KONINKLIJK NEDERLANDS
METEOROLOGISCH INSTITUUT

TECHNISCHE RAPPORTEN

T.R. - 11

E.Bouws, G.J.Komen, R.A. van Moerkerken,
H.H.Peeck and M.J.M.Saraber.

An evaluation of the KNMI operational wave model GONO for the period October 1980 - April 1981

De Bilt, 1982

Publicationnumber: K.N.M.I. T.R. - 11 (OO/CWD)

Koninklijk Nederlands Meteorologisch Instituut,
Oceanografisch Onderzoek,
Centrale Weerdienst,
Postbus 201,
3730 AE De Bilt,
Nederland.

U.D.C.: 551.466.33

AN EVALUATION OF THE KNMI OPERATIONAL WAVE MODEL GONO FOR THE PERIOD OCTOBER 1980 - APRIL 1981.

E. BOUWS, G.J. KOMEN, R.A. VAN MOERKERKEN,
H.H. PEECK AND M.J.M. SARABER.

Abstract : Results of the KNMI wave model GONO on wave height, low frequency wave height, wind speed and wind direction are compared with observations. The comparison is made for the period October 1980 until April 1981 for three different locations in the southern North Sea and for two northerly stations.

Note : The time series mentioned in this report are contained in a separate Supplement, which is available from the KNMI library on request.

1. INTRODUCTION

The operational wave model GONO is designed for the prediction of wind sea and swell. In order to monitor the over-all quality of the model, the results are compared with observational data for five different locations in the North Sea. This evaluation program started in December 1979. During the first half year of the evaluation the results were also compared with the operational UK Met. Office wave model.

The results of that comparison are described elsewhere (Bouws, et al, 1980). In this report the results over the period October 1980 until April 1981 are presented. The model results were compared with observational data at the following locations:

				depth
0	EURO	51°59'N	3°30'E	20 m
1	IJMUIDEN	52°34'N	4°04'E	25 m
2	PENNZOIL	53°13'N	3°13'E	22 m
3	EKOFISK	56°33'N	3°13'E	60 m
4	OWS MIKE	66°00'N	2°00'E	> 200 m

Wave data were obtained by means of waverider measurements, with the exception of OWS MIKE which are visual estimates. The data from EURO and PENNZOIL were collected by Rijkswaterstaat, Directie Noordzee; the IJMUIDEN data have been taken with the KNMI waverider. The evaluation concentrates on the significant wave height H_S and the low frequency energy. The sifnificant wave height is defined as:

$$H_S = 4 \left[\int_0^\infty E(f).df \right]^{\frac{1}{2}}$$

where E(f) is the variance spectrum whose integral over all positive frequencies f gives the mean square surface displacement. For the evaluation of the low frequency part of the spectrum a "low" frequency

wave height $H_{S,10}$ was introduced, defined as:

$$H_{S,10} = 4 \left[\int_{0}^{0.1} E(f).df \right]^{\frac{1}{2}}$$

Also a quantity E_{10} is used as a measure of the low frequency energy (wave period > 10 sec.). Its relation to $H_{S,10}$ is:

$$E_{10} = \left[\tfrac{1}{4} H_{S,10} \right]^2$$

The atmospheric input of the model plays an essential role. Therefore also a comparison of calculated and measured wind speeds and directions was made. Wind data for EURO were taken from the nearby light platform GOEREE or, if missing, from Hook of Holland.

At the end of February a new version of the GONO model became operational. In this version some minor programming errors were corrected, improving the calculation of the energy spectra for selected points.

2. OBSERVATIONAL DATA.

The comparison of the model results requires a uniform quality of observational data. This requirement cannot be fully met. In an earlier report (Bouws, et al, 1980) the problem of non-uniform quality of the observational data is discussed in extenso. We will here refer to the conclusions from that report, namely

- Wind speeds have been observed under very different conditions. Therefore comparison of wind data must be carried out with sufficient caution.
- Wave data from the station EURO, IJMUIDEN en PENNZOIL are of good quality. For the measurements at location EKOFISK data from AUK or EKOFISK were used. However, these data are not complete. The visual estimates of wave heights at location OWS MIKE seem of poor quality during the periods that the "POLAR FRONT" was at station.

3. TIME SERIES

In this section a qualitative description of the main features of the time series are given. This time series can be found in the Supplement of this report; this contains plots of H_S, $H_{S,10}$ and wind of the model analysis, +12 hour forecast and +24 hour forecast together with observational data, for the five selected locations. In the discussion we will concentrate on a comparison of calculations starting from the analysed weather data. Deviations in the forecasts are obvious and are not commented on as a rule.

OCTOBER 1980 (See Supplement, Figs. 1-5)

01-03

The first few days of October GONO behaves quite well for both the southern and the northern stations. On the 2nd EKOFISK shows a steep rise in wave height up to 6 m.

05-09

On the 5th winds begin to increase, reaching 19 m/s on the 8th. This westerly gale generates waves of 4-5 metres at the southern stations. For these southern locations GONO overpredicted the wave heights, in particular $H_{S,10}$ on the 7th. At this date at the location EKOFISK H_S increases to more than 6 m; then it falls off sharply to 3.5 m. This steep decrease in wave height was followed too slowly by GONO.

09-14

During this period there was some swell. $H_{S,10}$ was about 0.5 m at the southern locations and greater than 1 m at EKOFISK. The source of this swell probably is a northerly gale north of Iceland on the 7th and 8th October.

16-21

The 16th shows a peak in the wind sea, which is described well by the model. On the 18th GONO shows a wind speed for the locations EURO and PENNZOIL which is too high; 15 m/s instead of an observed wind speed of 12 m/s. The wind direction was northwest. GONO describes the wave heights at the southern stations quite well (observed H_S of about 3-5 m), except on the 18th at EURO when GONO overpredicted H_S. On the 17th about 0000 GMT GONO yields a wind sea which is too low: 4 m instead of the observed 6 m. This probably is due to the wind speed: GONO calculated 13.4 m/s whereas the observed wind speed was 16 m/s. On the 18th at 1800 GMT GONO predicts waves of 7 m whereas only 5.5 m is observed. In this case GONO overpredicts the wind by a factor of 2.

23-28

On the 23rd at EURO there is a wind-sea peak of 1.5 m. GONO calculates 2.0 m and a correct wind. PENNZOIL showes a good agreement between observations and calculations. Later, wave heights of 1.5-3.5 m are observed at the southern stations, which are overestimated by GONO by 0.5-1.0 m, whereas the GONO-winds are correct. At EKOFISK GONO underestimates the swell (observed $H_{S,10}$ is about 2 m). On the 24th GONO shows a small peak in $H_{S,10}$ at the southern locations which has not been observed. On the 26th, swell originating from a northerly storm (EKOFISK gives H_S greater than 4 m), is correctly calculated by GONO at EURO and almost correctly at PENNZOIL. From the 26th until 28th waves of 1.5-2.0 m are observed at EURO, whereas the model is 0.5-1.0 m too high, which is probably caused by too high wind speeds. On the 27th GONO yields correct winds at PENNZOIL but the wave height H_S is too high. At MIKE there is a good agreement between GONO and observations.

28-31

During this period northwesterly winds in the central North Sea generate waves of 2.5-3.0 m at the southern stations. The wind speeds are calculated reasonably well, but H_S is overestimated by 0.5-1.0 m. On the 29th GONO overpredicts winds by 5 m/s at EKOFISK, which results in too high waves. Later the wind decreases sharply and this is in better agreement with observations. At MIKE the agreement is good.

NOVEMBER 1980 (See Supplement, Figs. 6-10).

For the location IJMUIDEN no wave measurements are available during this month.

01-03

For EURO and PENNZOIL the model behaves reasonably well. On the 1st the wave height at EKOFISK is 4.4 m which is followed quite well by GONO. At MIKE GONO predicts a wave height of 7.5 m at the 2nd whereas about 10 m is observed.

04-08

On the 6th the southern stations show wave heights of 3-4 m which are analysed well by the model; also the decrease in wave height is followed reasonably well. GONO gives a good description of the peak on the 6th. At EKOFISK H_S is good, except on the 5th where GONO underestimates H_S by 0.5-1.0 m. At MIKE on the 4th GONO is about 2 m too low compared with a wave height of 2.5-3.5 m.

08-13

At the southern stations at the 10th the peak is described very well by GONO. On the 11th and 12th the model is about 1 m too high at EURO and 0.5-1.0 m too high at PENNZOIL. On the 9th GONO performs quite well at

EKOFISK which shows a wave height of 4.7 m. GONO shows the peak in $H_{S,10}$ about 6 hours later than the observations.

14-20

During this period GONO overestimates the wave heights at EURO, especially on the 17th and 18th when the model is 1.0-1.5 m too high. The observed wave height is 1.5-3.5 m. For PENNZOIL the model behaves better. At EKOFISK the swell-peaks on the 14th and 19th are well described, but the fall-off on the 20th is not so good.

28-30

For the southern stations GONO behaves well, especially the peak on the 29th is followed well. (At PENNZOIL H_S is about 4.8 m). At EKOFISK the observed wave heights are about 4.5 m. For this station the model is less good than for the southern stations.

DECEMBER 1980 (See Supplement, Figs. 11-15).

2-8

At the southern locations the winds are northwest and generate wave heights of 3.5-5.0 metres. GONO follows reasonably well, except at EURO from 3 to 6 December and at IJMUIDEN and PENNZOIL from 5-6 December; for this case H_S is 0.5-1.0 m too high and $H_{S,10}$ is about 0.5 m too high. On December 3rd EKOFISK has an observed northerly wind of 17 m/s and a wave height of 6.7 m. GONO shows a somewhat higher wind speed (20 m/s) which results in a wave height of 7.5 m.

9-12

During this period the wind is mainly southwest with a wind speed varying between 12 and 18 m/s, resulting in wave heights of 2-3 m at the southern locations. The model analyses the wind speed 3-5 m/s too high, resulting in wave heights that are about 1 m too high. Also at EURO the

model wind is veered 20-30 degrees compared with the observed wind direction. At EKOFISK on December 9 the wind is westsouthwest and the wind speed is 15 m/s resulting in a wave height of 4.8 m. The model predicts well, only $H_{S,10}$ is too high.

12-15

At the southern stations the dominating wind direction is southwest, the wind speeds vary between 10 and 17 m/s, the wave heights between 2 and 3 m. At EURO and IJMUIDEN GONO overestimates the wave heights by 0.5-1.5 m whereas $H_{S,10}$ is 0.5-1.0 m too high. This is due to veering of the model wind; also wind speeds are about 1-3 m/s too high compared with observations. At PENNZOIL the model behaves better, however, also for this location the wind speeds and wave heights are too high.

17-18

On the 17th southwesterly wind dominates at the southern stations with wind speeds of 11-16 m/s and wave heights between 2.5-4.0 m. The model analyses wind speeds that are more than 5 m/s too high. At EKOFISK on the 17th the observed wind speed is 15 m/s and the wave height at the peak is 4 m. GONO gives a wind speed of 18 m/s and a wave height of 5.7 m.

19-20

During this period the southern stations show southeasterly winds with speeds of 10-14 m/s and wave heights between 1.5 and 3.7 m. GONO shows wind speeds of 10-20 m/s resulting in wave heights of 2.5-4.5 m.

23-25

On the 23rd at the southern stations the wind speeds are about 13 m/s and the wave heights 1-2 m. At EURO and IJMUIDEN the model wind is veered about 20 degrees. GONO predicts waves which are about 1 m too high. On the

24th GONO overestimates the wind speed by 1-2 m/s and the wave heights by 1 m. At EKOFISK on the 23rd the wind increases to 19 m/s and the wave height to 5.0 m. GONO follows well, except at 1800 GMT where H_S is 3.6 m and $H_{S,10}$ 2.5 m too low. On the 25th the model underestimates the wave height by about 0.5 m.

28-31

At the southern stations between the 28th and the 30th GONO overpredicts the wind speeds by 1-3 m/s and H_S by about 1 m; the observed wave height is 1-2 m. On December 31st the model analyses wind and waves very poorly. GONO gives a wind speed of 3-5 m/s and wave heights of 1.5-2.0 m too high. The actual wind speed is 12-16 m/s and H_S is 2-3 m. The wind directions of the model are veered about 20 degrees, however, for PENNZOIL GONO gives the right wind direction. At EKOFISK the model results are much better.

JANUARY 1981 (See Supplement, Figs. 16-20).

During this month the southern stations showed similar behaviour.

2-5 and 13-18

During this period wave heights of about 4 m occurred. GONO overestimated both H_S and $H_{S,10}$. The reason for this overestimation is the wind speed which in the model was high; the error was about 1-1.5 m/s for a maximum observed wind speed of 17 m/s.

11 and 26

On these two days swell occurred, which was also calculated by the model. However, the agreement with observations was better for PENNZOIL than for EURO; at the latter location the swell was overestimated.

EKOFISK

At EKOFISK wave heights of about 8 metres were observed during the first days of January. The model showed waves of about 10 m, which was due to the model wind speed which was about 5-10 m/s too high at that time. The same situation occurred in the period 14-18 January. The maximum observed wind speed was 16 m/s whereas the calculated wind speed was about 2-5 m/s too high. The remaining days showed observed wave heights of 2-5 m, which were reasonably well calculated.

MIKE

Until the 10th the "CUMULUS" was on location of OWS MIKE, during which period H_S was reasonably well calculated by the model. After the 10th when the "POLAR FRONT" took station, the agreement was worse.

FEBRUARY 1981 (See Supplement, Figs. 21-25).

On the 25th a new version of the GONO model became operational. The remaining days no GONO-data were available for verification . During the whole period the wind of GOEREE was used at the EURO location.

Southern stations

These stations show the same model characteristics in both wind and wave height.

2-8 and 10-13

During these periods model winds were about 1-2 m/s too high and the wave heights were 1-2 m too high. In particular for the locations EURO and IJMUIDEN winds were calculated which were veered about 20-30 degrees relative to the observed wind. Also the calculated swell height $H_{S,10}$ was systematically too high, about 0.5-1.0 m.

17-24

During this period model results were in reasonably good agreement with measurements.

EKOFISK

01-15

For the location EKOFISK the model results were in good agreement with observations, although sometimes the winds seemed somewhat too strong.

16-24

In this period both H_S and $H_{S,10}$ were too low.

MARCH 1981 (See Supplement, Figs. 26-30).

In general during this month the quality of the GONO-model is rather poor for locations EURO and IJMUIDEN and reasonable for PENNZOIL and EKOFISK.

Southern stations

7-11

For both EURO and IJMUIDEN calculated H_S is much too high, for PENNZOIL the results were less bad. The observed H_S was about 2 m, calculated were values of about 4 m. GONO also showed swell at EURO with $H_{S,10}$ about 1 m, however, no swell was observed. At IJMUIDEN and PENNZOIL some swell was observed but also overestimated by the model. An explanation for this might be that the observed wind direction was southwest, i.e. practically along the coastline. The calculated winds were much more veered and also too strong. This results in an incorrect calculation of swell. PENNZOIL is much more offshore, therefore swell has been observed at this location.

18-28

GONO shows peaks in H_S which were much too high; measurements varied between 1-3 metres, while tops of about 4 m were calculated. The swell calculations were also systematically too high. The results for EURO were poorest and for PENNZOIL less bad than for the other locations. The calculated winds for EURO and IJMUIDEN were veered compared with observations, in particular for strong winds.

EKOFISK

For the location EKOFISK the calculation of significant wave height and swell was good, although sometimes the maximal values of H_S and $H_{S,10}$ were much too high. The calculated winds were moderate to good, except on the 18th and 28th when GONO calculated too strong winds.

APRIL 1981 (See Supplement, Figs. 31-35).

For this month there was good agreement between model data and measurements, both for wind and wave data.

Southern stations.

13-18

During this period the analysed model data were quite good, wind speed and wind direction showed good agreement with observations. Also H_S and $H_{S,10}$ were of good quality.

19-25

Also during this period the analysis was good, in particular the steep rise from 0.5 m to about 3 m in wave height was followed very well by GONO. Also the swell was calculated well by GONO. During this period the wind blew from northwest to north with a very long fetch. The swell was generated in

the area near MIKE and reached the southern North Sea between the 21st and the 25th. At first the swell calculations were good, but later, from the 23rd until 25th, the model was somewhat too high. This is probably due to the fact that the analysed wave field in the source area near MIKE was somewhat too high, because of too strong model winds.

24-29

Generally wind and waves were calculated very well, except on the 28th when H_S was too low, and on the 26th when at EURO the wave height was too low. The peak in wave height of about 3 to 4 metres which occurred on the 27th was followed very well by the model.

EKOFISK

In general both wind and waves at location EKOFISK were represented very well by GONO. However, a few peaks in wave height were analysed rather poorly which was due to too low winds. From 18-22 April the model follows the wave observations very well, but after the 22nd wave heights stayed too low, due to errors in the wind speed. The wind direction as calculated by the model during this period was good, also the turning of the wind on the 24th was represented quite well.

4. STATISTICS

Monthly summary tables are presented for statistical evaluation. A comparison will be made with the results of last year (December 1979 - April 1980). Next a description is given of the interesting features of the tables. Each table consists of: location, number of observations, average of the errors (calculated minus observed values), RMS error, SI (Scatter Index), number of cases overpredicted and number of cases underpredicted, for each position. In contrast with previous calculations, the RMS error is

calculated with respect to the average values of the errors. The scatter index is defined as the ratio of the RMS error and the average of the observations and given as a percentage. Figures 2-6 contain for each position plots of the scatter index of wind speed, H_S and $H_{S,10}$. We have treated wind speed and wind direction as independent statistical variables. The average direction is not given since it is not a meaningful quantity. For the calculation of the wind direction error, cases with a wind speed less than 10 knots are omitted. The data of OWS MIKE are not discussed in detail because of the uncertainty of the wave observations and the absence of $H_{S,10}$ data. Our main interest concerns the three southern stations: EURO, IJMUIDEN and PENNZOIL. When in a table "ANALYSIS" appears this means that analysed data are presented. There are also tables for the +12 hour and +24 hour forecasts. We shall successively discuss the wind direction, wind speed, significant wave height (H_S) and low frequency energy ($H_{S,10}$).

i. Wind direction

Last year the RMS error varied between 15-20 degrees. This value has come down to about 15 degrees. The wind direction of PENNZOIL has backed during the whole period, compared with the observations. For the forecasts we see that the calculated directions are systematically veered a little. During January and February the RMS error went up to 45 degrees for the +24 hour forecasts.

ii. Wind speed

The average errors were small just as during the previous winter season. The RMS error was about 2 m/s, which was slightly better than for the previous winter. The calculated wind speed for April was too low, especially for EURO. Last year the tendency was, the longer the forecast period, the lower the calculated wind speed with respect to the observations. This tendency

was continued in October. For the rest of the period the average errors remained small.

Average error (dm/s)

8102:	analysis	+12	+24	8010:	+24
EURO	2	5	- 5		-20
IJMUIDEN	-6	-12	-10		-24
PENNZOIL	3	- 1	3		-20
EKOFISK	6	- 5	1		- 7

The RMS error increased to 35-40 dm/s, in January even to 40-50 dm/s for the +24 hour forecast.

iii. H_S

The results for EURO and PENNZOIL were 30 cm too high on average. December 1980 was worse, namely 50 cm too high. Only during April 1981 the significant wave heights were calculated too low, in consistency with the average of the wind speed. For October, November and December the scatter index gave good values, as can be seen also from figures 2-6. The forecasts for October were too low. November and December, however, remained too high. The RMS error increased with a longer forecast period from 50 till 80 cm. A high value for the scatter index for February and March shows the strong dependence of this index on the average of the observations.

iv. $H_{S,10}$

The model overpredicts low frequency wave components, especially for EURO and PENNZOIL. Only for April the average of the errors was compatible in magnitude with the values of last year. During January much swell was measured. Especially for EURO the RMS error exceeds the average of the observations, which is also very clear from the plots of the scatter index

(see fig. 2-6). The increase of the RMS error in the forecast for IJMUIDEN in October is strange.

v. Dependency on wind direction

In addition to this presentation of the model results, we have looked also at the dependency of the performance of GONO on wind direction for the southern North Sea. To this end, some data have been classified according to wind direction sectors. Detailed results of this investigation are not presented here, but some features will be discussed below.

Statistics of four wind sectors for PENNZOIL show that the average model wave height has the tendency to be too great for sector 180-270 (SW), in agreement for sector 270-360 (NW), too low for sector 0-90 (NE) and very scattered for sector 90-180 (SE). The same picture we get at EURO for SE and NW (NE and SE are not relevant there due to the nearness of the coast). The reason for this cannot be explained here, but some speculations may be made. Southwesterly winds may have been affected by coasts; local depth at PENNZOIL is less than in the fetch area in northeasterly directions; southeasterly winds are usually associated with passages of lows and are therefore rather variable. It has been found that the amount of southwesterly wind during winter 1980-1981 was 30% greater than during the previous winter; also the average wave height was greater, also leading to greater absolute errors. Combining this with the apparent directional sensitivity of the model we may conclude that the differences between the winter season 1979-1980 and this winter season can be attributed, at least partly, to a different distribution of wind directions with respect to the previous season.

5. CONCLUSIONS

From the foregoing discussion we conclude that the wind calculation by the GONO model showed some improvement with respect to last year.

However, the quality of the calculation of significant wave height, H_S and low frequency energy $H_{S,10}$ was poorer than last year, especially for the locations EURO and PENNZOIL. It has been found, in section 4, that the model shows some directionality at EURO and PENNZOIL, with too large wave heights during southwesterly winds (sector 180-270). Combining this with the fact that during this winter the number of cases with southwesterly winds was about 30% greater than during the previous season we conclude that positive bias of wave height with respect to the previous winter may merely be due to differences in wind conditions between both winter seasons. A reason for this behaviour of the model may be that the growth curve as used in the model is not quite realistic. Presently, ways are being considered to improve the model on this point.

In a few cases GONO generated low frequency energy in the southern North Sea which actually was not observed. One reason for this behaviour of the model probably is that the model winds are veered about 20 degrees as compared with observed winds which were southwesterly. In such cases, the actual wind was along the coast whereas the model wind was much more onshore.

ACKNOWLEDGMENTS

We would like to thank Henk Kalle for his helpful handling of data.

REFERENCES

- Bouws, E., Golding, B.W., Komen, G.J., Peeck, H.H. and Saraber, M.J.M. (1980). Preliminary results on a comparison of shallow water wave predictions. KNMI Scientific Report W.R. 80-5.

- Bouws, E., Komen, G.J., Moerkerken, R.A. van, Peeck, H.H., and Saraber, M.J.M. (1980). A comparison of shallow water wave predictions. KNMI Report, V-362.

- Bruinsma, J., Janssen, P.A.E.M., Komen, G.J., Peeck, H.H., Saraber, M.J.M. and Voogt, W.J.P. de. (1980). Description of the KNMI operational wave forecast model GONO. KNMI Scientific Report, W.R. 80-4.

FIGURE CAPTIONS

1. Grid of GONO model.

2-6. Plots of Scatter Indices for wind speed, significant waveheight (H_S) and low frequency energy ($H_{S,10}$) for the selected locations.

The time series are given in a supplement to this report.

TABLE CAPTIONS

1-21. Summary tables, giving results for wind direction, wind speed, H_S and $H_{S,10}$ (from top to bottom). Given are respectively location, number of observations, average of the observations, average error, RMS error, Scatter Index, number of cases overpredicted and number of cases underpredicted.

