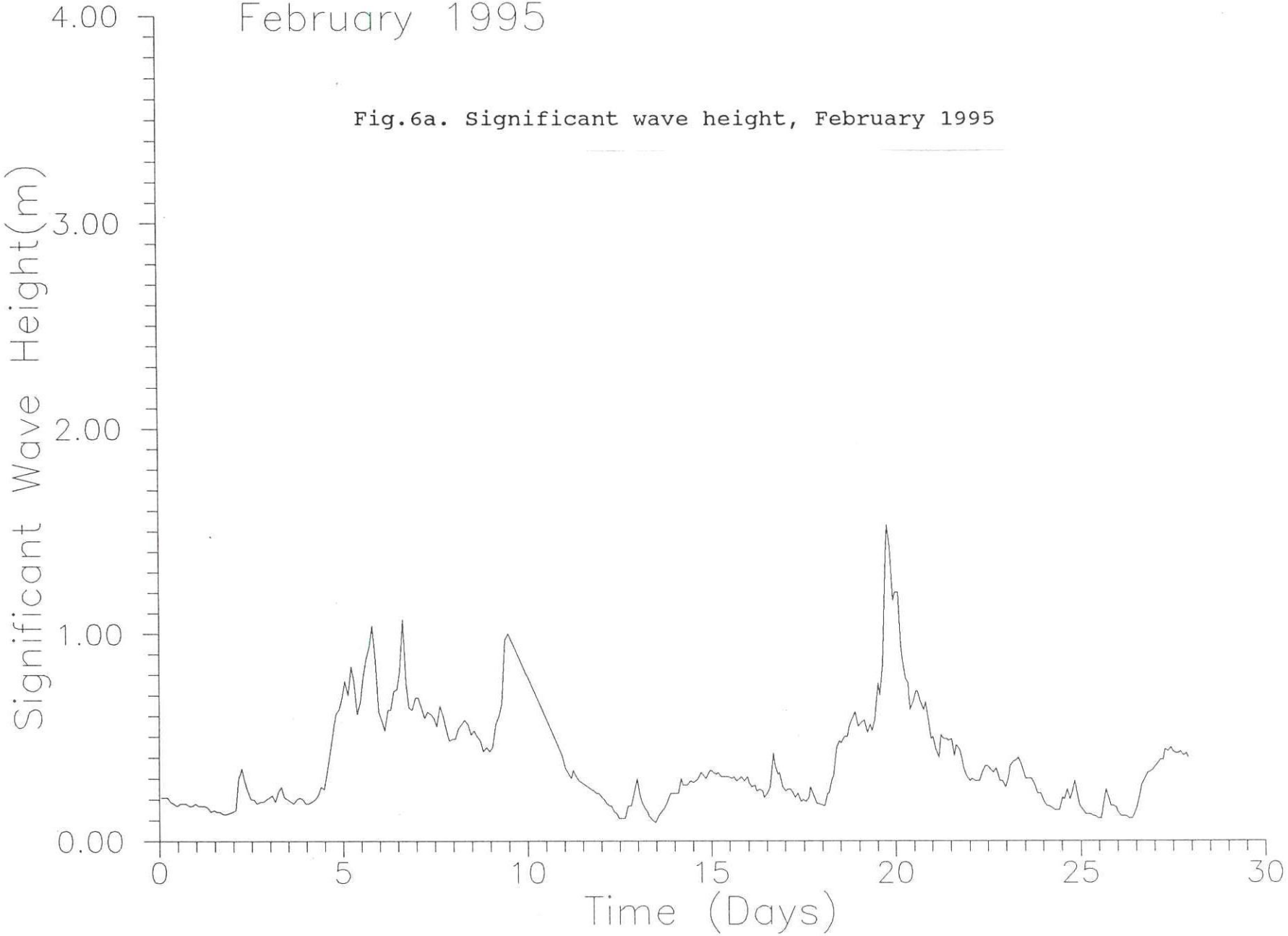

Fig.6a. Significant wave height, February 1995

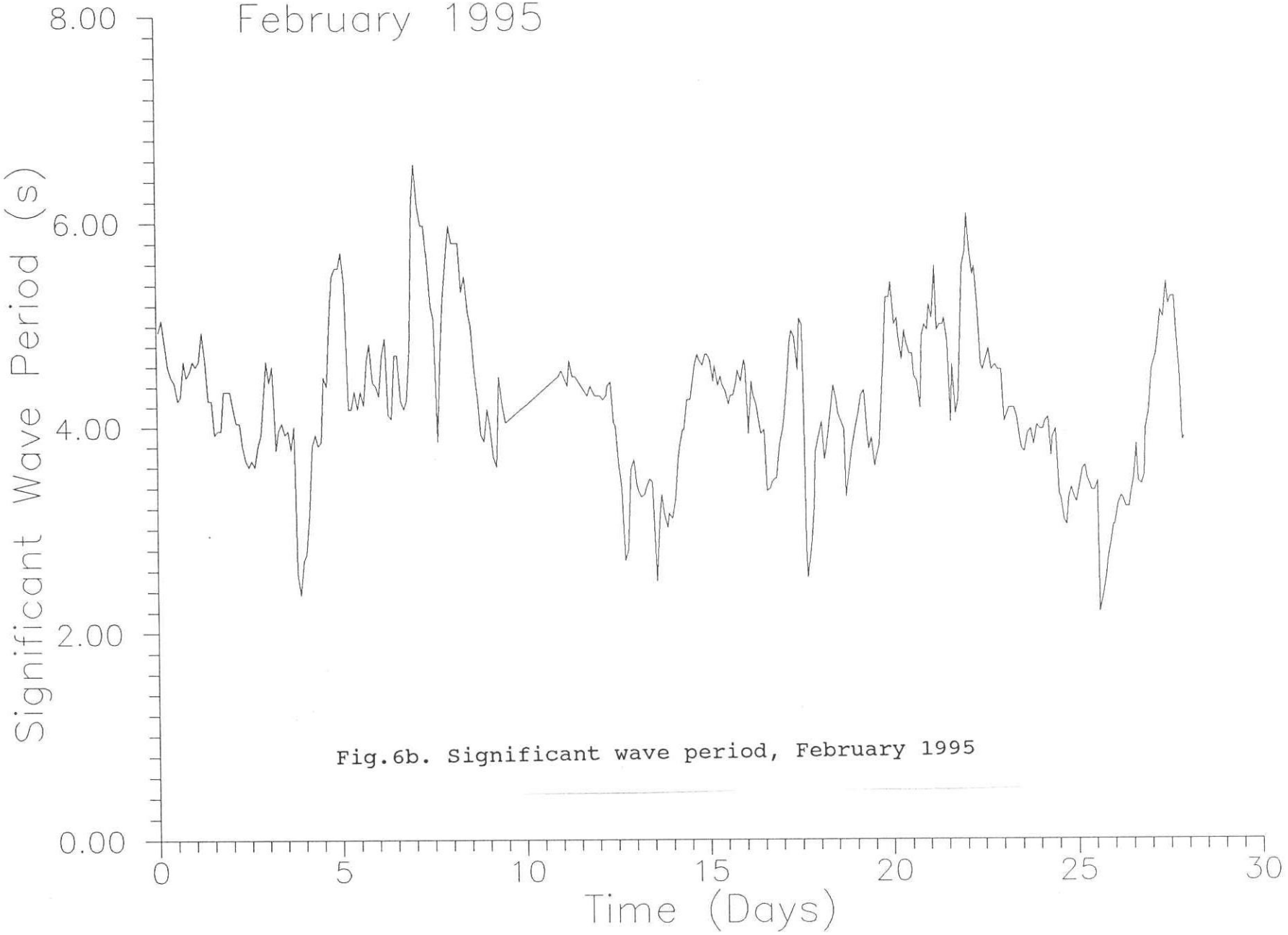

Fig.6b. Significant wave period, February 1995

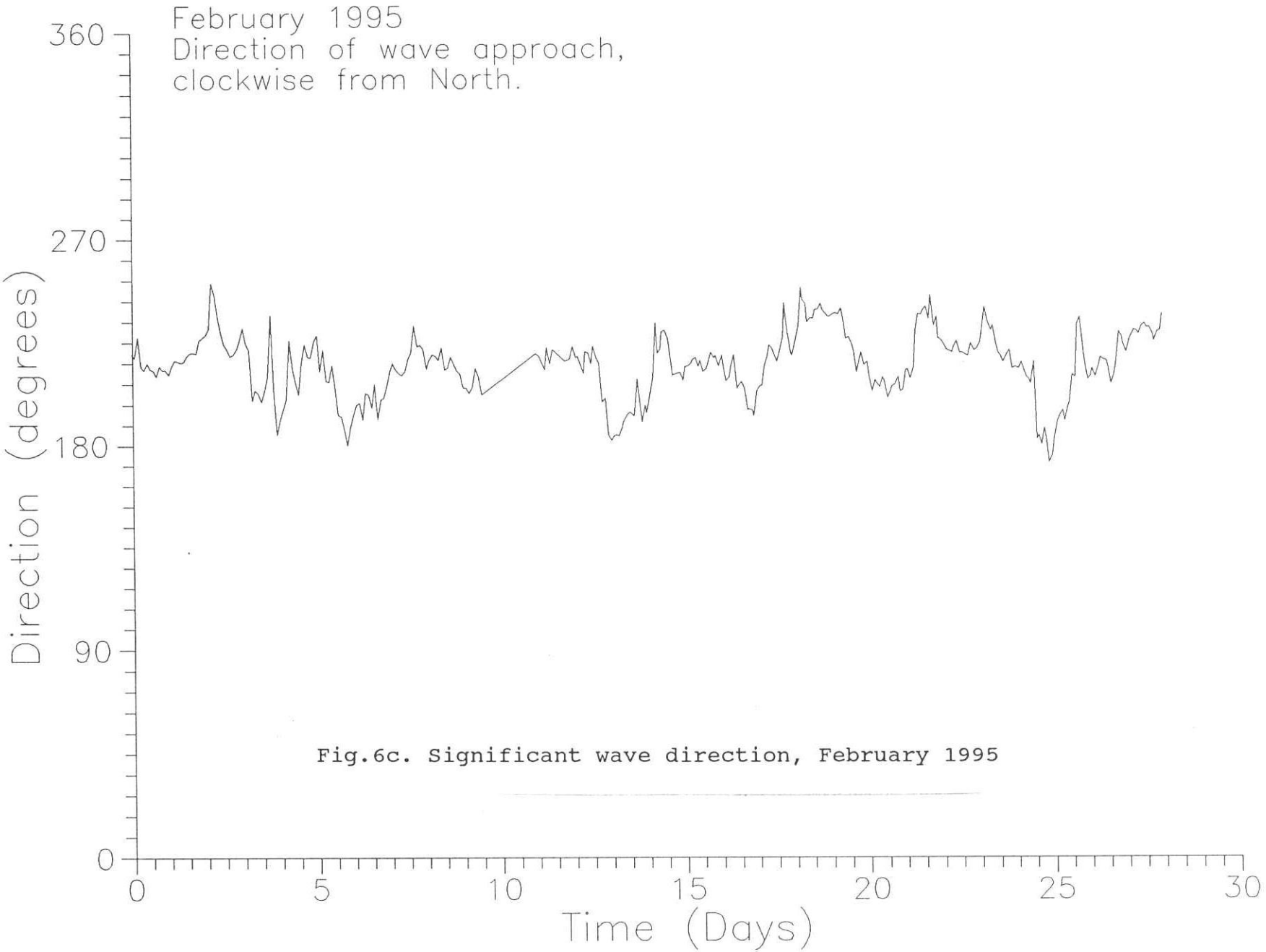

Fig.6c. Significant wave direction, February 1995

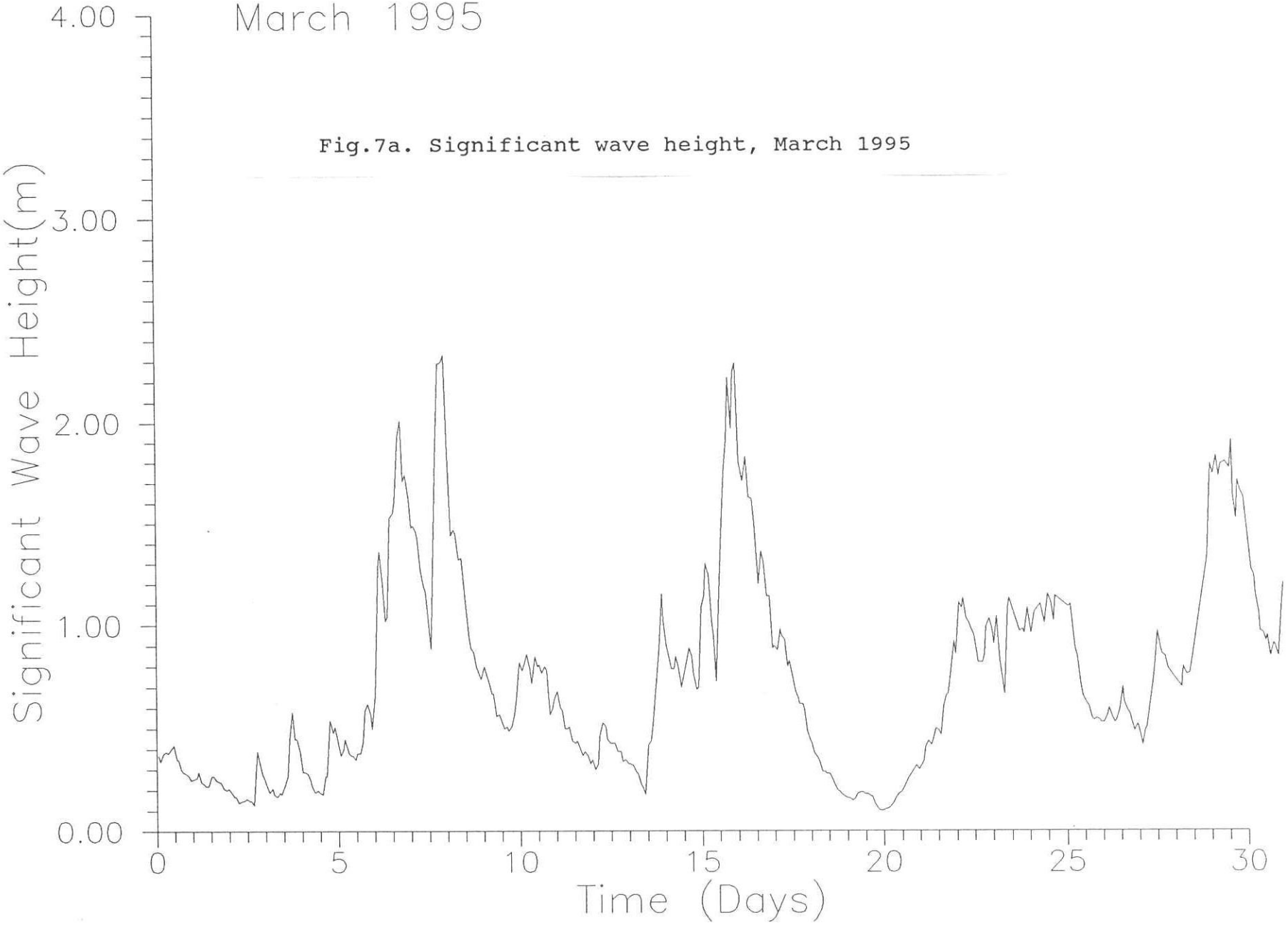

Fig.7a. Significant wave height, March 1995

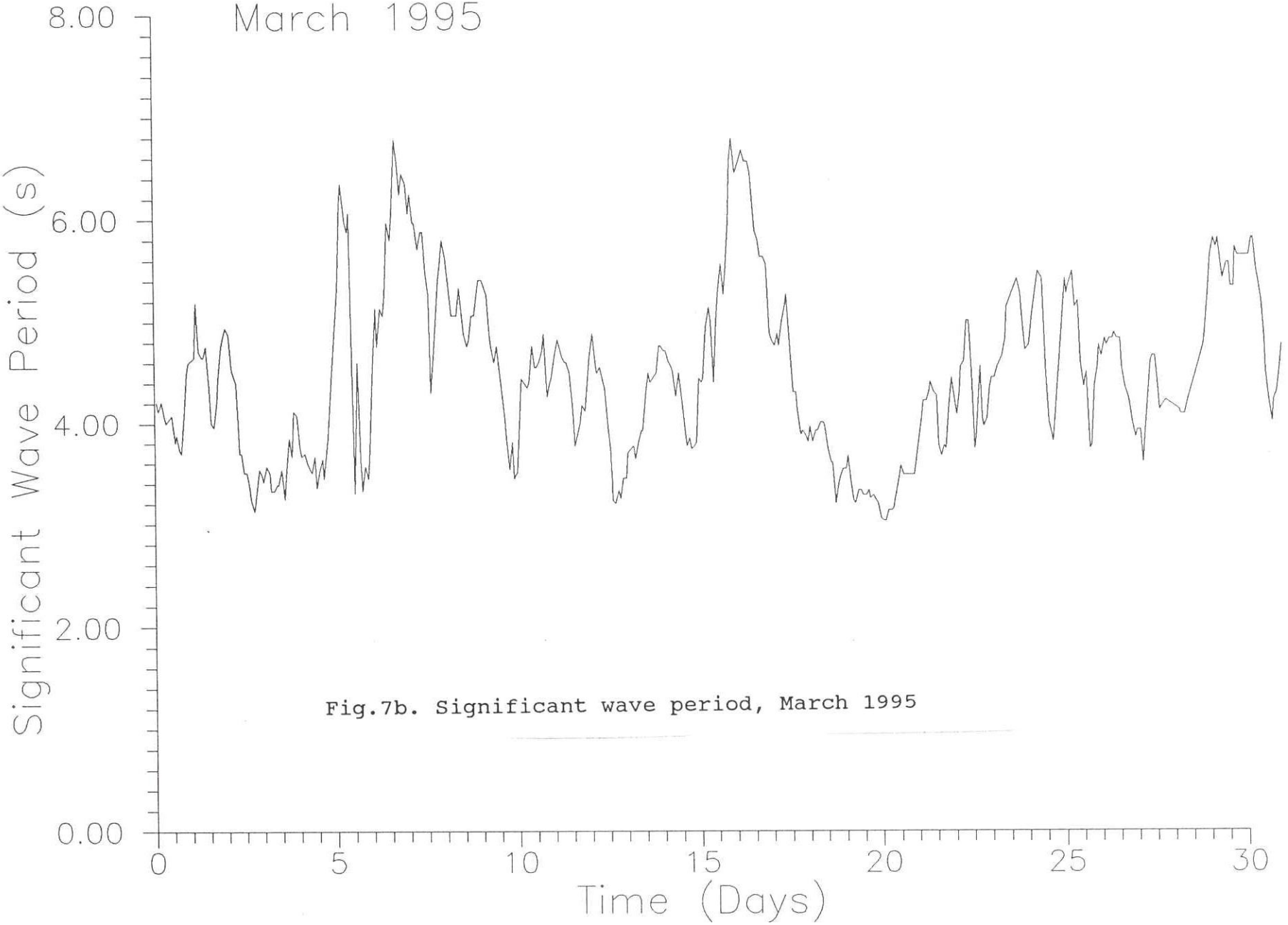

Fig.7b. Significant wave period, March 1995

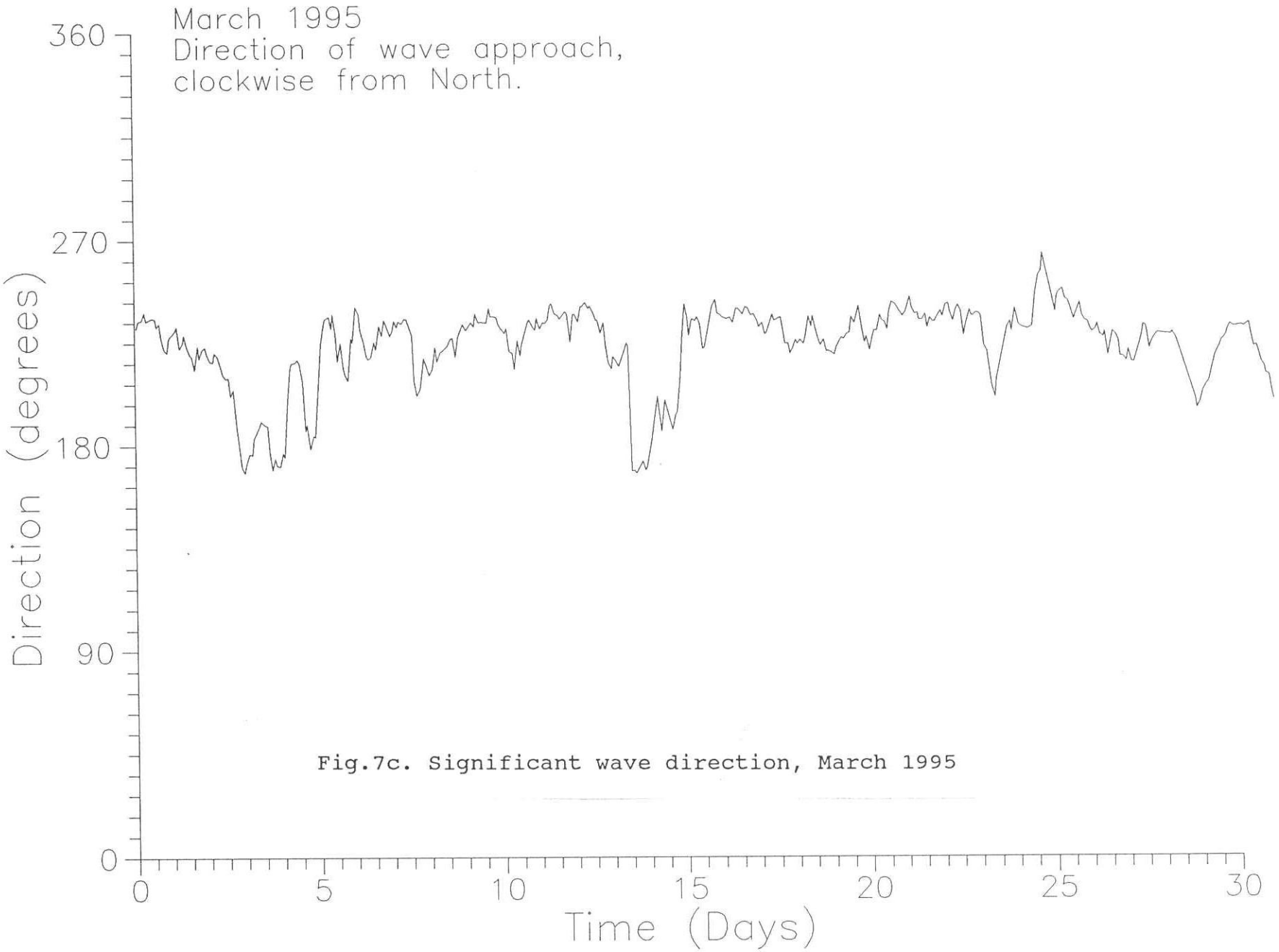

Fig.7c. Significant wave direction, March 1995

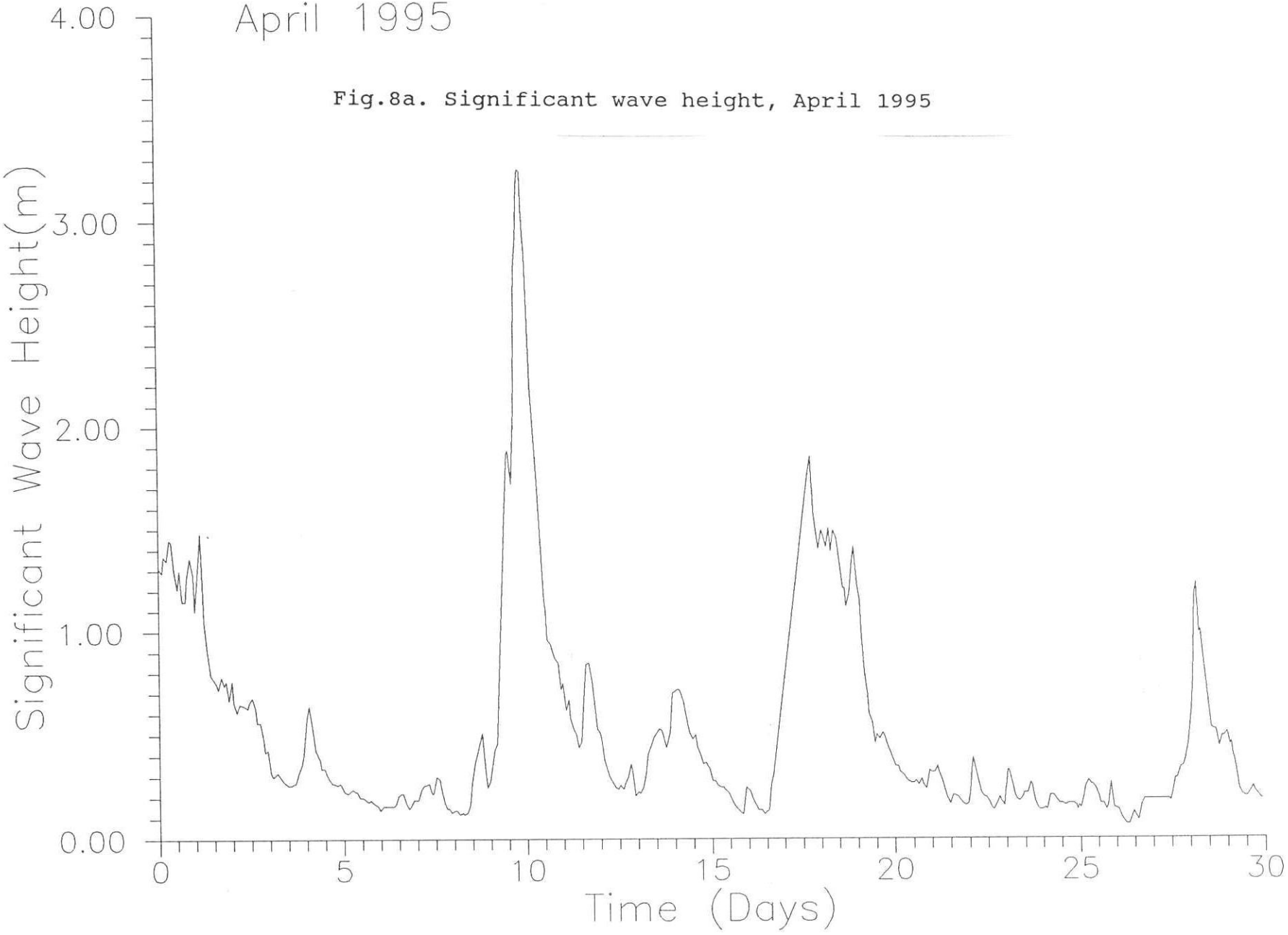

Fig.8a. Significant wave height, April 1995

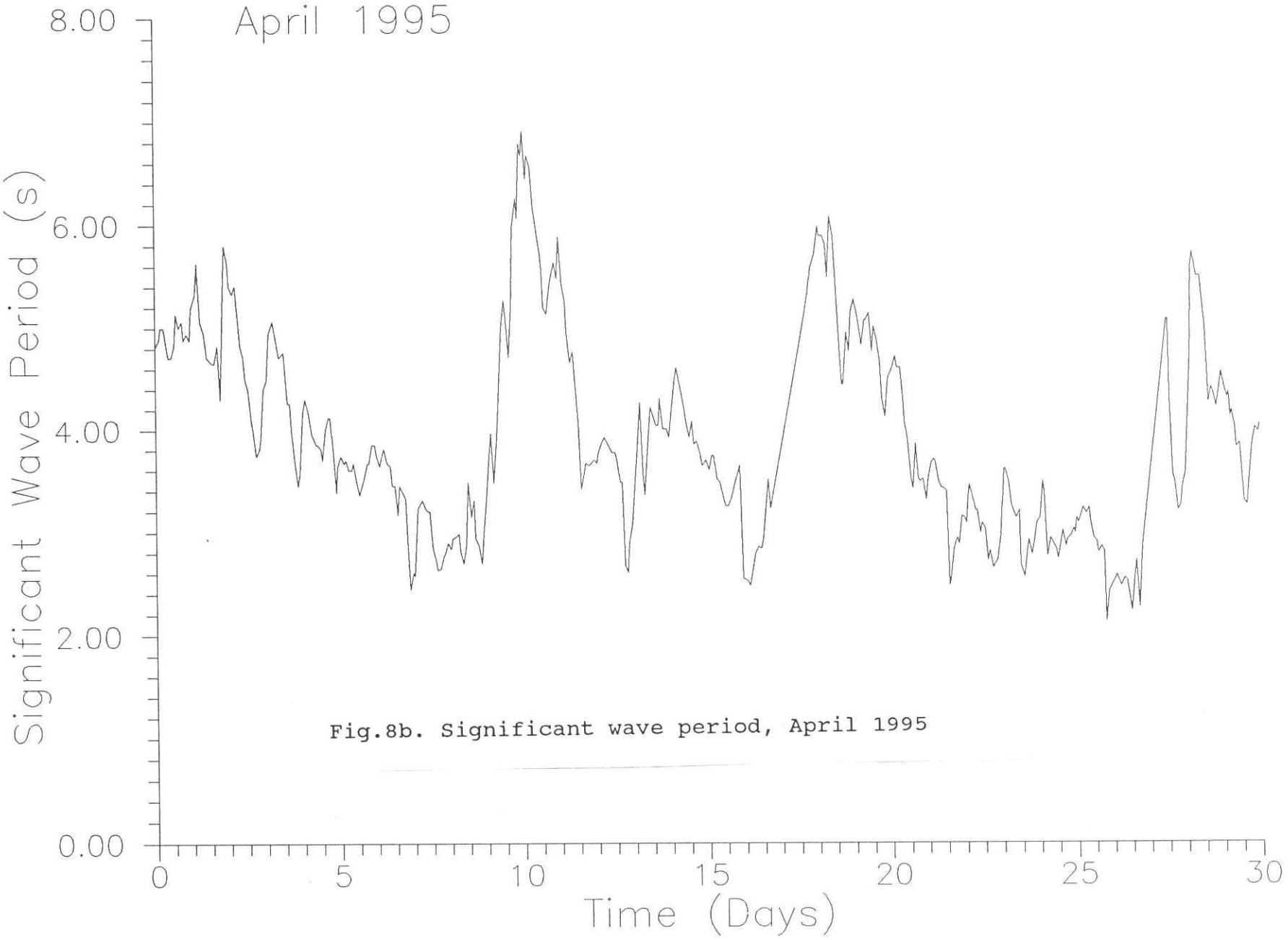

