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TITTEL

A STUDY OF WIND CONDITIONS
UTSIRA - STORD
JANUARY - FEBRUARY

UTARBEIDET AV

ALV SUNDE
MAGNAR REISTAD

OPPDRAKSGIVER

NORWEGIAN CONTRACTORS

OPPDRAKSNR.

SAMMENDRAG

1. Study of long term statistics from Utsira
2. Comparison of wind data Utsira-Stord and estimating transfer coefficients for forecasting purpose.
3. Some typical weather situations

UNDERSKRIFT

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SAKSBEHANDLER

FAGSJEF

A STUDY OF WIND CONDITIONS UTSIRA - STORD, JANUARY - FEBRUARY.

The study is based on:

1. Wind statistice from Utsira 1951 - 1984.
2. Two years of wind data from a recorder erected on a 38 meter high mast near the northern shore of Digernessundet.

One year's data from a recorder at Kjøtteintåa, Aker-Stord Shipyard.

Previous studies of wind data from the roof of Aker-Stord Administration building.

3. Comparison of simultaneons wind-data Utsira-Stord for selected weather situations.
4. Estimates of transfer coefficients for wind speed and directions Utsira-Stord.
5. Study of a number of typical weather situations to find probable predictors for "Very short forecasts" for Digernessundet.

STATISTICS UTSIRA.

The frequency statisties (table 1) show that wind of gale force or more might occure from nearly any direction in January and February, even storm force 10 is not rare.

A thorough examination of the data shows a large variation from year to year. Fig 1a and b show the number of 6 hour's terms when maximum wind has been force 7 Beaufort or more.

January 1974, 1983 and 1984 was extremely windy, whereas in 1977, 1978 and 1985 strong winds were rather rare. Note the substantial lower frequency of strong wind in February.

The graphs fig. 2 display a gliding 10 day's mean frequency of wind \geq force 5,6,7, and 8 Beaufort. An interesting feature is the sudden drop in occurence of strong winds by end of January - early days of February.

The substantial lower occurrence of strong wind in February consists with the maximum occurrence of blocking high over the area West Norway to 20°W. (See fig. 3)

DURATION OF PERIODES WITH WEAK WIND UTSIRA.

Table 2 shows the number of events when the wind force at Utsira is equal or less than 4 Beaufort successive 1, 2 or 3 days. Every year has at least one day with wind \geq 4 Beaufort in January and February, and also spells of 2 days occur most years.

The wind recording at Stord.

The windrecorder near Digernessundet has been in operation since November 1983. The exposure is recognized to be representative for the sound when the winds are blowing from the sector SE to W, where no obstacles are sheltering the recorder.

When wind directions are from the northern sector W to E, the air flow is hampered due to streaming over uneven ground covered by high tress, Northerly wind is also diverted and chanalled on both sides of the Stord isle.

When the wind is blowing parallell to the sound, the representativity of the recordings is questionable due to land friction, and the real wind over the sea is most likely reinforced by the sound.

Temporarily wind recordings from Kjøtteintåa confirm this for easterly winds.

These effects have been considered when estemating the transfer coefficients.

Transfer coefficients Utsira - Digernessundet.

Winds are contingent upon the pressure gradient. Over the open sea the pressure patterns usually are rather regular. When the air is flowing over the shore and the inland, the pressure pattern and corresponding wind field become iregular due to friction and the topography. The local winds are substantial influenced by these effects.

To obtain a prognostic tool for transfer of an expected wind on the coast to the local area Digernessundet, a number of of different weather situations have been selected. These situations show typical pressure patterns, and the corresponding maximum winds on the two sites have been compared. In all 118 cases have been examined.

The wind direction, 10 min. mean wind and gusts have been compared statistically. The estimated transfer coefficients are shown in tabl. 3.

Usually there is a time lag, approximately 1-2 hours, between the occurrence of the maximum wind speed due to the eastward movements of the pressure systems. These time lags have been made allowance for.

To reduce intercorrelation only one pair of wind values of each wind direction has been chosen from each situation, i.e. the same front or low approaching the area.

Some examples of different pressure patterns and corresponding winds on the two sites are shown on the figures *4, 5, 6, 7 and 8*

There are some important features to notice. The wind directions always show a backing from Utsira to Stord. The wind speed is always weaker on Stord than on Utsira, the reduction depends on the wind direction.

Description of some typical winter situations.

1. Cold High over the Inland.

When high air pressure is established over Scandinavia in the winter time, it often persists for a rather long period.

Lows might move along tracks across the British Isles into the southern North Sea, and become stationary and weakening.

The wind direction in such cases is rather steady southeasterly at Utsira, while in the Stord area the wind is easterly.

The wind speed frequently becomes gale force at the outer coast and in the inner fjords. In the Stord area the pressure gradient due to topographical effects is weaker, and the reduction coefficient Utsira-Stord is estimated to be 0,7 for the 10 minutes wind speed and 0,8 for gusts in such cases.

The wind speed is increasing and slowing down according to pressure falls and pressure rises approaching the coast.

Such areas with pressure changes are easily followed as they move across the British Isles and pass the drilling sites in the North Sea. They are good predictors for short range wind forecasts, as the wind reports are, and justify the importance of following neatly the hourly weather reports.

Fig 4 shows a typical example of such weather situation. On the weather maps 21.1 - 22.1.85 a drop of approximately 5mb/3h in the Western North Sea is moving NE reaching the Norwegian Coast 6-9 hours later. Notice the change in the pressure pattern during the period.

The corresponding winds at Utsira and the recorder at Stord are shown on the graphs. The wind speed at Stord reaches its maximum ENE 17 knots gusting 30. The few samples of wind recording of NE wind from Kjøtteintåa shows that the speeds recorded on the shore near Digernessundet in such cases are too low, and the wind over the sea might be approximately 5 knots higher. This fact has been considered when estimating the transfer coefficient Utsira-Stord to be 0,7 for 10 min. mean speed and 0,8 for gusts.

These coefficients will probably be revised on base of the wind recordings from the recorder erected on the Gullfaks GBS.

Fig 5 is an illustration of what happens to the pressure pattern over the Utsira-Stord area when the wind field veers southerly. The pressure pattern is less influenced by the topography, and the wind field over the whole area is more homogeneous.

The southerly wind at Utsira is backed 20° at Stord and the wind speed is on the average reduced by a factor 0,8. The standard deviation is rather low and the factor is recognized to be fairly reliable.

2. Weak high over the inland and a strong south west or westerly air flow over the Atlantic and British Isles.

In these cases lows developing in the westerlies usually follow a track near Scotland towards West Norway and the Norwegian Sea, some times they cross south Norway.

Such situations might cause winds from any directions over the Utsira-Stord area. As lows and associated fronts are passing, wind speeds at Utsira usually become 30 knots or more.

Such cases are shown at fig. 5 and the successive weather maps fig. 6

A strong low approaching south Norway from W breaks down the inland high. The associated strong winds at Utsira and Stord are shown on the graphs.

The reduction of the wind speeds and the backing of the wind directions are shown as well, and consists fairly well with the transfer coefficients estimated on basis of the large number of cases. (see table 3)

The time lag in occurrence of maximum wind speed and change of wind directions are in this case approximately 2 hours. The time lag depends on the speed of the whole pressure system, but in many cases 1 - 3 hours seem to be a useful estimate for prognostic purpose.

Moving ridges of highs in between the lows might give short spells of rather calm winds.

North Westerly air flow over the Norwegian Sea and the North Sea.

3. In the winter time some times extremely cold air from the arctic is penetrating the sea area west of Norway. Over the inland often the cold high persists, and a weak trough develops along the coast.

Such north westerly air flow in January - February is usually extremely cold and become instabile due to heating and absorbing moisture from the sea.

Small scale whirles in the air flow develop to lows (polar lows), and drifting southwards along the coast.