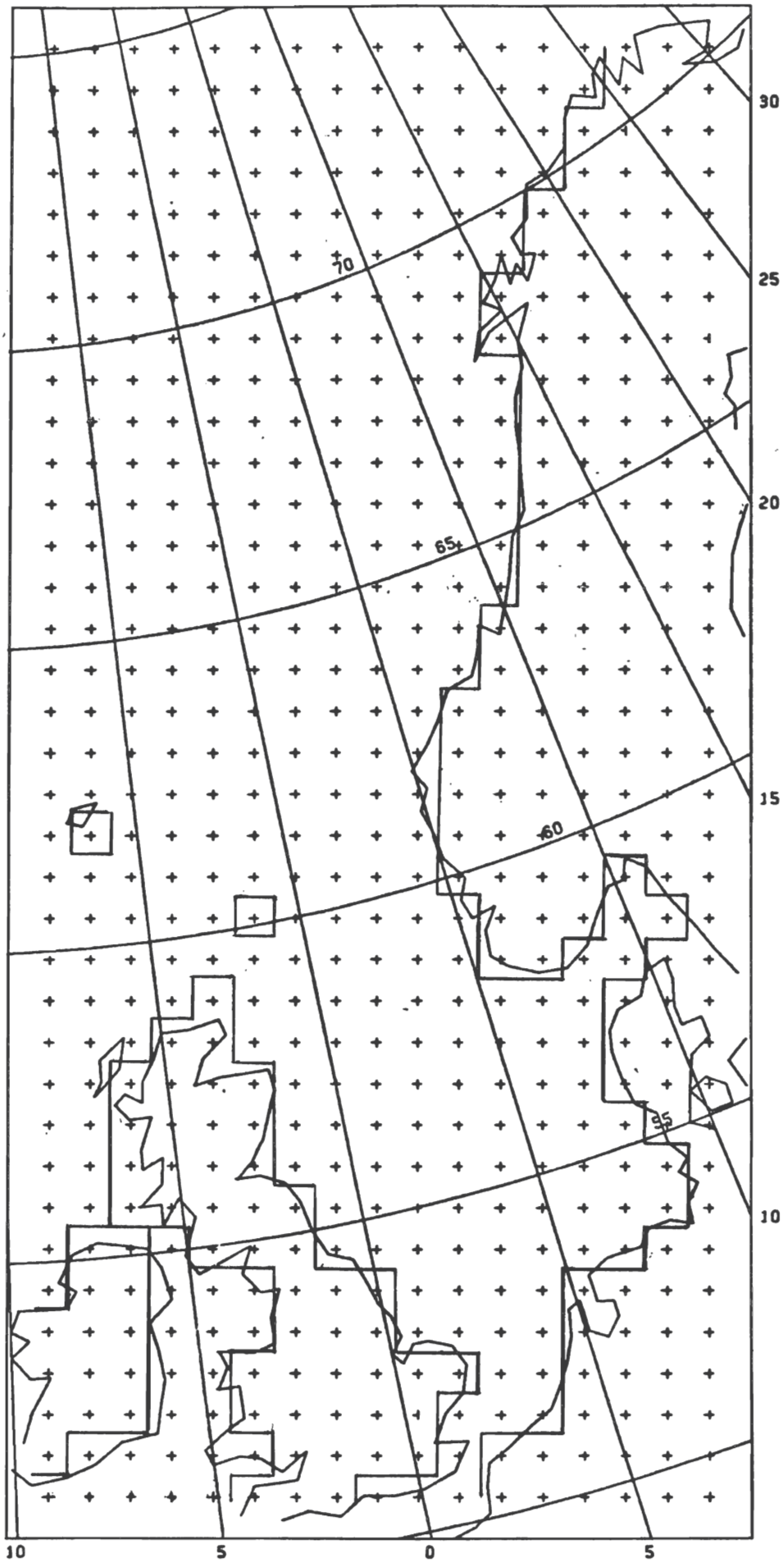


Fig. 1

GØNØGRID.

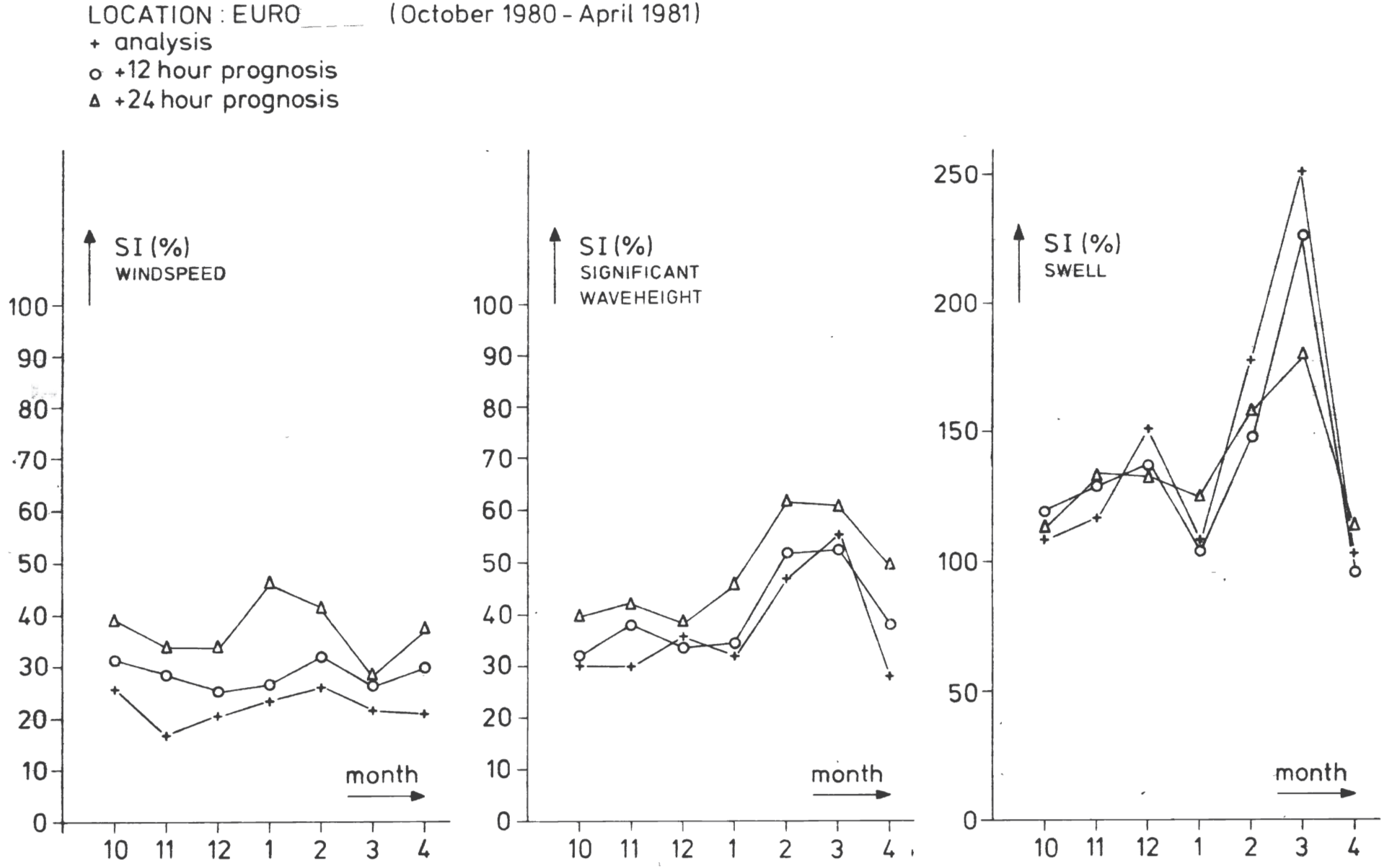

LOCATION : EURO____ (October 1980 - April 1981)
+ analysis
o +12 hour prognosis
Δ +24 hour prognosis
SI (%)
WINDSPEED
SI (%)
SIGNIFICANT
WAVEHEIGHT
SI (%)
SWELL
month
0
10
20
30
40
50
60
70
80
90
100
150
200
250
10 11 12 1 2 3 4

Fig. 2

LOCATION: UMUIDEN (October 1980 - April 1981)
+ analysis
o +12 hour prognosis
Δ +24 hour prognosis

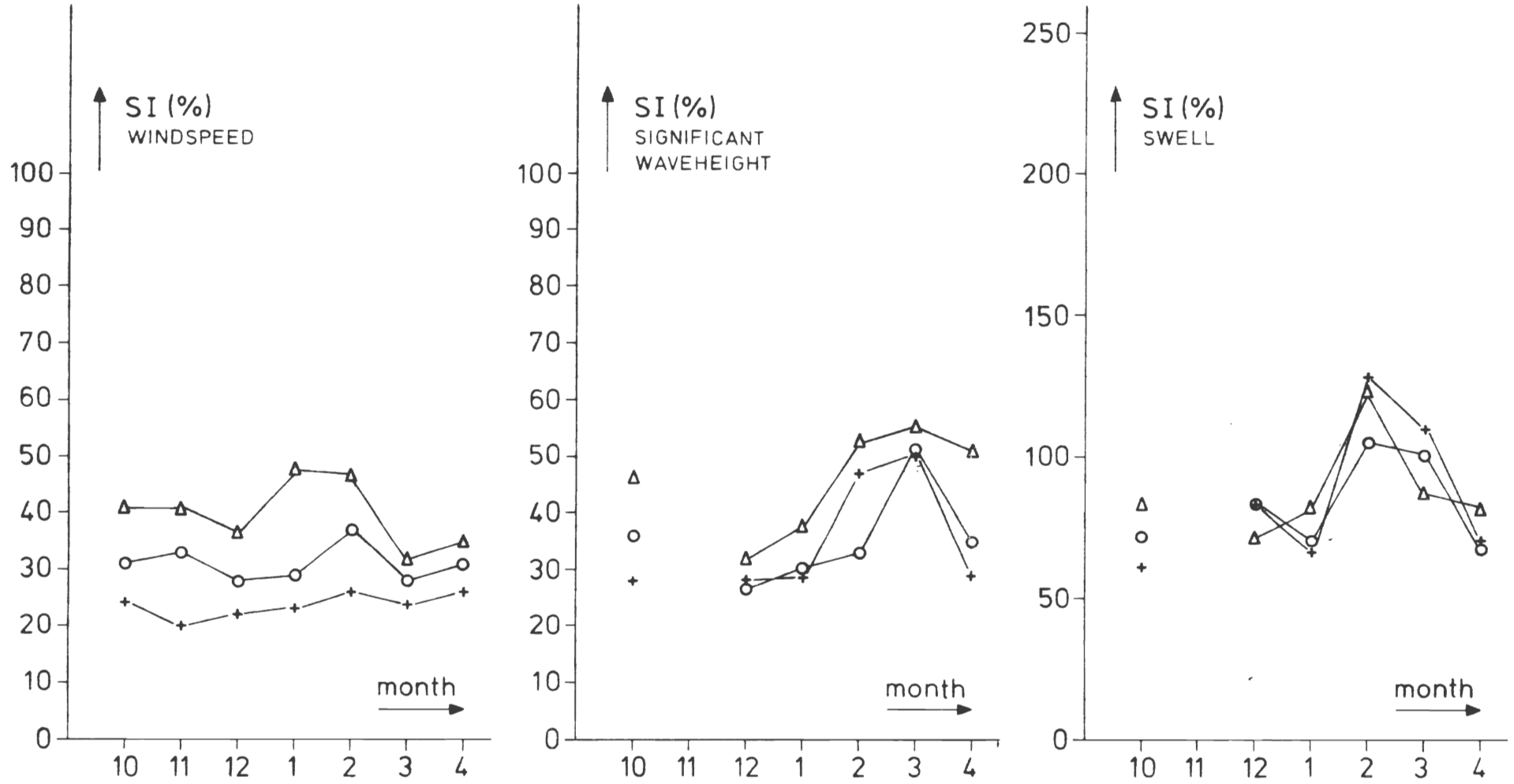


Fig. 3

LOCATION: PENNZOIL (October 1980 - April 1981)
+ analysis
o + 12 hour prognosis
Δ + 24 hour prognosis

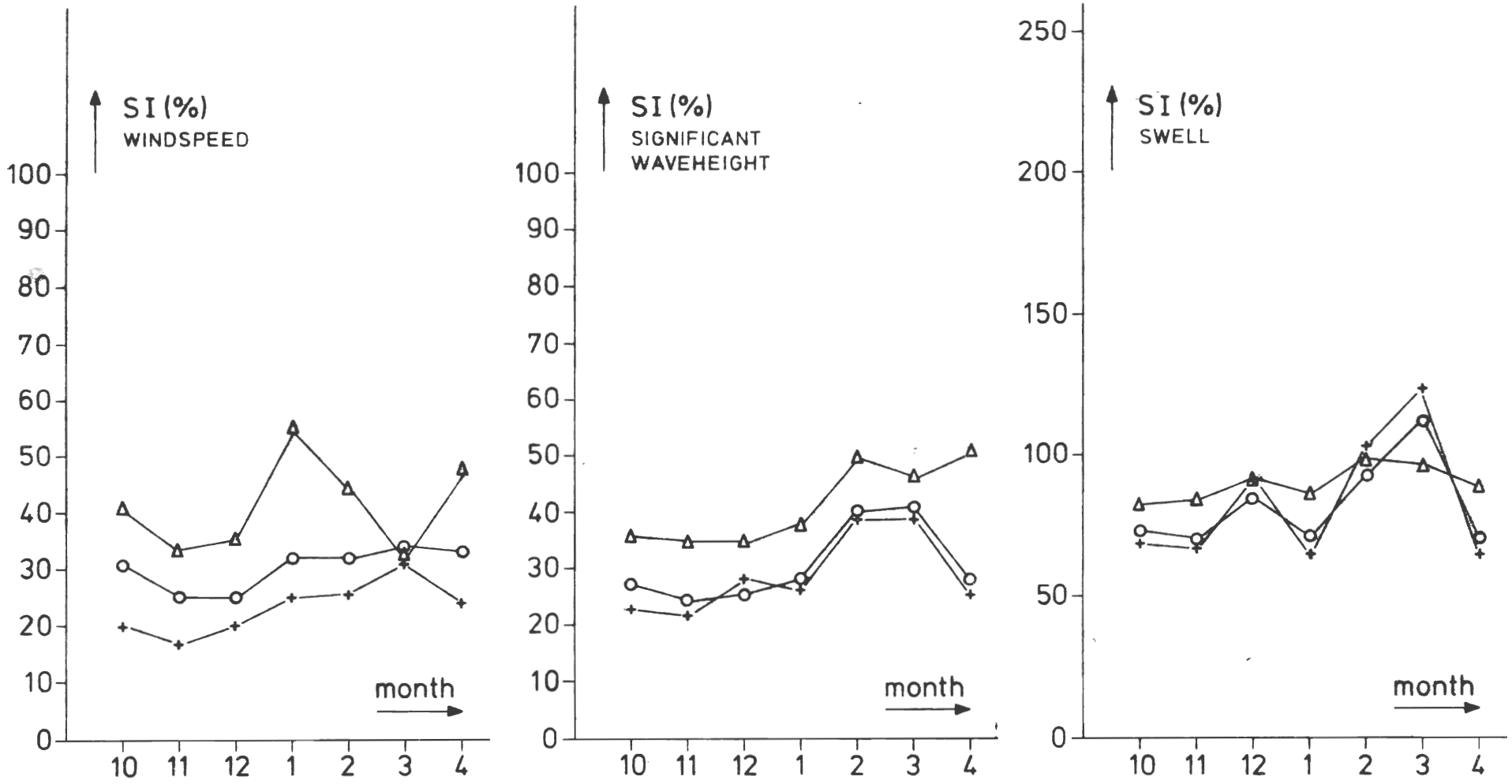


Fig. 4

LOCATION: EKOFISK (October 1980 - April 1981)
+ analysis
o +12 hour prognosis
Δ +24 hour prognosis

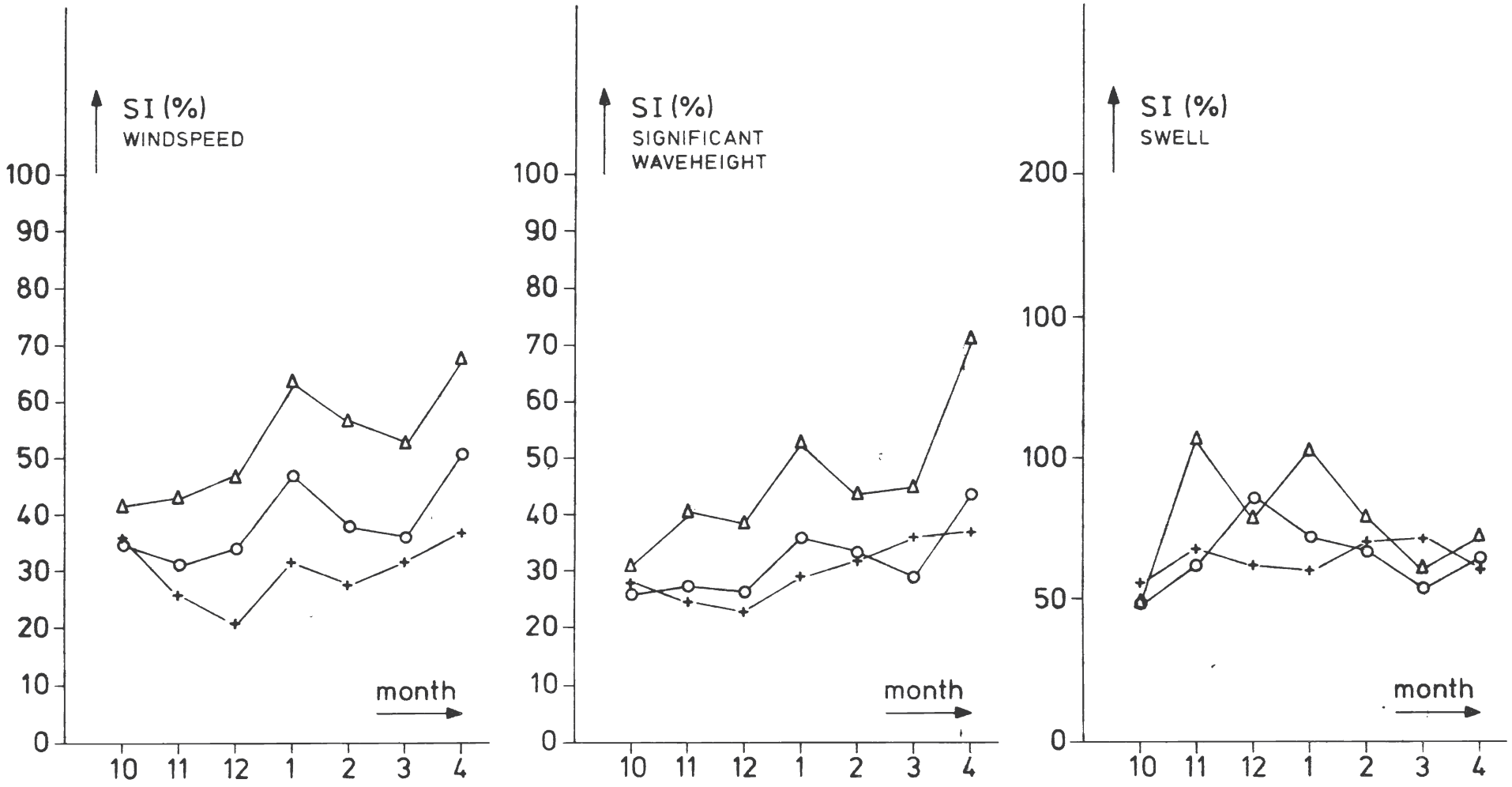


Fig. 5

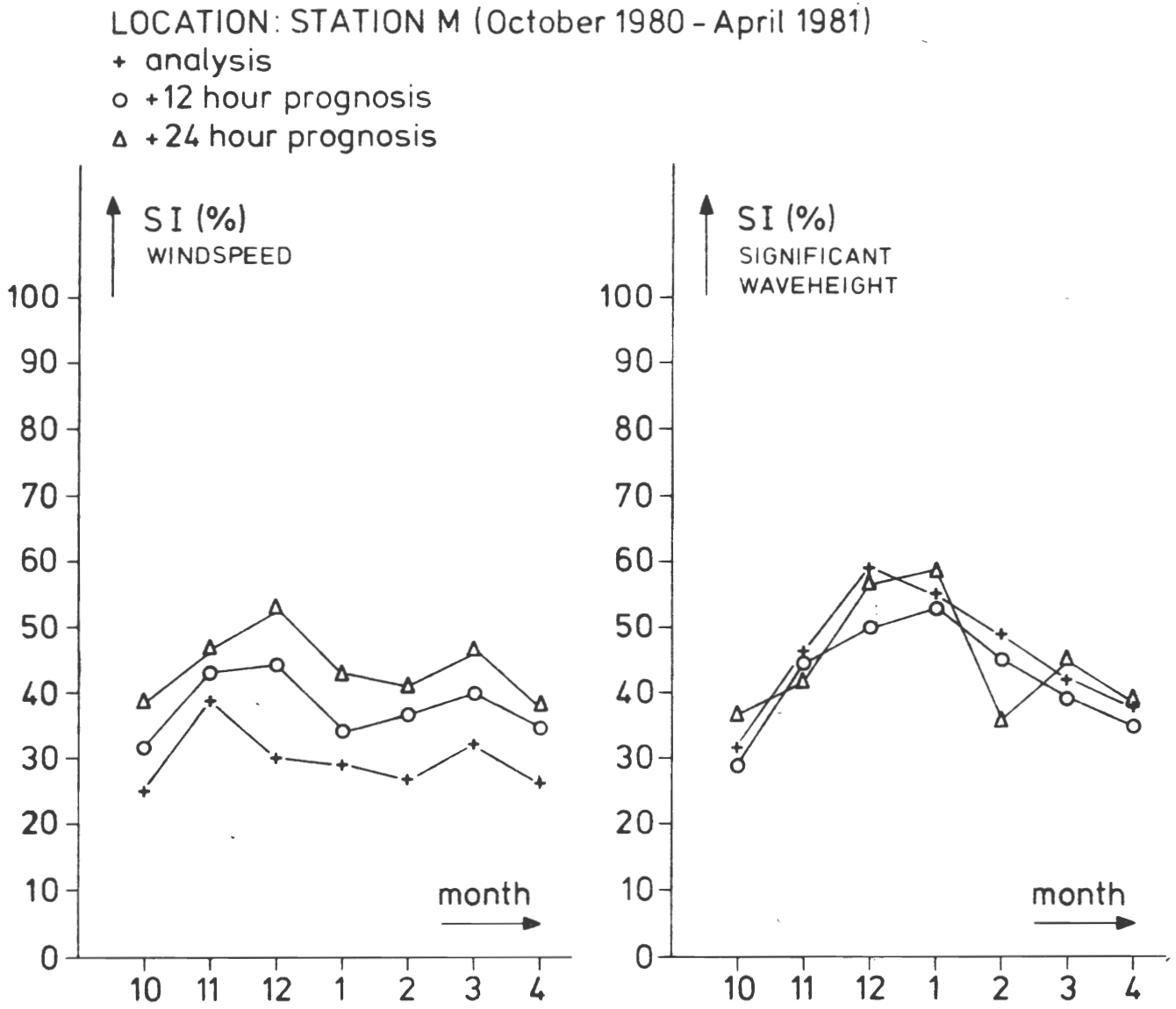

LOCATION: STATION M (October 1980 - April 1981)
+ analysis
o +12 hour prognosis
Δ +24 hour prognosis
SI (%)
WINDSPEED
SI (%)
SIGNIFICANT
WAVEHEIGHT
100
90
80
70
60
50
40
30
20
10
0
month
10 11 12 1 2 3 4

Fig. 6

ALL MEASUREMENTS PERIOD 80100100-80103118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	091	***	005	017	***	060	029
IJMUIDEN	090	***	005	017	***	060	027
PENNZOIL	081	***	-007	014	***	021	058
EKOFISK	083	***	001	013	***	044	038
STATION M	095	***	000	024	***	049	043

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	123	084	001	022	026	059	061
IJMUIDEN	122	089	-002	021	024	052	067
PENNZOIL	111	083	005	017	020	067	041
EKOFISK	123	082	007	029	036	075	046
STATION M	119	104	-018	026	025	028	090

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	111	168	019	052	031	067	042
IJMUIDEN	072	183	001	051	028	032	040
PENNZOIL	113	222	005	050	023	056	057
EKOFISK	119	281	002	079	028	053	066
STATION M	119	287	-019	092	032	045	074

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	111	027	018	030	109	075	034
IJMUIDEN	072	059	-001	036	061	027	045
PENNZOIL	113	062	012	043	070	058	055
EKOFISK	112	129	008	073	056	046	066
STATION M	000						

TABLE 1.

ALL MEASUREMENTS PERIOD 80100100-80103118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	080	***	004	021	***	046	034
IJMUIDEN	079	***	006	020	***	048	030
PENNZOIL	074	***	-005	021	***	031	041
EKOFISK	078	***	014	020	***	063	013
STATION M	089	***	010	027	***	059	029

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	122	084	-012	026	031	032	090
IJMUIDEN	121	088	-017	028	031	031	087
PENNZOIL	110	083	-010	026	031	039	070
EKOFISK	122	082	-004	029	035	053	068
STATION M	118	104	-025	034	032	026	091

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	110	168	-005	054	032	051	058
IJMUIDEN	071	184	-023	066	036	018	053
PENNZOIL	112	222	-026	060	027	031	080
EKOFISK	118	282	-029	072	026	038	078
STATION M	118	288	-035	083	029	034	084

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	110	027	015	033	119	064	042
IJMUIDEN	071	059	-006	042	072	027	044
PENNZOIL	112	062	004	045	073	052	060
EKOFISK	111	129	-012	061	048	034	077
STATION M	000						

TABLE 2.

