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THE STORM OF JANUARY 1. 1992

BJØRN AUNE AND KNUT HARSTVEIT

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THE STORM OF JANUARY 1. 1992

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OPPDRAGSGIVER

DNMI - KLIMAAVDELINGEN

OPPDRAGSNR.

SAMMENDRAG

The report describes the storm that hit Norway and especially the coastal areas of northern part of Vestlandet, Møre og Romsdal and Trøndelag on January 1. 1992. The wind speeds went up to around their 200 years return period values over large areas of Nordfjord and Møre og Romsdal. The wind was very turbulent in the fjord areas within the coast. Places were the topography strengthened the wind had periods with wind speeds up to hurricane force and/or wind gusts above 50 m/s.

UNDERSKRIFT

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SAKSBEHANDLER

Bjørn Aune
FAGSJEF

1. INTRODUCTION

This report describes the storm of January 1. 1992, a storm that caused great damage in coastal areas of Norway, especially in the county Møre and Romsdal.

The report is written in English because it will have several non-Scandinavian readers. We hope that this choice does not create to much inconveniences for the Norwegian readers, and on the last page is the Beaufort windscale given with both English and Norwegian names.

2. DESCRIPTION OF THE STORM

The storm that hit Norway and especially the coastal areas of northern part of Vestlandet, Møre og Romsdal and Trøndelag on January 1th 1992 was caused by a low pressure area with an attached frontal system that on December 31. 1991, 1900 hours Norwegian local time (NLT), was south of Iceland (Figure 1). The air pressure in the centre of the area decreased rapidly. The centre and a widespread windfield of at least storm force (Beaufort Force 10) moved towards northeast with a speed of approximately 90 km/hour.

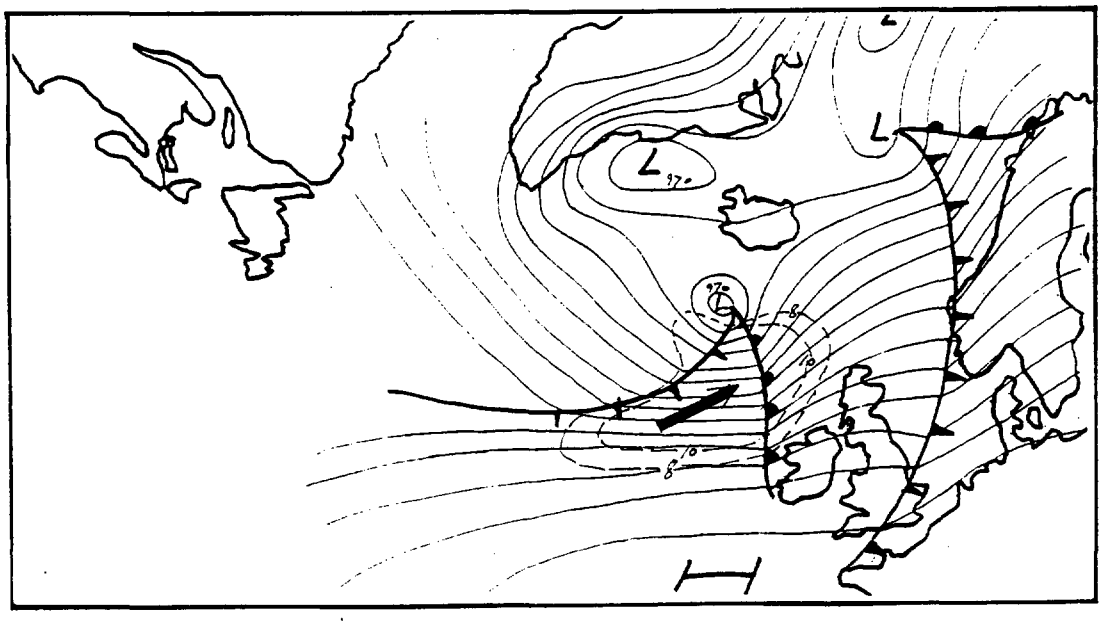

Figure 1. Simplified weather map for 1900 hours LNT 31/12/1991. (Source for the maps in figures 1 - 4 is Vær & Klima, No. 2/1992, Universitetsforlaget, Oslo.)

Six hours later at 0100 hours NLT on January 1. 1992 had the low pressure centre reached the Faeroe Islands (Figure 2). The decrease of air pressure had continued and south of the centre indicated the pressure gradients hurricane wind speeds (Beaufort Force 12).