Such lows might be difficult to discover on the weather maps, as the observation grid is rather open in the Norwegian sea.

Satelite photos are a good aid to discover such small scale features.

Such small scale lows might be rather wigerous for a short time.

Fig. 7 and 8 show ~~an~~ examples of a small scale low penetrating the Utsira-Stord area.

Summery:

Long term statistics from Utsira show strong winds from most directions both in January and February. The variation from year to year are large.

Spells of 1-2 days with weak winds occure nearly every year, but successive 3 days or more are rather rare.

There is a significant drop in the frequency of wind exceeding force 4 Beaufort by end of January. February is statistically more favourable of periodes with weak winds.

By comparing winds recorded at Utsira and Stord, it is possible to estimate coefficients for an expected wind at the coast to the more complicated topography inshore.

There is always a backing of the wind-direction, and there is also a reduction of the wind speed from Utsira to Stord. The reduction coefficients of the speed depend on the direction.

Utsera 1951-1984

Frequency %

Table 1

January

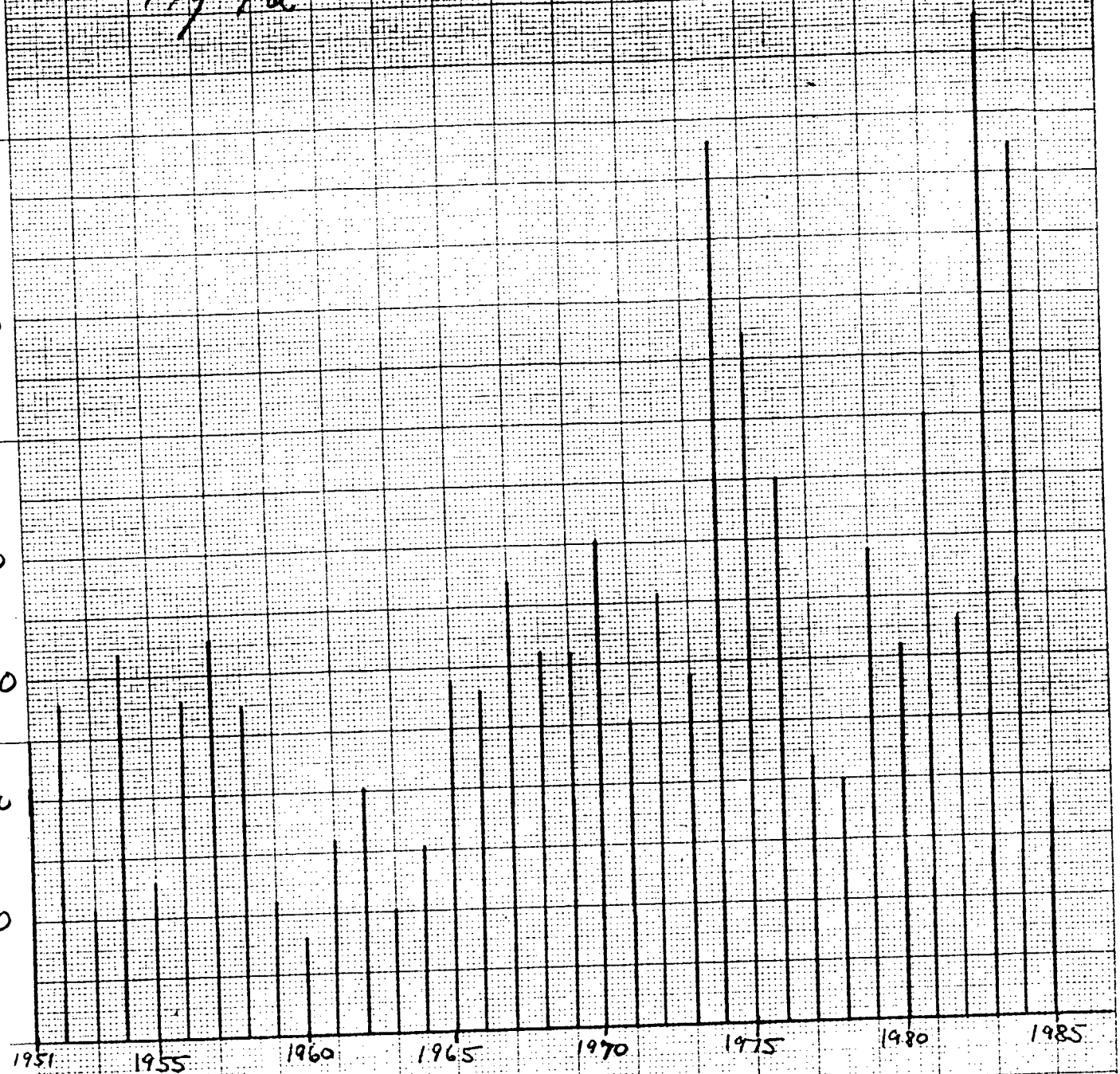
Beaufort

Value	2	3	4	5	6	7	8	9	10	11	12	Direction
calm	3.13											
N 360	0.60	1.14	1.24	1.19	1.14	0.87	0.35	0.12	0.00	0.00	0.00	360 N
030	0.97	1.44	0.97	0.74	0.32	0.35	0.00	0.00	0.00	0.00	0.00	030
060	0.77	0.74	0.40	0.10	0.02	0.00	0.00	0.00	0.00	0.00	0.00	060 E
E 090	0.94	1.07	1.02	0.35	0.17	0.27	0.00	0.00	0.02	0.00	0.00	090 E
120	0.99	2.03	1.99	1.49	1.04	0.67	0.32	0.02	0.00	0.00	0.00	120
150	1.99	3.13	2.43	3.00	1.91	1.81	0.94	0.25	0.05	0.00	0.00	150 S
S 180	0.94	2.06	2.88	3.00	3.28	1.96	1.04	0.10	0.02	0.00	0.00	180 S
210	0.65	1.56	1.96	1.34	1.29	0.30	0.00	0.00	0.00	0.00	0.00	210
240	0.60	1.34	1.54	1.29	0.99	0.45	0.32	0.07	0.00	0.00	0.00	240 W
270	0.40	0.97	1.07	0.84	0.72	0.47	0.47	0.07	0.00	0.00	0.00	270 W
300	0.55	0.84	1.29	1.02	0.97	0.55	0.12	0.07	0.02	0.00	0.00	300
330	0.45	0.74	0.82	0.74	0.69	0.45	0.30	0.10	0.02	0.02	0.00	330
9.83	11.71	17.07	17.59	15.11	12.56	8.14	3.87	0.82	0.15	0.02	0.00	

February

Value	2	3	4	5	6	7	8	9	10	11	12	Direction
calm	3.57											
N 360	1.12	0.87	1.25	1.31	1.28	0.60	0.35	0.03	0.03	0.00	0.00	360 N
030	0.98	0.98	0.90	0.76	0.27	0.19	0.05	0.00	0.00	0.00	0.00	030
060	1.31	0.98	0.33	0.14	0.03	0.00	0.00	0.00	0.00	0.00	0.00	060 E
E 090	1.50	1.01	1.17	0.71	0.22	0.05	0.05	0.00	0.00	0.00	0.00	090 E
120	1.39	1.88	1.91	1.33	0.73	0.46	0.00	0.00	0.00	0.00	0.00	120
150	2.31	3.65	3.08	2.78	1.88	1.17	0.98	0.05	0.03	0.00	0.00	150 S
S 180	1.47	3.08	3.67	3.02	2.75	1.22	0.52	0.05	0.03	0.00	0.00	180 S
210	0.95	1.85	1.42	1.01	0.60	0.41	0.03	0.00	0.00	0.00	0.00	210
240	1.01	1.25	1.03	0.63	0.33	0.19	0.03	0.03	0.00	0.00	0.00	240 W
270	0.41	1.03	0.79	0.93	0.52	0.38	0.08	0.08	0.00	0.00	0.00	270 W
300	0.44	1.14	1.25	0.87	0.65	0.19	0.14	0.05	0.00	0.00	0.00	300
330	0.44	0.65	0.41	0.54	0.46	0.44	0.11	0.00	0.00	0.00	0.00	330
13.31	15.19	18.37	17.20	14.92	9.72	5.01	2.34	0.30	0.08	0.02	0.00	

1951-1985



Antal finländare med
målar 10-minn orend \geq styrke 7

Utsira, januar 1951-1985

Fig 1a.