Fig.8b. Significant wave period, April 1995

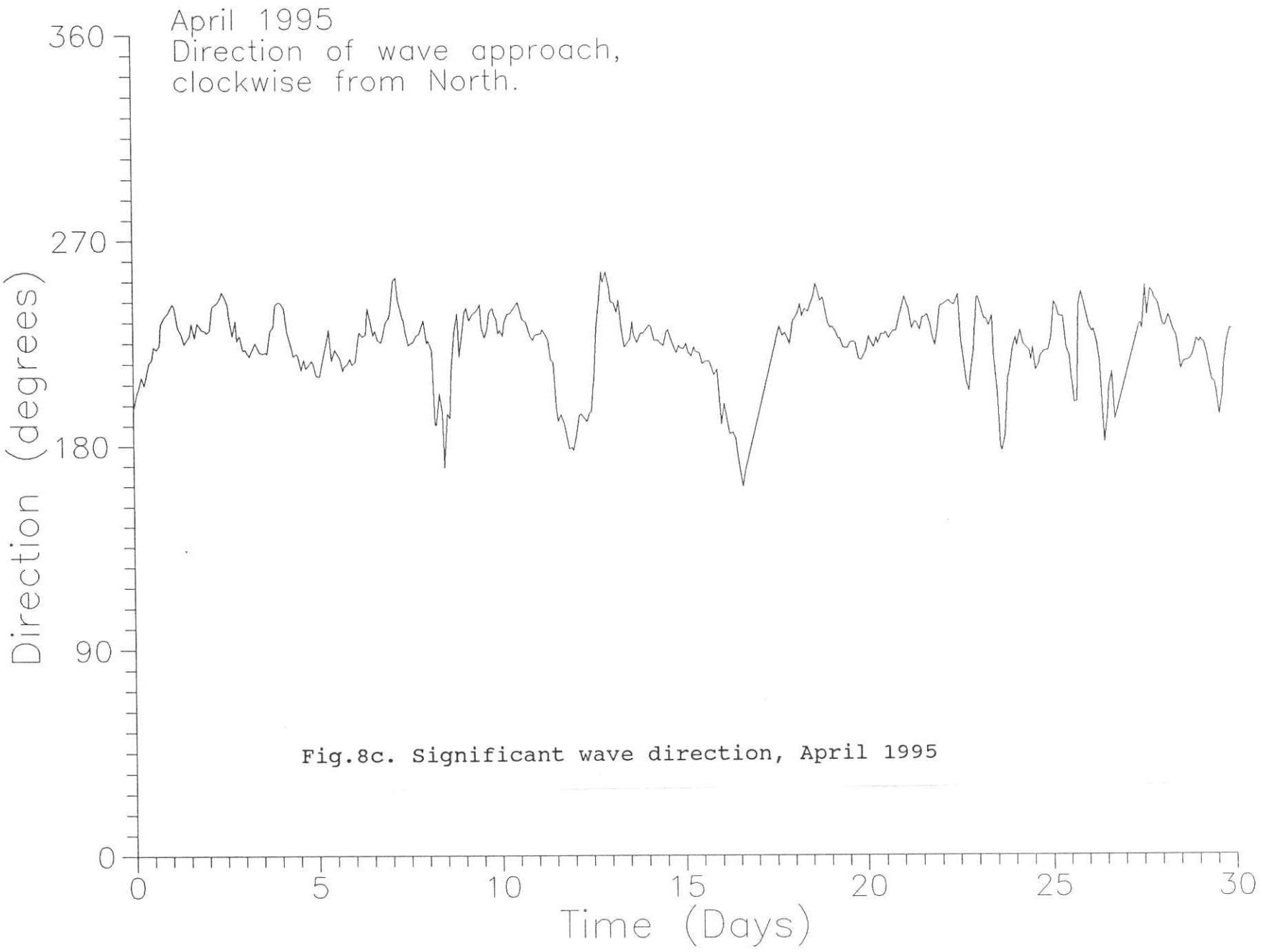

Fig.8c. Significant wave direction, April 1995

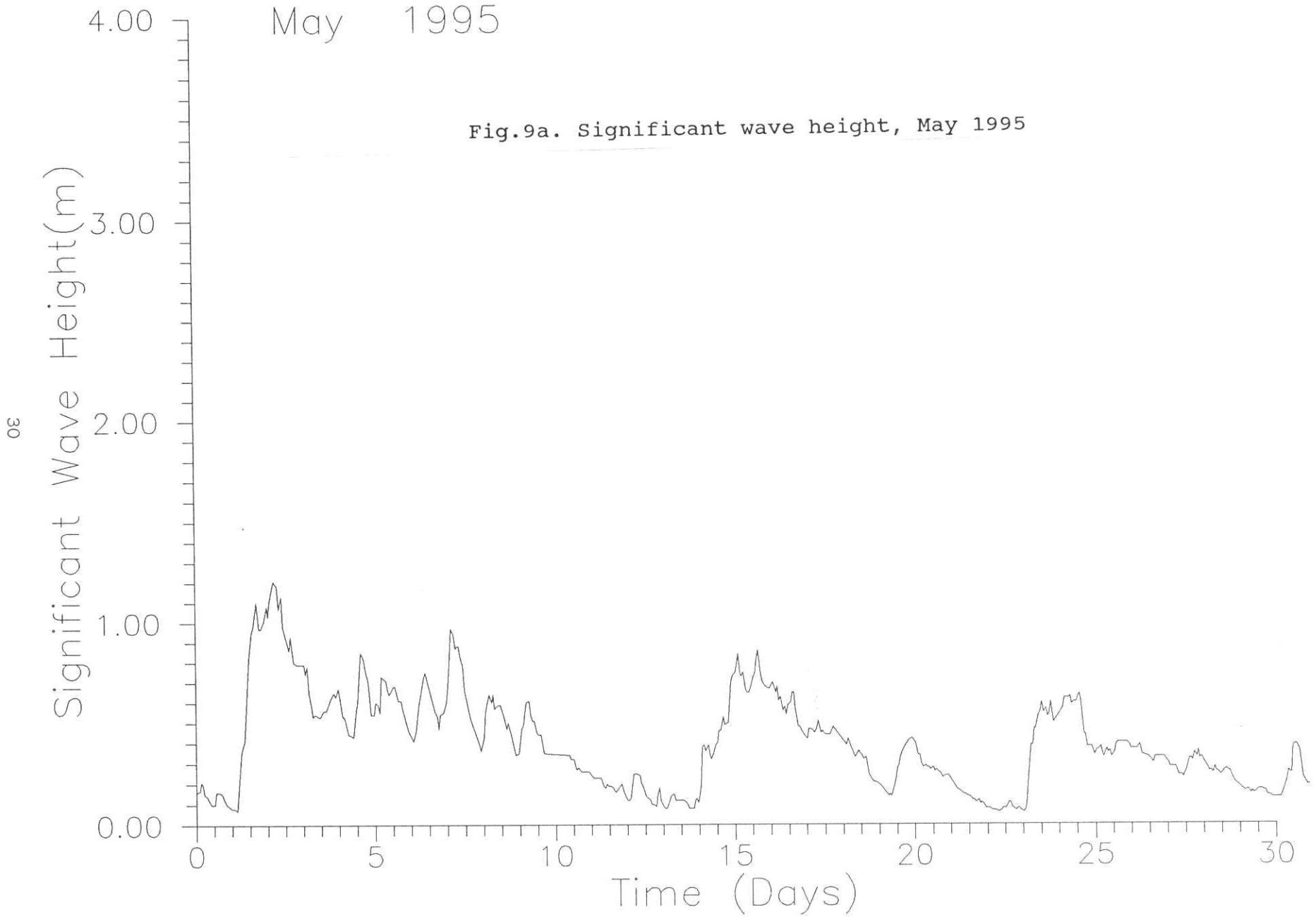

Fig.9a. Significant wave height, May 1995

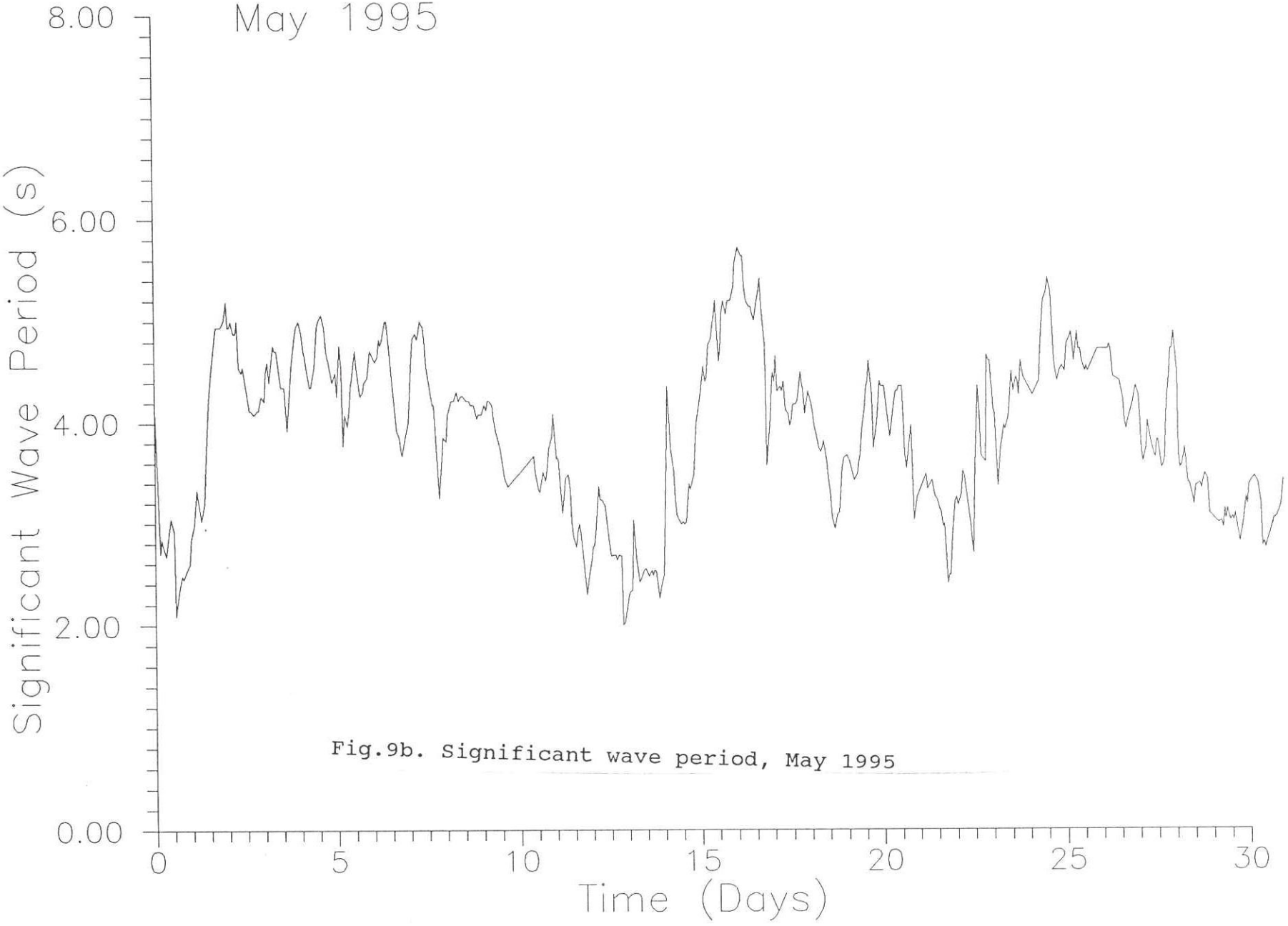

Fig.9b. Significant wave period, May 1995

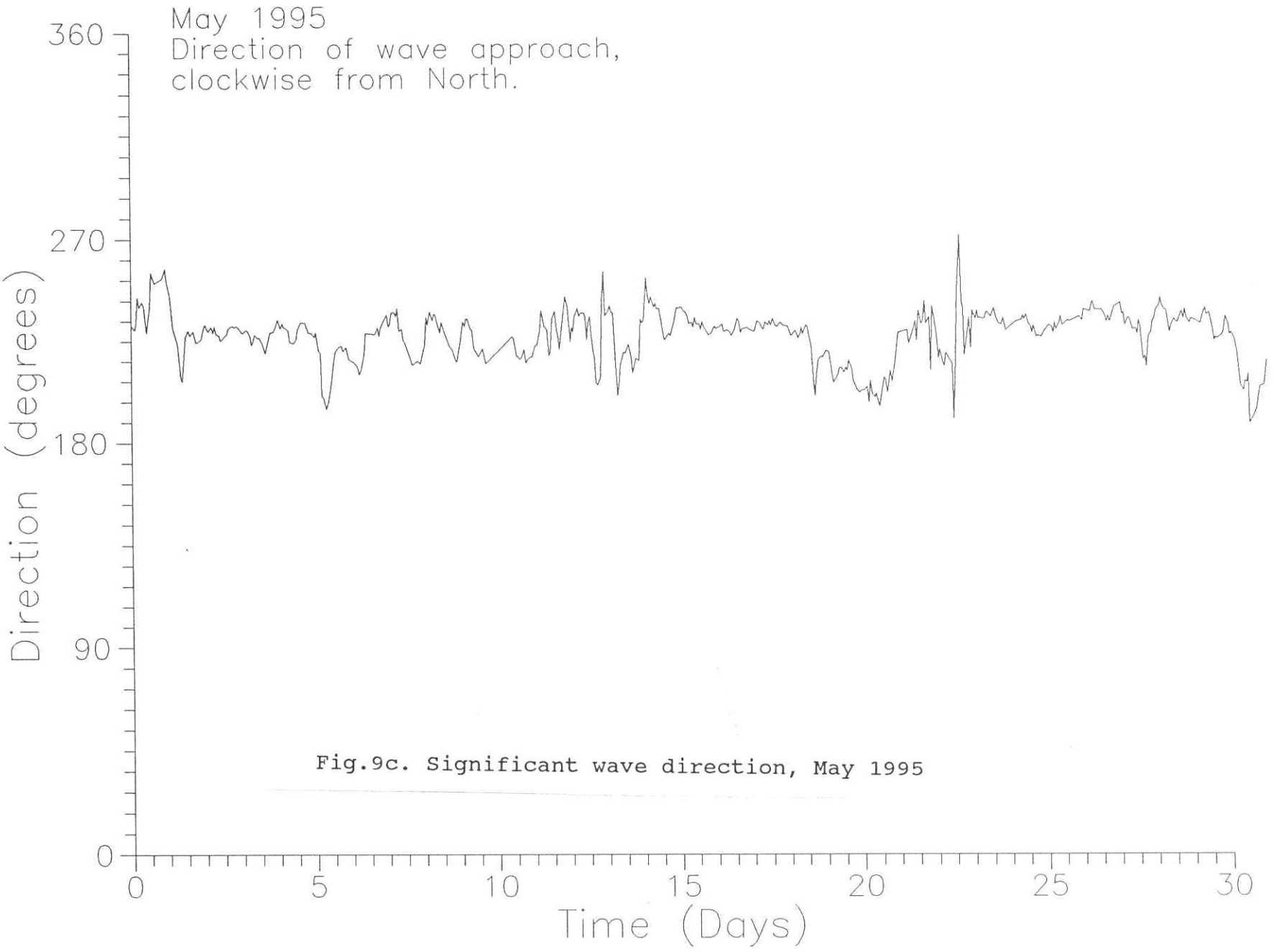

Fig.9c. Significant wave direction, May 1995

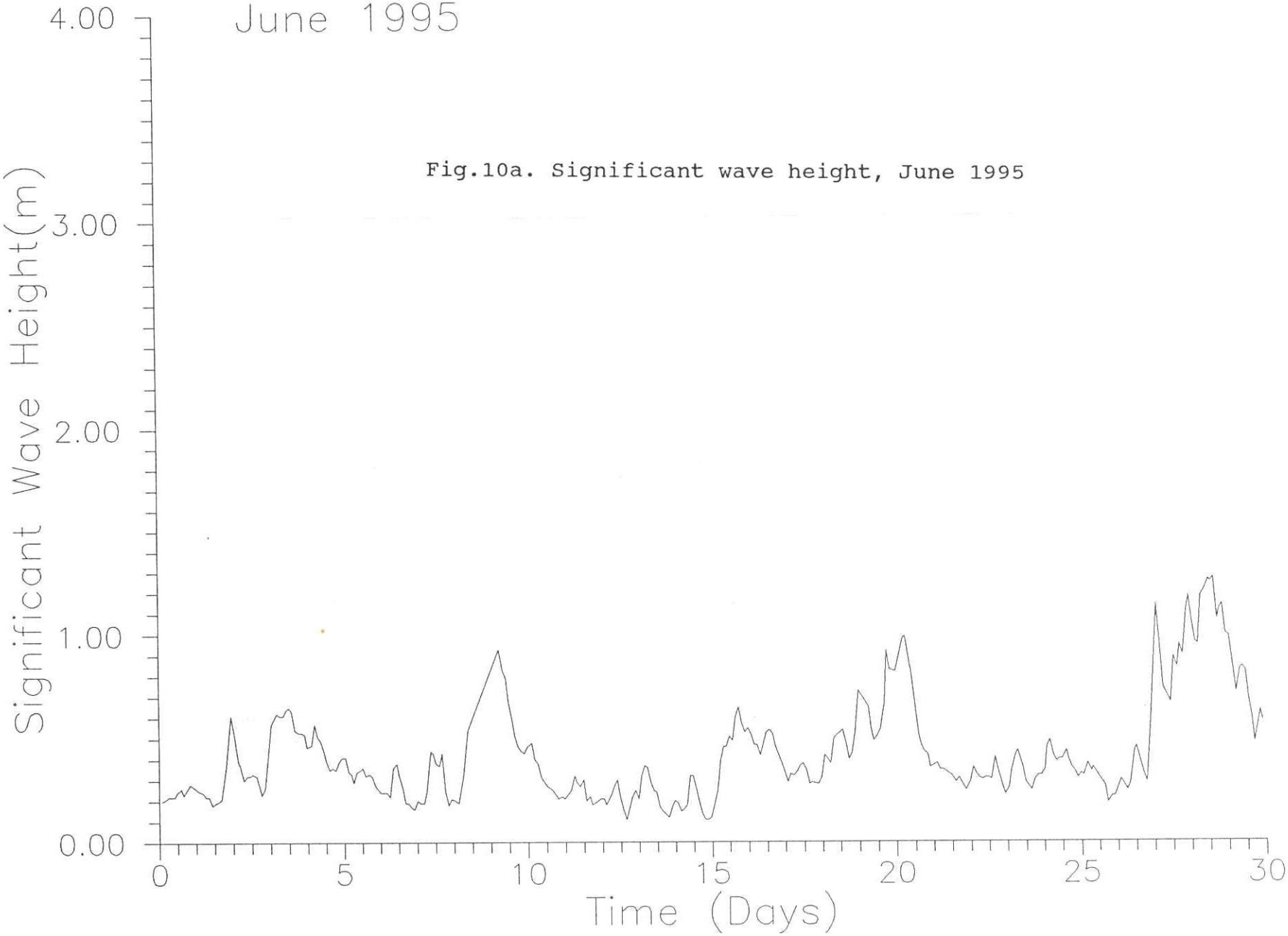

Fig.10a. Significant wave height, June 1995

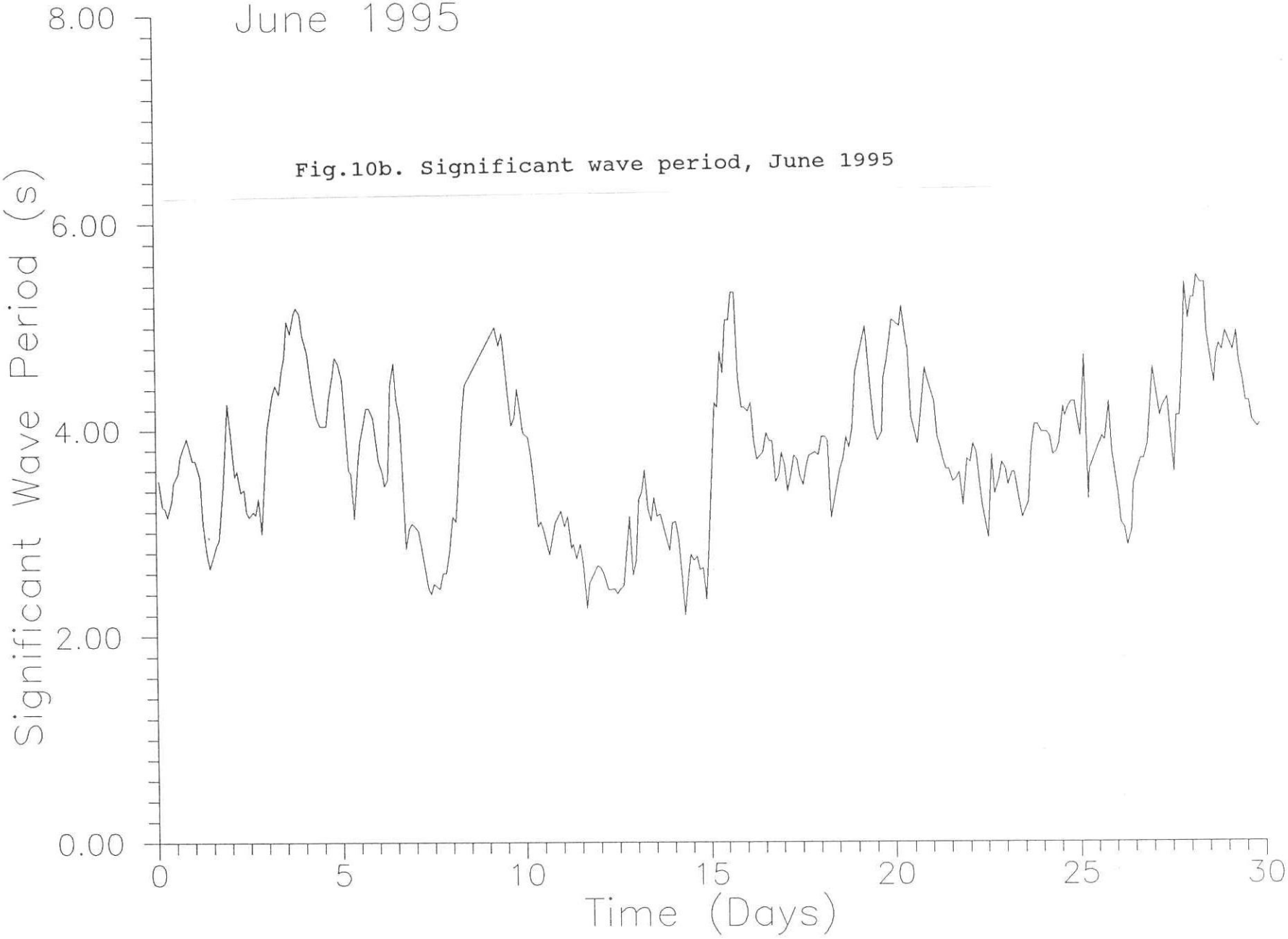

Fig.10b. Significant wave period, June 1995

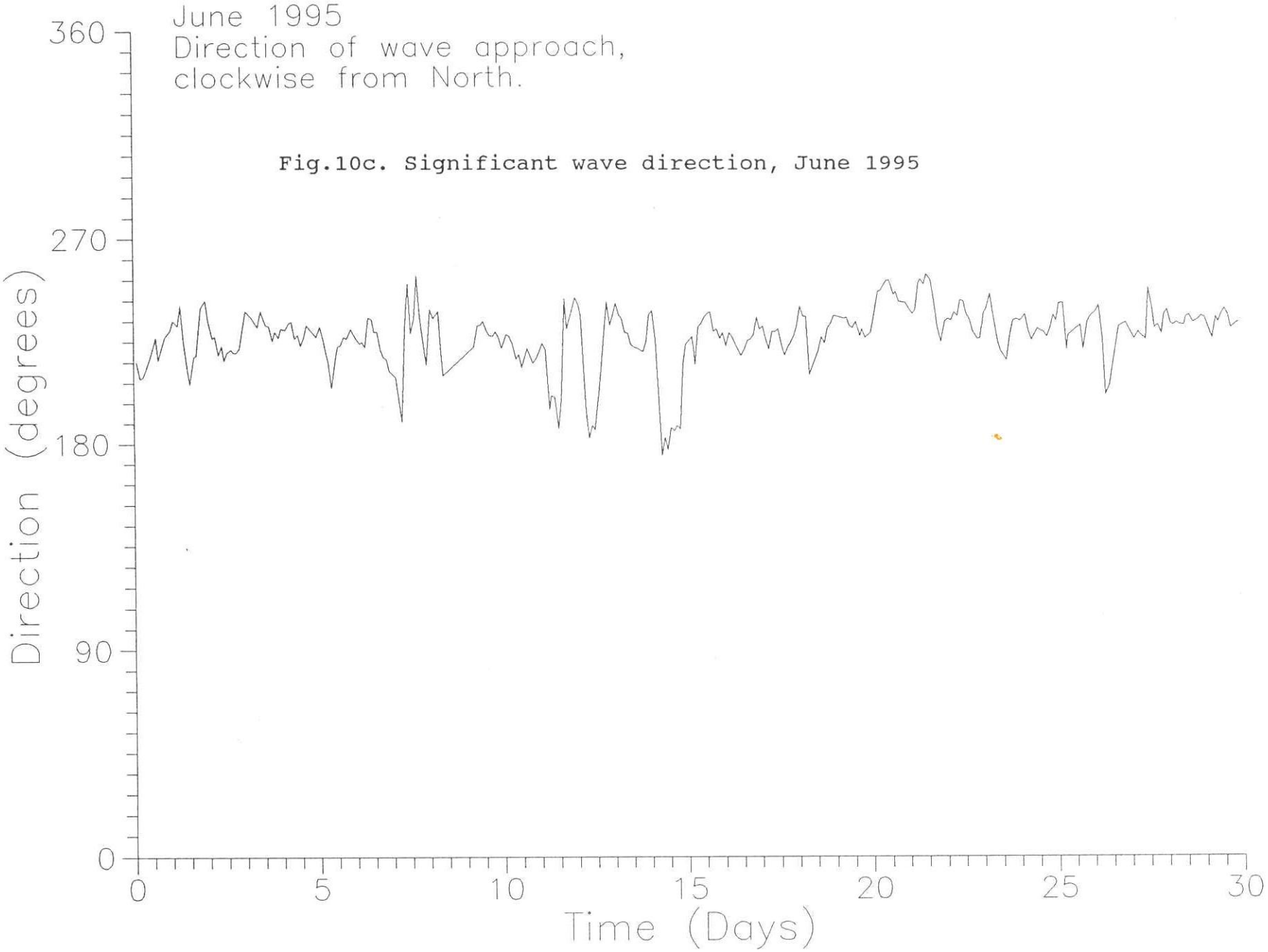

Fig.10c. Significant wave direction, June 1995

APPENDIX

WIND: CUMULATIVE FREQUENCY DATA

Antalya wind speed data for: N

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
19.	20.	19.5	0	0	.0000000
18.	19.	18.5	1	1	.0000379
17.	18.	17.5	1	2	.0000758
16.	17.	16.5	3	5	.0001896
15.	16.	15.5	3	8	.0003033
14.	15.	14.5	9	17	.0006445
13.	14.	13.5	4	21	.0007961
12.	13.	12.5	23	44	.0016681
11.	12.	11.5	40	84	.0031845
10.	11.	10.5	140	224	.0084919
9.	10.	9.5	203	427	.0161877
8.	9.	8.5	319	746	.0282811
7.	8.	7.5	639	1385	.0525059
6.	7.	6.5	1028	2413	.0914777
5.	6.	5.5	1811	4224	.1601335
4.	5.	4.5	3126	7350	.2786413
3.	4.	3.5	4162	11512	.4364243
2.	3.	2.5	5694	17206	.6522860
1.	2.	1.5	6444	23650	.8965805