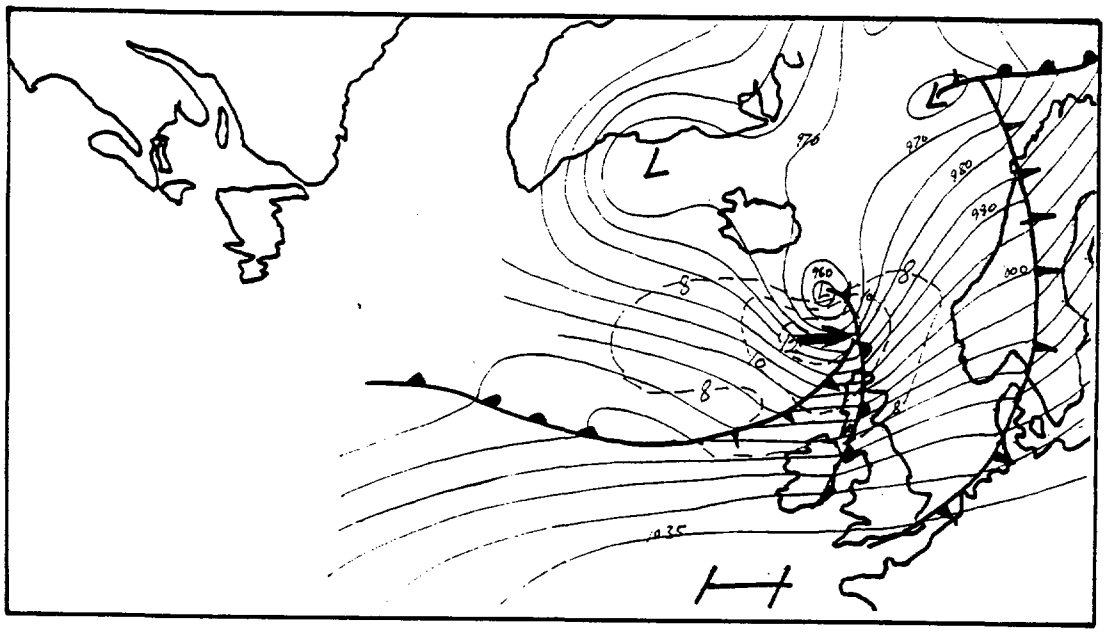

Figure 2. Simplified weather map for 0100 hours NLT 01/01/1992.

At 0700 hours NLT on January 1. 1992 had the low pressure centre reached a position outside the coast of Norway just north of Stad (Figure 3, next page). The air pressure in the centre had decreased below 960 hPa. South of the centre had up to hurricane wind speeds (Beaufort Force 12) reached the coastal areas north of Hardangerfjorden.

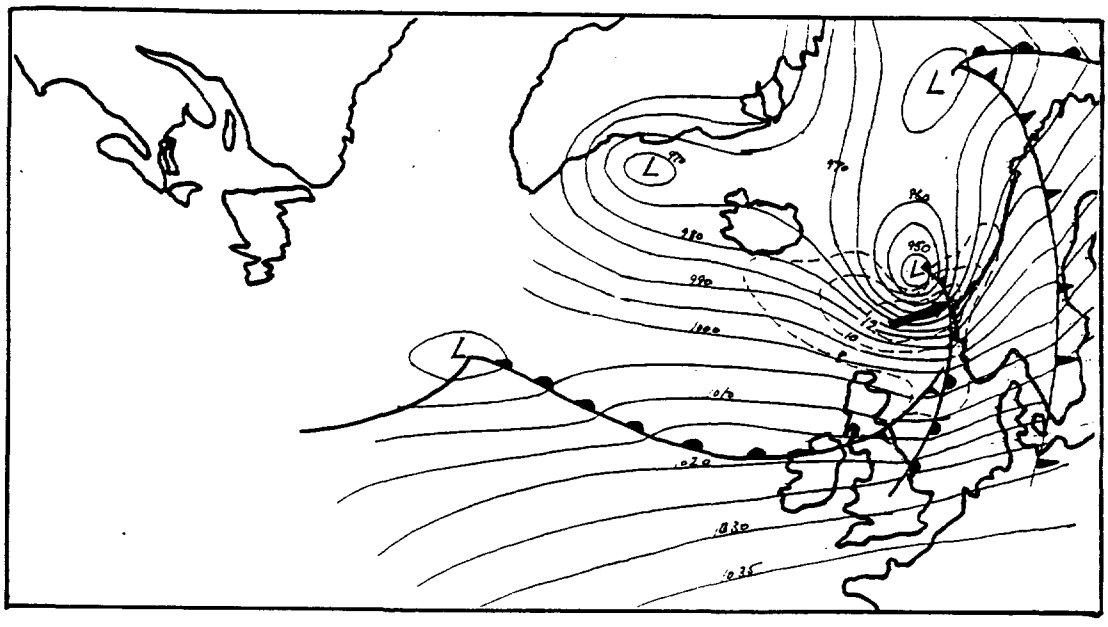

Figure 3. Simplified weather map for 0700 hours NLT 01/01/1992.