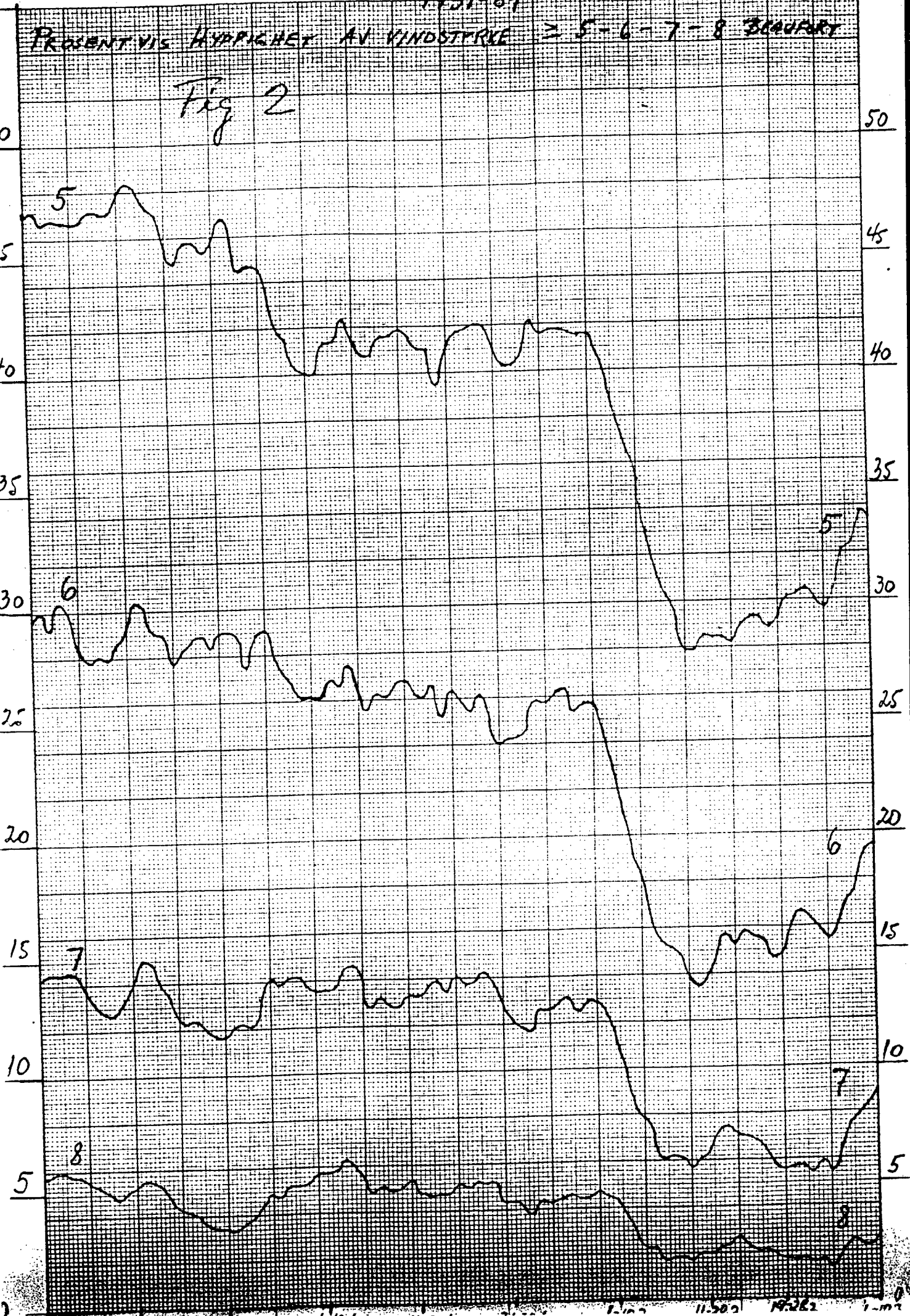


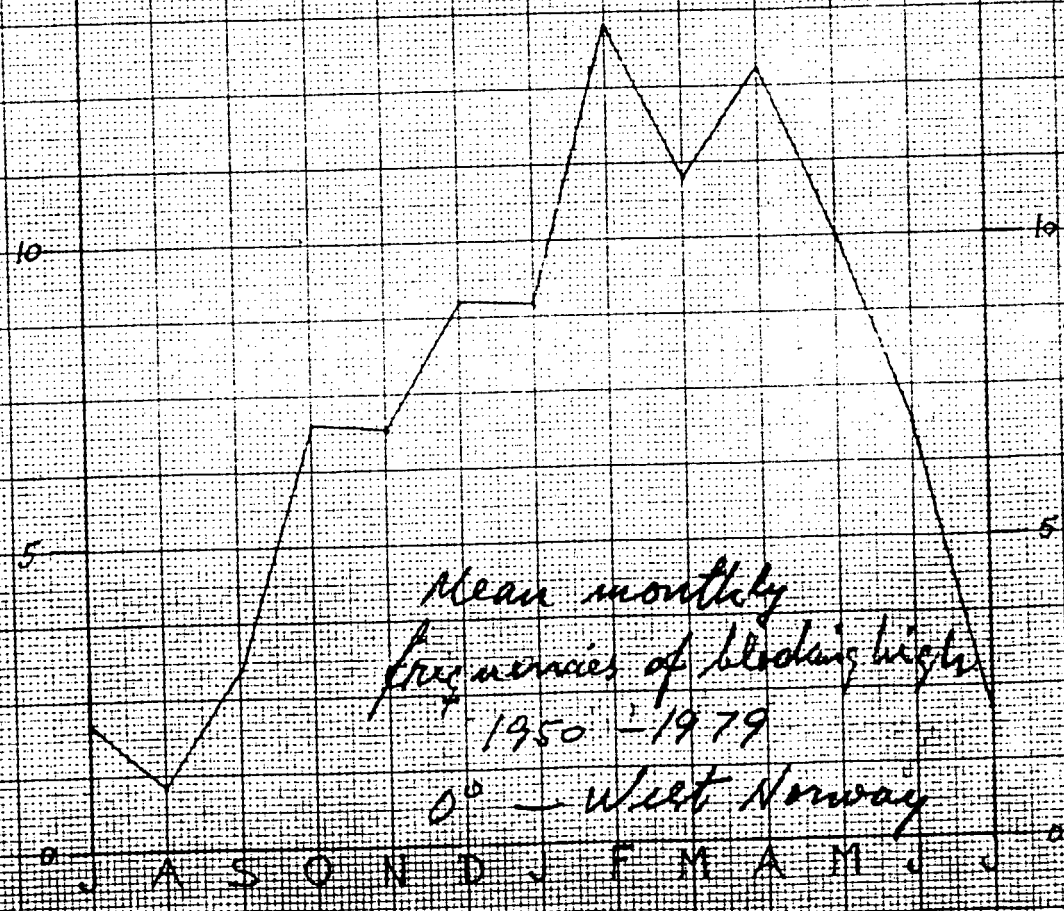
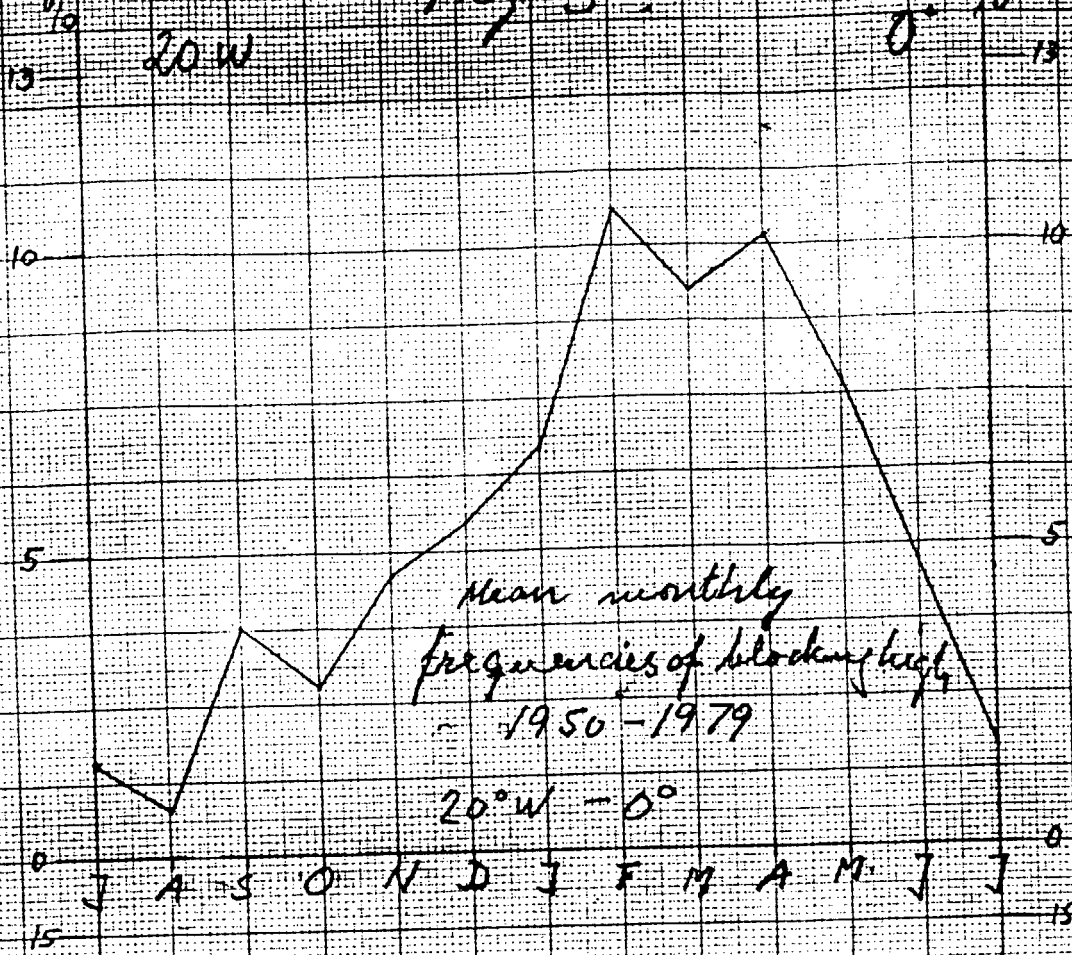
Antal stormer med maks. 10-min vind
≥ styrke 7