Antalya wind speed data for: NNE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
13.	14.	13.5	0	0	.0000000
12.	13.	12.5	3	3	.0001342
11.	12.	11.5	4	7	.0003131
10.	11.	10.5	9	16	.0007156
9.	10.	9.5	61	77	.0034438
8.	9.	8.5	63	140	.0062615
7.	8.	7.5	160	300	.0134174
6.	7.	6.5	303	603	.0269690
5.	6.	5.5	672	1275	.0570240
4.	5.	4.5	1668	2943	.1316248
3.	4.	3.5	3345	6288	.2812290
2.	3.	2.5	5779	12067	.5396932
1.	2.	1.5	7329	19396	.8674806

Antalya wind speed data for: NE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
10.	11.	10.5	0	0	.0000000
9.	10.	9.5	2	2	.0002933
8.	9.	8.5	1	3	.0004400
7.	8.	7.5	7	10	.0014667
6.	7.	6.5	26	36	.0052801
5.	6.	5.5	53	89	.0130537
4.	5.	4.5	194	283	.0415078
3.	4.	3.5	622	905	.1327369
2.	3.	2.5	1624	2529	.3709299
1.	2.	1.5	2776	5305	.7780874

Antalya wind speed data for: ENE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
12.	13.	12.5	0	0	.0000000
11.	12.	11.5	1	1	.0001334
10.	11.	10.5	0	1	.0001334
9.	10.	9.5	2	3	.0004002
8.	9.	8.5	9	12	.0016009
7.	8.	7.5	29	41	.0054696
6.	7.	6.5	52	93	.0124066
5.	6.	5.5	132	225	.0300160
4.	5.	4.5	335	560	.0747065
3.	4.	3.5	833	1393	.1858324
2.	3.	2.5	1836	3229	.4307631
1.	2.	1.5	2888	6117	.8160352

Antalya wind speed data for: E

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
9.	10.	9.5	0	0	.0000000
8.	9.	8.5	2	2	.0006351
7.	8.	7.5	21	23	.0073039
6.	7.	6.5	36	59	.0187361
5.	6.	5.5	64	123	.0390600
4.	5.	4.5	183	306	.0971737
3.	4.	3.5	310	616	.1956177
2.	3.	2.5	517	1133	.3597968
1.	2.	1.5	1215	2348	.7456335

Antalya wind speed data for: ESE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
23.	24.	23.5	0	0	.0000000
22.	23.	22.5	1	1	.0001359
21.	22.	21.5	0	1	.0001359
20.	21.	20.5	1	2	.0002719
19.	20.	19.5	8	10	.0013594
18.	19.	18.5	6	16	.0021751
17.	18.	17.5	2	18	.0024470
16.	17.	16.5	2	20	.0027189
15.	16.	15.5	3	23	.0031267
14.	15.	14.5	2	25	.0033986
13.	14.	13.5	8	33	.0044861
12.	13.	12.5	17	50	.0067972
11.	12.	11.5	27	77	.0104676
10.	11.	10.5	34	111	.0150897
9.	10.	9.5	43	154	.0209353
8.	9.	8.5	67	221	.0300435
7.	8.	7.5	76	297	.0403752
6.	7.	6.5	109	406	.0551930
5.	6.	5.5	270	676	.0918978
4.	5.	4.5	568	1244	.1691137
3.	4.	3.5	1093	2337	.3176998
2.	3.	2.5	1473	3810	.5179445
1.	2.	1.5	2163	5973	.8119902

Antalya wind speed data for: SE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
21.	22.	21.5	0	0	.0000000
20.	21.	20.5	2	2	.0002329
19.	20.	19.5	2	4	.0004659
18.	19.	18.5	12	16	.0018635
17.	18.	17.5	20	36	.0041929
16.	17.	16.5	21	57	.0066387
15.	16.	15.5	27	84	.0097834
14.	15.	14.5	22	106	.0123457
13.	14.	13.5	39	145	.0168880
12.	13.	12.5	53	198	.0230608
11.	12.	11.5	49	247	.0287678
10.	11.	10.5	59	306	.0356394
9.	10.	9.5	99	405	.0471698
8.	9.	8.5	120	525	.0611461
7.	8.	7.5	144	669	.0779175
6.	7.	6.5	258	927	.1079665
5.	6.	5.5	519	1446	.1684137
4.	5.	4.5	1163	2609	.3038668
3.	4.	3.5	1781	4390	.5112975
2.	3.	2.5	1564	5954	.6934544
1.	2.	1.5	1478	7432	.8655952

Antalya wind speed data for: SSE

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
25.	26.	25.5	0	0	.0000000
24.	25.	24.5	1	1	.0000479
23.	24.	23.5	0	1	.0000479
22.	23.	22.5	1	2	.0000959
21.	22.	21.5	1	3	.0001438
20.	21.	20.5	3	6	.0002877
19.	20.	19.5	7	13	.0006233
18.	19.	18.5	6	19	.0009109
17.	18.	17.5	14	33	.0015821
16.	17.	16.5	30	63	.0030204
15.	16.	15.5	42	105	.0050340
14.	15.	14.5	51	156	.0074791
13.	14.	13.5	50	206	.0098763
12.	13.	12.5	63	269	.0128967
11.	12.	11.5	73	342	.0163966
10.	11.	10.5	100	442	.0211909
9.	10.	9.5	154	596	.0285742
8.	9.	8.5	176	772	.0370122
7.	8.	7.5	274	1046	.0501486
6.	7.	6.5	505	1551	.0743600
5.	6.	5.5	1151	2702	.1295426
4.	5.	4.5	2958	5660	.2713587
3.	4.	3.5	5124	10784	.5170199
2.	3.	2.5	4588	15372	.7369834
1.	2.	1.5	3378	18750	.8989357

Antalya wind speed data for: S

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
20.	21.	20.5	0	0	.0000000
19.	20.	19.5	5	5	.0002901
18.	19.	18.5	3	8	.0004641
17.	18.	17.5	4	12	.0006961
16.	17.	16.5	8	20	.0011602
15.	16.	15.5	13	33	.0019144
14.	15.	14.5	31	64	.0037127
13.	14.	13.5	25	89	.0051630
12.	13.	12.5	36	125	.0072514
11.	12.	11.5	59	184	.0106741
10.	11.	10.5	78	262	.0151990
9.	10.	9.5	109	371	.0215222
8.	9.	8.5	156	527	.0305720
7.	8.	7.5	255	782	.0453649
6.	7.	6.5	506	1288	.0747186
5.	6.	5.5	1176	2464	.1429400
4.	5.	4.5	2682	5146	.2985265
3.	4.	3.5	4014	9160	.5313842
2.	3.	2.5	3341	12501	.7252001
1.	2.	1.5	2468	14969	.8683722

Antalya wind speed data for: SSW

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
19.	20.	19.5	0	0	.0000000
18.	19.	18.5	1	1	.0000734
17.	18.	17.5	0	1	.0000734
16.	17.	16.5	0	1	.0000734
15.	16.	15.5	1	2	.0001468
14.	15.	14.5	3	5	.0003669
13.	14.	13.5	4	9	.0006604
12.	13.	12.5	9	18	.0013208
11.	12.	11.5	20	38	.0027884
10.	11.	10.5	30	68	.0049897
9.	10.	9.5	32	100	.0073378
8.	9.	8.5	67	167	.0122542
7.	8.	7.5	138	305	.0223804
6.	7.	6.5	426	731	.0536396
5.	6.	5.5	1094	1825	.1339155
4.	5.	4.5	1803	3628	.2662166
3.	4.	3.5	2298	5926	.4348400
2.	3.	2.5	2752	8678	.6367772
1.	2.	1.5	2807	11485	.8427502

Antalya wind speed data for: SW

Speed group		Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
11.	12.	11.5	0	0	.0000000
10.	11.	10.5	1	1	.0003614
9.	10.	9.5	2	3	.0010842
8.	9.	8.5	7	10	.0036140
7.	8.	7.5	16	26	.0093965
6.	7.	6.5	19	45	.0162631
5.	6.	5.5	65	110	.0397542
4.	5.	4.5	158	268	.0968558
3.	4.	3.5	254	522	.1886520
2.	3.	2.5	479	1001	.3617637
1.	2.	1.5	944	1945	.7029274

Antalya wind speed data for: WSW

Speed group	Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
12.	13.	12.5	0	0	.0000000
11.	12.	11.5	1	1	.0003814
10.	11.	10.5	0	1	.0003814
9.	10.	9.5	1	2	.0007628
8.	9.	8.5	1	3	.0011442
7.	8.	7.5	8	11	.0041953
6.	7.	6.5	24	35	.0133486
5.	6.	5.5	26	61	.0232647
4.	5.	4.5	59	120	.0457666
3.	4.	3.5	121	241	.0919146
2.	3.	2.5	345	586	.2234935
1.	2.	1.5	1067	1653	.6304348

Antalya wind speed data for: W

Speed group	Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
10.	11.	10.5	0	0	.0000000
9.	10.	9.5	1	1	.0005157
8.	9.	8.5	1	2	.0010315
7.	8.	7.5	5	7	.0036101
6.	7.	6.5	5	12	.0061888
5.	6.	5.5	8	20	.0103146
4.	5.	4.5	31	51	.0263022
3.	4.	3.5	69	120	.0618876
2.	3.	2.5	174	294	.1516245
1.	2.	1.5	889	1183	.6101083

Antalya wind speed data for: WNW

Speed group	Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
14.	15.	14.5	0	0	.0000000
13.	14.	13.5	1	1	.0001128
12.	13.	12.5	4	5	.0005638
11.	12.	11.5	13	18	.0020295
10.	11.	10.5	24	42	.0047356
9.	10.	9.5	46	88	.0099222
8.	9.	8.5	63	151	.0170256
7.	8.	7.5	105	256	.0288646
6.	7.	6.5	144	400	.0451009
5.	6.	5.5	251	651	.0734017
4.	5.	4.5	577	1228	.1384598
3.	4.	3.5	1182	2410	.2717330
2.	3.	2.5	1511	3921	.4421017
1.	2.	1.5	3216	7137	.8047131

Antalya wind speed data for: NW

Speed group	Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
16. 17.	16.5	0	0	.0000000
15. 16.	15.5	1	1	.0000438
14. 15.	14.5	8	9	.0003938
13. 14.	13.5	15	24	.0010502
12. 13.	12.5	32	56	.0024506
11. 12.	11.5	80	136	.0059513
10. 11.	10.5	139	275	.0120340
9. 10.	9.5	278	553	.0241992
8. 9.	8.5	428	981	.0429284
7. 8.	7.5	778	1759	.0769736
6. 7.	6.5	1068	2827	.1237091
5. 6.	5.5	1561	4388	.1920182
4. 5.	4.5	2251	6639	.2905216
3. 4.	3.5	3049	9688	.4239454
2. 3.	2.5	3306	12994	.5686154
1. 2.	1.5	6929	19923	.8718274

Antalya wind speed data for: NNW

Speed group	Avg spd	Obsrv.	Cum.obsv.	Cum.frq.
17. 18.	17.5	0	0	.0000000
16. 17.	16.5	1	1	.0000210
15. 16.	15.5	8	9	.0001893
14. 15.	14.5	21	30	.0006310
13. 14.	13.5	36	66	.0013883
12. 13.	12.5	106	172	.0036180
11. 12.	11.5	145	317	.0066681
10. 11.	10.5	266	583	.0122634
9. 10.	9.5	486	1069	.0224863
8. 9.	8.5	736	1805	.0379680
7. 8.	7.5	1319	3124	.0657131
6. 7.	6.5	1992	5116	.1076146
5. 6.	5.5	2952	8068	.1697097
4. 5.	4.5	5071	13139	.2763778
3. 4.	3.5	7475	20614	.4336138
2. 3.	2.5	9495	30109	.6333404
1. 2.	1.5	12987	43096	.9065208

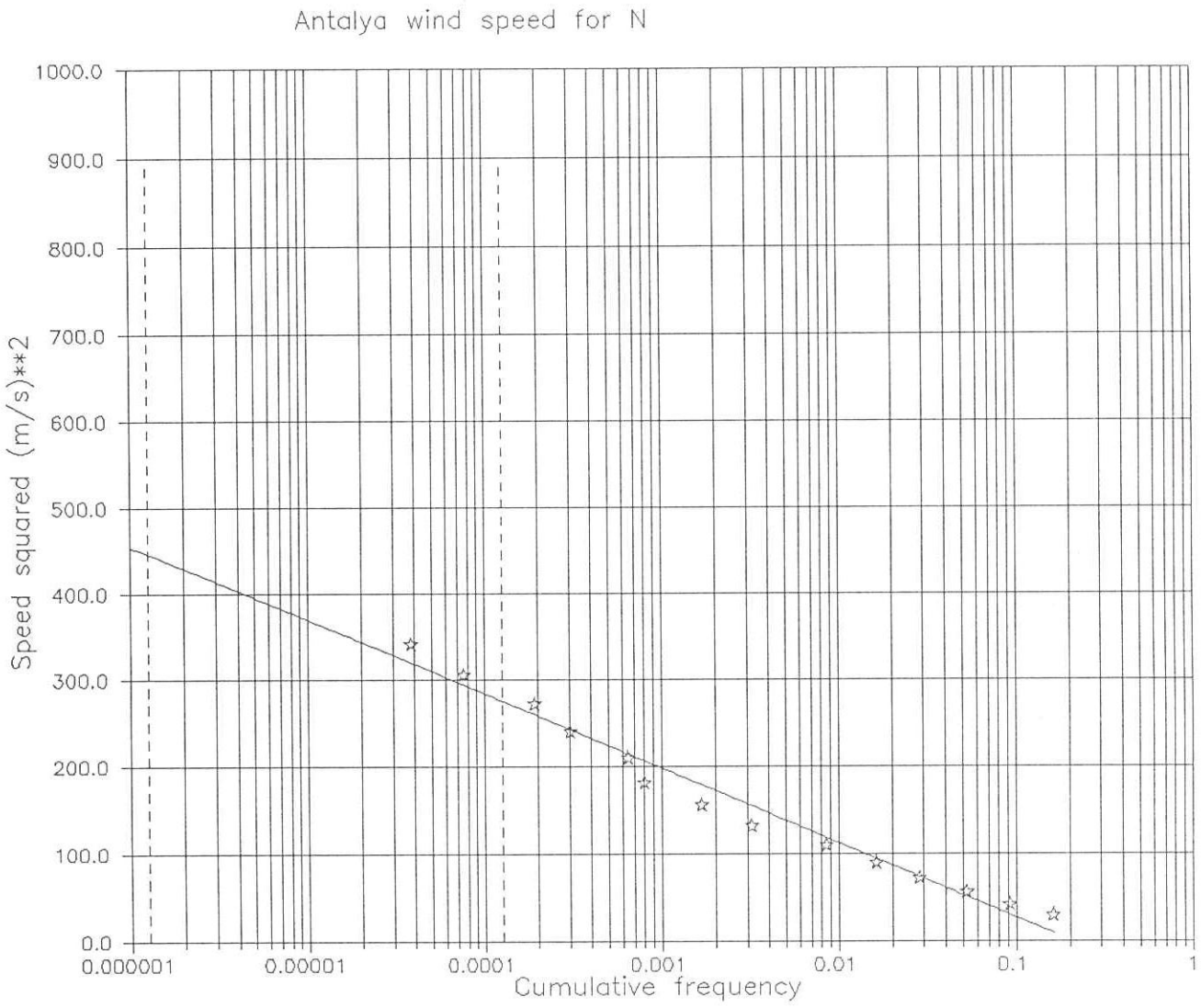

Fig.A-1. Cumulative frequency plot of Wind for N.