The low pressure area moved further northeast parallell to the coast and was at 1300 hours NLT west of Sklinna Fyr (Figure 4). The greatest wind speeds south of the centre were now over the coastal areas of Sør-Trøndelag.

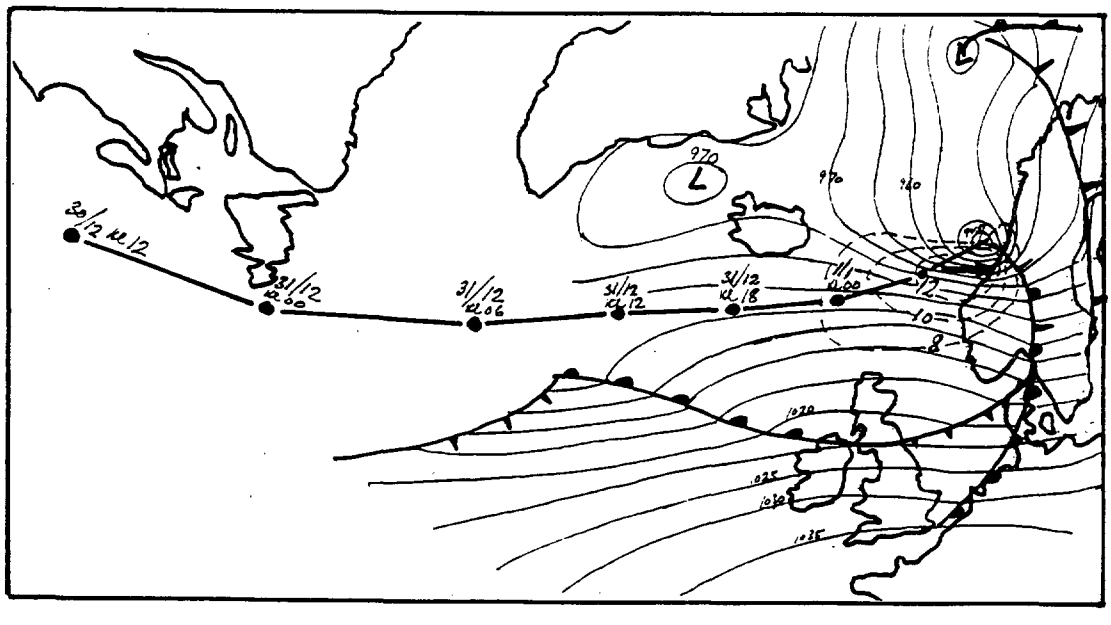

Figure 4. Simplified weather map for 1300 hours NLT 01/01/1992. The path of the centre of the low pressure area is shown with dates and time in UTC (LNT minus one hour)

After 1300 NLT did the low pressure area move eastwards and in over land south of Brønnøysund. It weakened rapidly and the wind speeds decreased.

3. WIND OBSERVATIONS

Most Norwegian meteorological observation stations observes wind speeds visually by using the Beaufort wind scale for land use.

Some stations have continuous registration of wind speeds (10 min. mean wind speeds and wind gusts) and wind direction on paper graphs. Most of them have, however, registration instruments that do not measure more than approximately 31 m/s* mean speeds and 41 m/s gusts. During the storm of January 1. 1992 did wind speeds on some stations go above these limits. The wind speeds during the periods when they were above the chart limit, have been extrapolated by extending the chart limit, studying the form of the curves and the relation between them, etc. There are therefor some uncertainties connected to these values, but the order of magnitude should be correct.

Mean wind speed for each half hour and the highest wind gust in previous half hour during January 1. 1992 are shown for 9 stations (Figure 5) with continuous wind speed registrations in Figures 6 A - I.

The figures 6 A - I show how the storm moved northwards during January 1. 1992. The highest wind speeds occurred at about 0500 hours LNT at Hellisøy Lighthouse, 0800 hours LNT at Molde Airport, 1100 hours LNT at Kristiansund Airport and at 1800 hours LNT at Sklinna Lighthouse.