Utsira, februar 1951-1985

PROSENTVIS HYPPIGHET AV VINDSTYRKE \geq 5-6-7-8 BEAUFORT

Fig 2





These figures are taken from
Lynne and Oswald (1981, 1983)

Table 2

Number of events with wind ≥ 4 Beaufort

RR	January			February		
	1 day	2 days	3 days	1 day	2 days	3 days
1963	15	11	8	16	12	9
1964	10	7	5	7	4	2
1965	5	1	0	4	0	0
1966	11	7	5	8	6	4
1967	5	2	0	3	1	0
1968	5	0	0	9	4	1
1969	2	0	0	16	12	9
1970	5	2	0	7	3	1
1971	9	5	2	4	1	0
1972	10	8	6	15	12	10
1973	7	3	0	10	5	2
1974	2	1	0	5	4	2
1975	3	1	0	18	14	12
1976	4	0	0	13	8	4
1977	9	6	3	14	11	9
1978	4	1	0	12	7	6
1979	9	5	4	4	0	0
1980	9	5	1	5	1	0
1981	2	0	0	6	4	2

TABLE 3

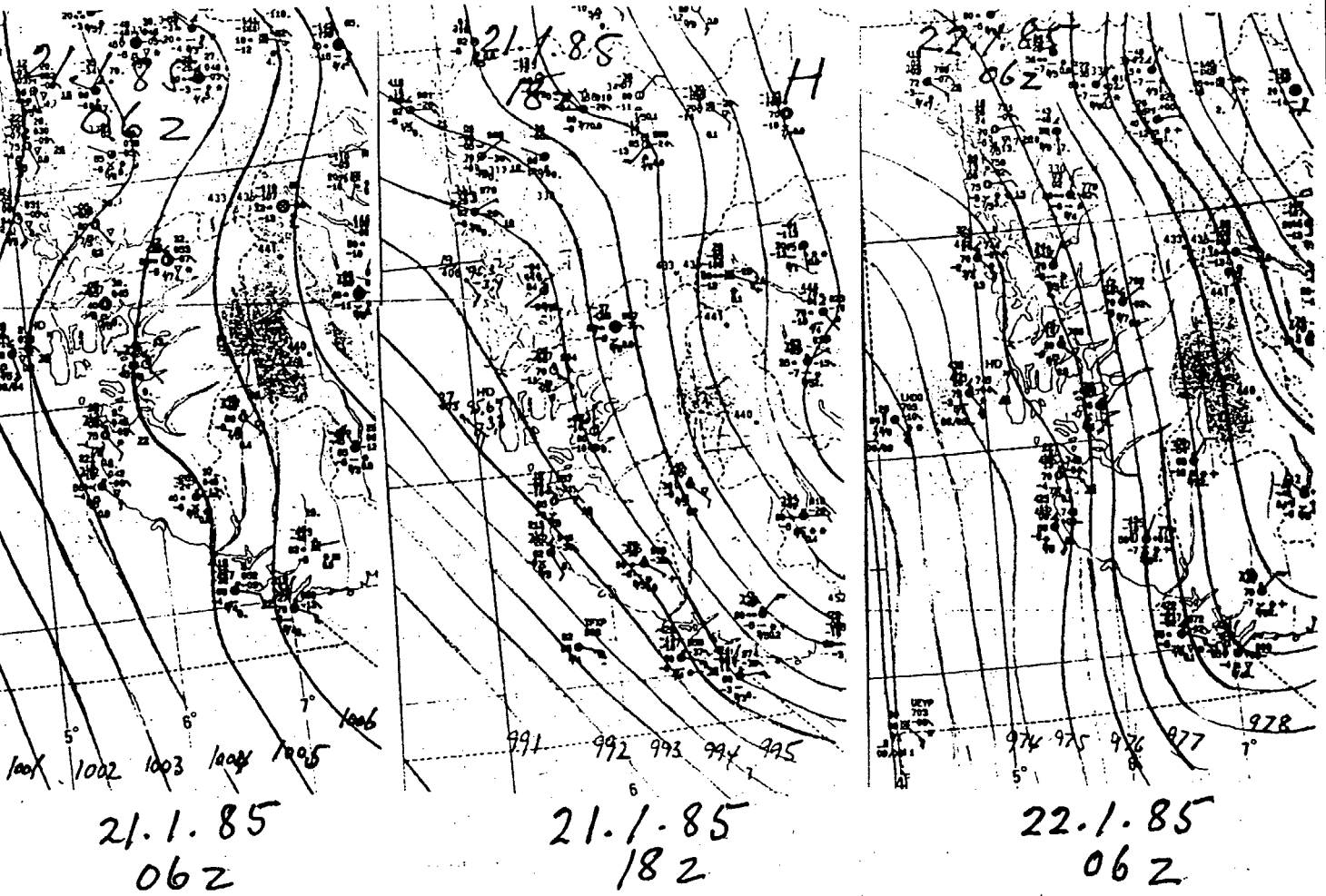
TRANSFER COEFISIENTS UTSIRA - STORD

Direction Utsira	N	NE	E	SE	S	SW	W	NW
Direction Stord	W-NW	N-NE	NE	E	SE-S	S-SW	SW	W
10 min mean								
Wind speed	0.4	0.5	0.7	0.7	0.8	0.8	0.8	0.6
Gusts	0.8	0.6	0.7	0.8	0.8	0.9	0.8	0.7
Correlation								
coef.	0.0	0.0	0.7	0.6	0.9	0.9	0.7	0.5