ALL MEASUREMENTS PERIOD 80100100-80103118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	071	***	001	029	***	034	037
IJMUIDEN	072	***	007	024	***	047	022
PENNZOIL	060	***	-004	029	***	022	036
EKOFISK	074	***	013	022	***	055	017
STATION M	087	***	014	033	***	056	029

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	122	084	-020	032	039	030	090
IJMUIDEN	121	088	-024	036	041	032	086
PENNZOIL	111	083	-020	034	041	032	076
EKOFISK	122	082	-007	034	042	052	068
STATION M	118	104	-022	041	039	037	080

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	110	168	-032	067	040	028	082
IJMUIDEN	071	183	-027	083	046	021	050
PENNZOIL	112	222	-058	079	036	019	093
EKOFISK	118	281	-064	086	031	026	090
STATION M	118	287	-025	106	037	043	074

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	110	027	007	031	113	052	055
IJMUIDEN	071	059	-011	049	084	024	047
PENNZOIL	112	062	-008	051	083	046	066
EKOFISK	111	128	-036	063	049	028	083
STATION M	000						

TABLE 3.

ALL MEASUREMENTS PERIOD 80110100-80113018

WIND DIRECTION (DEGREES) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	108	***	013	015	***	090	016
IJMUIDEN	105	***	010	016	***	079	025
PENNZOIL	114	***	-003	019	***	042	070
EKOFISK	100	***	-001	019	***	049	050
STATION M	070	***	-002	024	***	034	034

WIND SPEED (DM/SEC) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	120	104	-003	018	017	050	069
IJMUIDEN	118	105	-001	021	020	055	063
PENNZOIL	120	103	005	018	017	071	046
EKOFISK	120	088	012	023	026	088	031
STATION M	115	102	-022	040	039	024	091

HS SIGN. WAVE HEIGHT(CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	119	189	026	057	030	073	045
IJMUIDEN	000						
PENNZOIL	119	245	016	053	022	072	047
EKOFISK	117	282	-004	069	025	053	064
STATION M	115	285	-006	130	046	052	063

H S,10 (CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	119	027	016	031	117	077	040
IJMUIDEN	000						
PENNZOIL	119	051	021	035	068	078	039
EKOFISK	117	097	007	053	054	060	057
STATION M	000						

TABLE 4.

ALL MEASUREMENTS PERIOD 80110100-80113018

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	113	***	010	019	***	077	032
IJMUIDEN	105	***	009	019	***	069	034
PENNZOIL	108	***	003	025	***	056	051
EKOFISK	097	***	010	021	***	070	027
STATION M	073	***	003	031	***	034	039

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	120	104	001	030	029	058	061
IJMUIDEN	118	105	-001	034	033	057	061
PENNZOIL	120	103	-002	026	025	048	067
EKOFISK	120	088	001	028	031	062	054
STATION M	115	102	-029	044	043	022	091

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	119	189	035	072	038	078	041
IJMUIDEN	000						
PENNZOIL	119	245	001	060	024	054	064
EKOFISK	117	282	-022	075	027	041	074
STATION M	115	285	-020	127	045	048	067

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	119	027	016	035	131	073	044
IJMUIDEN	000						
PENNZOIL	119	051	014	035	069	076	041
EKOFISK	117	097	008	060	061	057	060
STATION M	000						

TABLE 5.

ALL MEASUREMENTS PERIOD 80110100-80113018

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	100	***	012	023	***	071	028
IJMUIDEN	095	***	011	024	***	065	029
PENNZOIL	100	***	004	028	***	055	045
EKOFISK	090	***	012	029	***	059	029
STATION M	073	***	020	046	***	046	027

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	120	104	-005	036	034	051	066
IJMUIDEN	118	105	-005	042	041	048	070
PENNZOIL	120	103	-005	035	034	051	069
EKOFISK	120	088	-002	038	043	052	067
STATION M	115	102	-024	048	047	031	084

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	119	189	024	078	042	070	049
IJMUIDEN	000						
PENNZOIL	119	245	-006	085	035	055	064
EKOFISK	117	282	-032	117	041	033	084
STATION M	115	285	-025	126	044	050	065

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	119	027	012	035	132	073	045
IJMUIDEN	000						
PENNZOIL	119	051	017	043	085	067	050
EKOFISK	117	097	013	105	108	053	064
STATION M	000						

TABLE 6.

ALL MEASUREMENTS PERIOD 80120100-80123118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	113	***	011	018	***	081	031
IJMUIDEN	111	***	009	021	***	076	032
PENNZOIL	116	***	-005	013	***	042	072
EKOFISK	105	***	000	013	***	060	043
STATION M	076	***	-011	024	***	024	050

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	124	099	009	022	022	079	045
IJMUIDEN	124	102	007	022	022	082	041
PENNZOIL	124	100	013	020	020	089	032
EKOFISK	120	103	012	022	021	090	027
STATION M	107	101	-011	031	030	036	069

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	124	187	052	066	035	087	037
IJMUIDEN	099	223	053	063	028	077	022
PENNZOIL	124	233	046	064	028	093	031
EKOFISK	114	331	015	077	023	060	054
STATION M	107	307	052	182	059	058	049

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	124	024	026	037	151	090	032
IJMUIDEN	099	051	018	043	083	061	038
PENNZOIL	124	050	028	045	091	089	035
EKOFISK	114	137	014	085	062	055	058
STATION M	000						

TABLE 7.

ALL MEASUREMENTS PERIOD 80120100-80123118

WIND DIRECTION (DEGREES) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	113	***	016	024	***	086	025
IJMUIDEN	108	***	017	026	***	085	021
PENNZOIL	114	***	003	019	***	070	042
EKOFISK	105	***	010	022	***	077	027
STATION M	074	***	-016	033	***	021	052

WIND SPEED (DM/SEC) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	124	099	002	024	025	070	052
IJMUIDEN	124	102	-000	028	028	058	053
PENNZOIL	124	100	003	025	025	065	054
EKOFISK	120	103	001	035	034	051	066
STATION M	107	101	-015	044	044	036	071

HS SIGN. WAVE HEIGHT(CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	124	187	040	064	034	088	035
IJMUIDEN	099	223	041	061	027	074	024
PENNZOIL	124	233	025	061	026	086	038
EKOFISK	114	331	-022	084	026	037	077
STATION M	107	307	039	154	050	053	053

H S,10 (CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	124	024	023	033	136	094	026
IJMUIDEN	099	051	016	042	082	062	037
PENNZOIL	124	050	025	043	086	095	029
EKOFISK	114	137	-007	087	063	044	070
STATION M	000						

TABLE 8.

ALL MEASUREMENTS PERIOD 80120100-80123118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	106	***	020	032	***	079	025
IJMUIDEN	104	***	021	034	***	08?	023
PENNZOIL	108	***	007	029	***	064	044
EKOFISK	097	***	016	030	***	074	022
STATION M	071	***	-017	044	***	022	048

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	124	099	-002	033	034	063	060
IJMUIDEN	124	102	-004	037	037	057	067
PENNZOIL	124	100	-002	035	035	057	064
EKOFISK	120	103	-005	048	047	050	069
STATION M	107	101	-011	054	053	045	061

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	124	187	029	073	039	076	047
IJMUIDEN	099	223	025	072	032	060	038
PENNZOIL	124	233	009	081	035	061	062
EKOFISK	114	331	-034	129	039	036	077
STATION M	107	307	034	176	057	055	051

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	124	024	019	032	133	078	041
IJMUIDEN	099	051	007	037	072	047	052
PENNZOIL	124	050	017	043	086	081	043
EKOFISK	114	137	-009	110	080	040	074
STATION M	000						

TABLE 9.

ALL MEASUREMENTS PERIOD 81010100-81013118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	090	***	009	017	***	068	021
IJMUIDEN	077	***	006	021	***	050	027
PENNZOIL	083	***	-008	013	***	019	062
EKOFISK	100	***	002	019	***	053	042
STATION M	105	***	-002	020	***	046	055

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	123	086	006	020	024	077	042
IJMUIDEN	106	089	005	021	023	062	041
PENNZOIL	123	084	005	021	025	073	047
EKOFISK	124	088	011	028	032	077	046
STATION M	116	130	-005	037	029	043	072

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	124	172	035	055	032	091	033
IJMUIDEN	062	213	018	061	029	037	025
PENNZOIL	124	211	023	058	027	078	046
EKOFISK	120	302	032	086	029	068	052
STATION M	116	345	155	191	055	091	025

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	124	037	028	040	108	084	033
IJMUIDEN	062	077	003	051	066	029	033
PENNZOIL	124	079	021	051	065	075	048
EKOFISK	120	153	035	091	060	062	057
STATION M	000						

TABLE 10.

ALL MEASUREMENTS PERIOD 81010100-81013118

WIND DIRECTION (DEGREES) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	079	***	018	032	***	058	020
IJMUIDEN	065	***	015	033	***	044	019
PENNZOIL	074	***	004	022	***	040	032
EKOFISK	087	***	012	034	***	060	027
STATION M	097	***	-000	026	***	050	046

WIND SPEED (DM/SEC) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	120	085	-008	023	027	039	078
IJMUIDEN	103	089	-007	026	029	039	062
PENNZOIL	120	083	-004	027	032	051	066
EKOFISK	121	088	001	041	047	044	075
STATION M	113	130	-020	044	034	033	079

HS SIGN. WAVE HEIGHT(CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	121	173	014	058	034	063	058
IJMUIDEN	061	215	002	064	030	030	031
PENNZOIL	121	213	009	057	027	058	059
EKOFISK	117	303	015	109	036	053	064
STATION M	113	348	116	184	053	085	027

H S,10 (CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	121	037	028	039	105	085	029
IJMUIDEN	061	078	005	054	070	029	032
PENNZOIL	121	079	022	056	071	073	047
EKOFISK	117	154	043	110	072	062	054
STATION M	000						

TABLE 11.

ALL MEASUREMENTS PERIOD 81010100-81013118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	073	***	018	044	***	053	020
IJMUIDEN	060	***	019	034	***	040	020
PENNZOIL	068	***	005	035	***	037	029
EKOFISK	078	***	012	051	***	051	027
STATION M	095	***	-000	035	***	046	049

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	120	086	-008	040	047	045	072
IJMUIDEN	103	089	-008	043	048	039	064
PENNZOIL	120	084	-001	046	055	056	063
EKOFISK	121	088	004	057	064	058	063
STATION M	113	130	-023	055	043	036	077

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	121	174	013	080	046	060	060
IJMUIDEN	062	213	-005	082	038	026	035
PENNZOIL	121	213	015	081	038	064	056
EKOFISK	117	302	019	160	053	054	062
STATION M	113	347	077	204	059	070	043

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	121	037	032	047	125	083	030
IJMUIDEN	062	077	003	062	081	029	033
PENNZOIL	121	080	032	069	086	073	046
EKOFISK	117	154	055	158	103	061	056
STATION M	000						

TABLE 12.

ALL MEASUREMENTS PERIOD 81020100-81022818

WIND DIRECTION (DEGREES) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	066	***	014	015	***	057	008
IJMUIDEN	064	***	009	020	***	045	018
PENNZOIL	055	***	-006	013	***	017	037
EKOFISK	070	***	-001	017	***	026	040
STATION M	067	***	-009	019	***	019	046

WIND SPEED (DM/SEC) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	094	073	002	019	026	046	047
IJMUIDEN	094	079	-004	020	026	042	052
PENNZOIL	092	069	003	018	026	050	041
EKOFISK	093	078	006	022	028	051	038
STATION M	080	113	-016	030	027	024	056

HS SIGN. WAVE HEIGHT(CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	094	126	018	059	047	045	049
IJMUIDEN	068	120	013	056	047	029	039
PENNZOIL	093	159	004	062	039	037	056
EKOFISK	088	233	-017	075	032	034	054
STATION M	080	367	-010	180	049	033	047

H S,10 (CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	093	017	012	030	178	040	042
IJMUIDEN	068	025	002	032	127	019	047
PENNZOIL	093	033	010	033	103	039	053
EKOFISK	087	094	-014	066	070	026	060
STATION M	000						

TABLE 13.

ALL MEASUREMENTS PERIOD 81020100-81022818

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	061	***	019	024	***	048	012
IJMUIDEN	065	***	018	029	***	044	019
PENNZOIL	054	***	010	039	***	030	023
EKOFISK	055	***	014	022	***	042	012
STATION M	066	***	-010	025	***	022	043

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	095	073	-005	023	032	035	059
IJMUIDEN	095	079	-010	029	037	038	056
PENNZOIL	093	069	-001	022	032	041	050
EKOFISK	094	076	-005	029	038	035	057
STATION M	081	111	-014	041	037	026	055

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	095	126	-001	065	052	042	053
IJMUIDEN	070	119	-004	040	033	030	040
PENNZOIL	094	159	-013	063	040	033	060
EKOFISK	089	228	-028	074	033	031	058
STATION M	081	362	-020	164	045	031	050

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	094	017	008	025	149	043	040
IJMUIDEN	069	025	-001	026	105	020	047
PENNZOIL	094	033	008	031	094	038	055
EKOFISK	088	092	-012	063	069	030	057
STATION M	000						

TABLE 14.

ALL MEASUREMENTS PERIOD 81020100-81022818

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	061	***	019	044	***	046	015
IJMUIDEN	068	***	021	038	***	045	021
PENNZOIL	057	***	001	044	***	034	021
EKOFISK	057	***	012	028	***	037	019
STATION M	067	***	-009	037	***	023	044

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	097	073	-005	032	043	039	058
IJMUIDEN	097	078	-008	037	047	041	055
PENNZOIL	095	069	003	031	045	048	046
EKOFISK	095	077	001	044	057	037	058
STATION M	084	112	-021	046	041	029	055

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	097	126	-005	079	063	036	060
IJMUIDEN	071	119	001	063	053	026	044
PENNZOIL	096	158	-011	080	050	033	063
EKOFISK	091	230	-028	101	044	032	058
STATION M	084	364	-061	131	036	027	057

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	096	017	006	027	158	037	047
IJMUIDEN	070	025	-004	031	122	018	050
PENNZOIL	096	032	008	032	100	038	057
EKOFISK	090	093	-006	074	080	027	062
STATION M	000						

TABLE 15.

ALL MEASUREMENTS PERIOD 81030100-81033118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	094	***	017	012	***	085	009
IJMUIDEN	091	***	014	014	***	078	011
PENNZOIL	080	***	-003	013	***	033	044
EKOFISK	071	***	-001	016	***	032	034
STATION M	089	***	005	027	***	063	022

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	123	085	-003	020	023	052	069
IJMUIDEN	123	084	-003	020	024	056	063
PENNZOIL	118	081	-002	026	032	048	068
EKOFISK	121	074	-001	023	032	060	060
STATION M	119	112	-025	036	032	030	089

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	123	122	035	067	055	078	044
IJMUIDEN	110	132	034	066	050	071	039
PENNZOIL	118	146	016	057	039	062	053
EKOFISK	115	207	-012	075	036	040	074
STATION M	119	283	-023	119	042	052	067

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	ANALYSIS GONO SI	PLUS	MINUS
EURO	123	011	011	027	251	059	055
IJMUIDEN	093	028	003	031	110	037	055
PENNZOIL	118	023	005	029	123	049	065
EKOFISK	115	072	-006	052	072	042	073
STATION M	000						

TABLE 16.

ALL MEASUREMENTS PERIOD 81030100-81033118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	080	***	024	020	***	067	013
IJMUIDEN	072	***	022	016	***	066	005
PENNZOIL	069	***	007	019	***	048	021
EKOFISK	064	***	013	032	***	046	018
STATION M	093	***	011	032	***	062	030

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	119	084	-012	023	027	037	081
IJMUIDEN	119	084	-013	024	028	037	079
PENNZOIL	114	081	-011	027	034	032	080
EKOFISK	117	074	-007	027	036	042	073
STATION M	115	113	-029	045	040	027	088

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	119	121	021	064	053	065	052
IJMUIDEN	106	131	021	067	051	064	041
PENNZOIL	114	145	001	060	041	048	065
EKOFISK	111	210	-035	061	029	027	084
STATION M	115	282	-026	111	039	045	070

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+12 GONO SI	PLUS	MINUS
EURO	119	011	010	025	227	060	050
IJMUIDEN	089	028	003	028	101	036	053
PENNZOIL	114	024	004	026	112	048	064
EKOFISK	111	074	-019	039	053	028	083
STATION M	000						

TABLE 17.

ALL MEASUREMENTS PERIOD 81030100-81033118

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	083	***	028	028	***	070	013
IJMUIDEN	073	***	025	026	***	062	011
PENNZOIL	063	***	011	026	***	043	020
EKOFISK	060	***	014	039	***	037	023
STATION M	103	***	009	048	***	067	036

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	119	085	-013	024	028	034	083
IJMUIDEN	119	085	-014	027	032	037	081
PENNZOIL	114	082	-012	027	033	038	074
EKOFISK	117	074	-005	039	053	052	064
STATION M	115	111	-013	052	047	047	067

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	119	121	012	073	061	055	064
IJMUIDEN	106	133	009	073	055	050	056
PENNZOIL	114	146	-009	069	047	041	073
EKOFISK	111	209	-044	080	038	027	083
STATION M	115	280	008	126	045	056	059

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	119	011	006	020	180	055	055
IJMUIDEN	089	028	-002	025	087	033	056
PENNZOIL	114	024	001	023	096	045	067
EKOFISK	111	074	-026	045	061	022	089
STATION M	000						

TABLE 18.

ALL MEASUREMENTS PERIOD 81040100-81043018

WIND DIRECTION (DEGREES) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	071	***	010	015	***	054	017
IJMUIDEN	076	***	002	016	***	040	036
PENNZOIL	080	***	-008	012	***	020	059
EKOFISK	063	***	-002	018	***	035	025
STATION M	088	***	-000	025	***	039	048

WIND SPEED (DM/SEC) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	119	071	-015	015	021	016	102
IJMUIDEN	119	071	-011	018	026	025	093
PENNZOIL	119	071	-005	017	024	045	071
EKOFISK	120	061	001	023	037	056	062
STATION M	112	103	-014	027	026	032	078

HS SIGN. WAVE HEIGHT(CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	120	115	-022	032	028	022	096
IJMUIDEN	119	113	-009	033	029	037	080
PENNZOIL	120	144	-016	036	025	029	090
EKOFISK	120	135	-002	050	037	053	066
STATION M	113	306	-066	115	038	021	092

H S,10 (CM) ANALYSIS GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	120	011	003	011	104	034	047
IJMUIDEN	113	023	-004	016	070	026	087
PENNZOIL	120	027	-002	017	065	030	088
EKOFISK	120	051	-015	031	061	017	103
STATION M	000						

TABLE 19.

ALL MEASUREMENTS PERIOD 81040100-81043018

WIND DIRECTION (DEGREES) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	067	***	018	017	***	055	009
IJMUIDEN	071	***	005	029	***	049	022
PENNZOIL	069	***	-000	016	***	032	036
EKOFISK	044	***	016	028	***	033	011
STATION M	076	***	-012	029	***	022	052

WIND SPEED (DM/SEC) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	115	072	-012	021	030	030	082
IJMUIDEN	115	072	-013	022	031	033	079
PENNZOIL	115	072	-011	023	033	039	074
EKOFISK	116	061	-005	031	051	042	074
STATION M	108	102	-025	036	035	018	090

HS SIGN. WAVE HEIGHT(CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	116	115	-017	044	038	029	086
IJMUIDEN	115	115	-011	040	035	037	078
PENNZOIL	116	145	-026	040	028	025	090
EKOFISK	116	136	-012	058	043	031	084
STATION M	109	304	-088	106	035	014	095

H S,10 (CM) +12 GONO

LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	SI	PLUS	MINUS
EURO	116	011	001	011	096	028	049
IJMUIDEN	109	023	-006	016	068	021	088
PENNZOIL	116	027	-004	019	070	023	091
EKOFISK	116	051	-017	033	064	014	101
STATION M	000						

TABLE 20.

ALL MEASUREMENTS PERIOD 81040100-81043018

WIND DIRECTION (DEGREES) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	073	***	025	027	***	061	012
IJMUIDEN	073	***	020	029	***	056	017
PENNZOIL	069	***	005	026	***	038	029
EKOFISK	045	***	018	036	***	031	013
STATION M	070	***	-006	043	***	022	046

WIND SPEED (DM/SEC) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	115	071	-007	027	038	040	074
IJMUIDEN	115	071	-007	025	035	043	071
PENNZOIL	115	071	-006	035	048	046	067
EKOFISK	116	060	002	041	068	052	063
STATION M	108	103	-030	039	038	024	084

HS SIGN. WAVE HEIGHT(CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	116	116	-008	058	050	045	071
IJMUIDEN	116	114	-003	059	052	048	066
PENNZOIL	116	145	-016	074	051	041	074
EKOFISK	116	132	002	097	073	043	072
STATION M	109	305	-108	118	039	018	091

H S,10 (CM) LOCATION	NUMBER	AV.OBS	AV.ERR	RMS	+24 GONO SI	PLUS	MINUS
EURO	116	011	002	013	114	032	047
IJMUIDEN	110	023	-006	019	082	022	088
PENNZOIL	116	027	-004	024	088	023	091
EKOFISK	116	051	-015	037	073	020	096
STATION M	000						

TABLE 21.

KONINKLIJK NEDERLANDS
METEOROLOGISCH INSTITUUT

TECHNISCHE RAPPORTEN

T.R. - 11

(Supplement)

E.Bouws, G.J.Komen, R.A. van Moerkerken,
H.H.Peeck, M.J.M.Saraber.

Time series diagrams for the KNMI operational wave model GONO. October 1980 - April 1981

Supplement to KNMI Technical Report T.R. - 11.