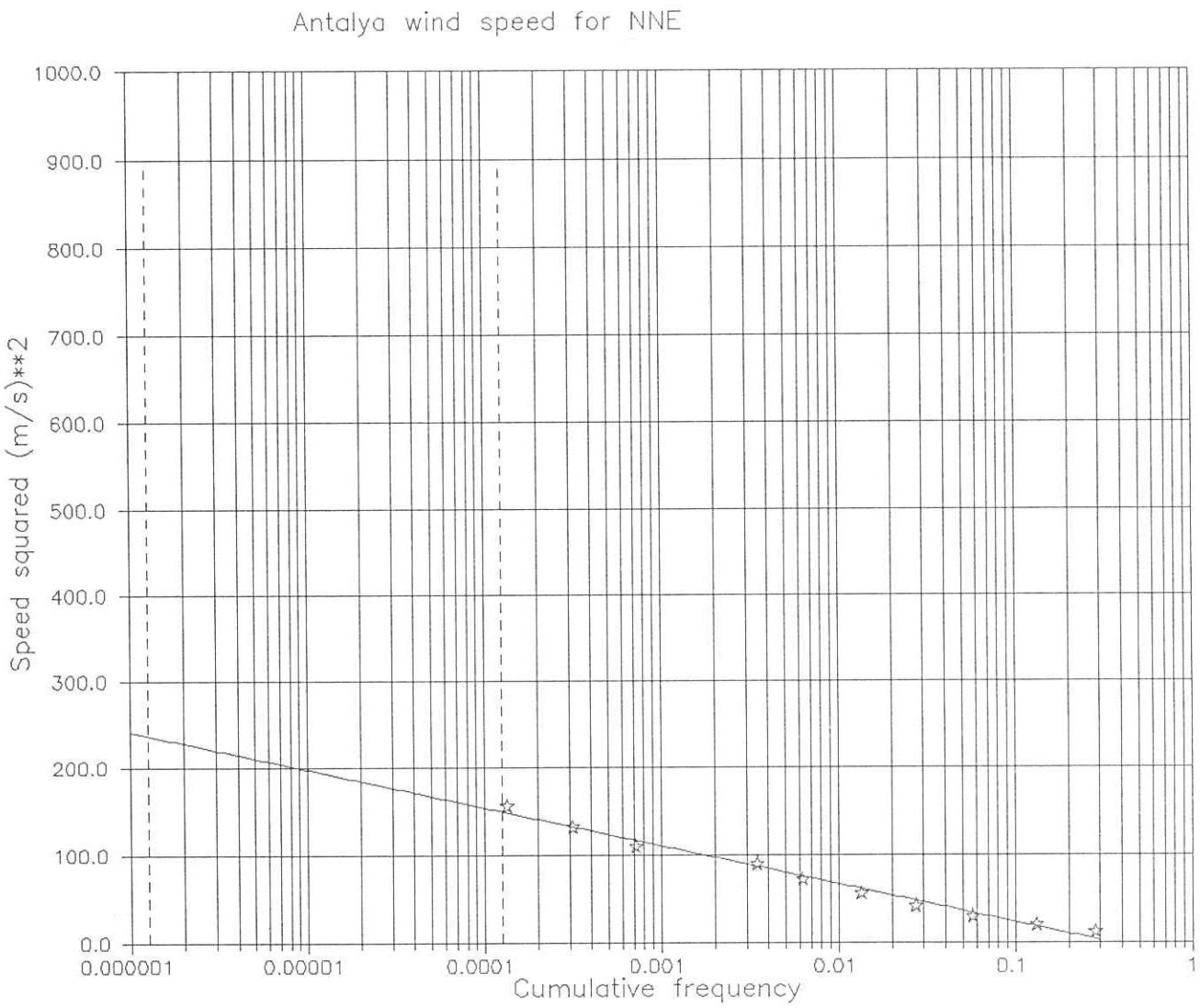

Fig.A-2. Cumulative frequency plot of Wind for NNE.

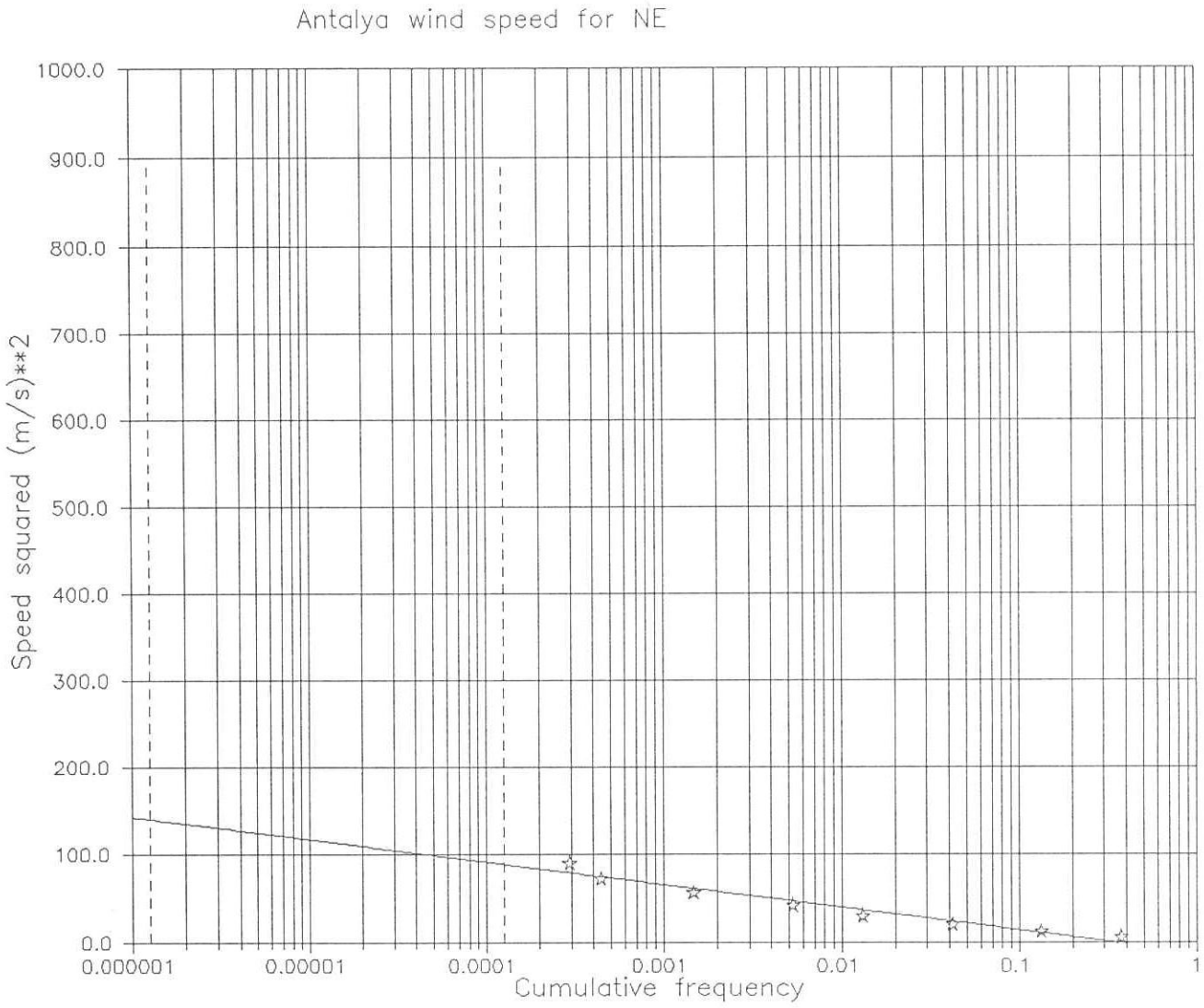

Fig.A-3. Cumulative frequency plot of Wind for NE.

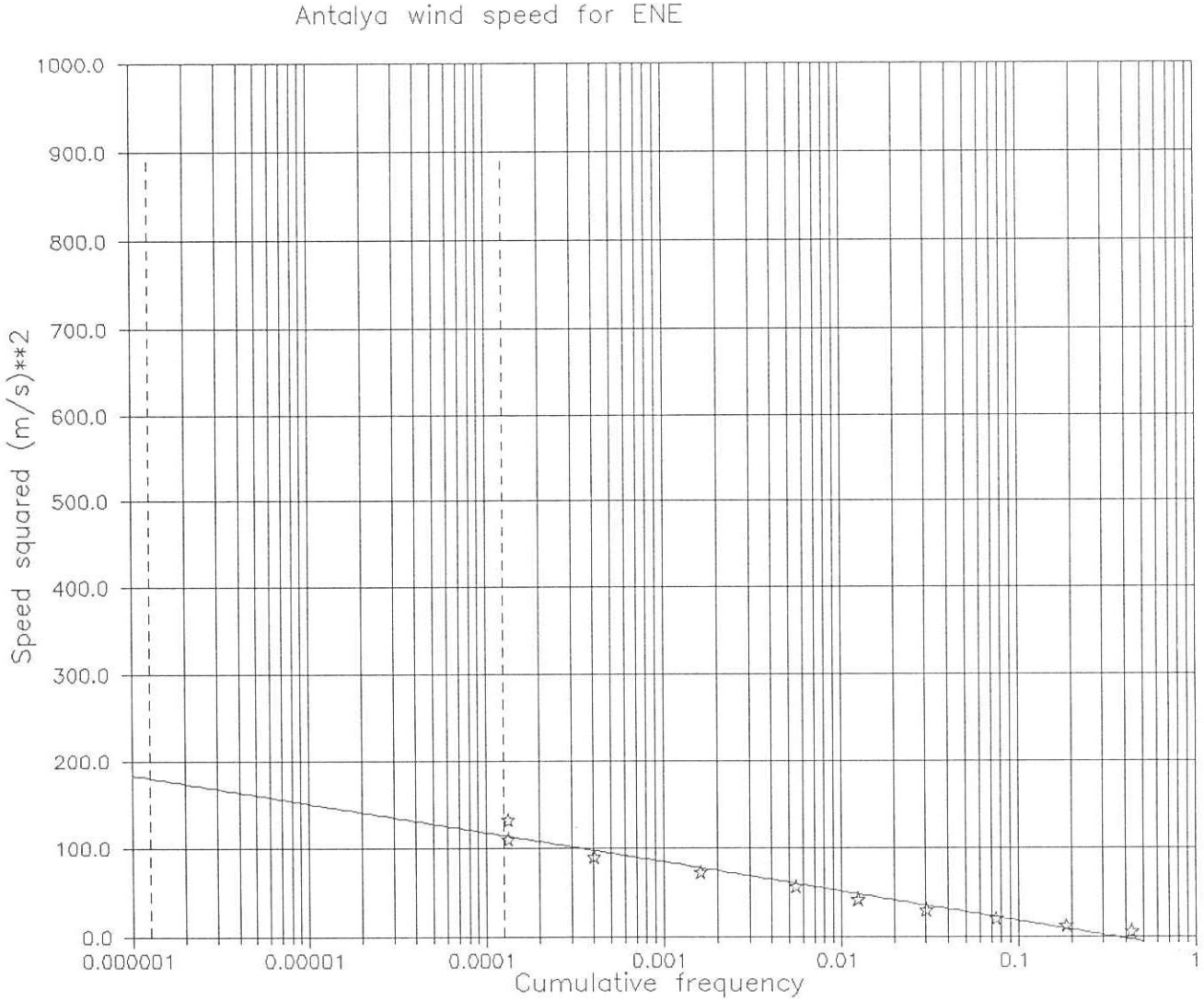

Fig.A-4. Cumulative frequency plot of Wind for ENE.

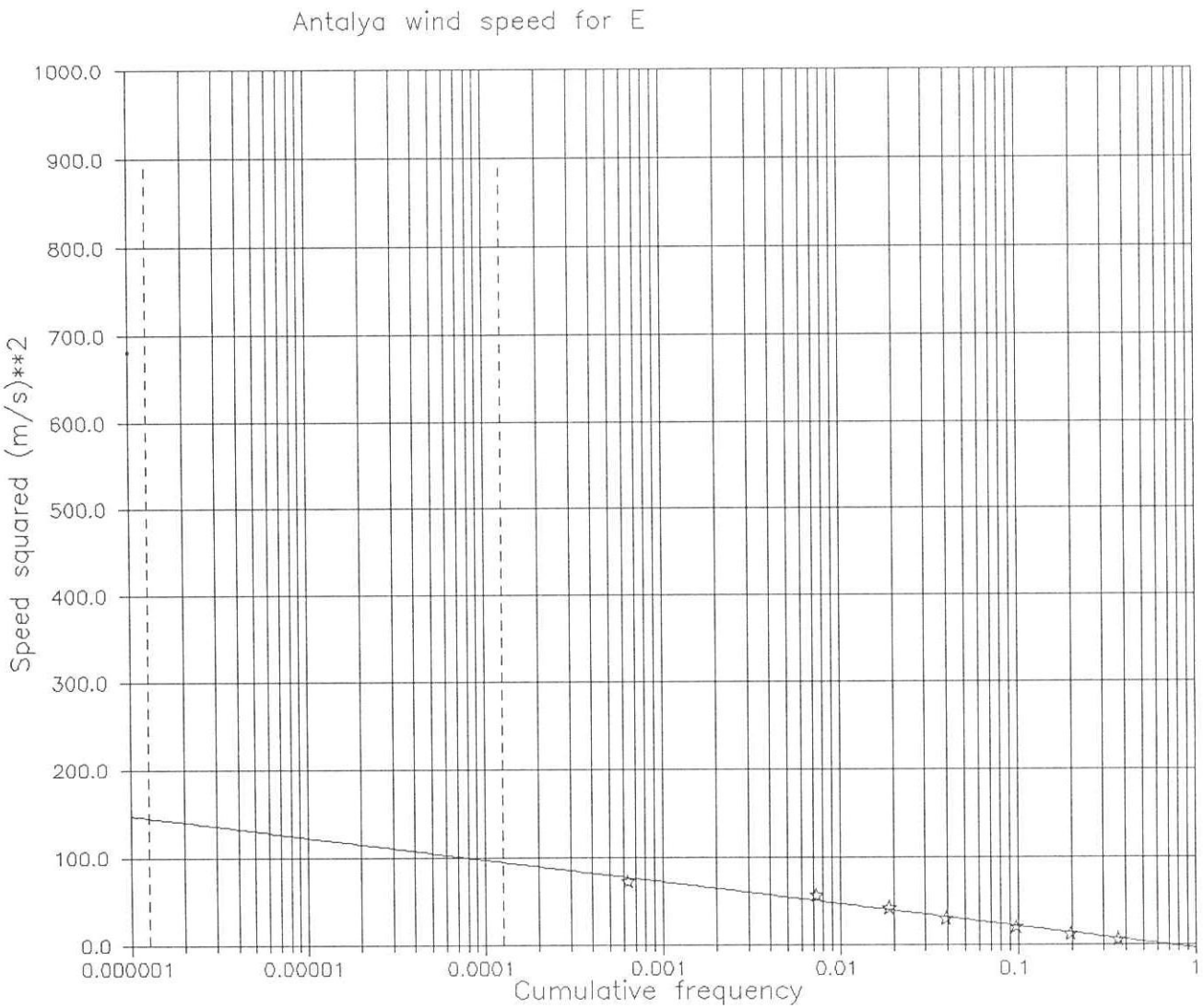

Fig.A-5. Cumulative frequency plot of Wind for E.

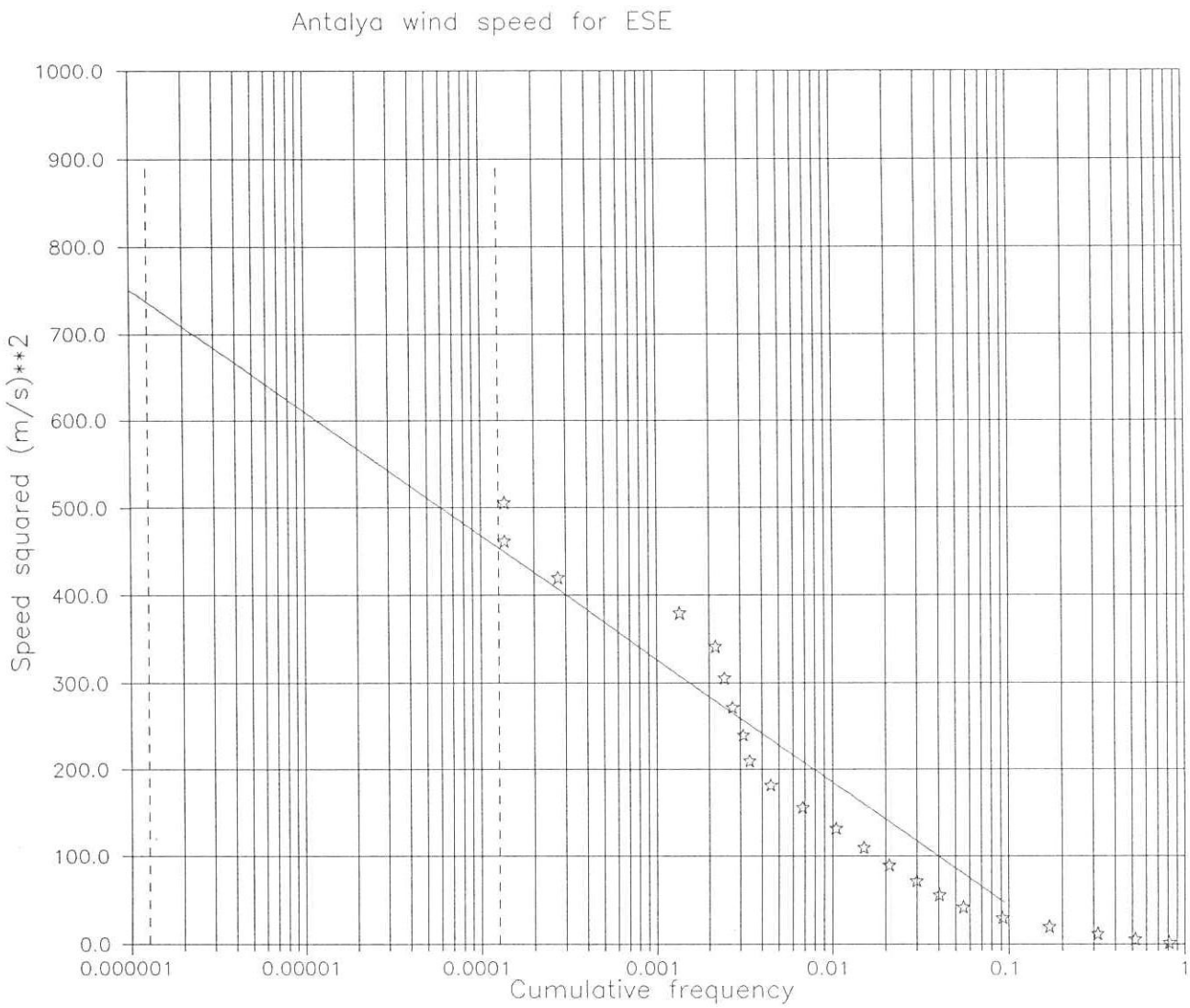

Fig.A-6. Cumulative frequency plot of Wind for ESE.