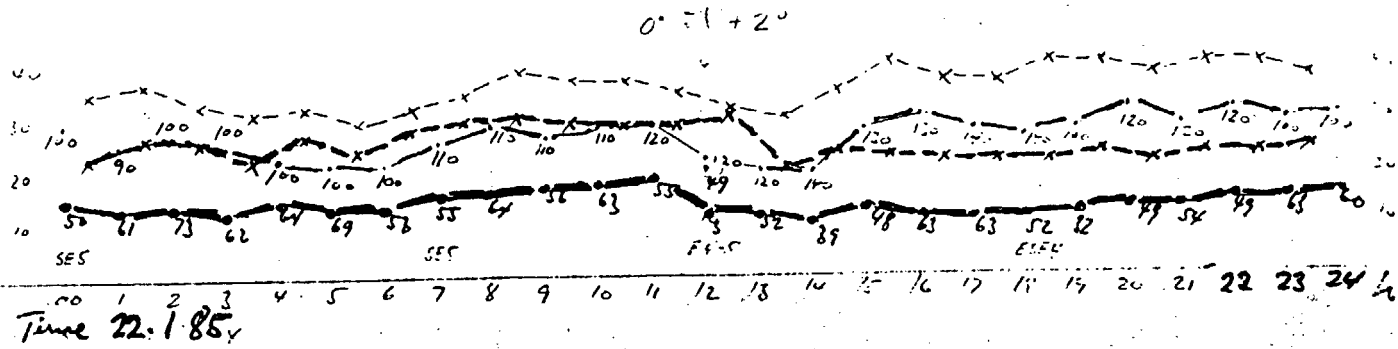
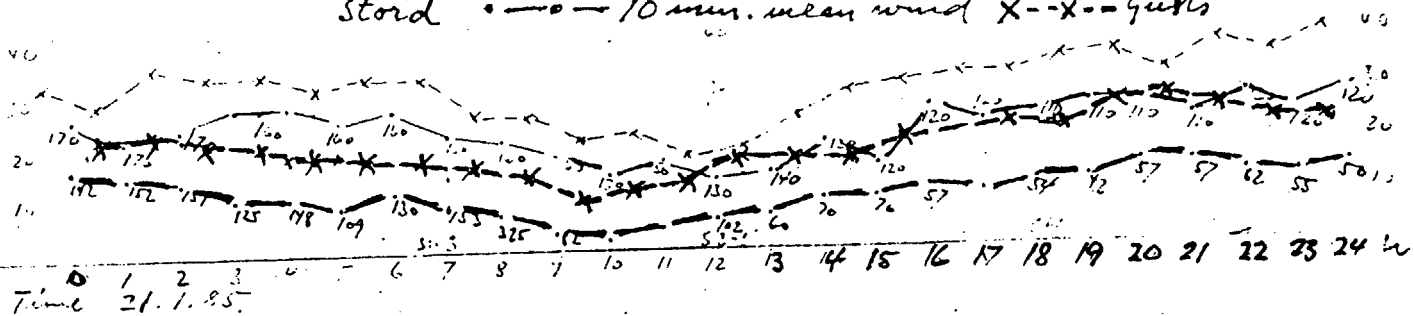
Change of wind direction (backing)

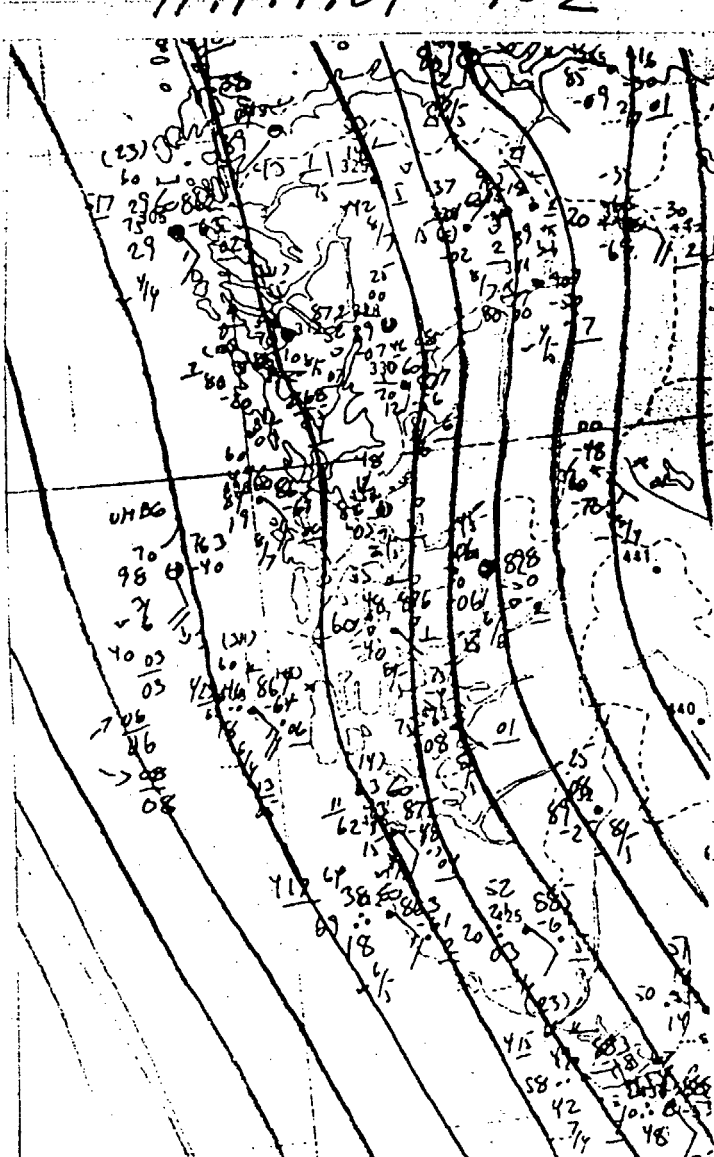
Utsira	N	NE	E	SE	S	SW	W	NW
Stord mean.	54°	25°	33°	45°	21°	28°	40°	35°
Standard dev.	± 34°	± 20°	± 14°	± 30°	± 9°	± 14°	± 22°	± 22°