De Bilt, 1982

Publicationnumber: K.N.M.I. TR-11 (Supplement)

Koninklijk Nederlands Meteorologisch Instituut,
Oceanografisch Onderzoek, Centrale Weerdienst,
Postbus 201,
3730 AE De Bilt,
Nederland

U.D.C.: 551.466.33

EURO

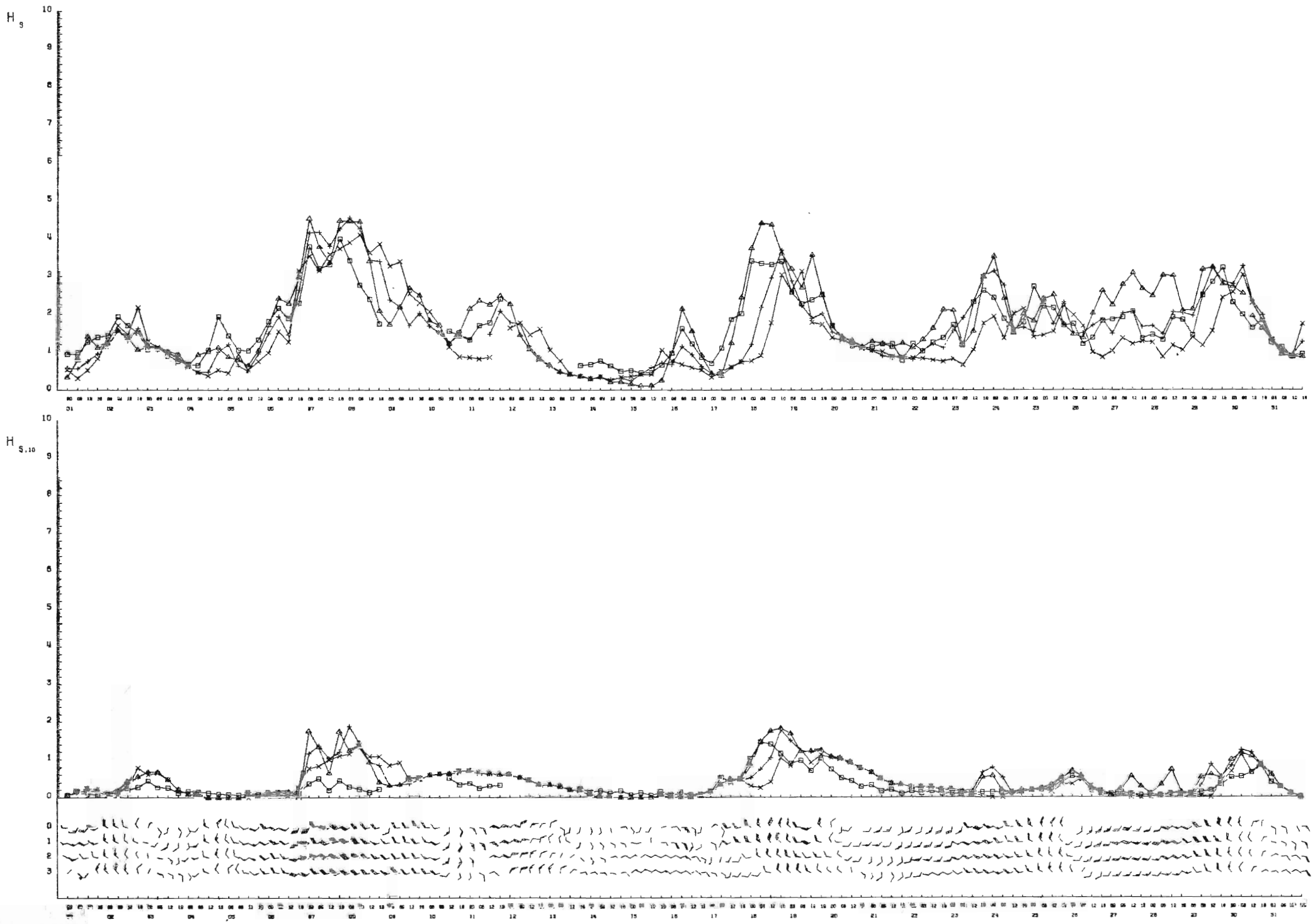
GONO

OCTOBER 1980

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

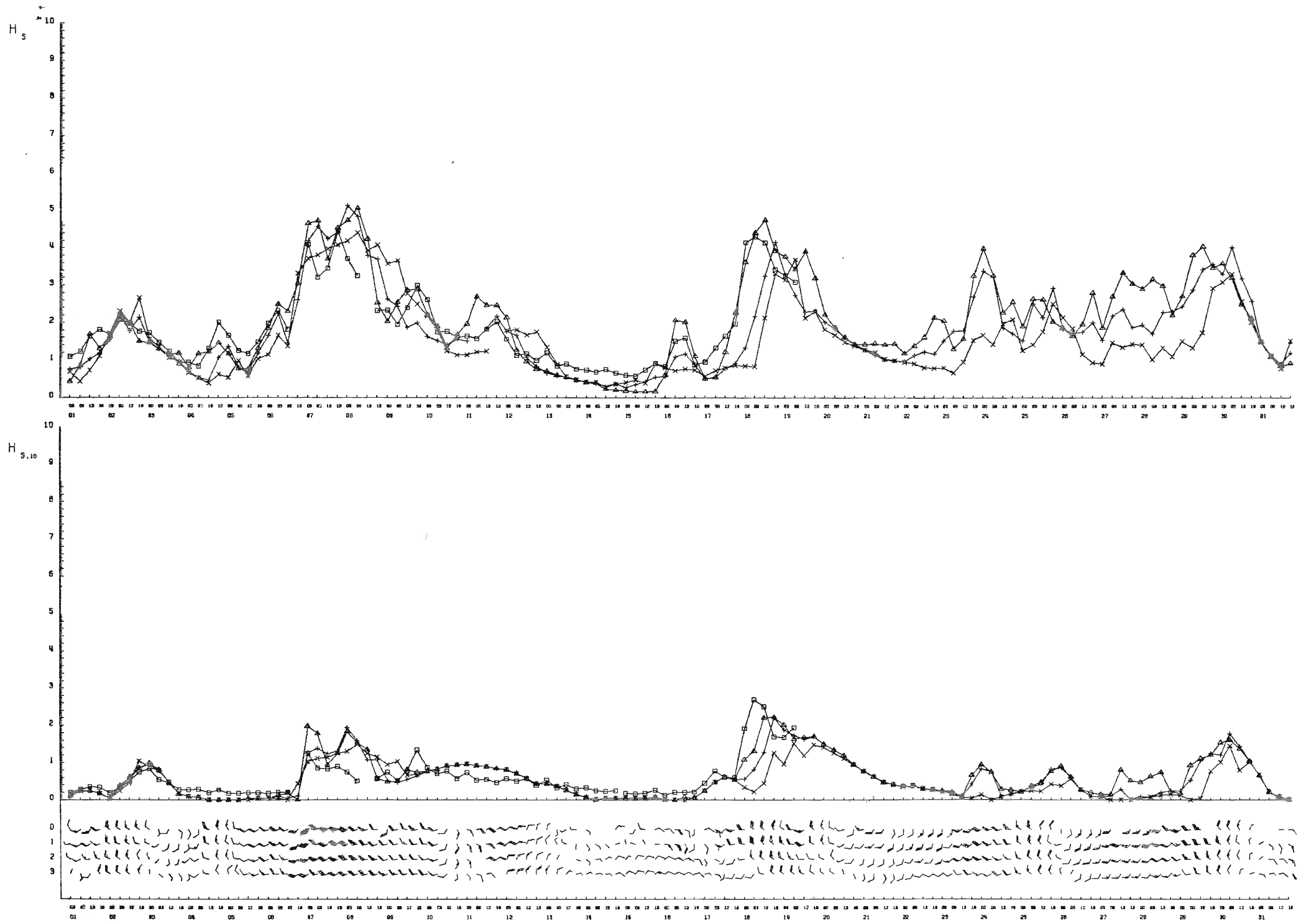
fig. 1



IJMUIDEN
GØNØ
ØCTØBER 1980

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 2



PENNZØIL

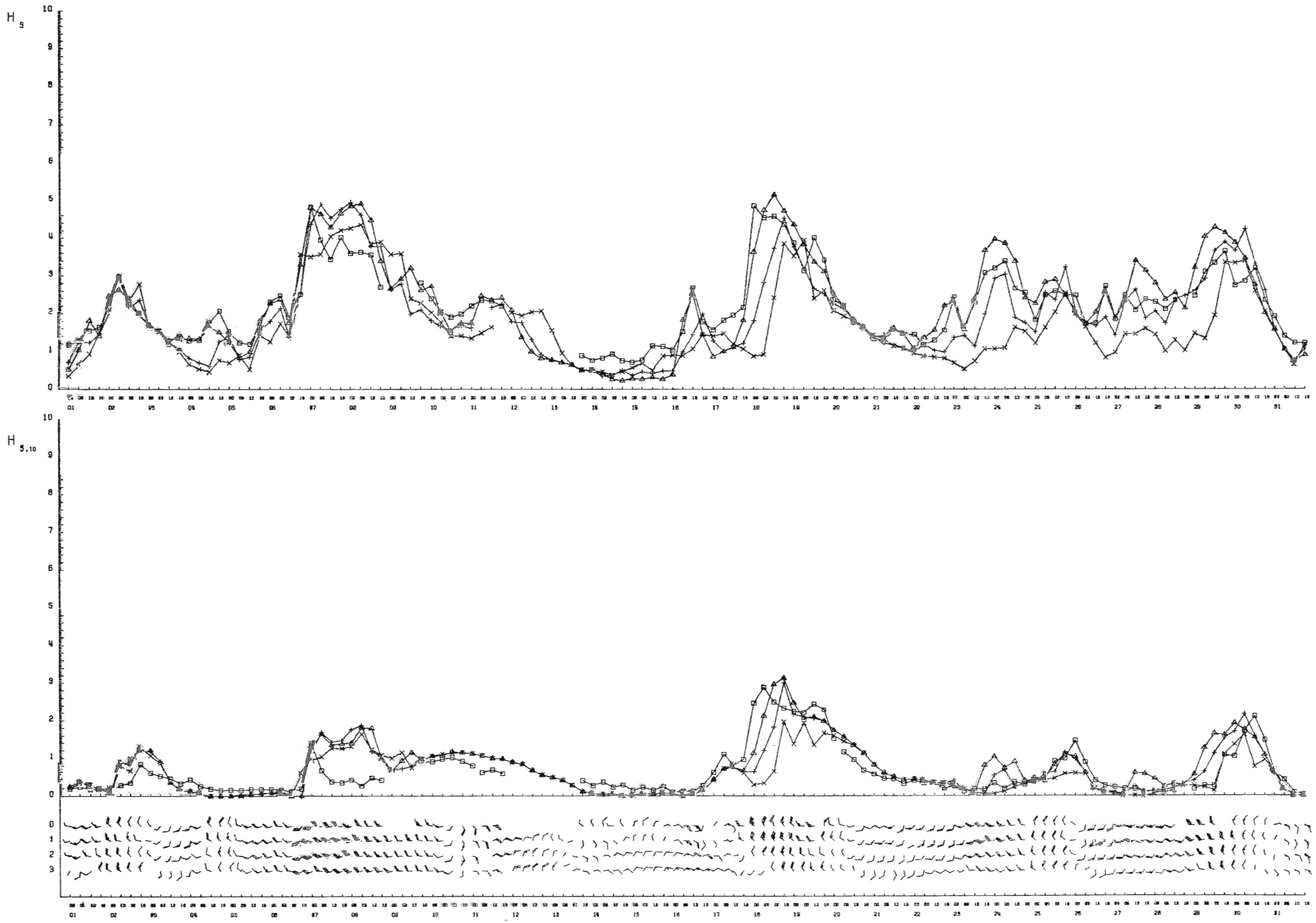
GØNØ

ØCTØBER 1980

MEASURED
ANALYSES
12 HØUR FØRECAST
24 HØUR FØRECAST

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 3



EKØFISK

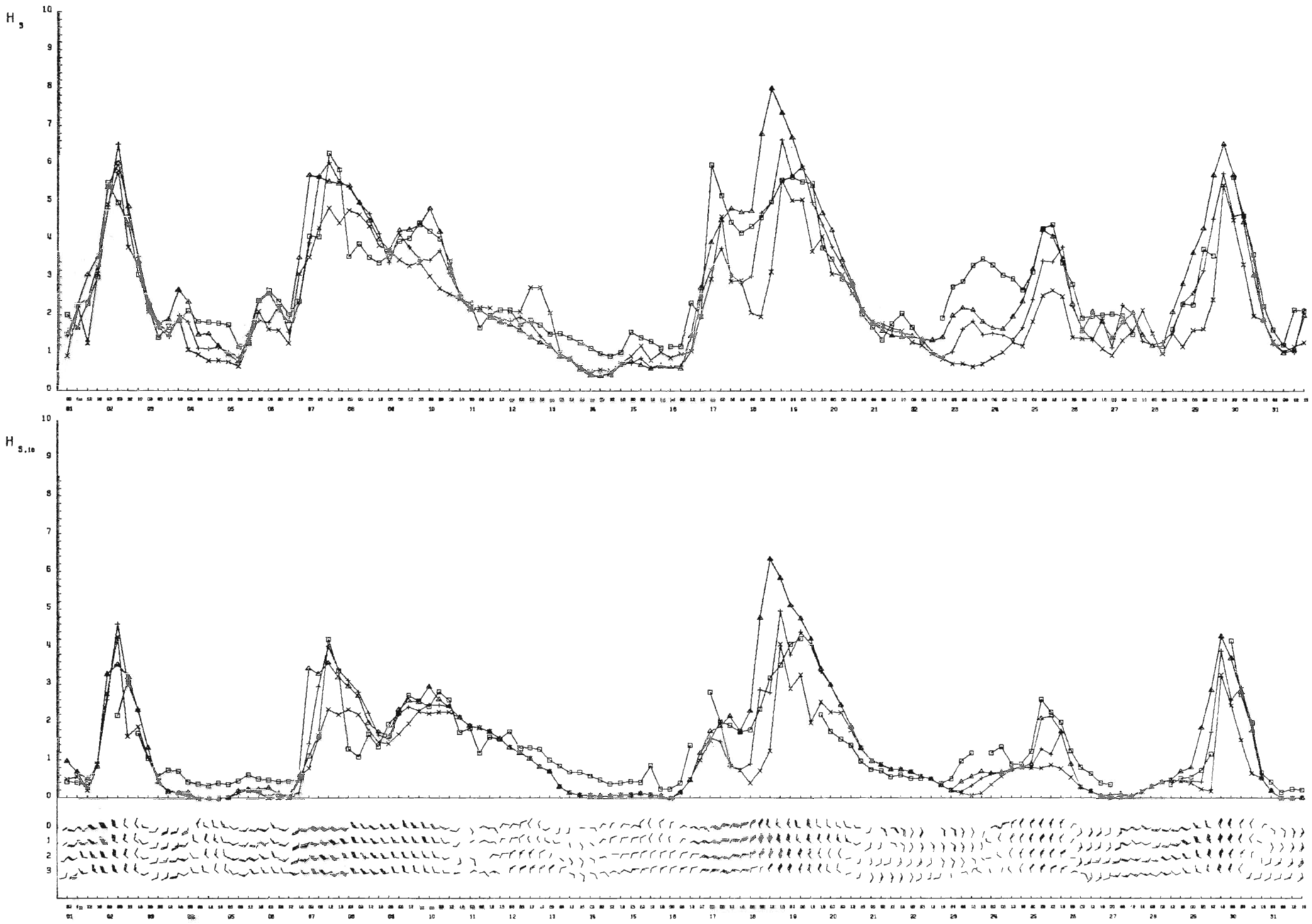
GØNØ

ØCTØBER 1980

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 4

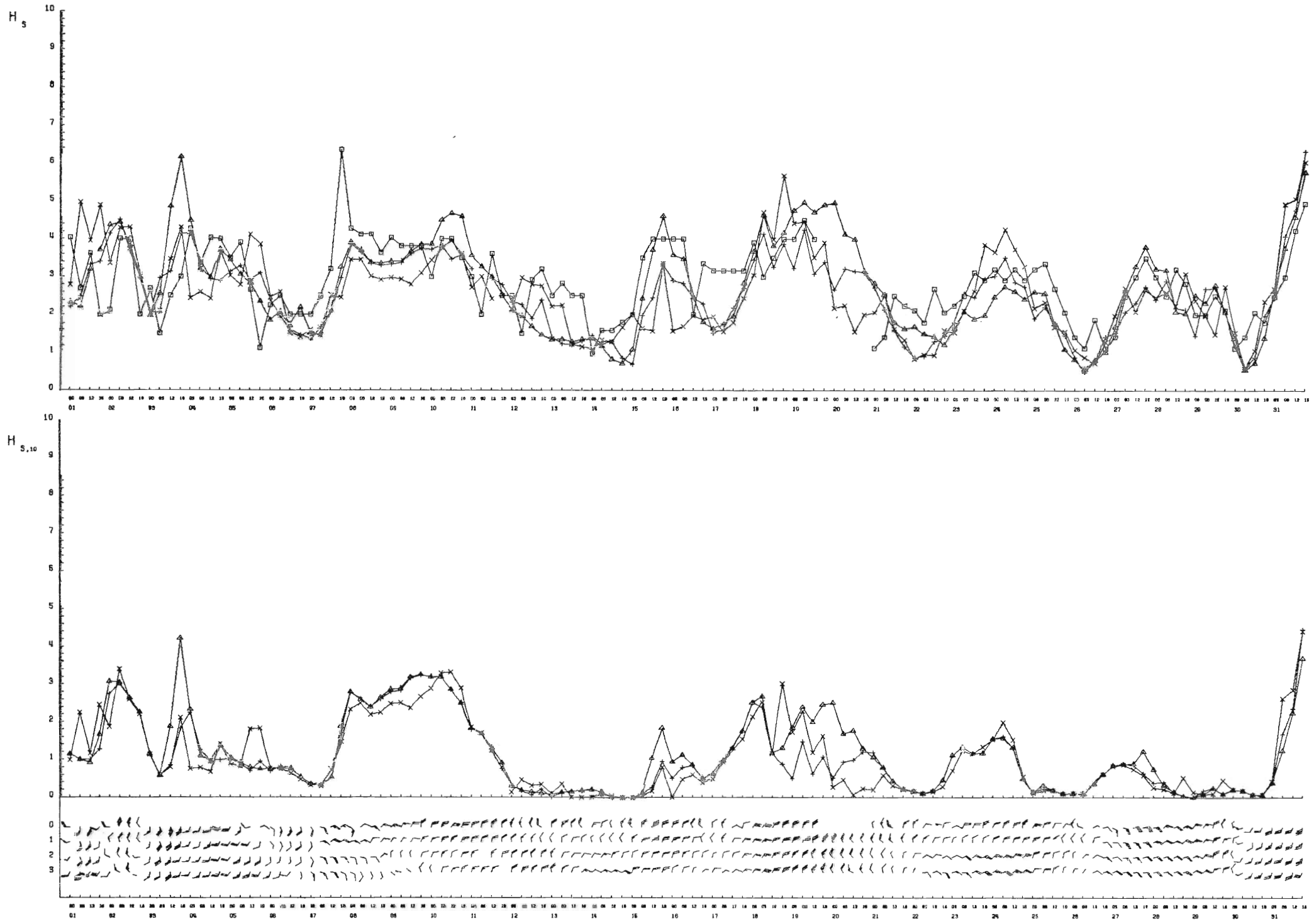


MIKE
GØNØ
ØCTØBER 1980

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 5



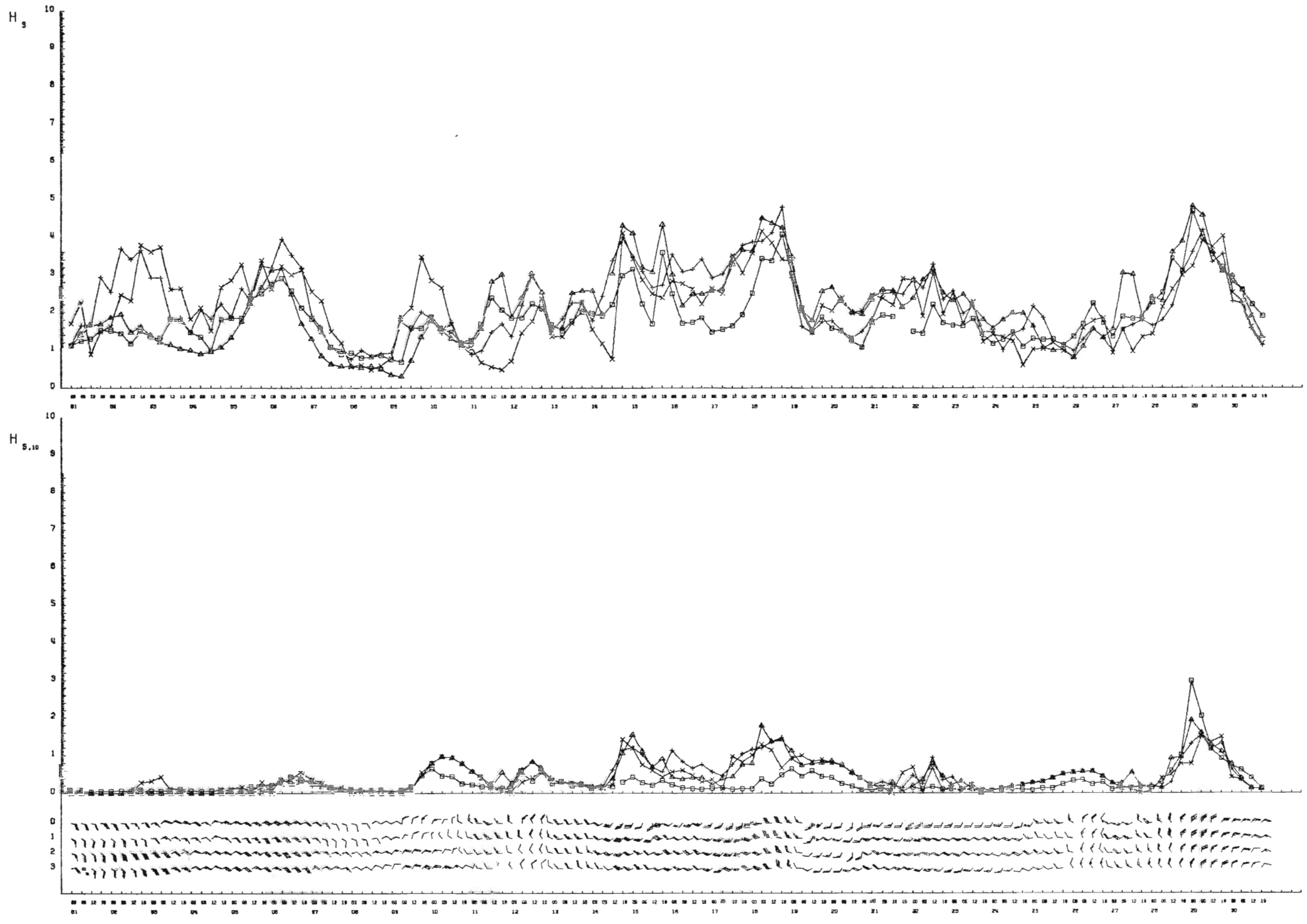
EURØ

GØNØ

NØVEMBER 1980

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 6