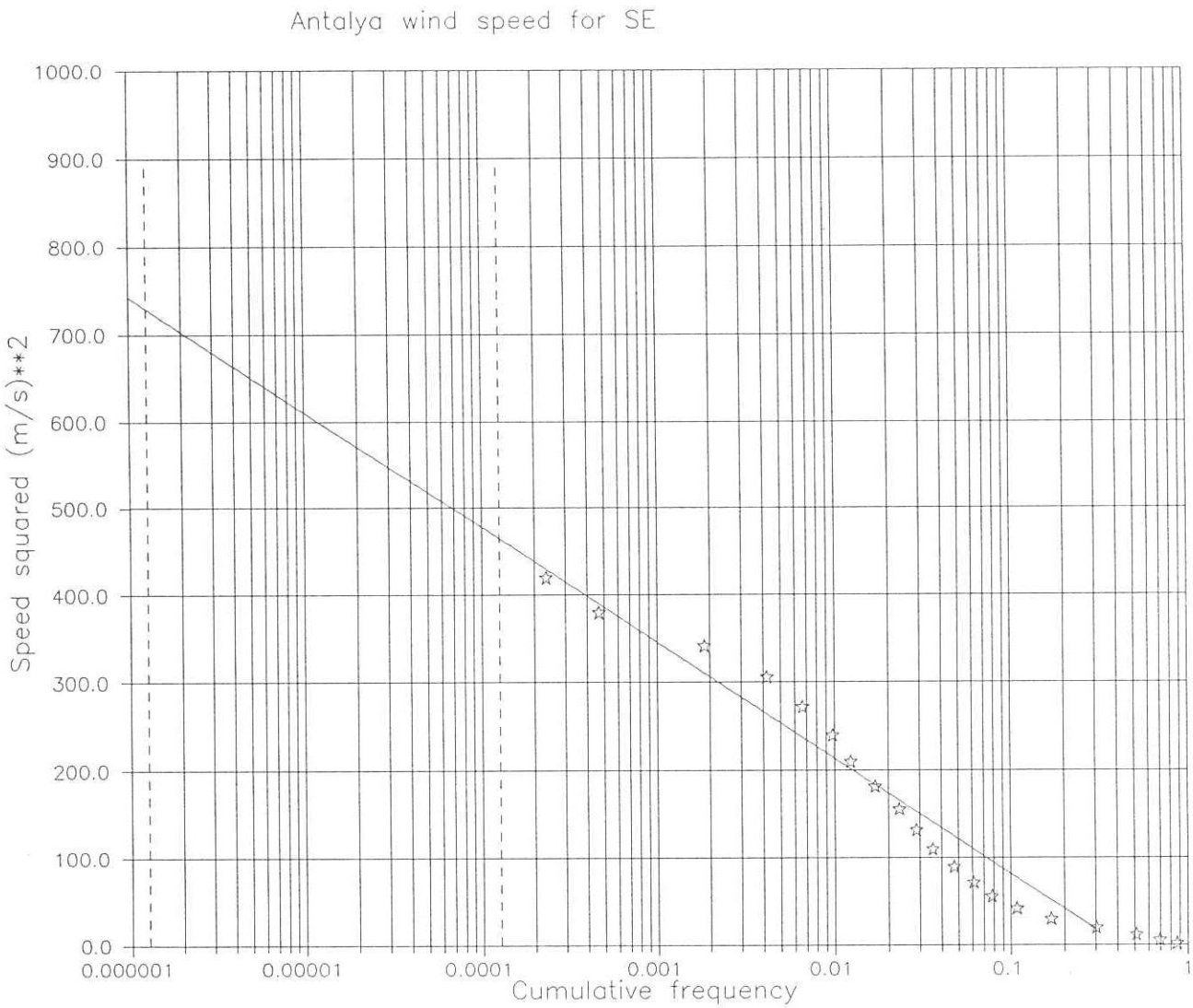

Fig.A-7. Cumulative frequency plot of Wind for SE.

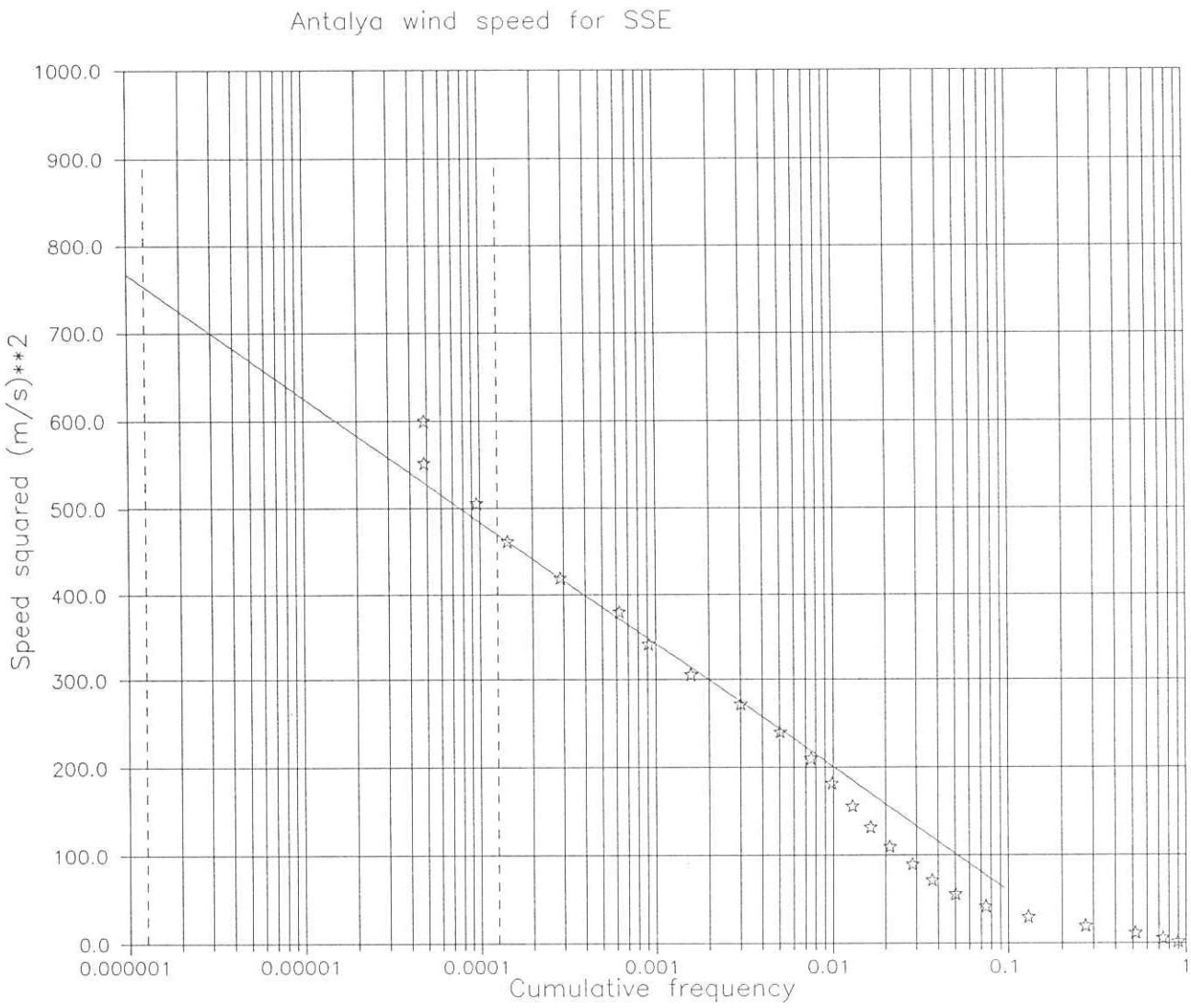

Fig.A-8. Cumulative frequency plot of Wind for SSE.

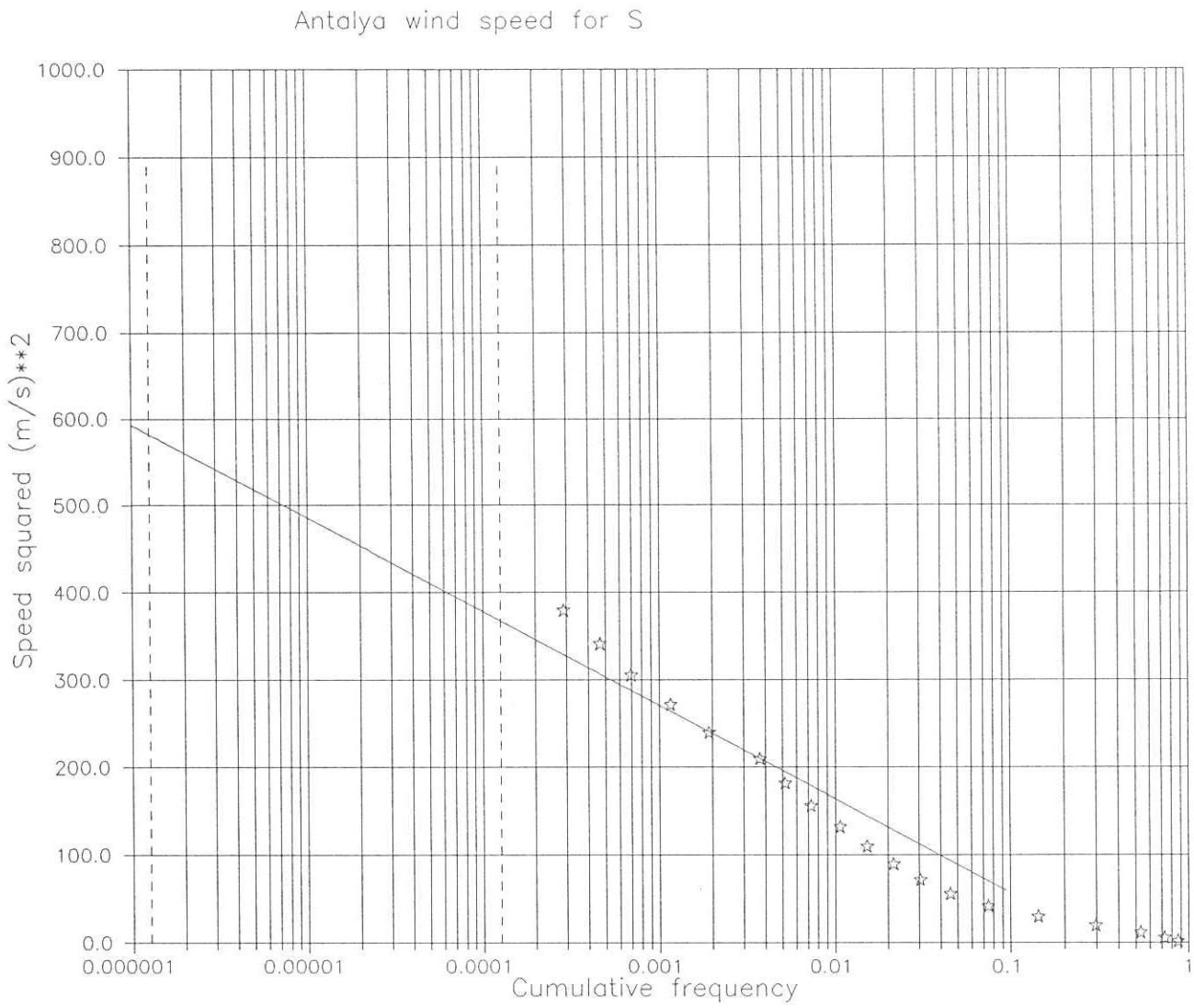

Fig.A-9. Cumulative frequency plot of Wind for S.

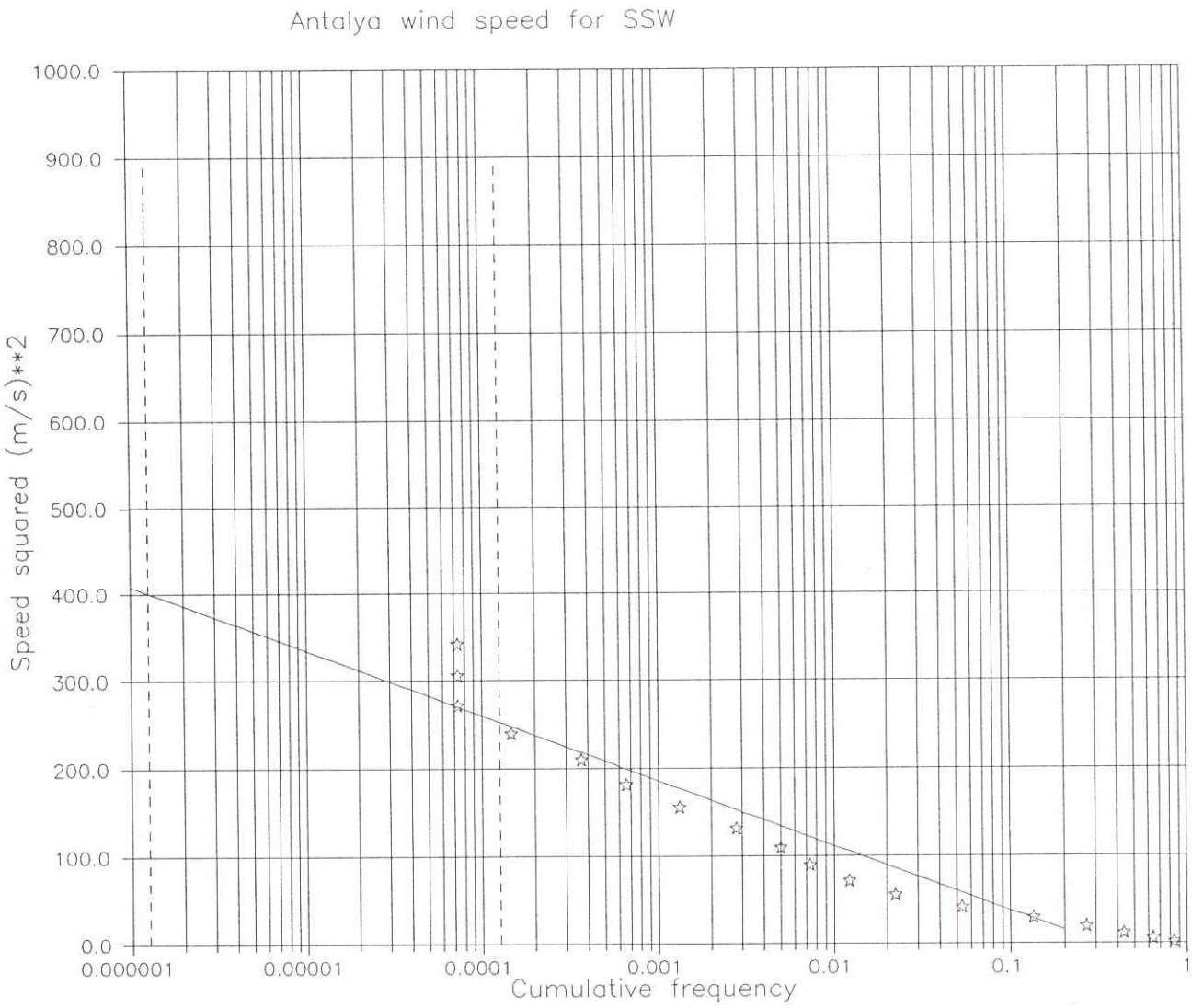

Fig.A-10. Cumulative frequency plot of Wind for SSW.

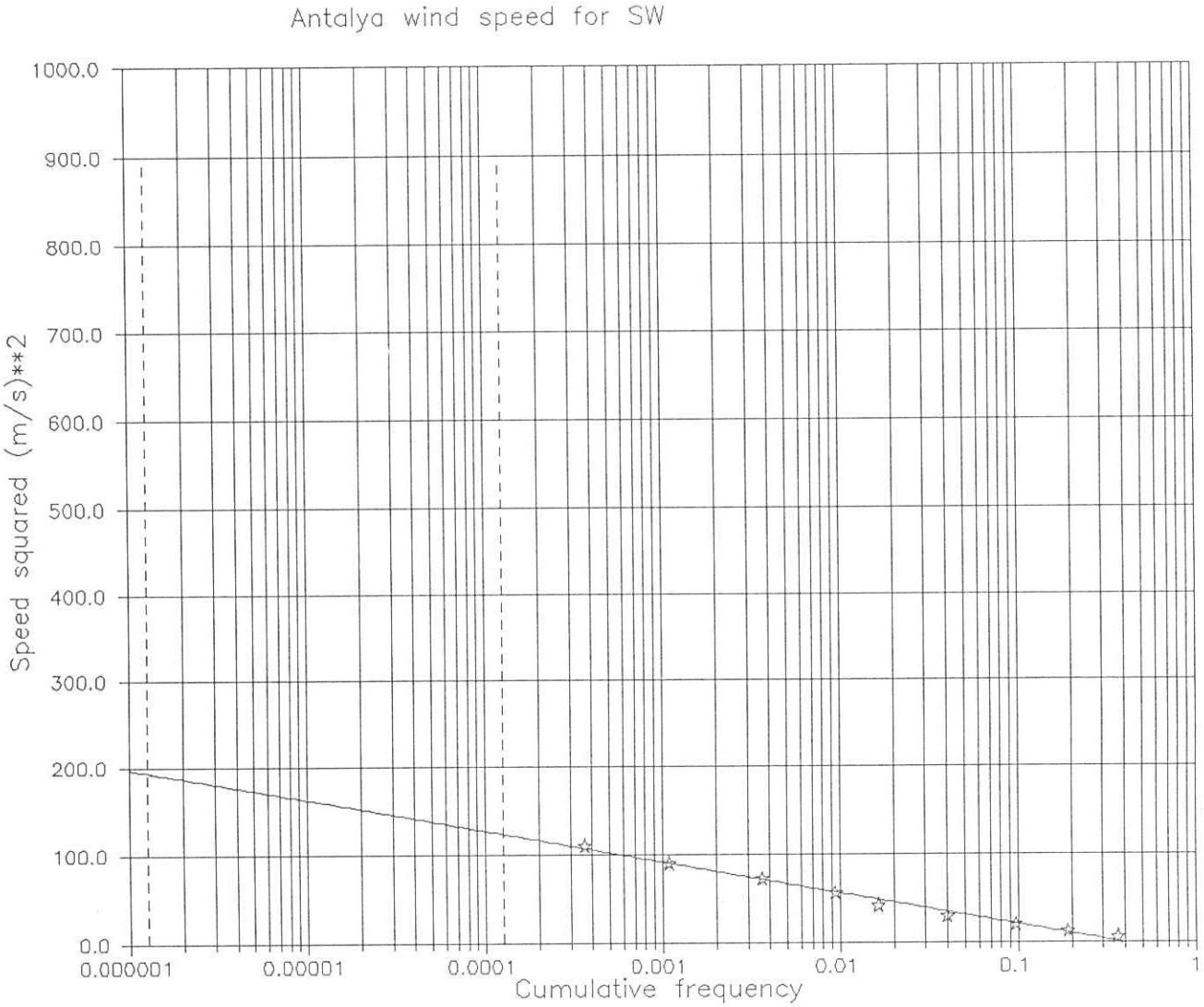

Fig.A-11. Cumulative frequency plot of Wind for SW.