Fig 4

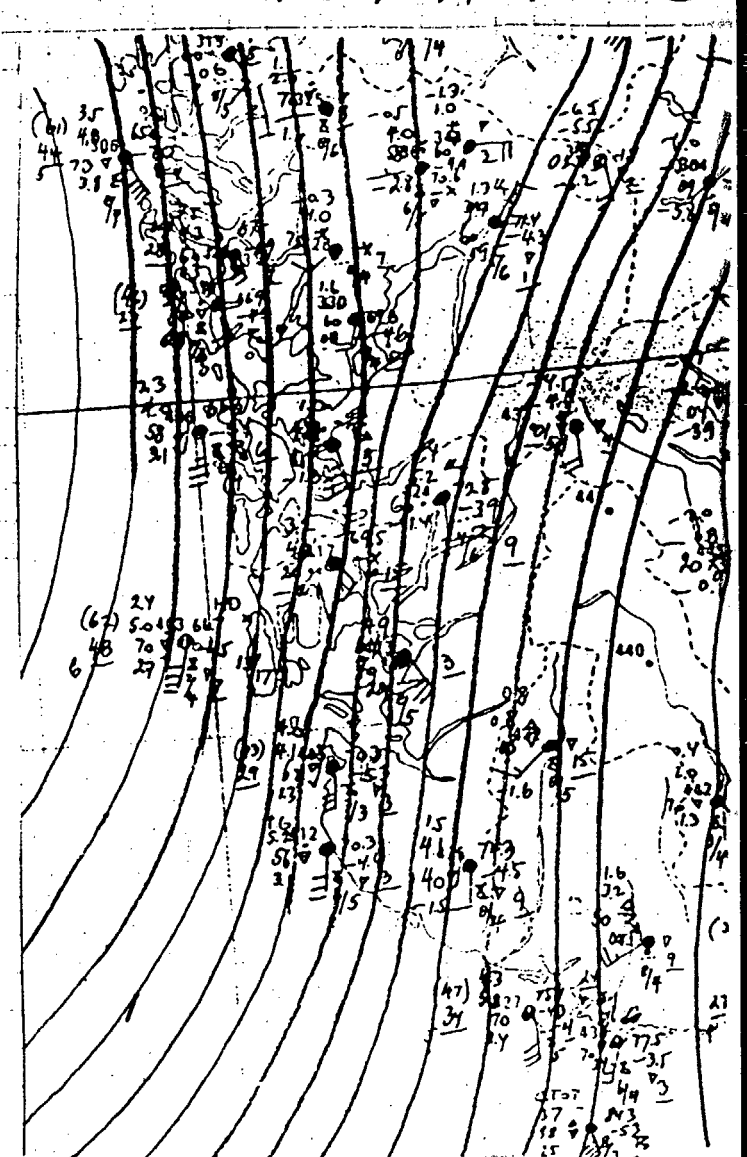


The figures along the graphs are wind directions
 Utsira - - - 10 min. mean wind x-x-x-gusts
 Stord •-•-• 10 min. mean wind x-x-x-gusts