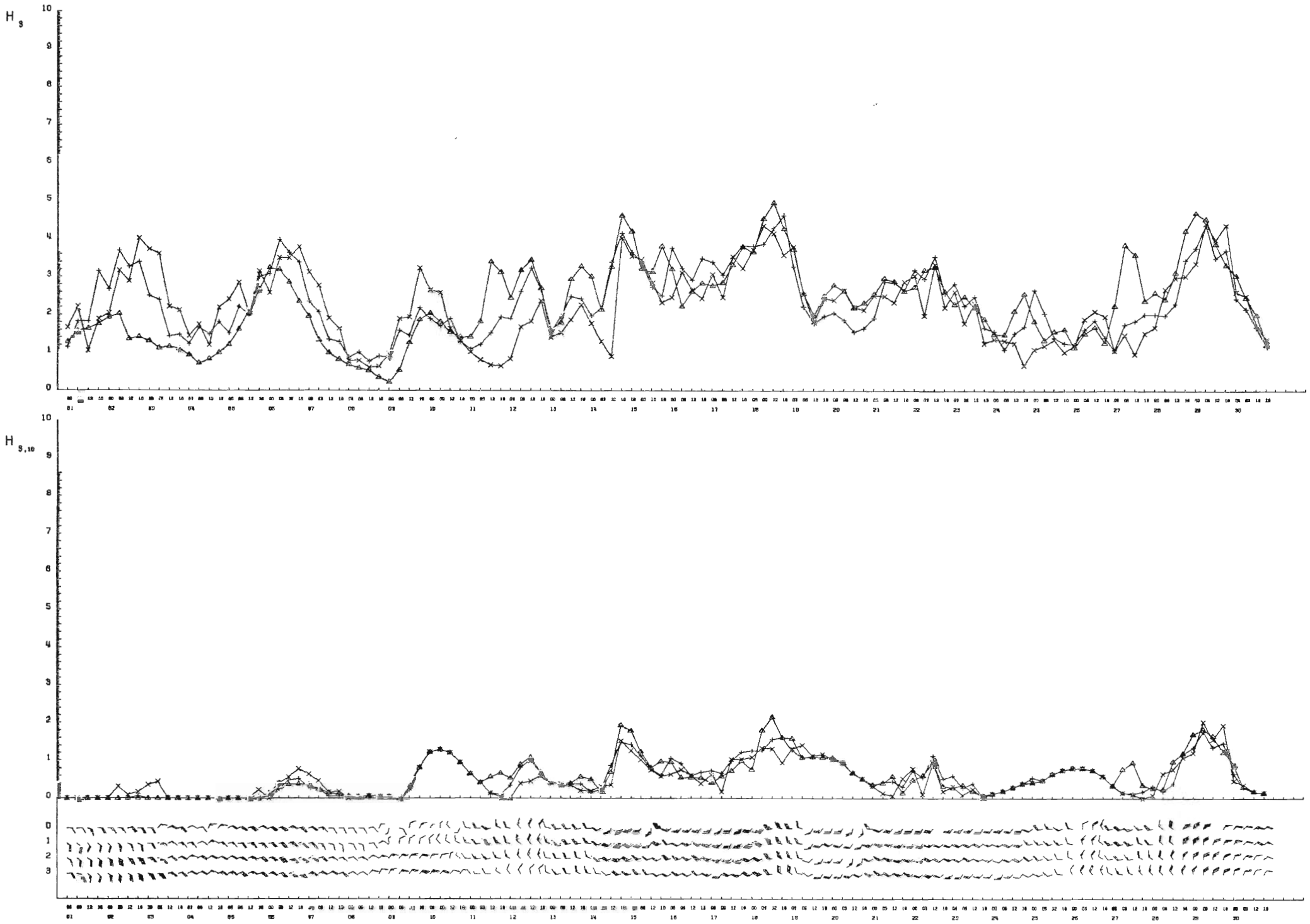


IJMUIDEN
GONØ
NØVEMBER 1980

MEASURED
ANALYSES
12 HØUR FØRECAST
24 HØUR FØRECAST

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 7



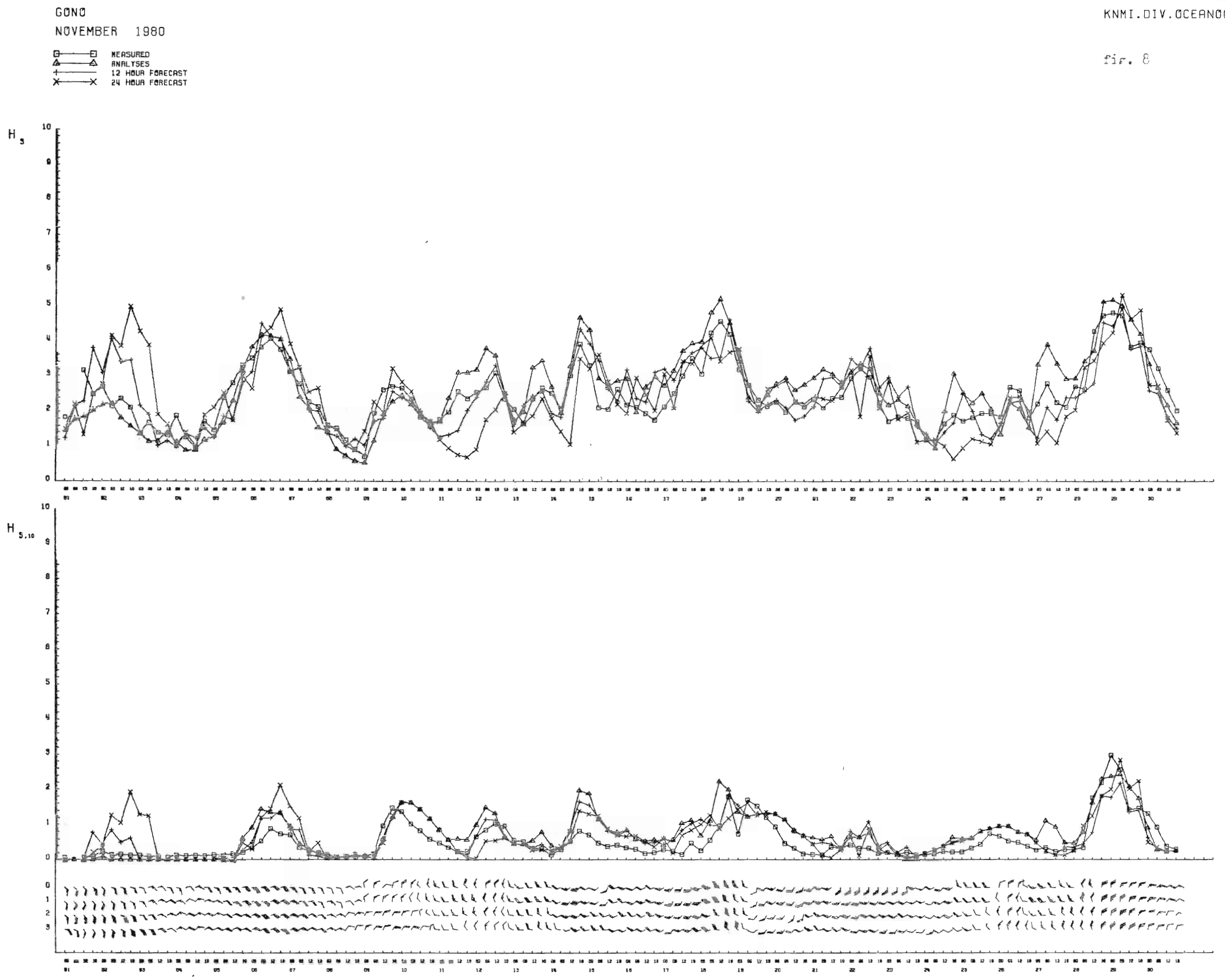
PENNZOIL

GONO

NOVEMBER 1980

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 8



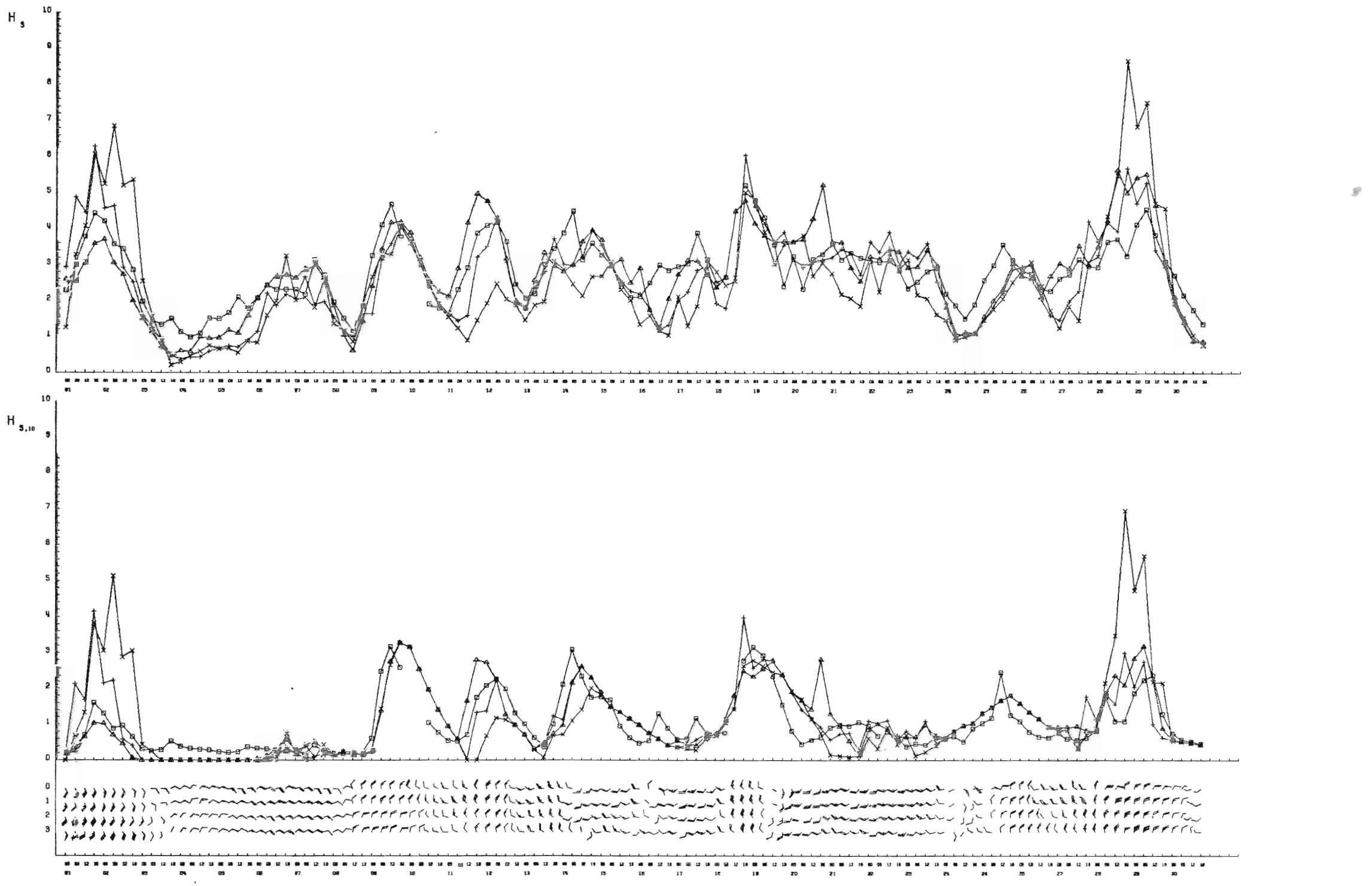
EKOFISK

GONO

NOVEMBER 1980

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

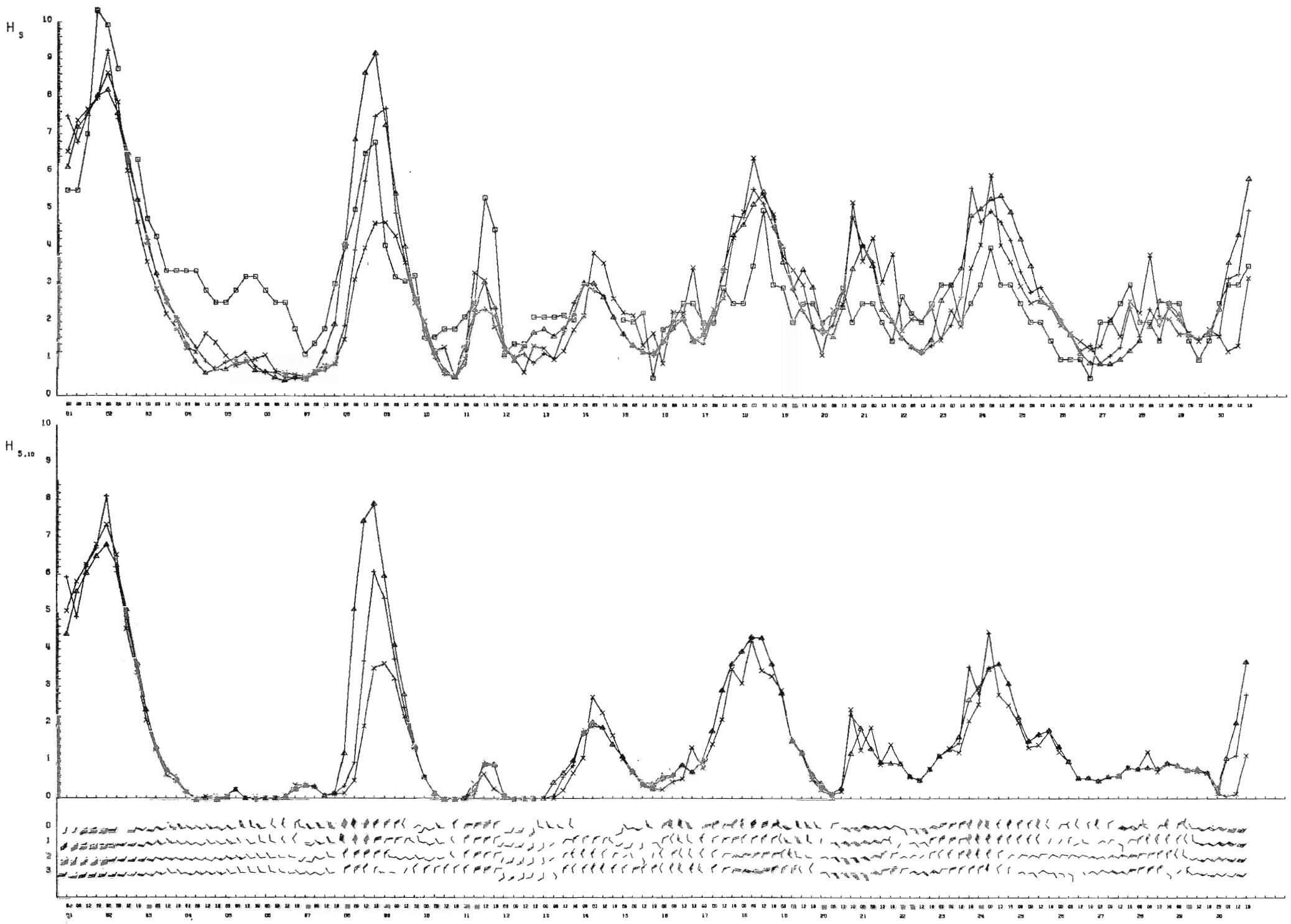
fig. 9



MIKE
GONO
NOVEMBER 1980

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 10



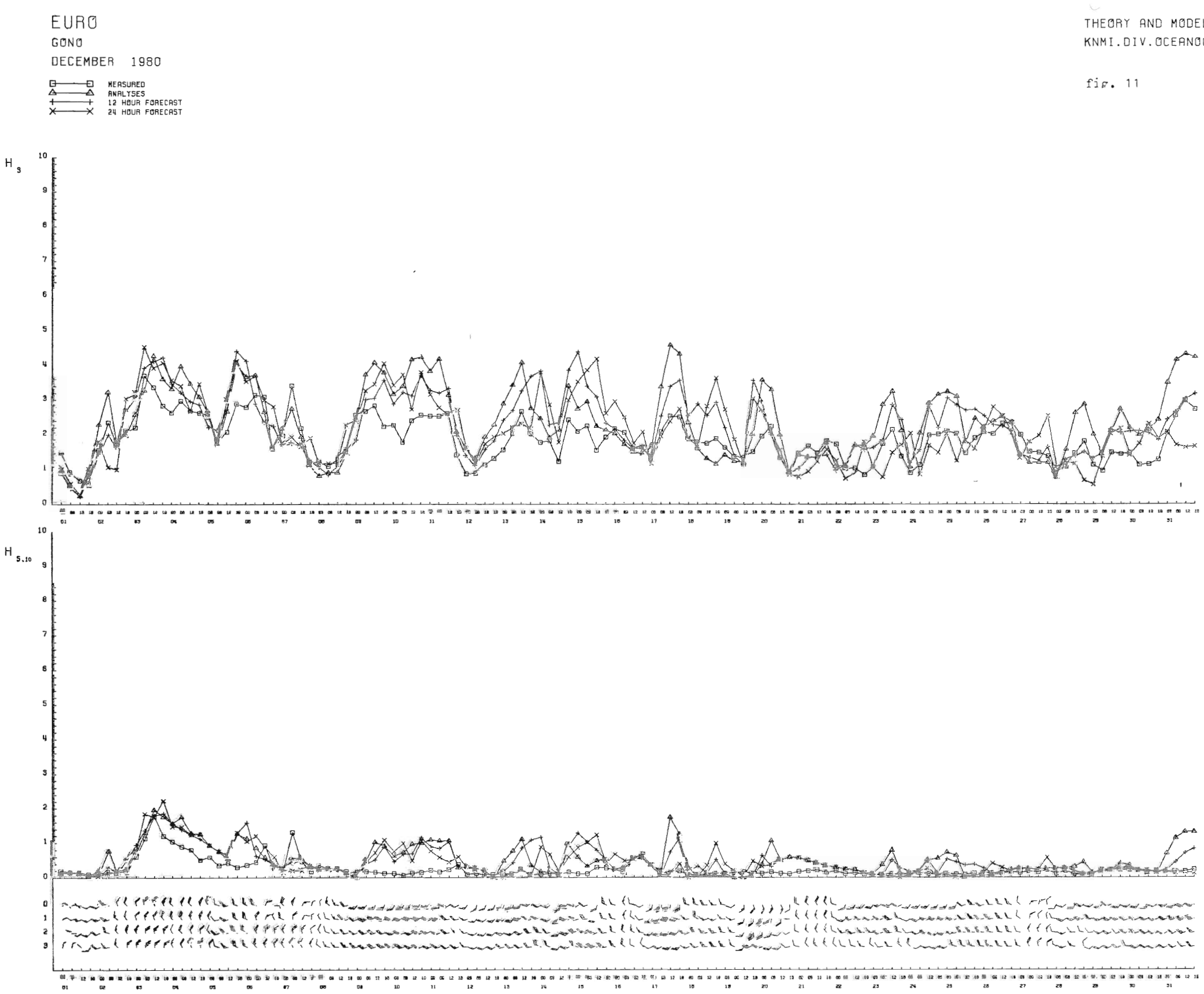
EURØ

GØNØ

DECEMBER 1980

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANØGRAPHY.

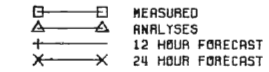
fig. 11



IJMUIDEN

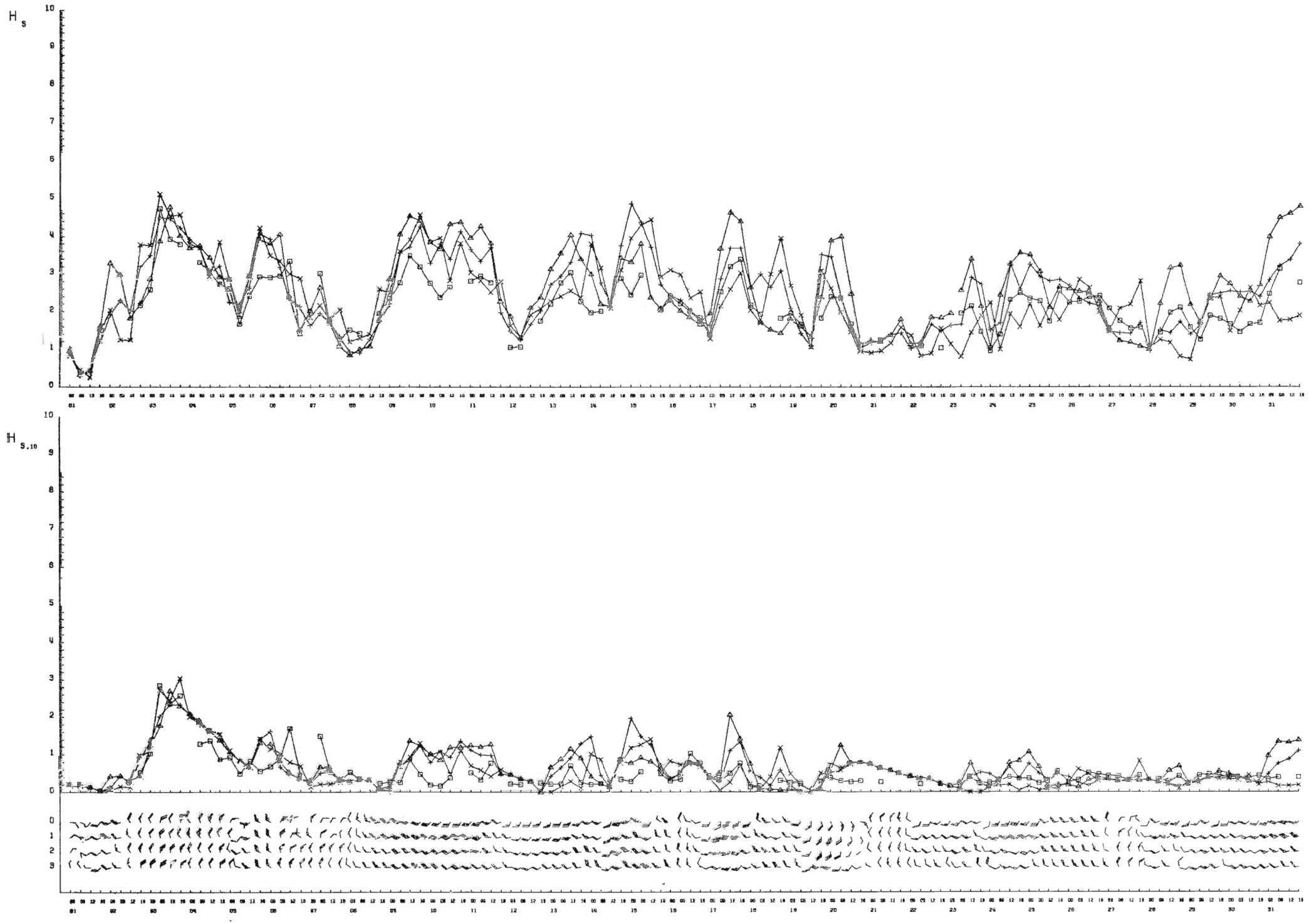
GØNØ

DECEMBER 1980



THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 12



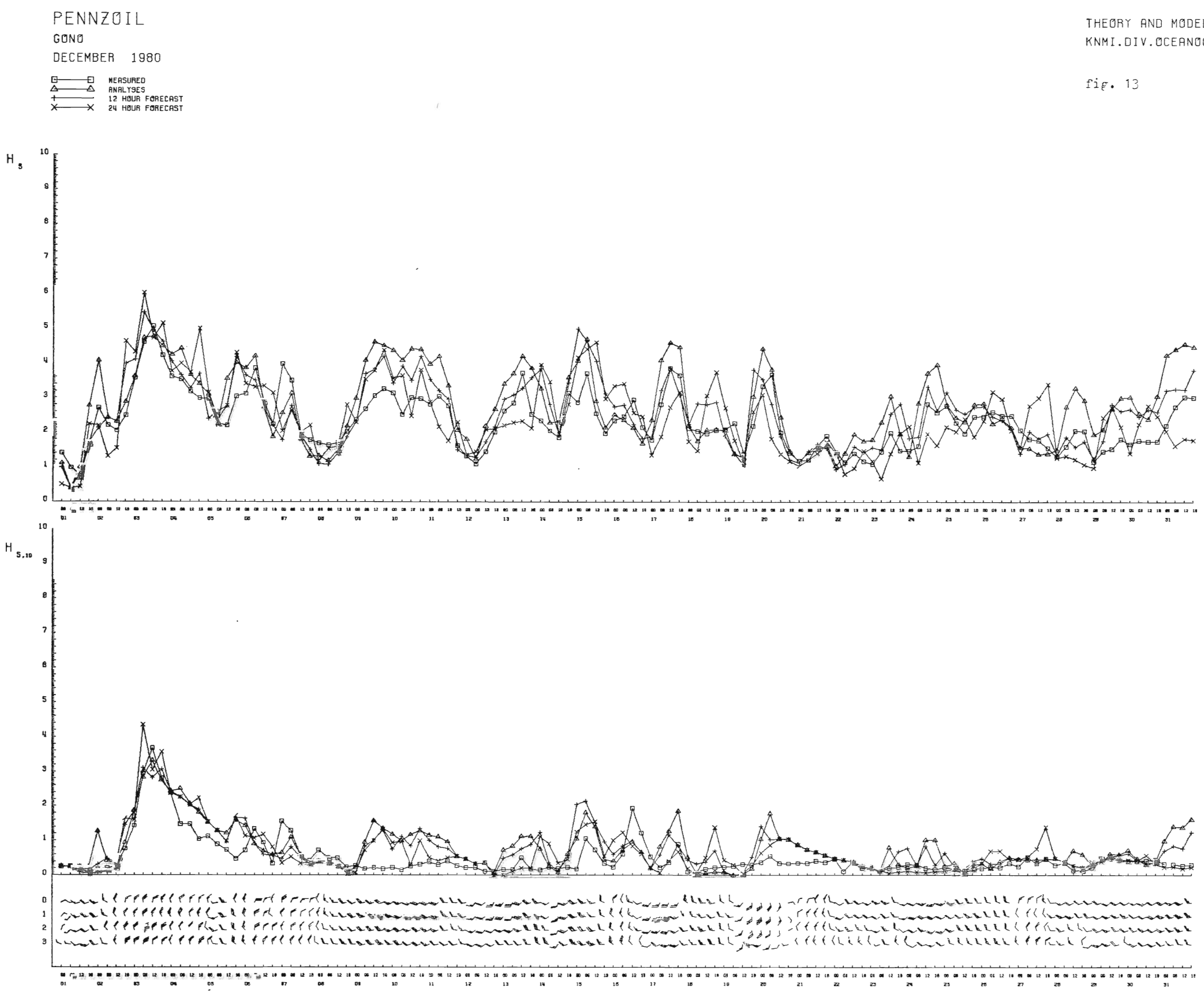
PENNZØIL

GØNØ

DECEMBER 1980

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANØGRAPHY.