* m/s : metres per second

1. Hellisøy Lighthouse
2. Sandane Airport - Anda
3. Svinøy Lighthouse
4. Ålesund Airport - Vigra
5. Molde Airport - Årø
6. Kristiansund Airport - Kvernberget
7. Skalmen Lighthouse
8. Ørland Airport
9. Sklinna Lighthouse
10. Farder Lighthouse
11. Torungen Lighthouse
12. Oksøy Lighthouse
13. Lista Lighthouse
14. Utsira Lighthouse
15. Ona
16. Halten lighthouse
17. Nordøyan Lighthouse

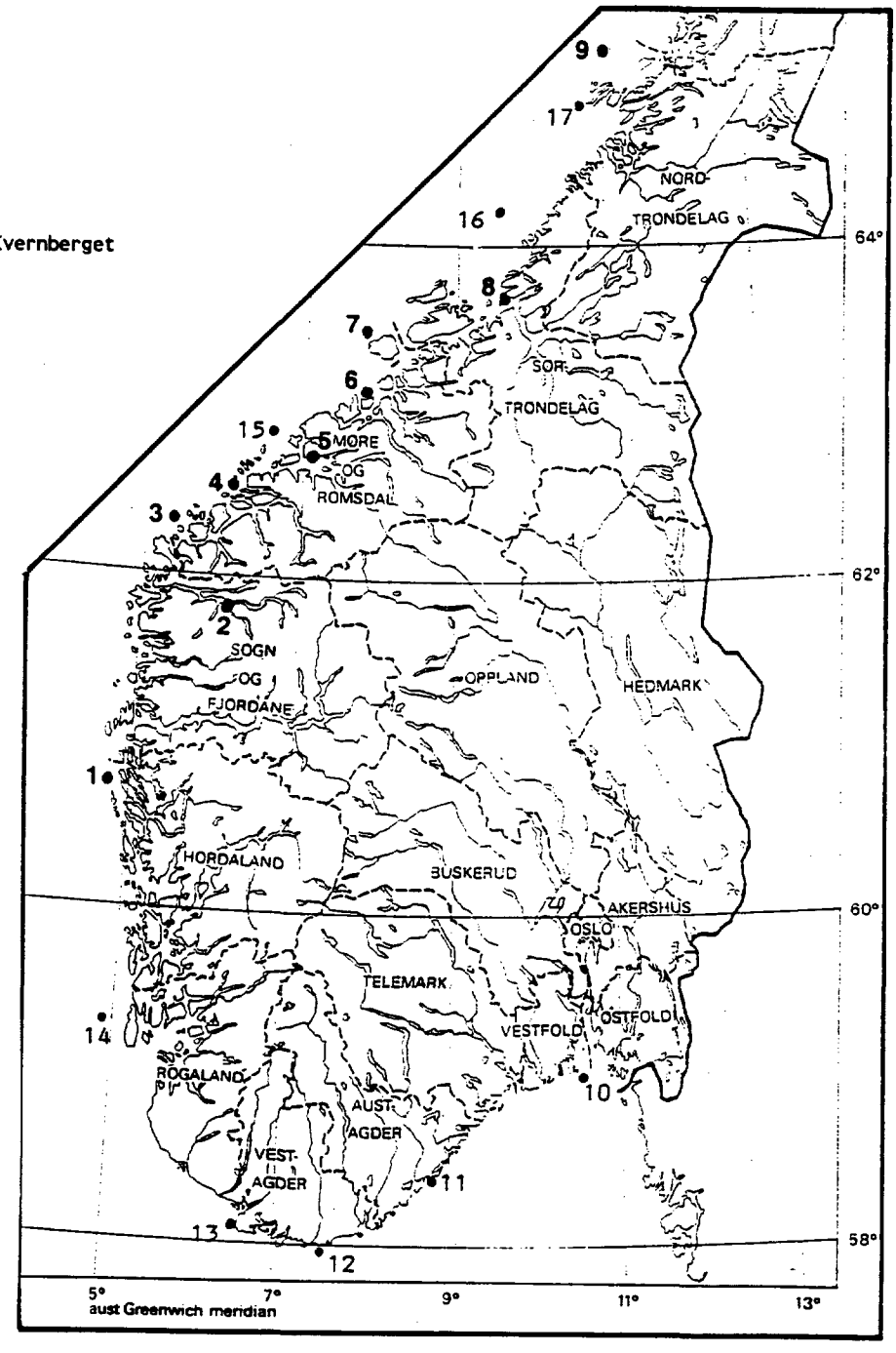

Figure 5. Meteorological observation stations.