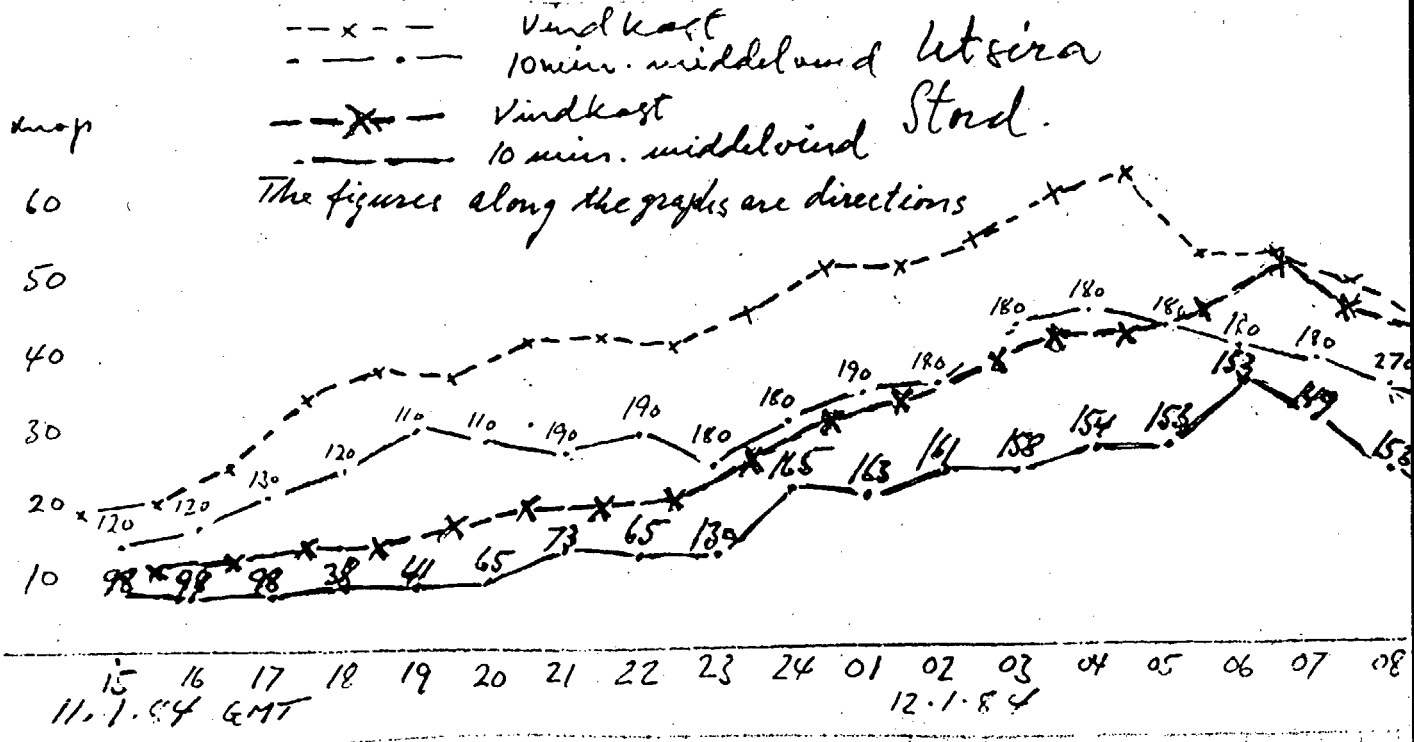




SE Utsira E Stord



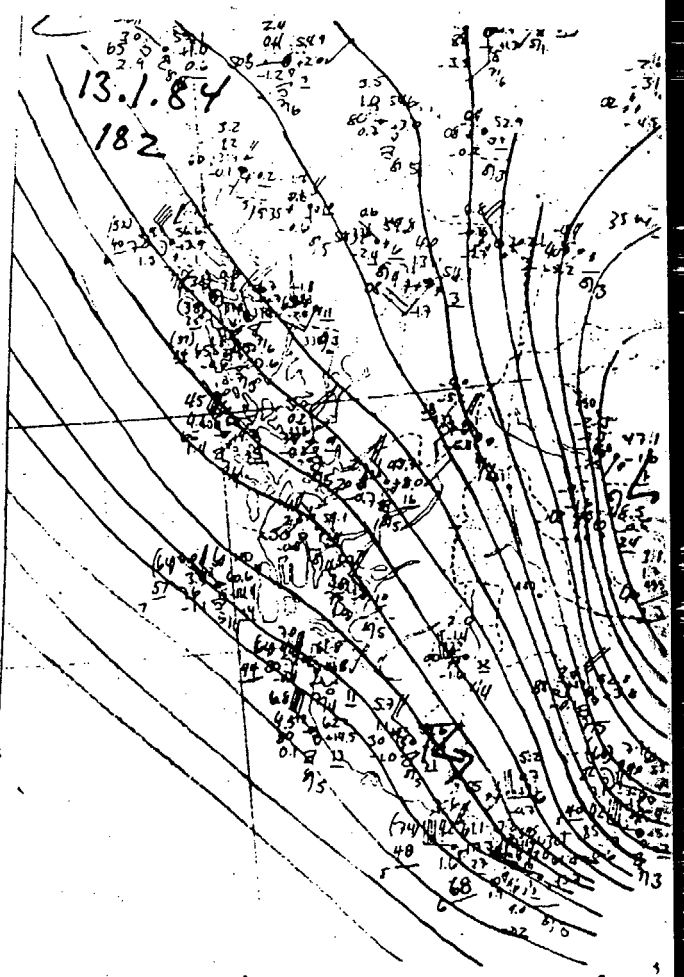
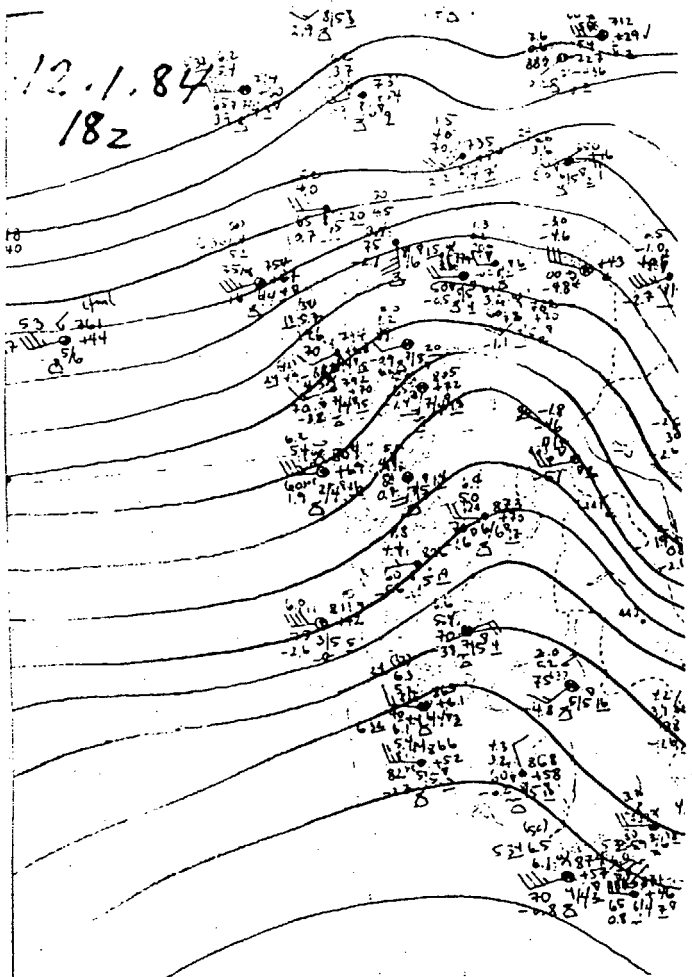
S Utsira SSE Stord



12.1.84 182

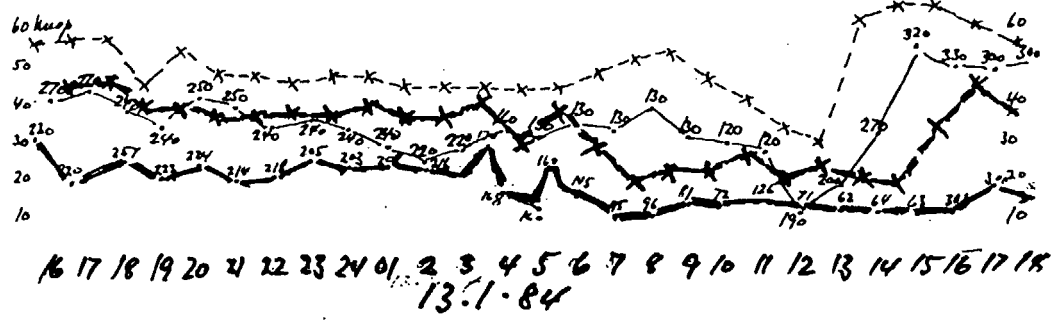
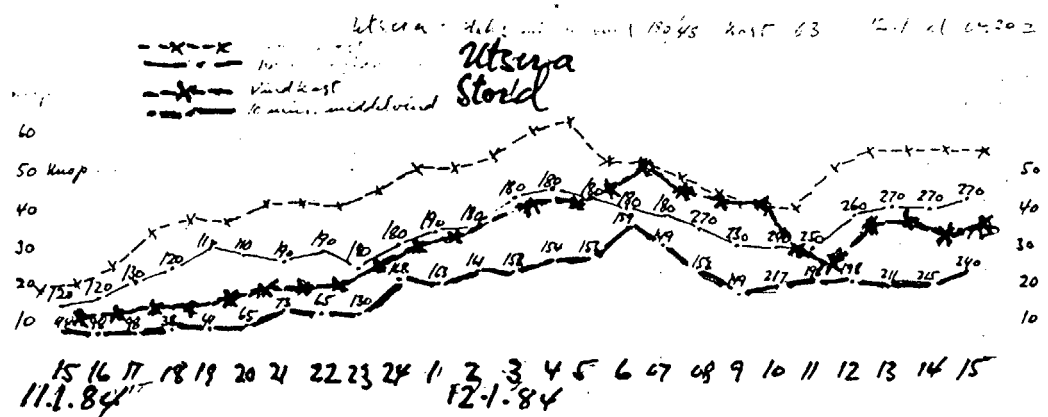
Fig 6