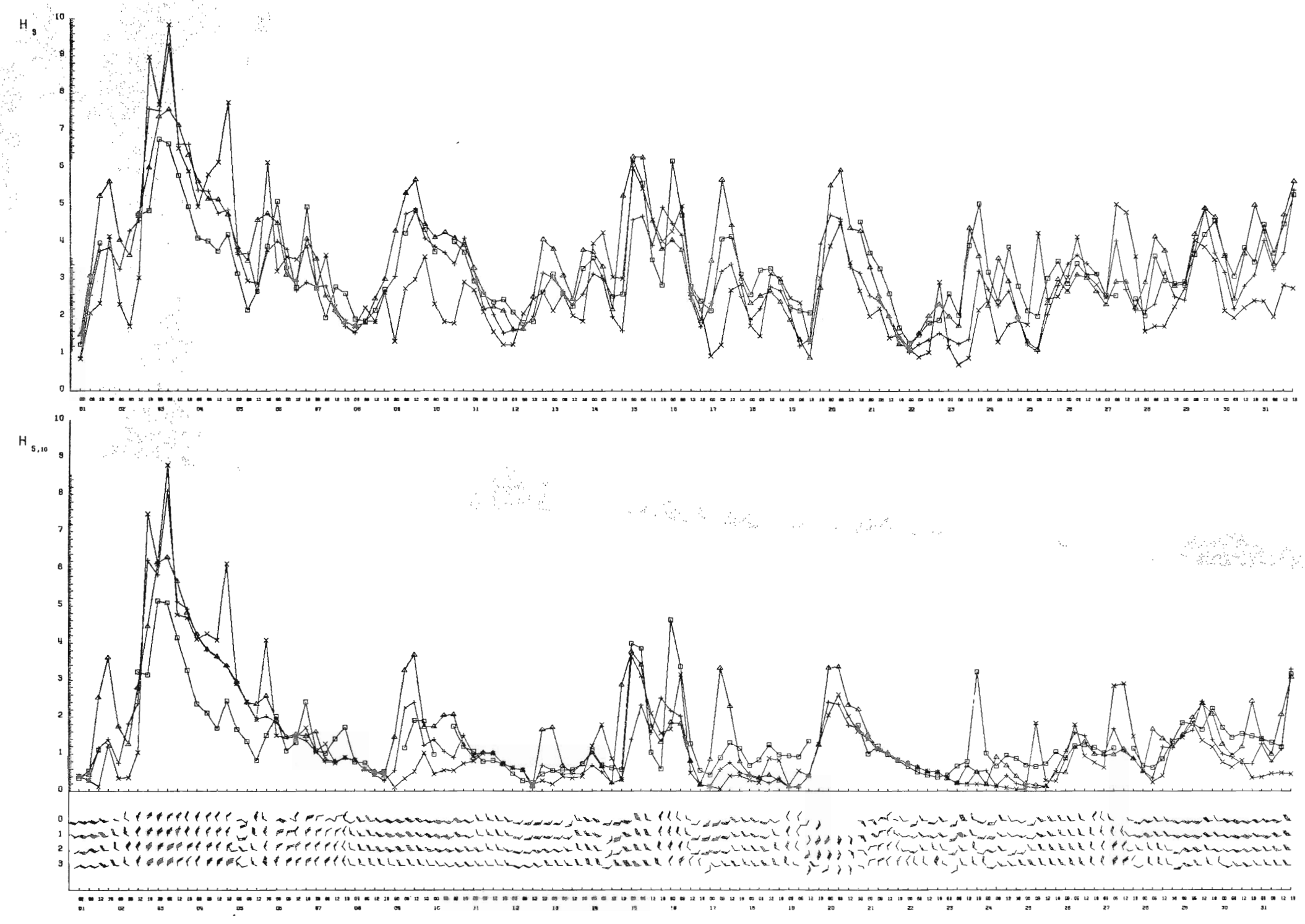
fig. 13



EKØFISK
GØNØ
DECEMBER 1980

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANOGRAPHY.

fig. 14



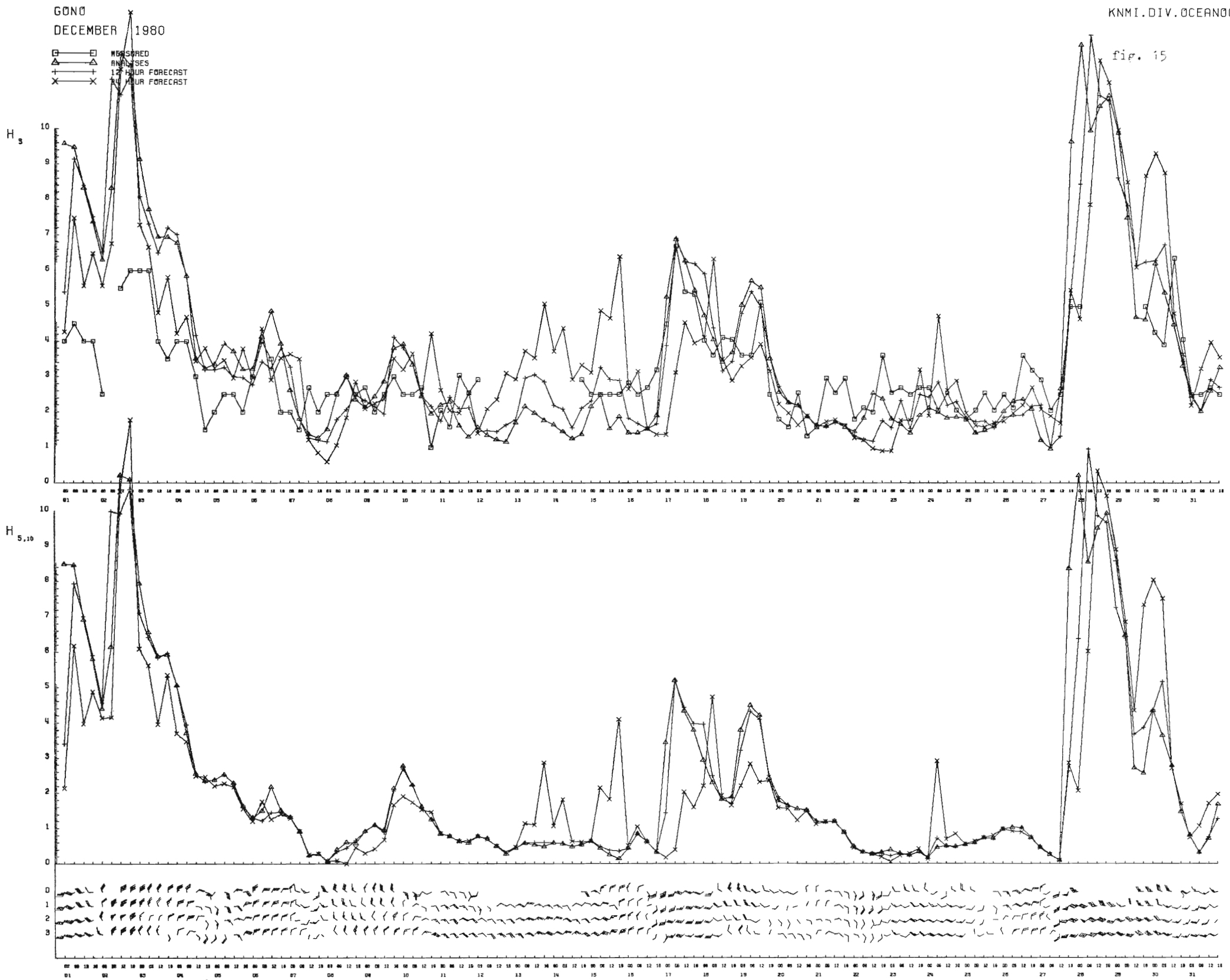
MIKE

GONO

DECEMBER 1980

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 15



EURØ

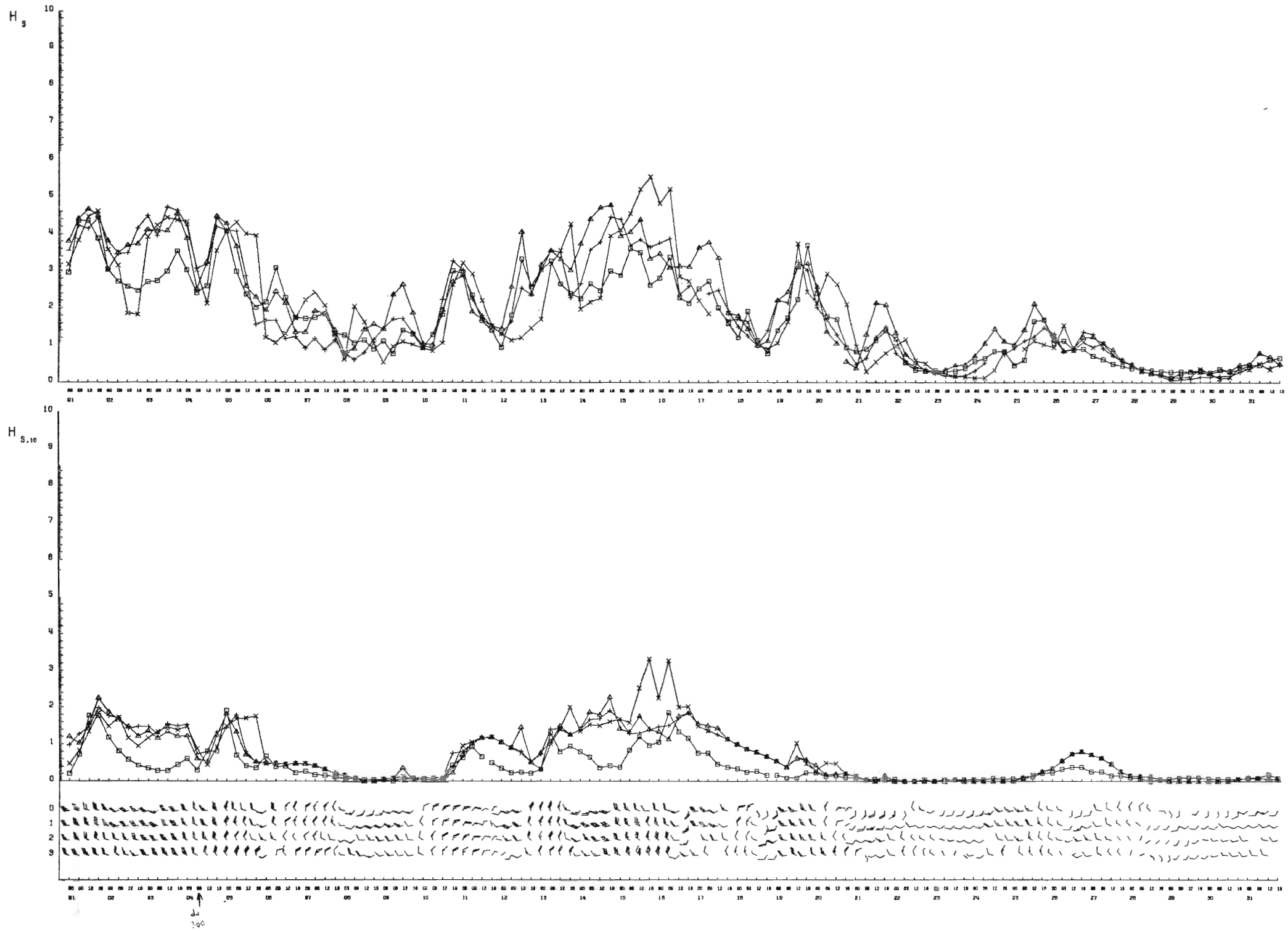
GØNØ

JANUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANØGRAPHY.

fig. 16



IJMUIDEN

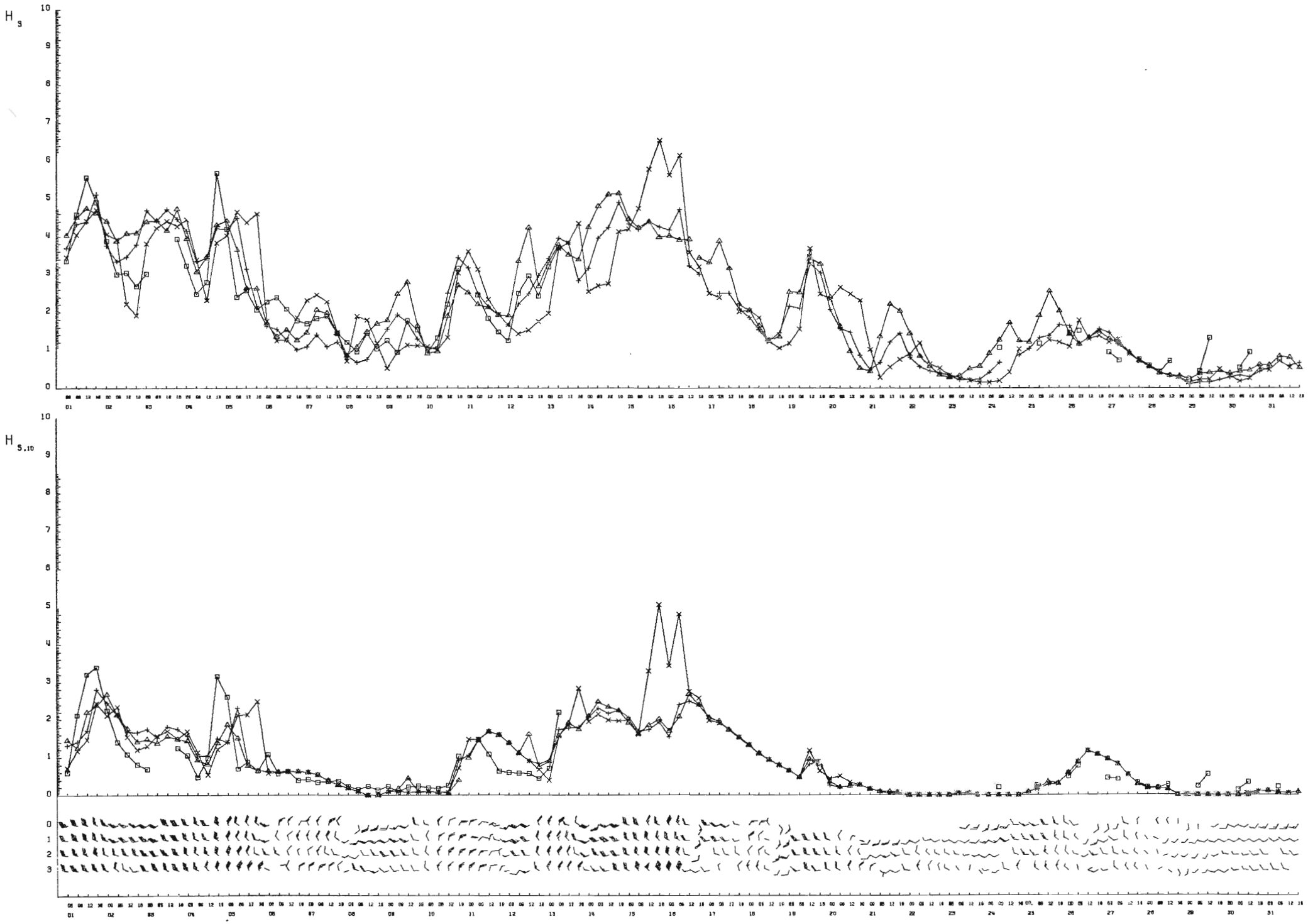
GONO

JANUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 17



PENNZOIL

GONG

JANUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

H_s

$H_{s,10}$

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 18

EKØFISK

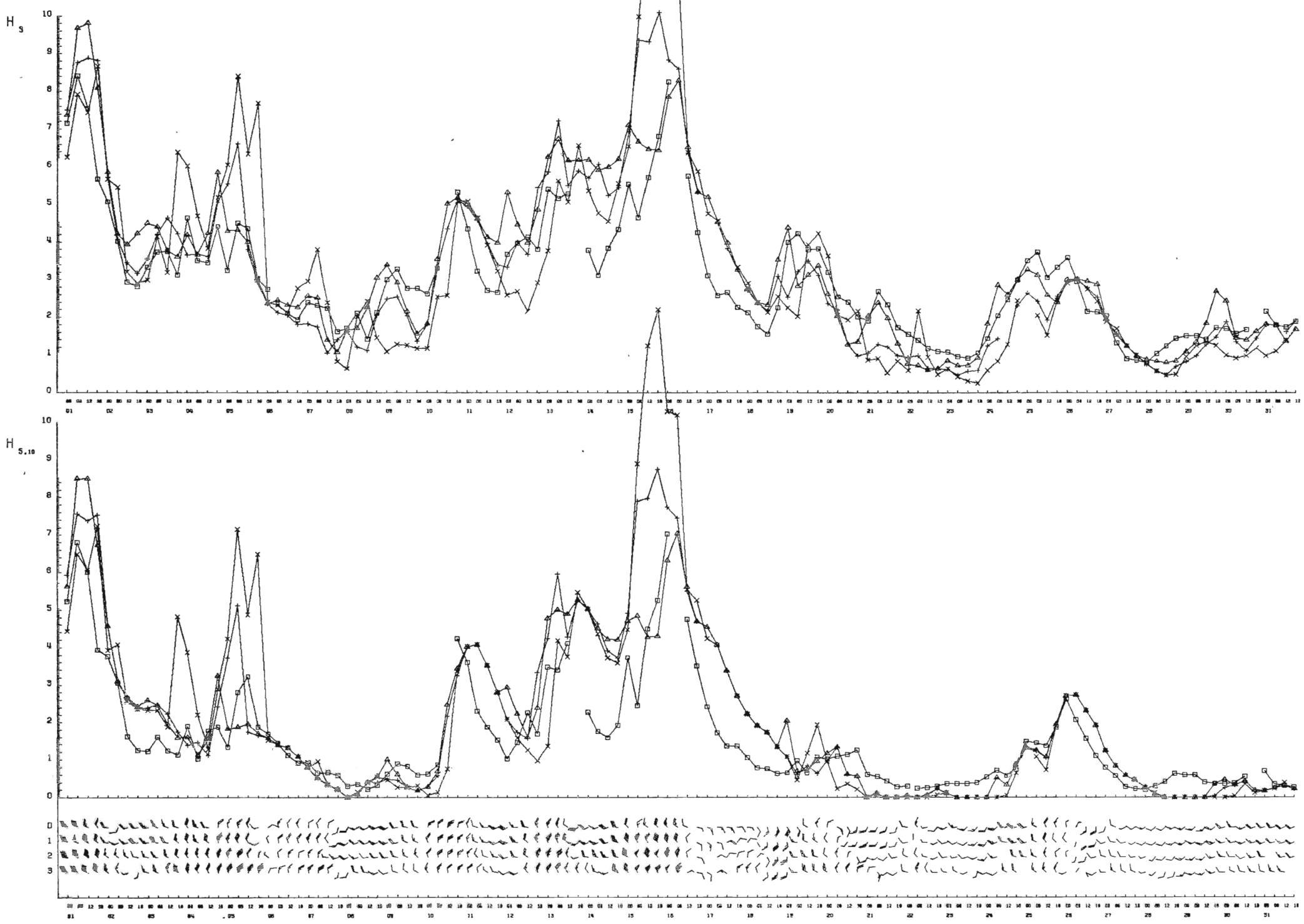
GØNØ

JANUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MØDELLING GRØUP
KNMI.DIV.OCEANOGRAPHY.

fig. 19



MIKE

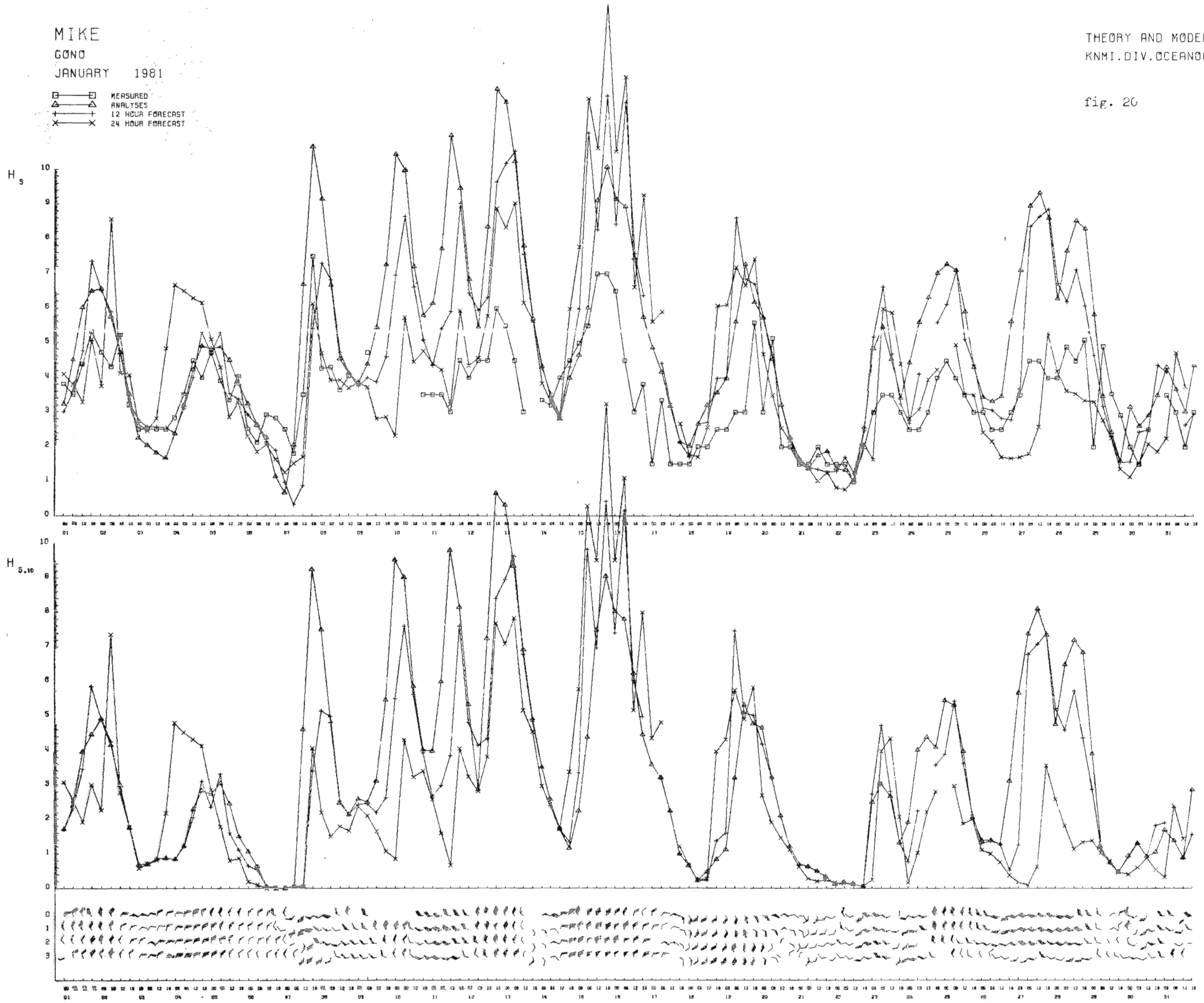
GØNO

JANUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 20



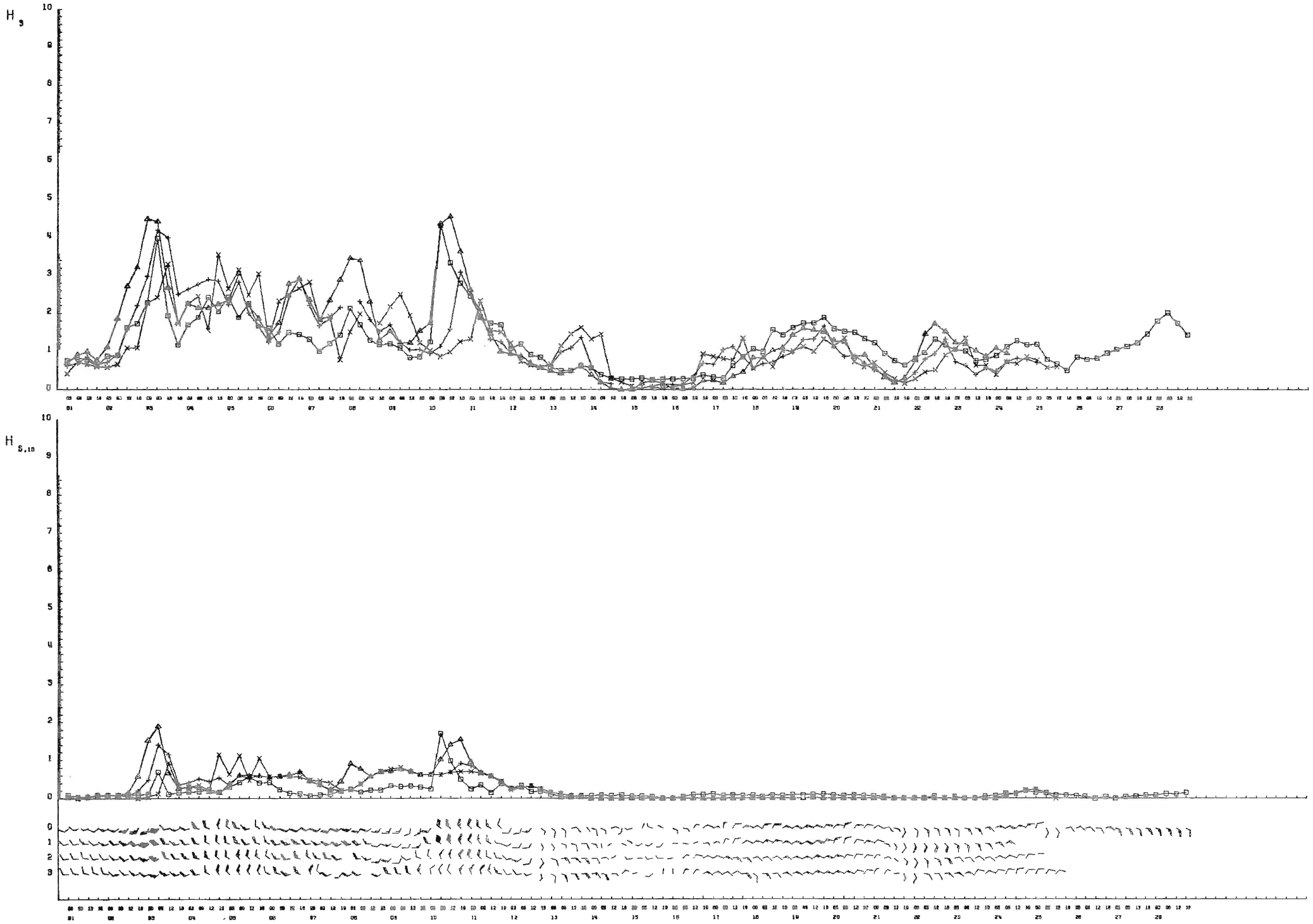
EURØ

GØNØ

FEBRUARY 1981

THEORY AND MØDELLING GRØUP
KNMI.DIV.OCEANOGRAPHY.