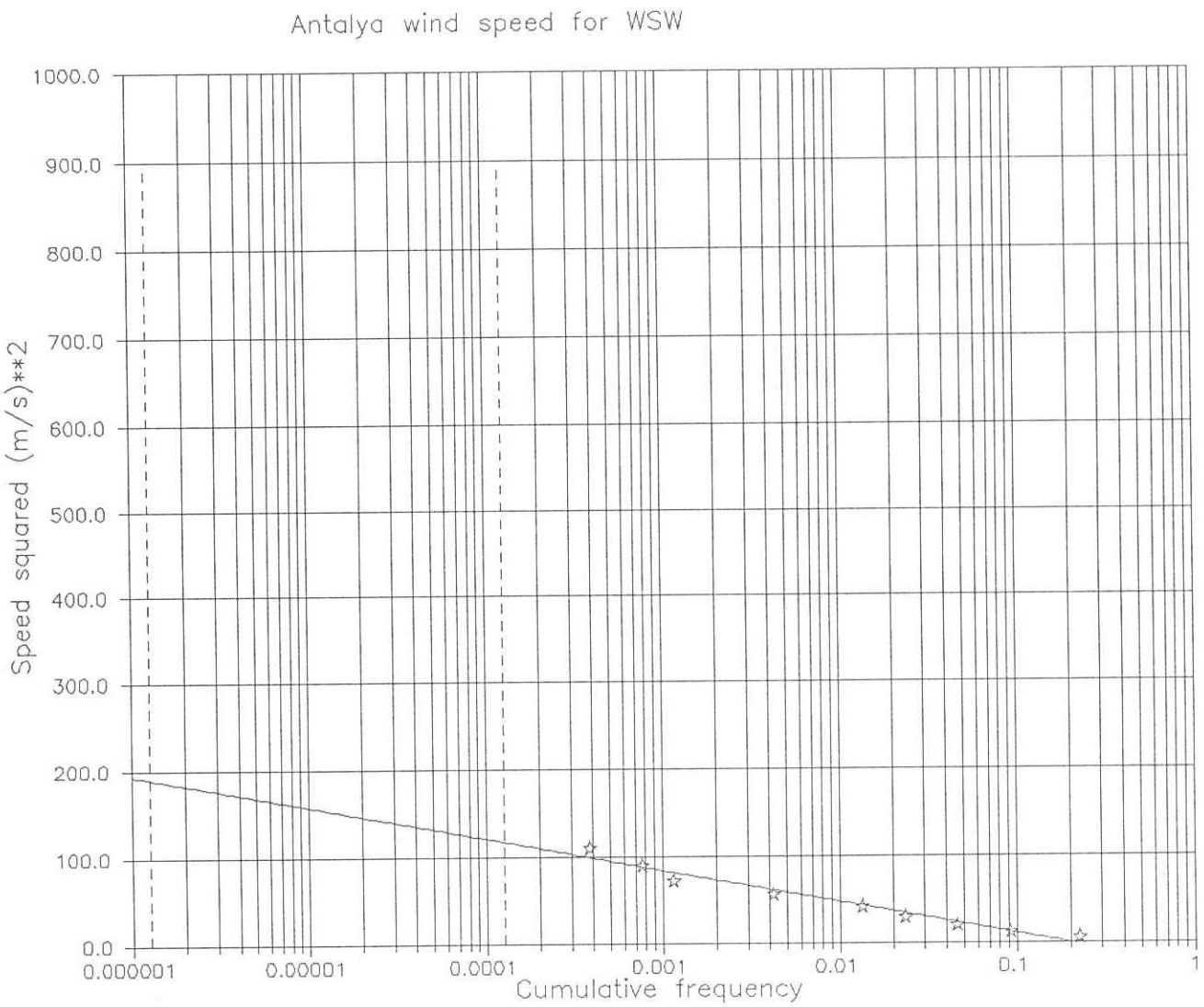

Fig.A-12. Cumulative frequency plot of Wind for WSW.

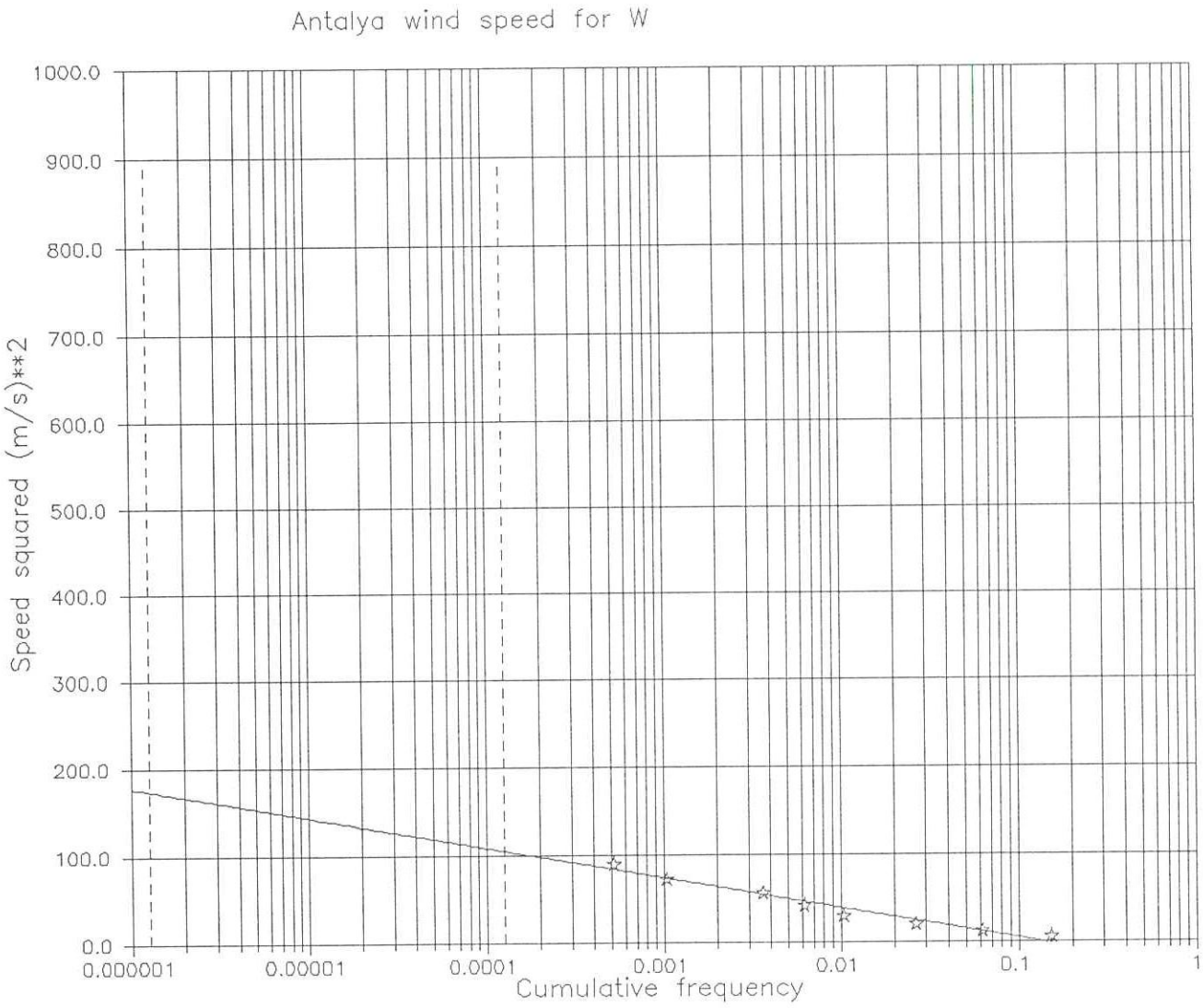

Fig.A-13. Cumulative frequency plot of Wind for W.

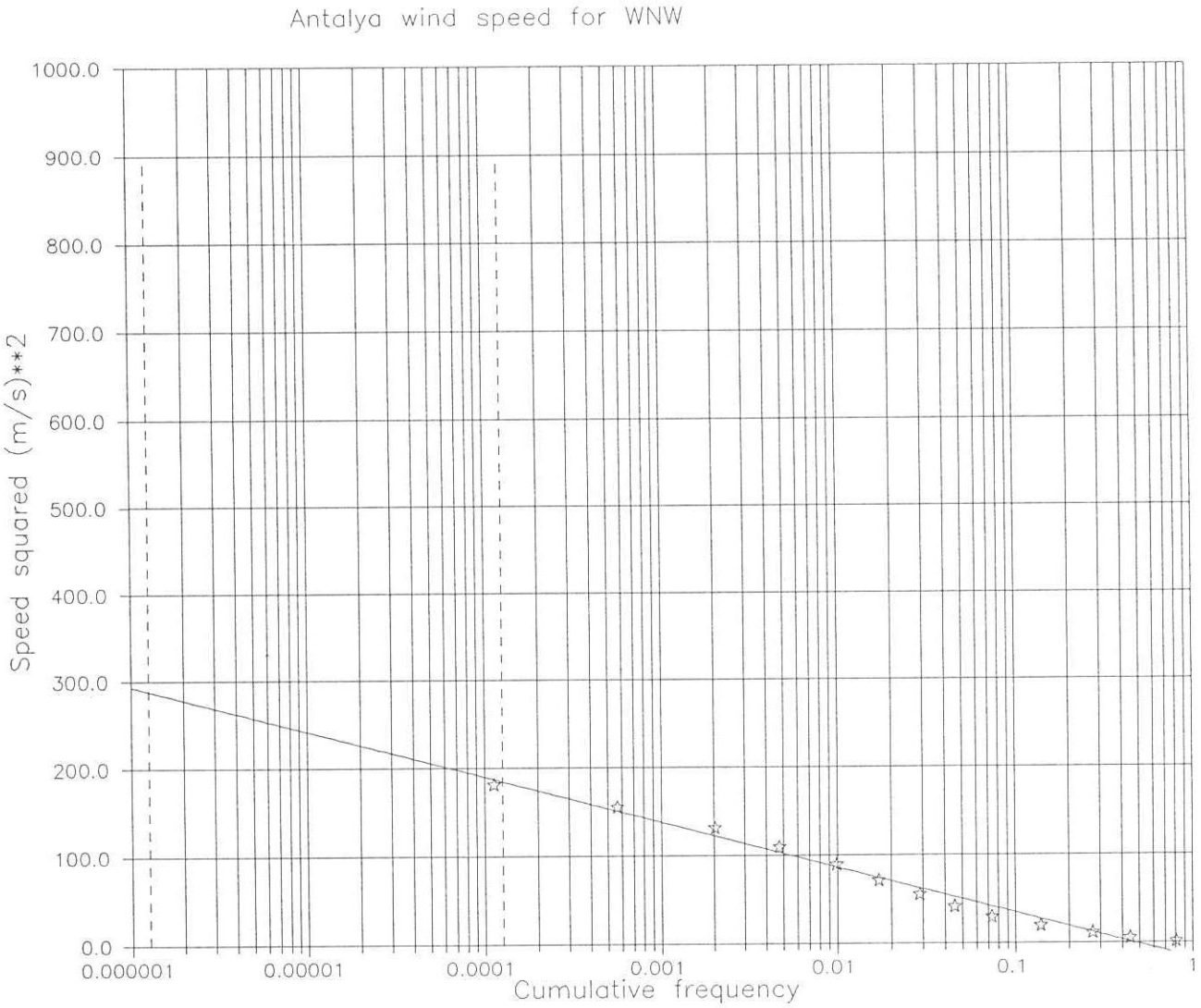

Fig.A-14. Cumulative frequency plot of Wind for WNW.

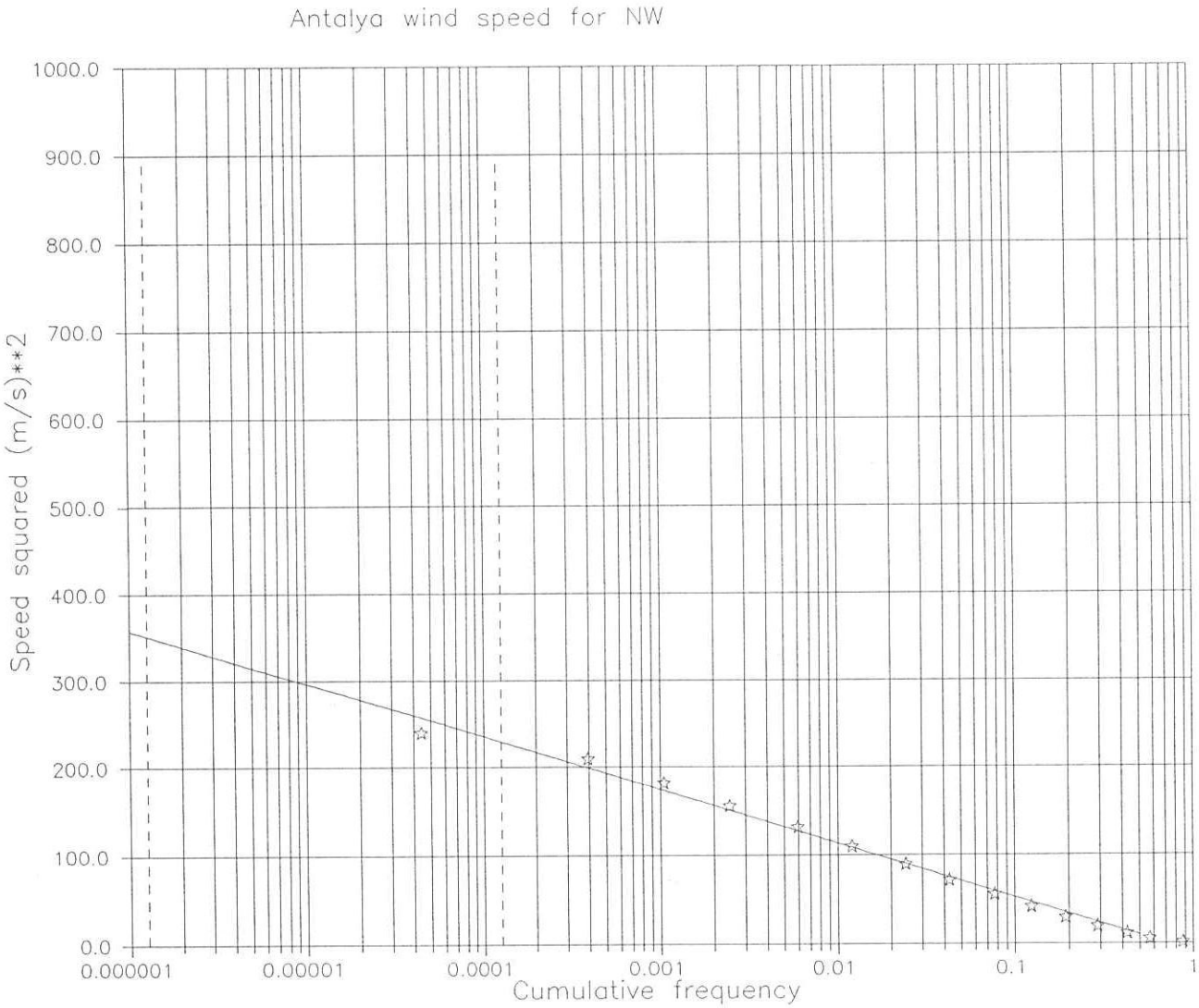

Fig.A-15. Cumulative frequency plot of Wind for NW.

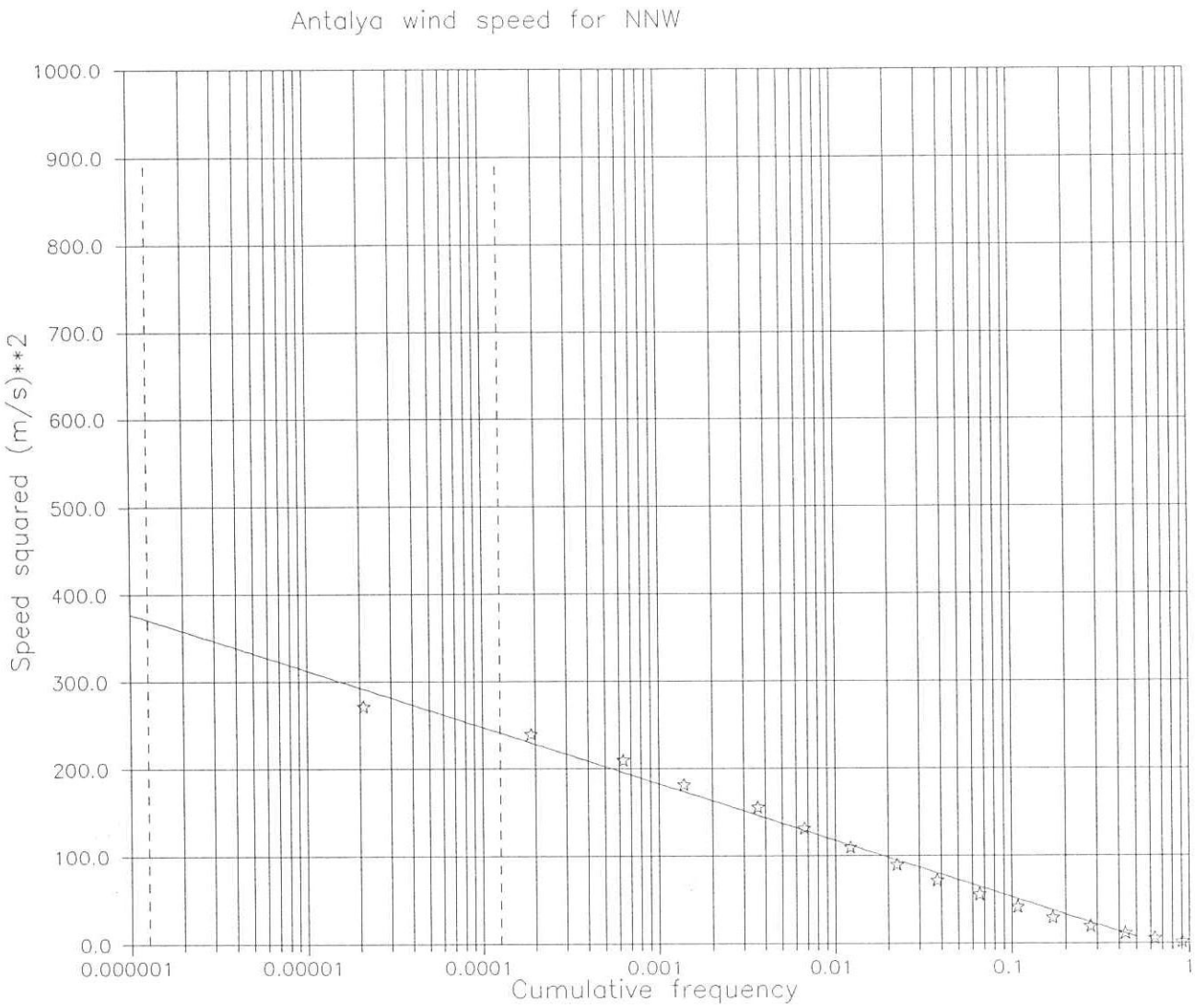

Fig.A-16. Cumulative frequency plot of Wind for NNW.