Figure 6 A - I. (next pages) Mean wind speeds for each half hour and the highest wind gust in previous half hour during January 1. 1992 for 9 stations (the first 9 stations in figure 5).
Values above graph limits are extrapolated for Sandane Airport, Svinøy Lighthouse, Ålesund Airport, Molde Airport, Skalmen Lighthouse and Kristiansund Airport.

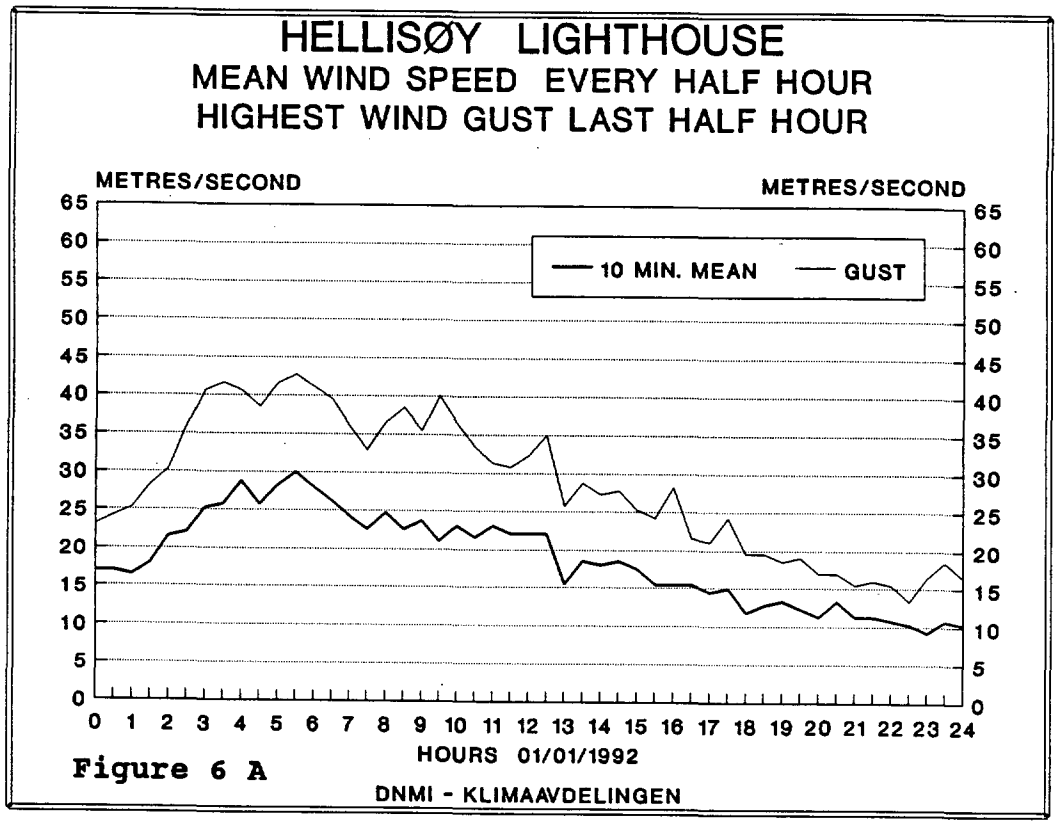

Figure 6 A

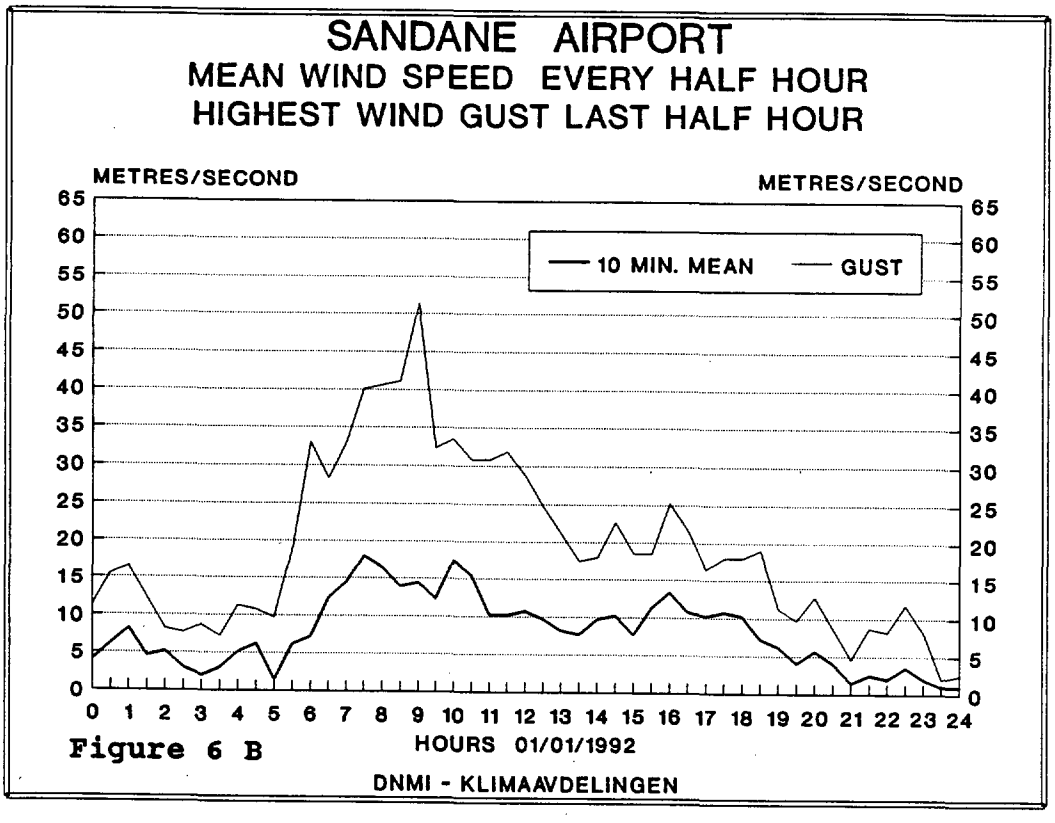

Figure 6 B

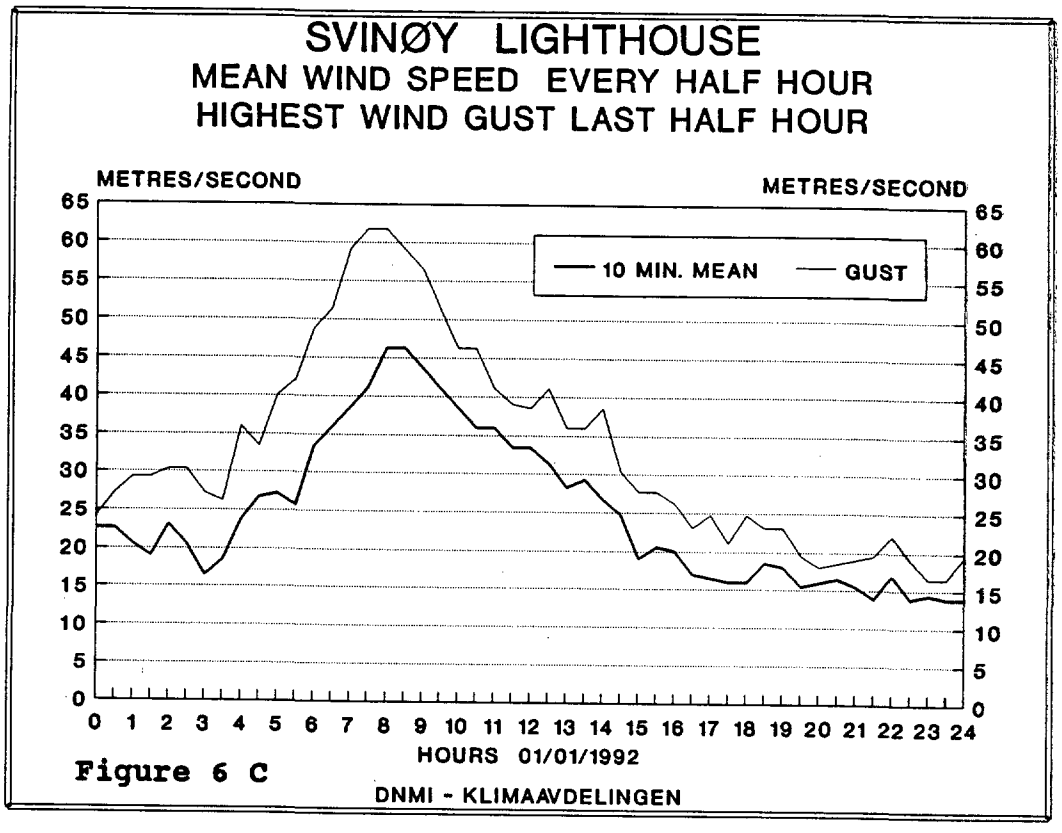