fig. 21



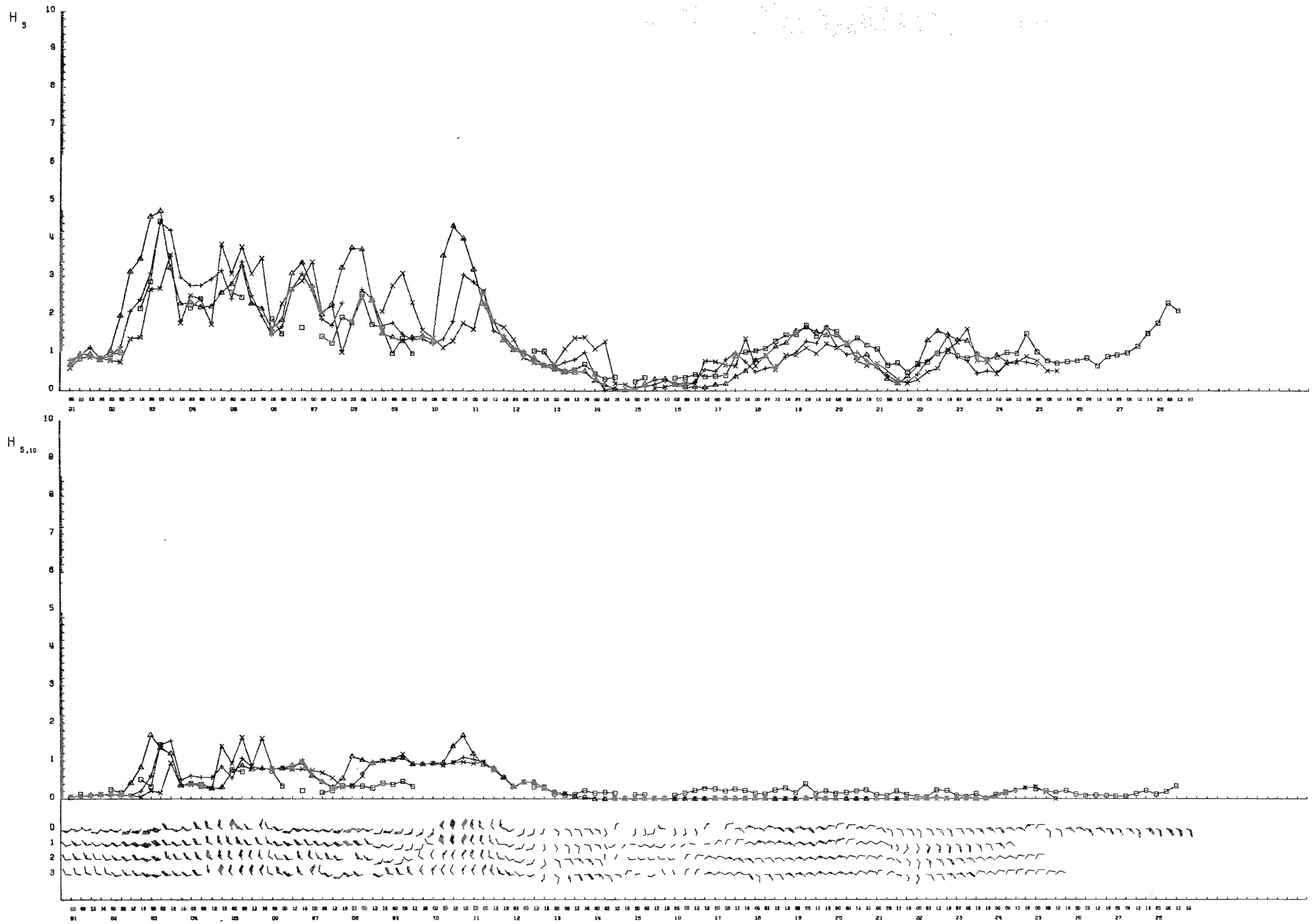
IJMUIDEN

GØNØ

FEBRUARY 1981

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 22



PENNZOIL

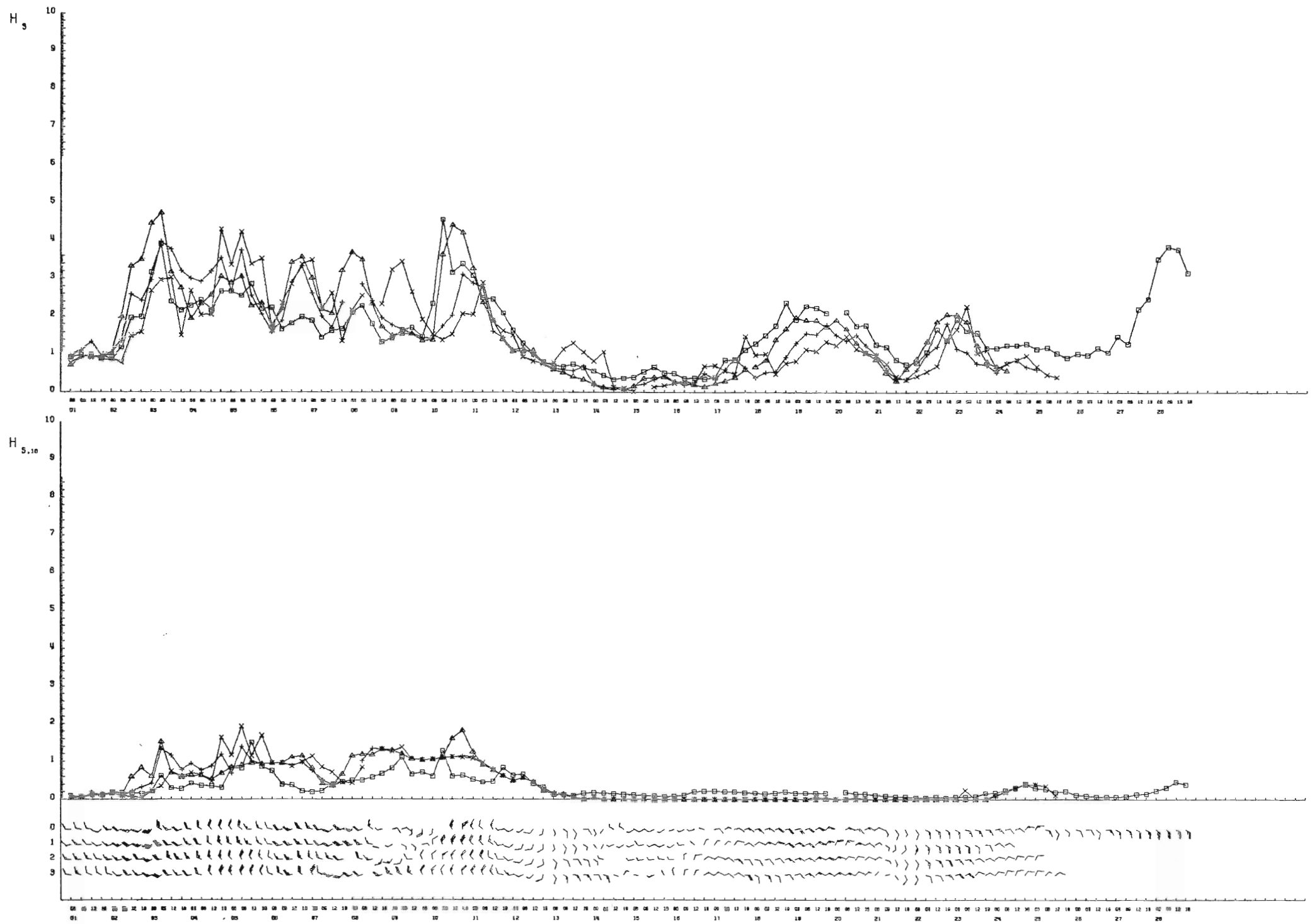
GONO

FEBRUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 23



EKOFISK

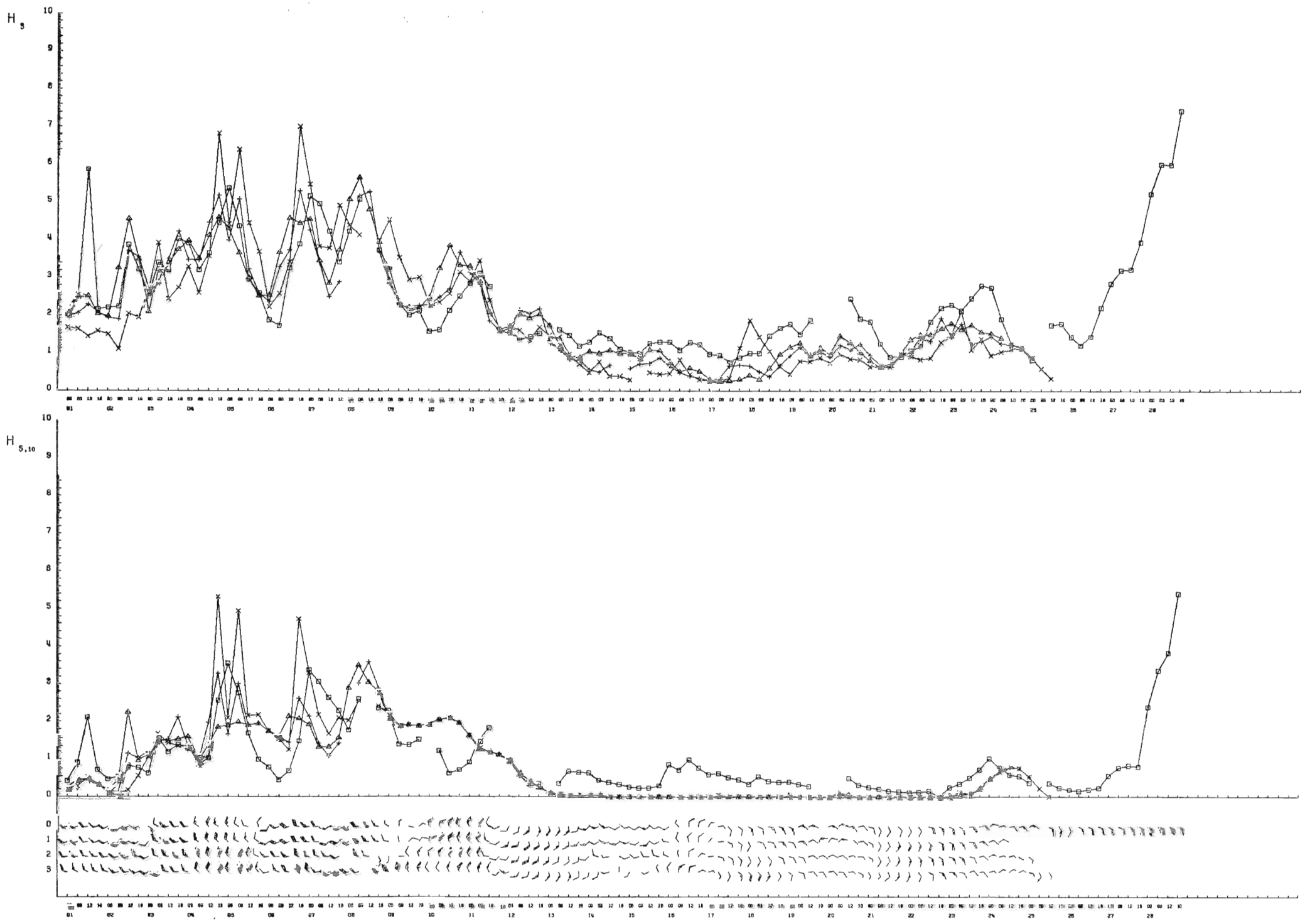
GONO

FEBRUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 24



MIKE

GONO

FEBRUARY 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

H_s

$H_{s,10}$

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

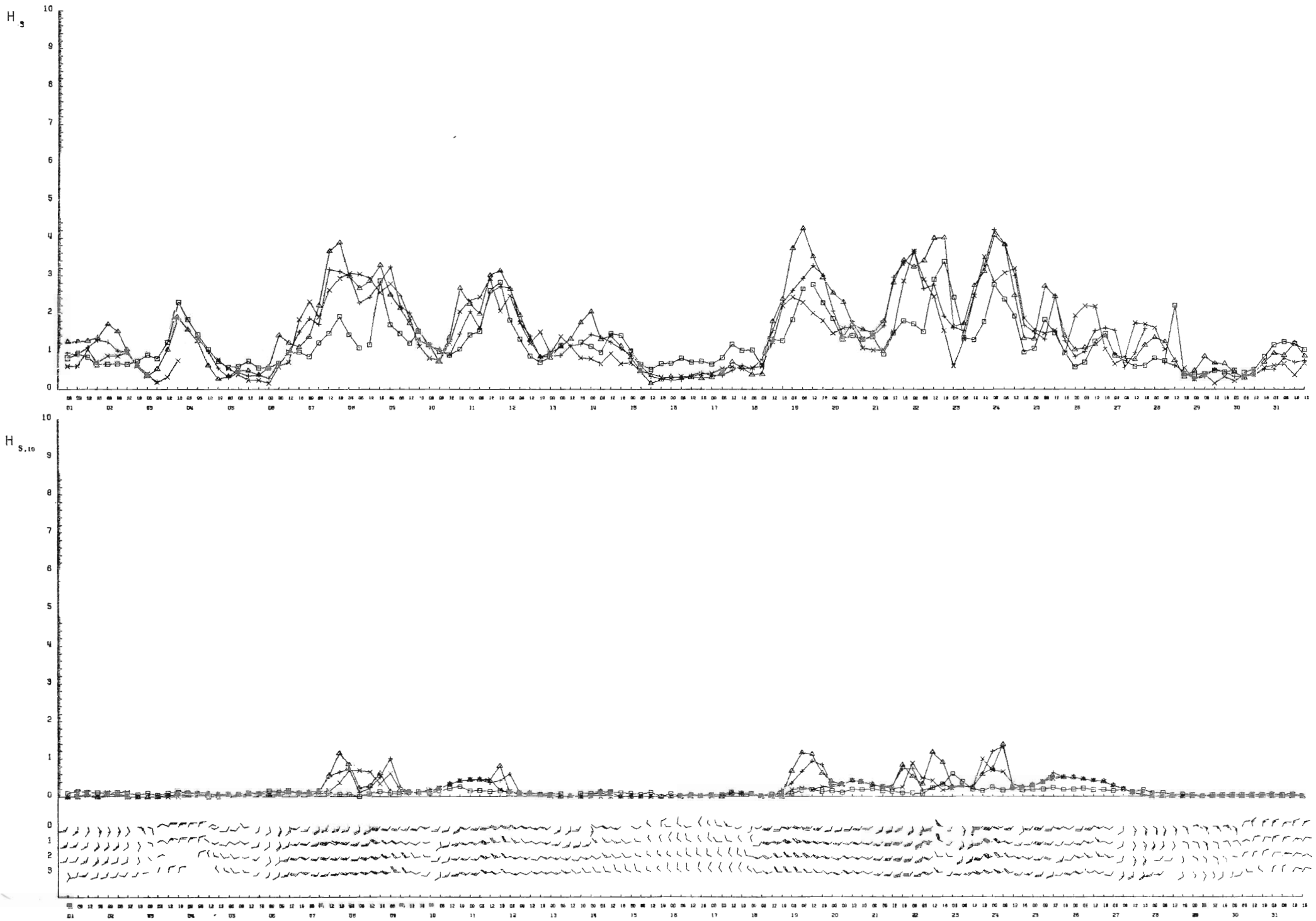
fig. 25

EURØ
GØNØ
MARCH 1981

MEASURED
ANALYSES
12 HØUR FORECAST
24 HØUR FORECAST

THEORY AND MØDELLING GRØUP
KNMI.DIV.ØCEANOGRAPHY.

fig. 26



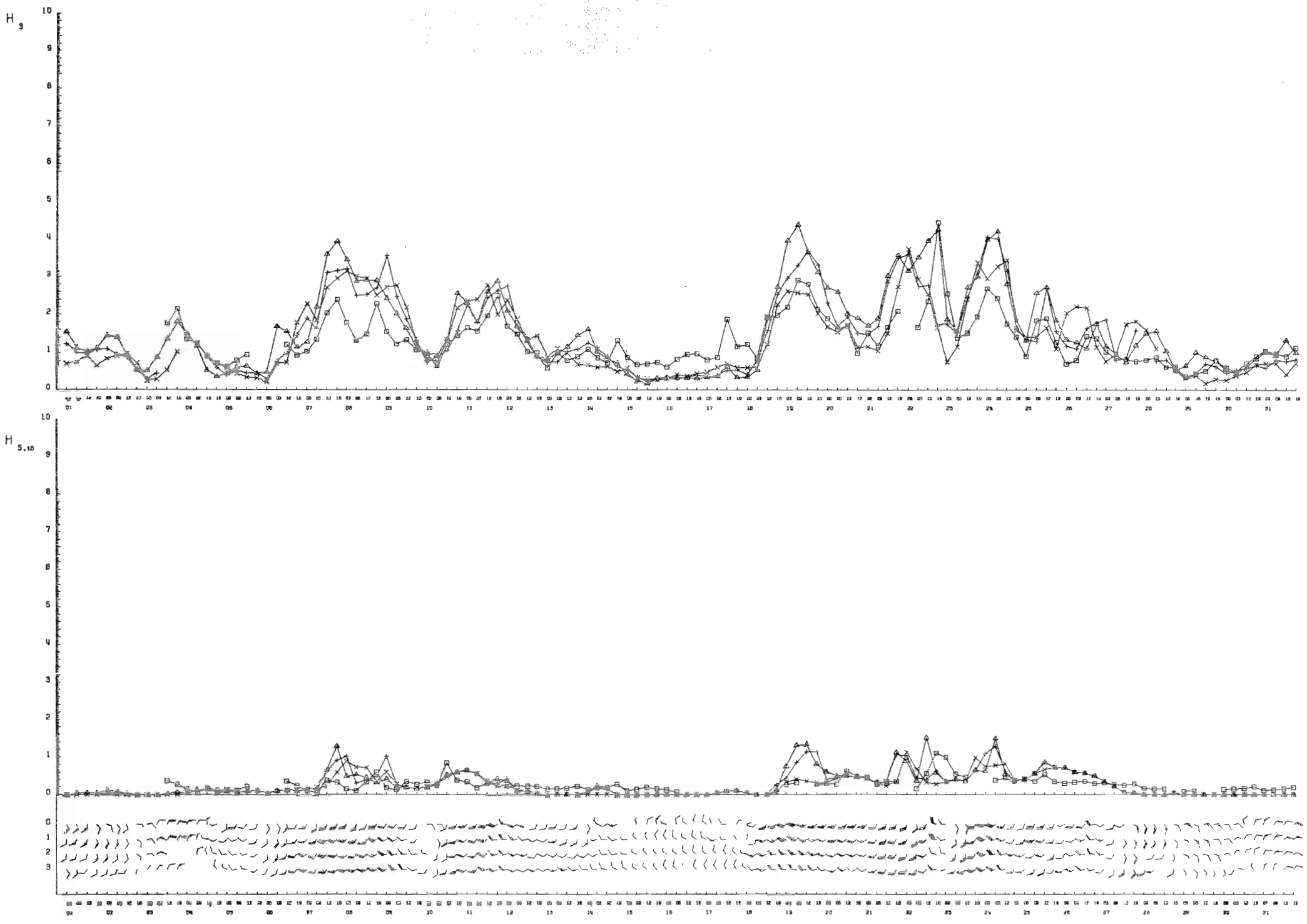
IJMUIDEN

GØNØ

MARCH 1981

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANOGRAPHY.