WAVES: CUMULATIVE FREQUENCY DATA
Hs and Hmax.

Hs data for: South

Height group (m)		Average H (m)	Obsrv.	Cum.obsv.	Cum.frq.
3.00	3.50	3.25	0	0	.0000000
2.50	3.00	2.75	1	1	.0022472
2.00	2.50	2.25	3	4	.0089888
1.50	2.00	1.75	10	14	.0314607
1.00	1.50	1.25	42	56	.1258427
.50	1.00	.75	105	161	.3617977
.00	.50	.25	284	445	1.0000000

Hs data for: Southwest

Height group (m)		Average H (m)	Obsrv.	Cum.obsv.	Cum.frq.
4.00	4.50	4.25	0	0	.0000000
3.50	4.00	3.75	1	1	.0004255
3.00	3.50	3.25	9	10	.0042553
2.50	3.00	2.75	13	23	.0097872
2.00	2.50	2.25	27	50	.0212766
1.50	2.00	1.75	60	110	.0468085
1.00	1.50	1.25	159	269	.1144681
.50	1.00	.75	604	873	.3714894
.00	.50	.25	1477	2350	1.0000000

Hs data for: West.

Height group (m)		Average H (m)	Obsrv.	Cum.obsv.	Cum.frq.
1.50	2.00	1.75	0	0	.0000000
1.00	1.50	1.25	16	16	.0919540
.50	1.00	.75	91	107	.6149426
.00	.50	.25	67	174	1.0000000

Hmax data for: ALL

Height group (m)		Average H (m)	Obsrv.	Cum.obsv.	Cum.frq.
5.50	6.00	5.75	1	1	.0006494
5.00	5.50	5.25	6	7	.0045455
4.50	5.00	4.75	11	18	.0116883
4.00	4.50	4.25	3	21	.0136364
3.50	4.00	3.75	16	37	.0240260
3.00	3.50	3.25	17	54	.0350649
2.50	3.00	2.75	45	99	.0642857
2.00	2.50	2.25	69	168	.1090909
1.50	2.00	1.75	140	308	.2000000
1.00	1.50	1.25	324	632	.4103896
.50	1.00	.75	500	1132	.7350649
.00	.50	.25	408	1540	1.0000000

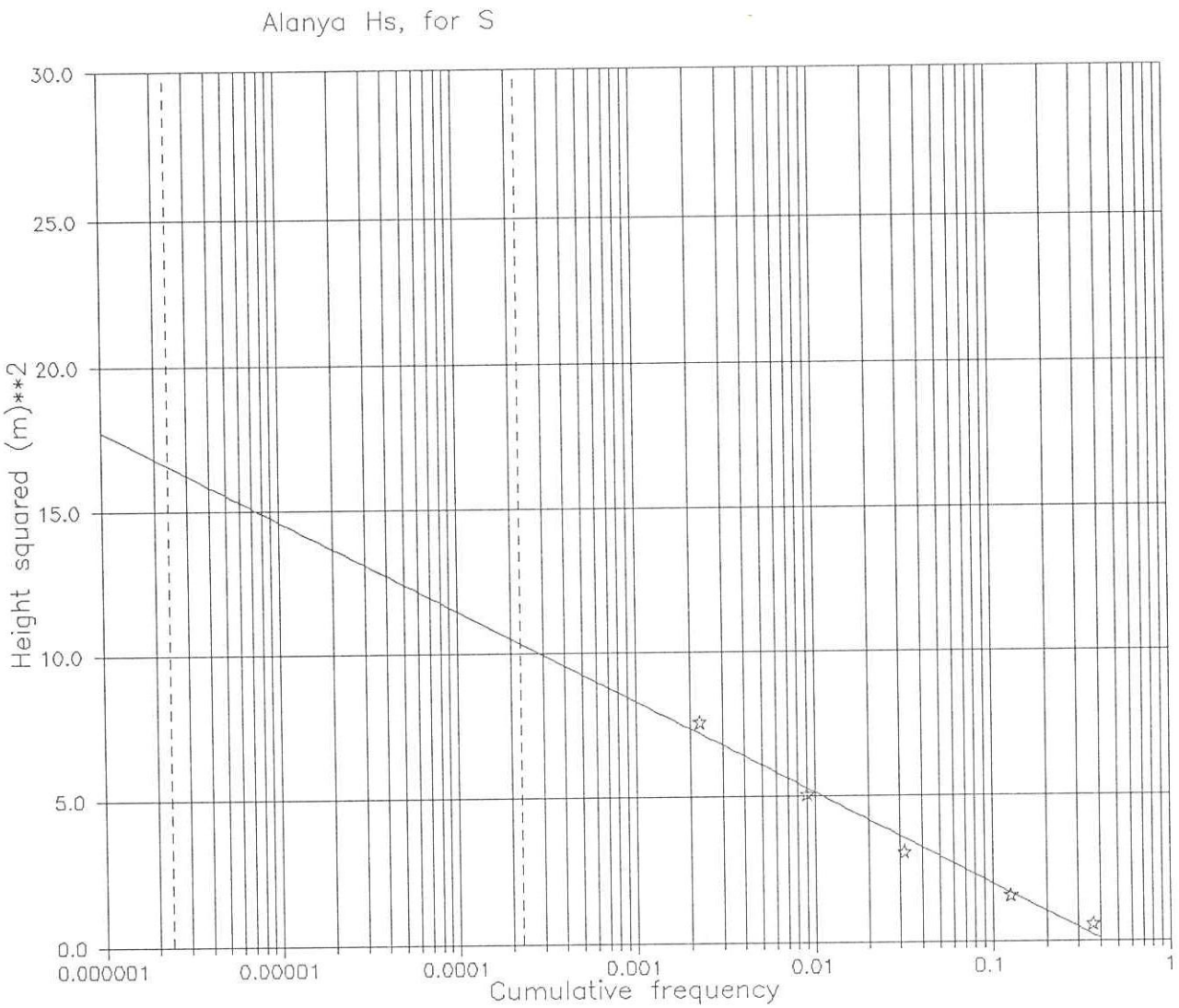

Fig.A-17. Cumulative frequency plot of Hs for S.

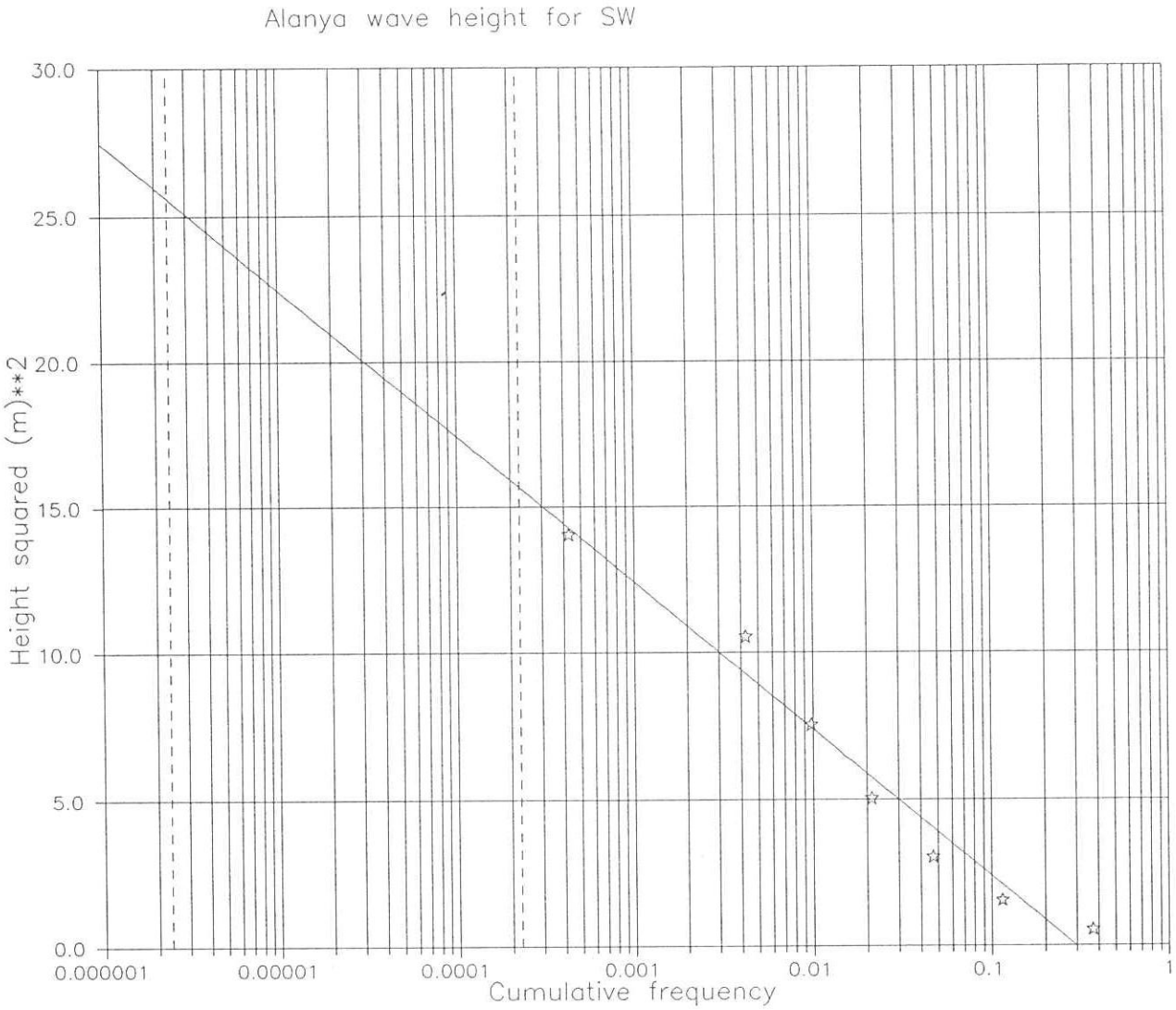

Fig.A-18. Cumulative frequency plot of Hs for SW.

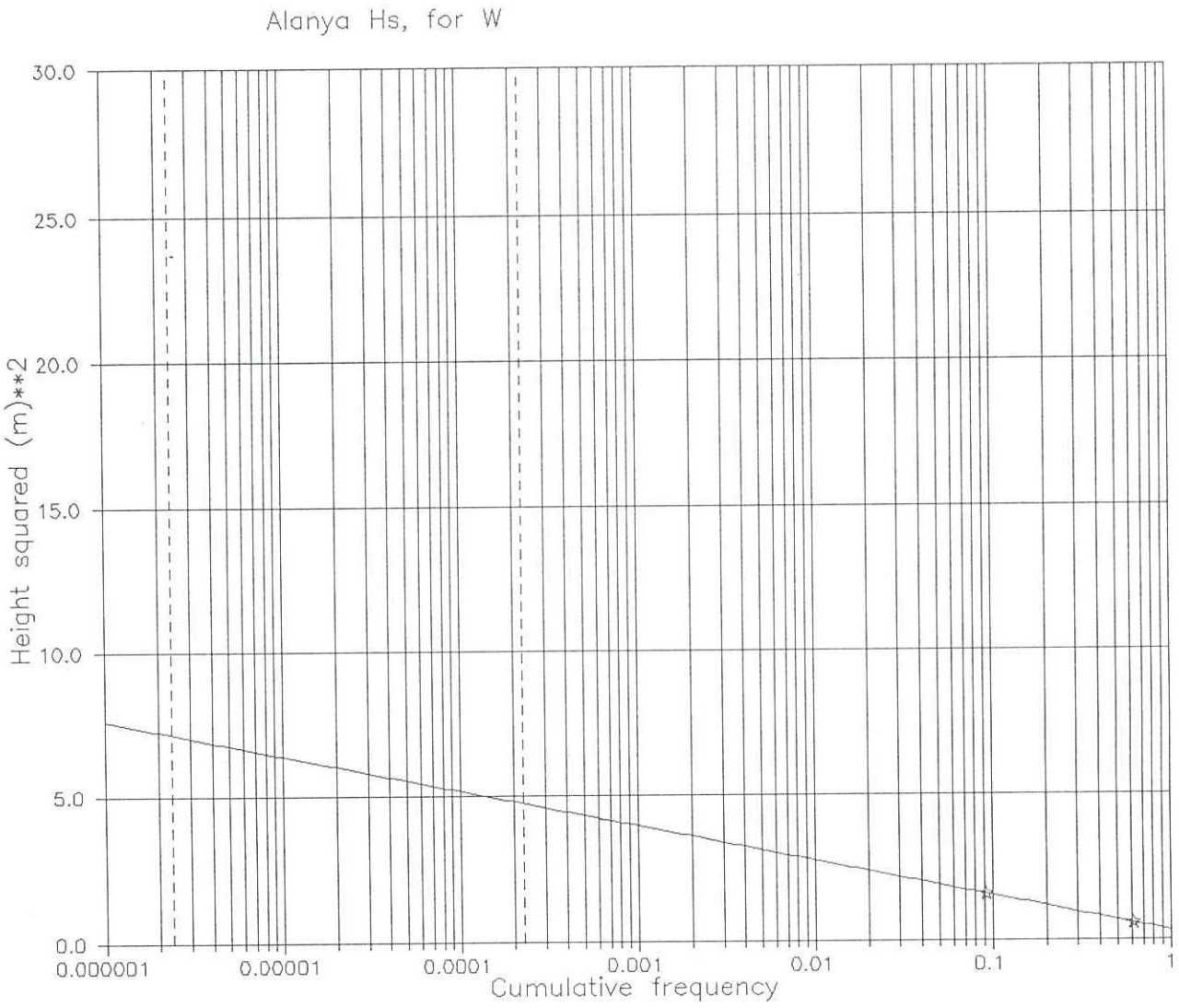

Fig.A-19. Cumulative frequency plot of Hs for W.

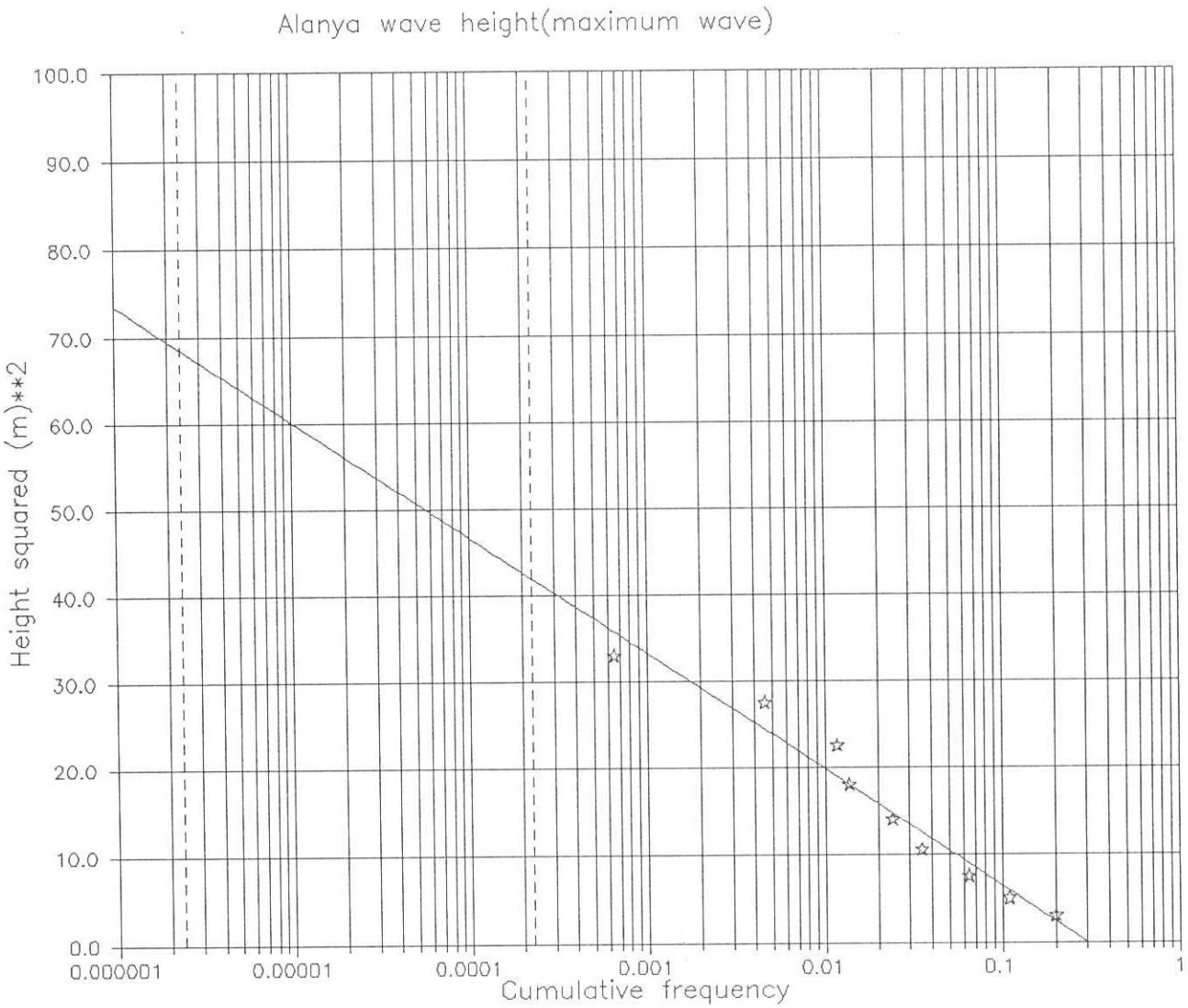

Fig.A-20. Cumulative frequency plot of Hmax for ALL.