13.1.84 182



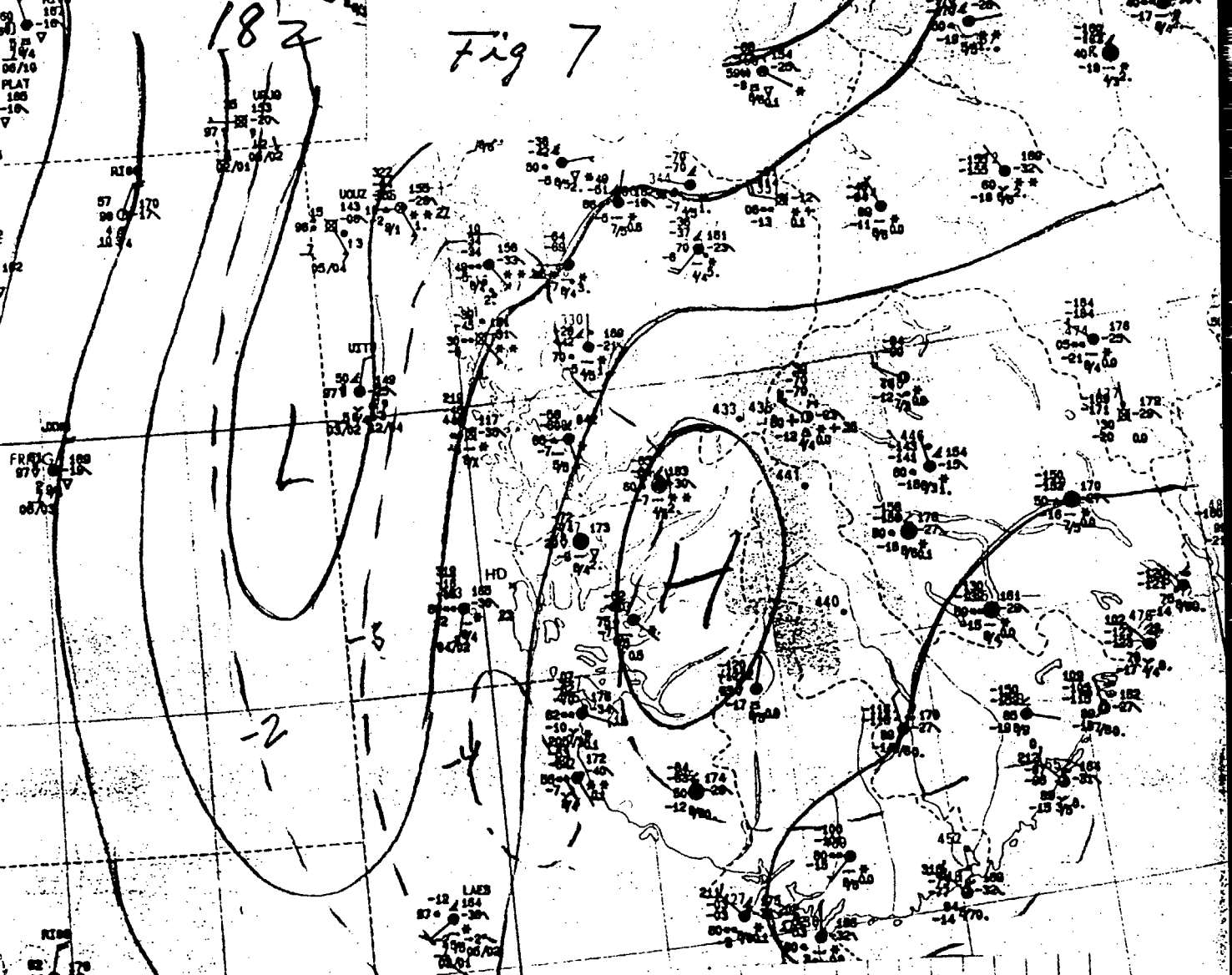
W Utsira SW Stord

NW Utsira WNW Stord

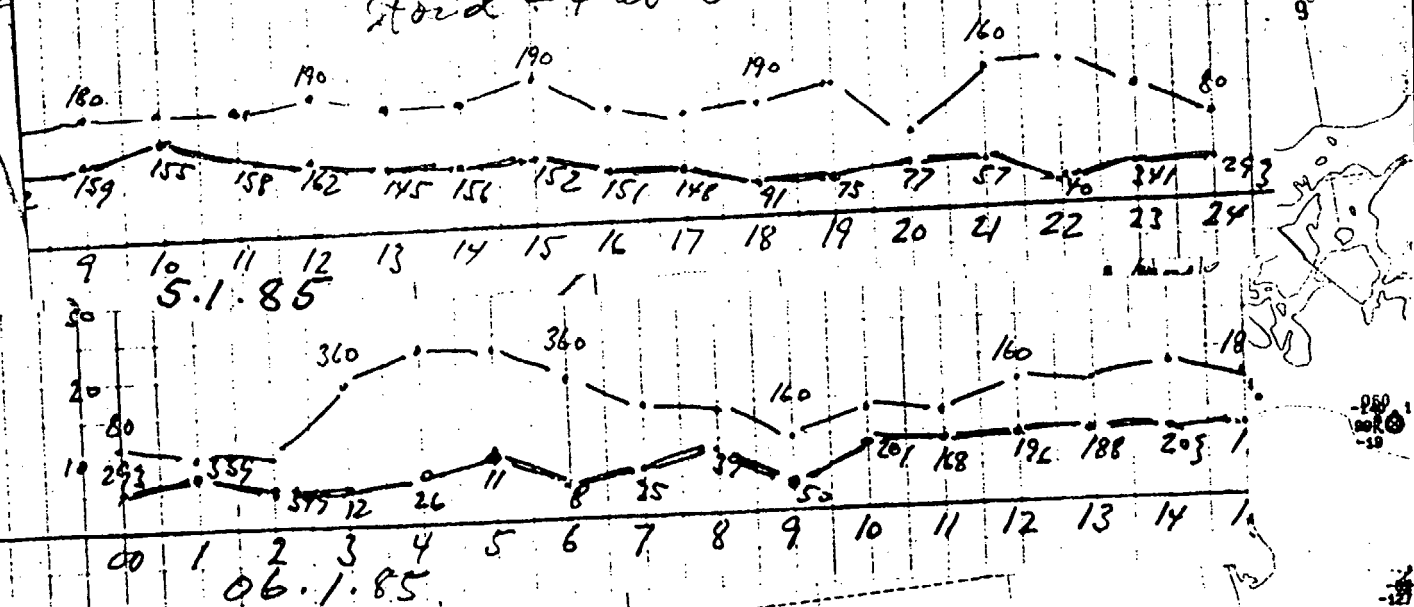


182

Fig 7

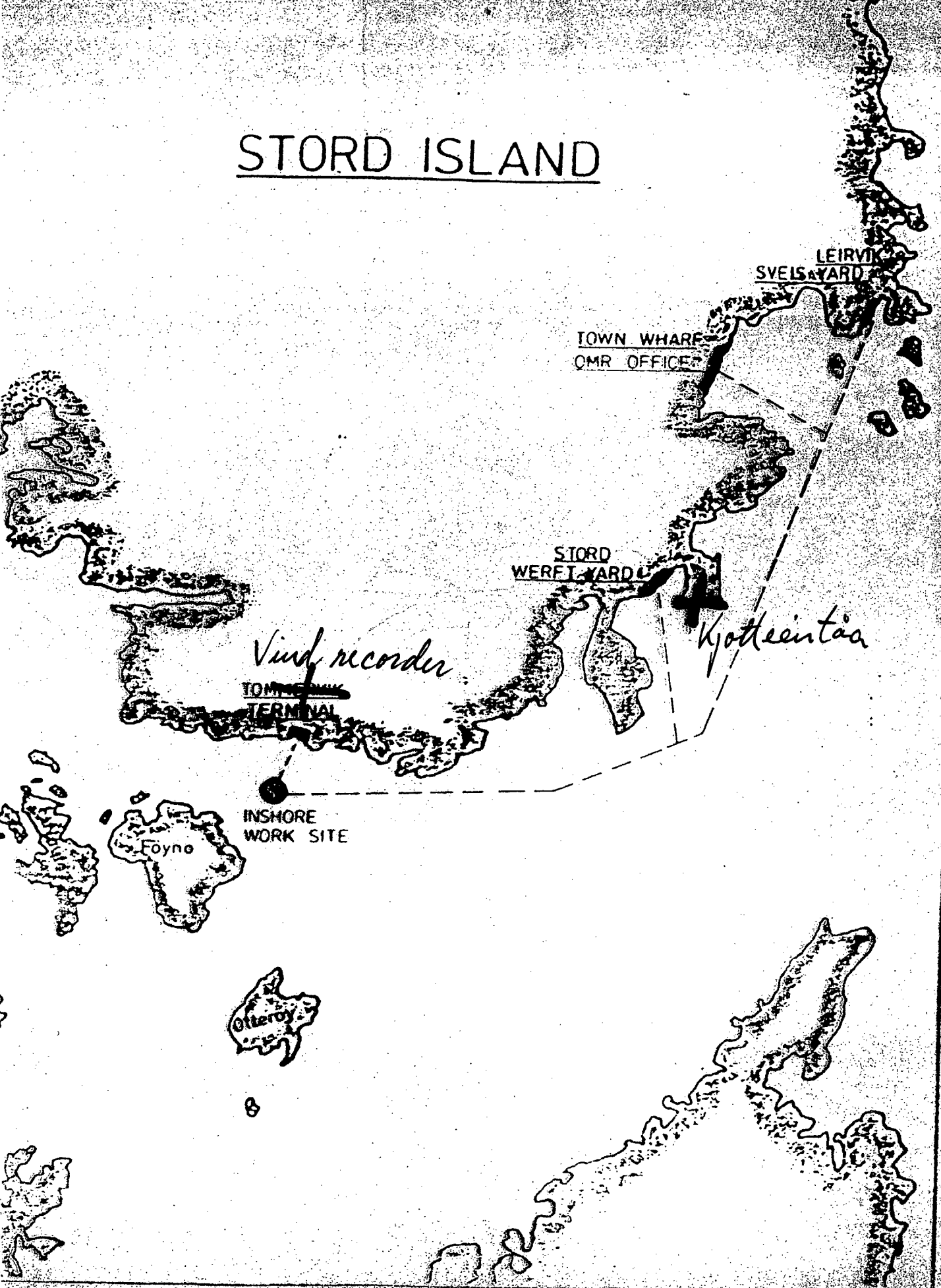


Stord - 4 ul - 6°



- - - 10 min. mean wind speed Utsira
 • - - - 10 min. mean wind Stord

STORD ISLAND



8

13