fig. 27



PENNZØIL

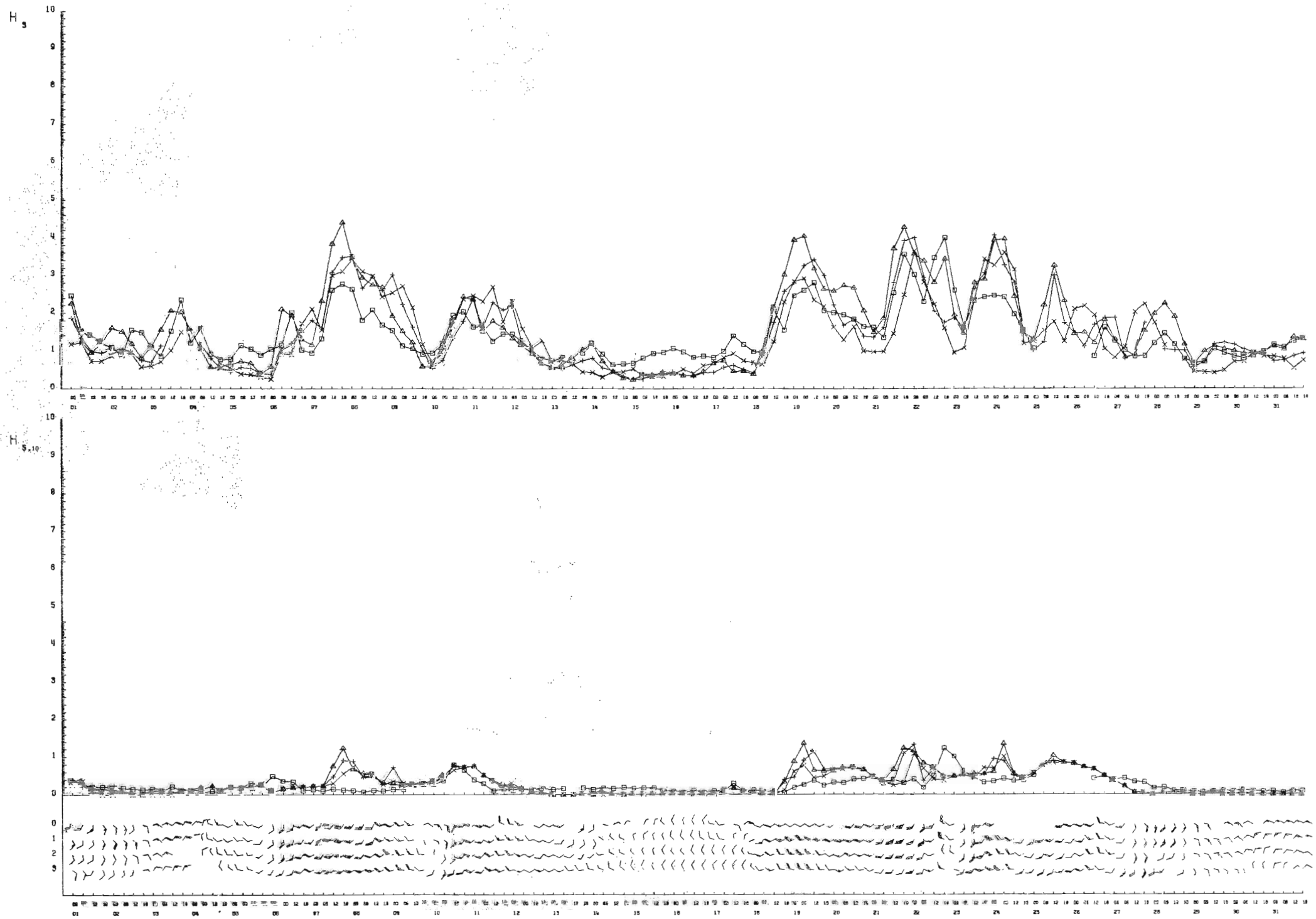
GØNØ

MARCH 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 28



EKOFISK

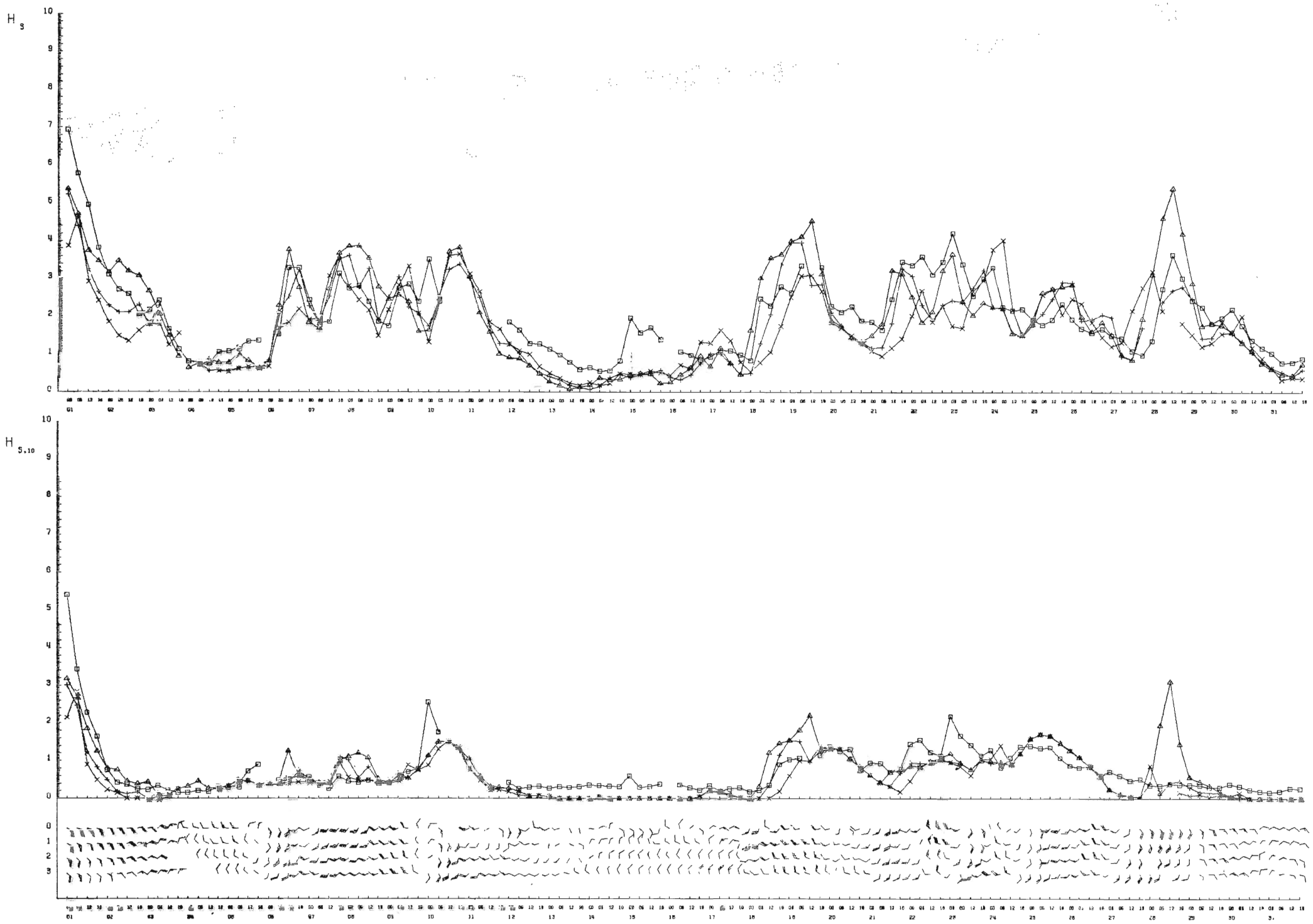
GONO

MARCH 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 29



MIKE

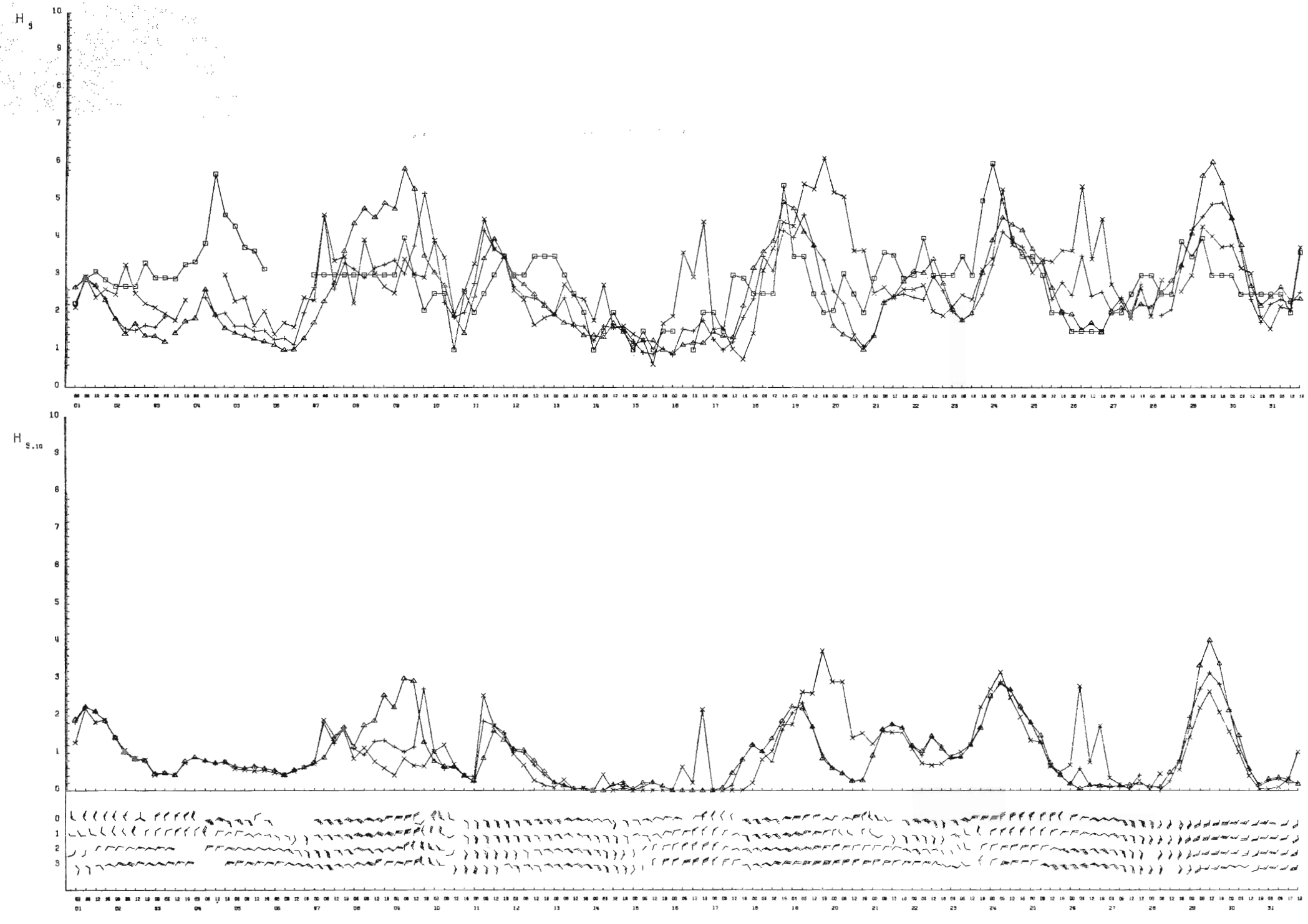
GØNØ

MARCH 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEØRY AND MØDELLING GRØUP
KNMI.DIV.ØCEANOGRAPHY.

fig. 30



EURØ

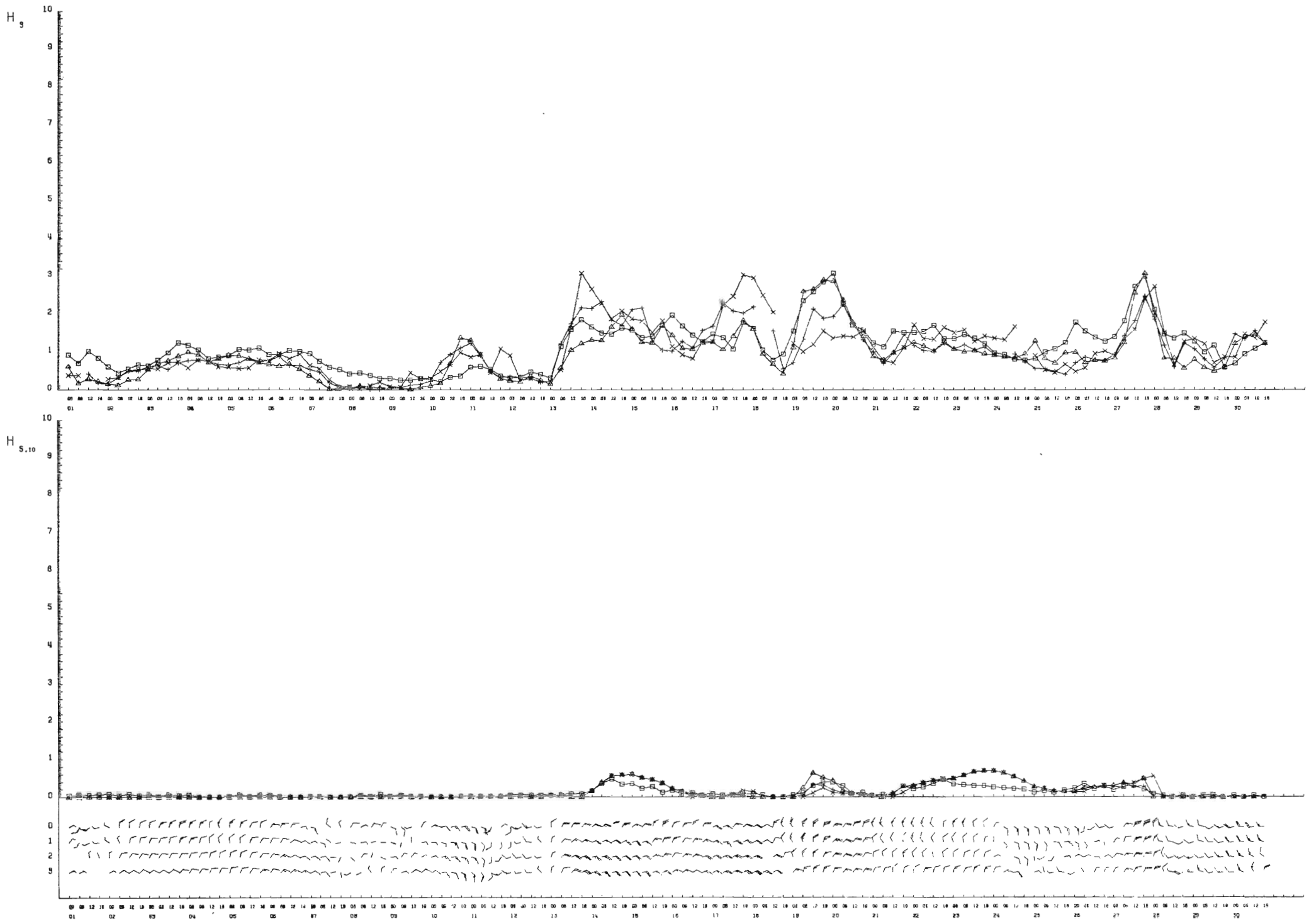
GØNØ

APRIL 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEØRY AND MØDELLING GRØUP
KNMI.DIV.OCEANØGRAPHY.

fig. 31



IJMUIDEN

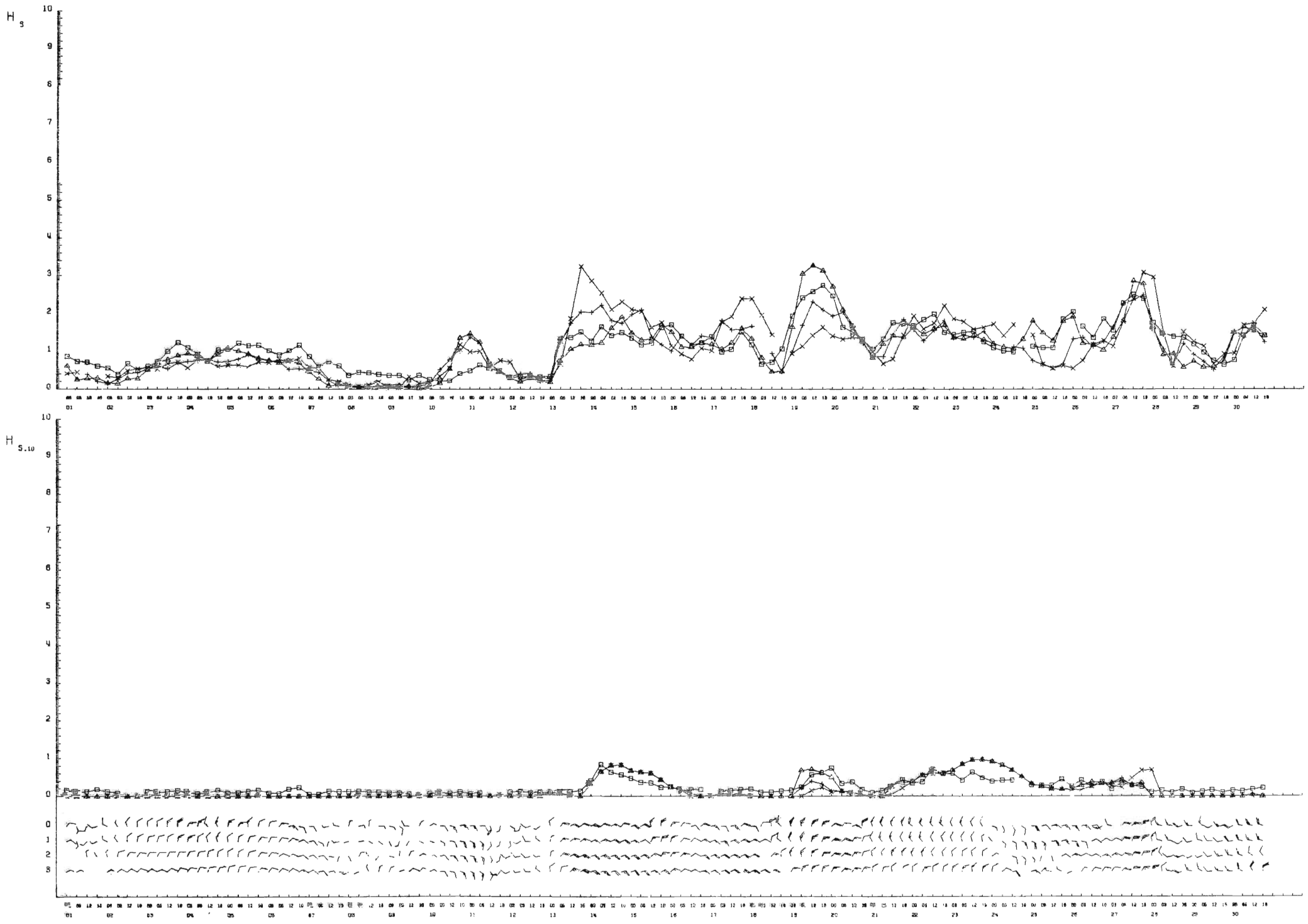
GØNØ

APRIL 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 32



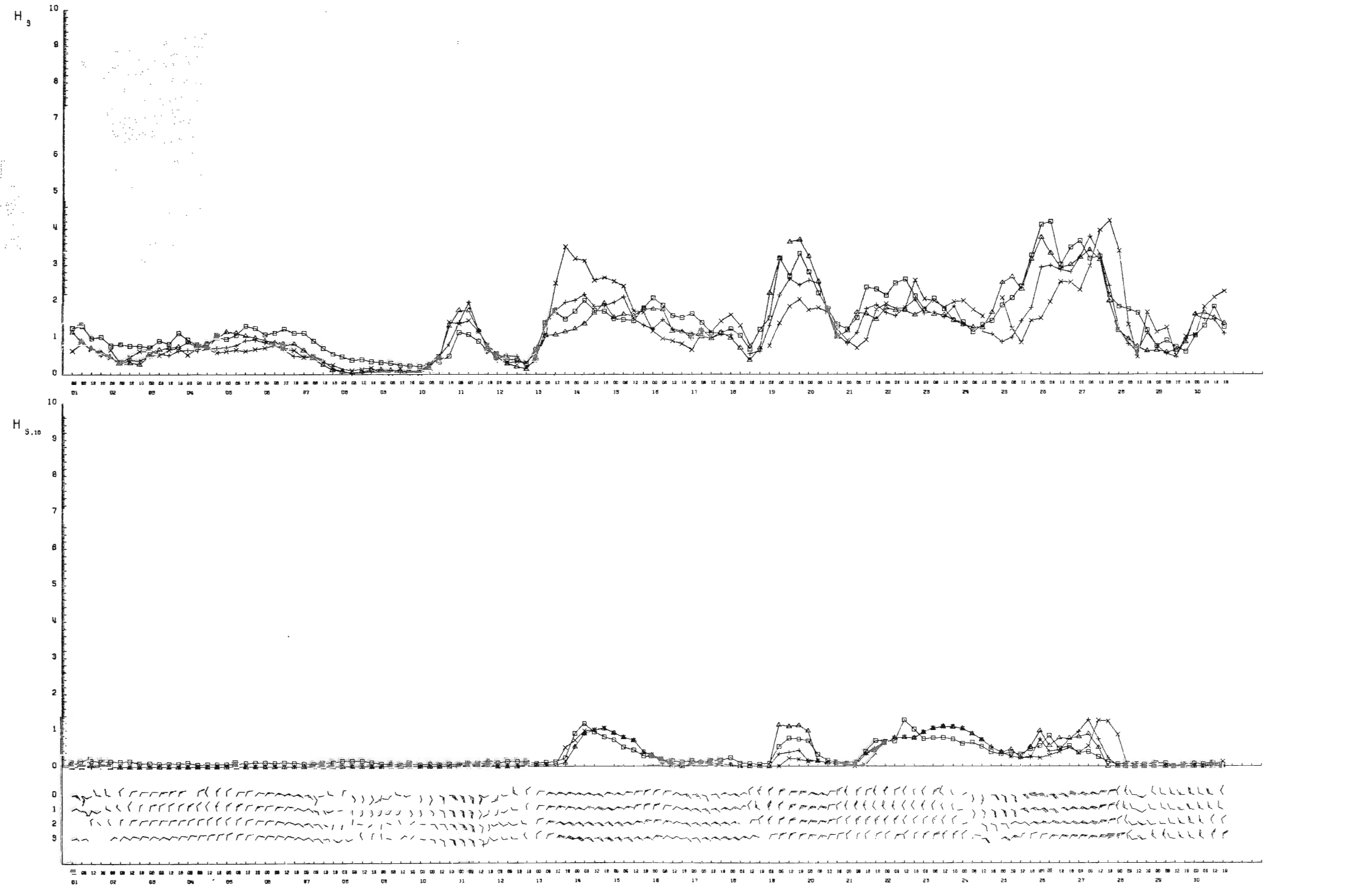
PENNZOIL

GONO

APRIL 1981

THEORY AND MODELLING GROUP
KNMI.DIV.OCEANOGRAPHY.

fig. 33



EKØFISK

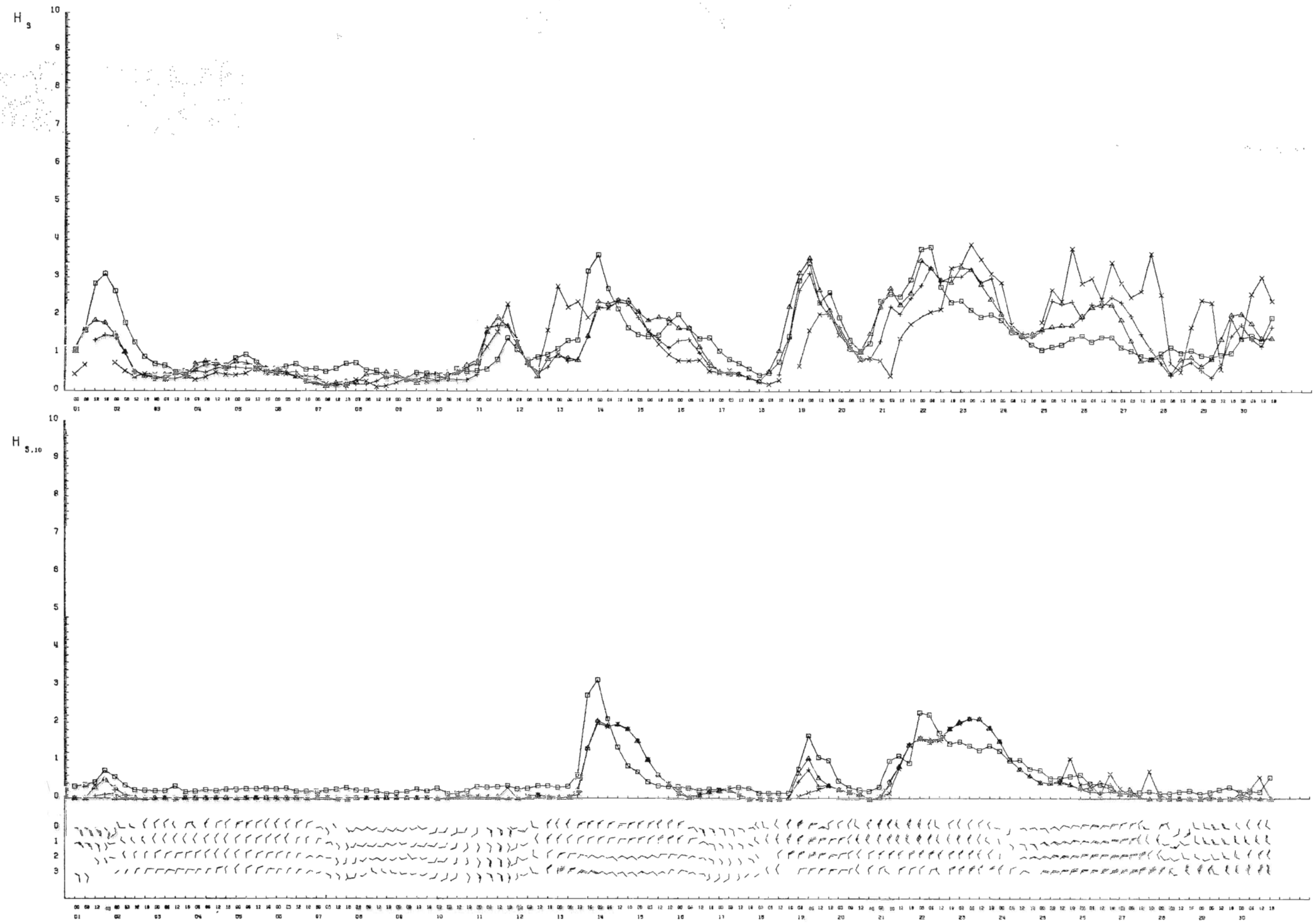
GØNØ

APRIL 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

THEØRY AND MØDELLING GROUP
KNMI.DIV.ØCEANØGRAPHY.

fig. 34



MIKE
GONO
APRIL 1981

MEASURED
ANALYSES
12 HOUR FORECAST
24 HOUR FORECAST

H_s

$H_{s,10}$

THEORY AND MODELLING GROUP
KNMI. DIV. OCEANOGRAPHY.

fig. 35