Figure 6 C

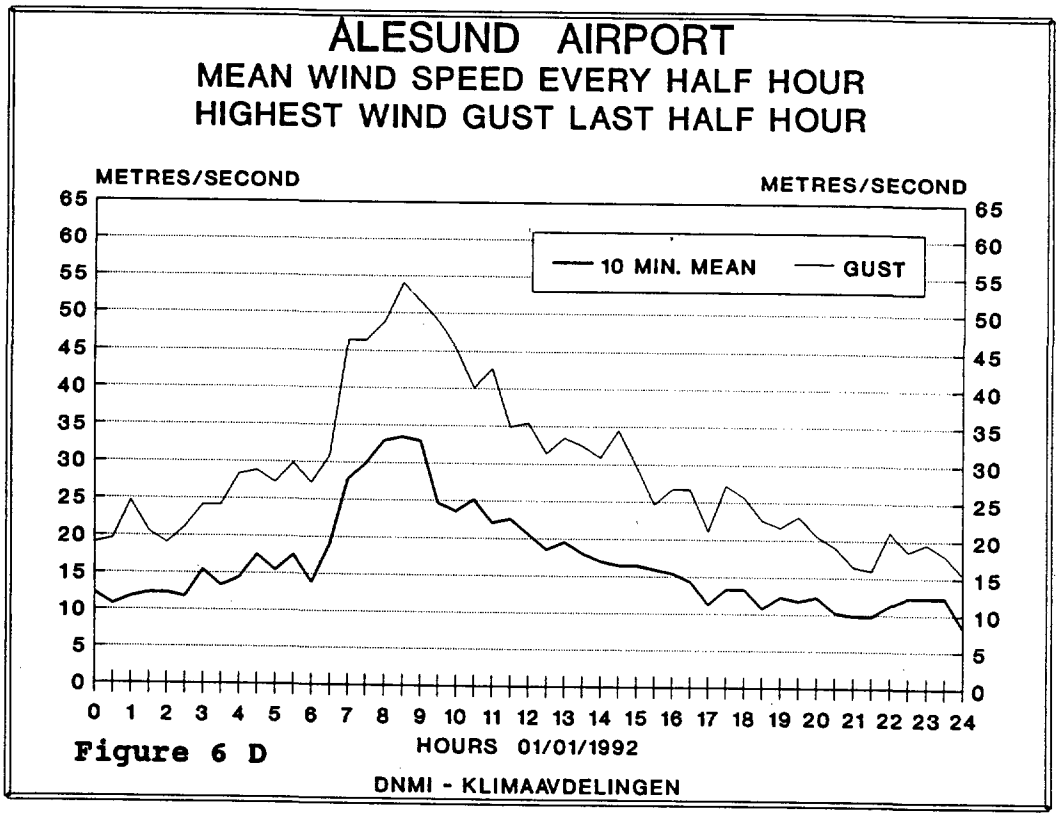

Figure 6 D

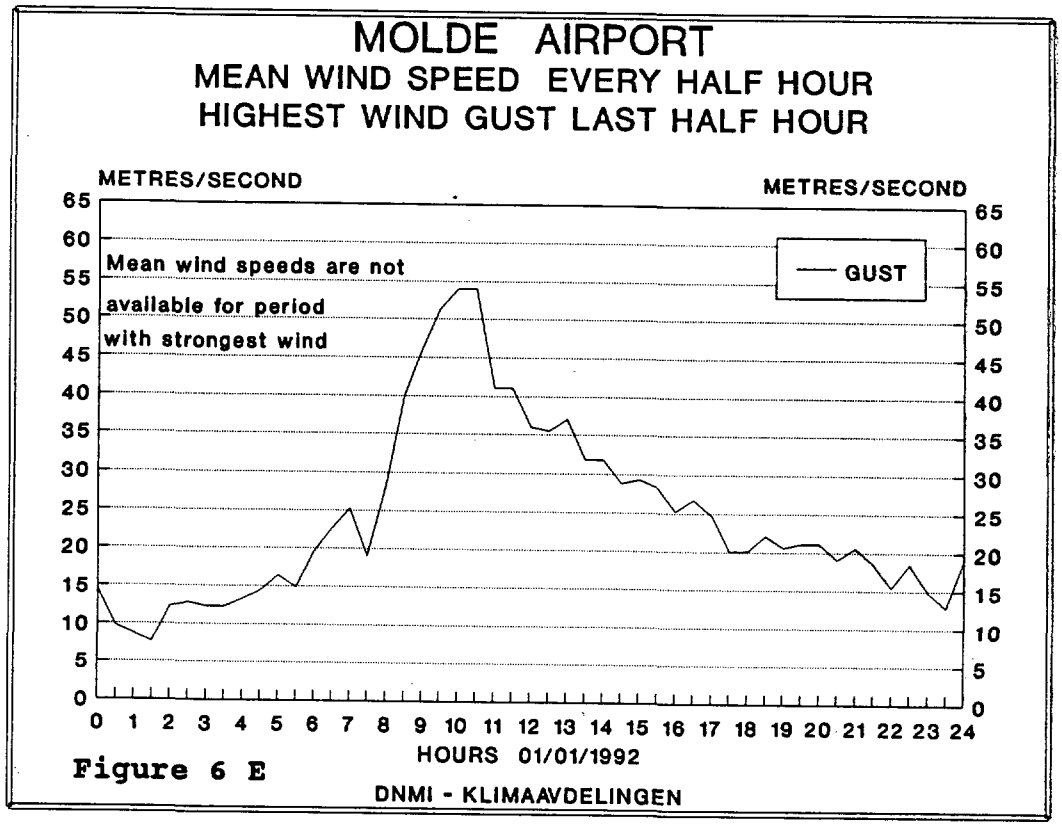

Figure 6 E

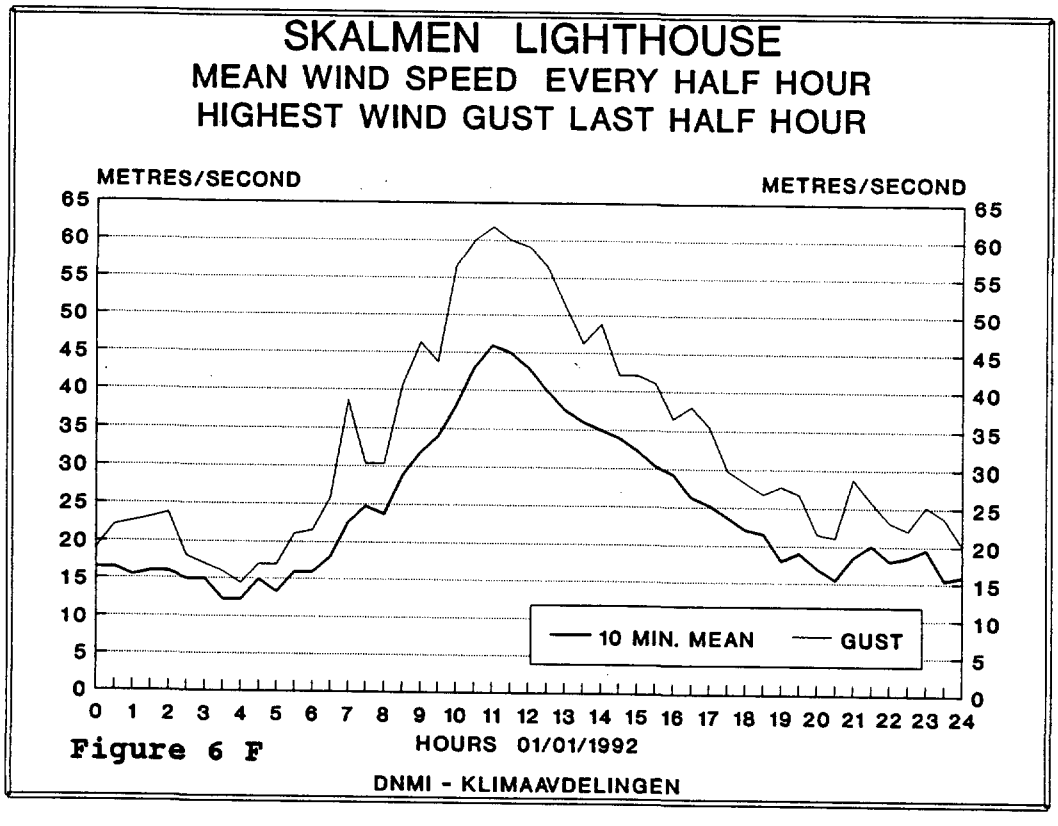

Figure 6 F

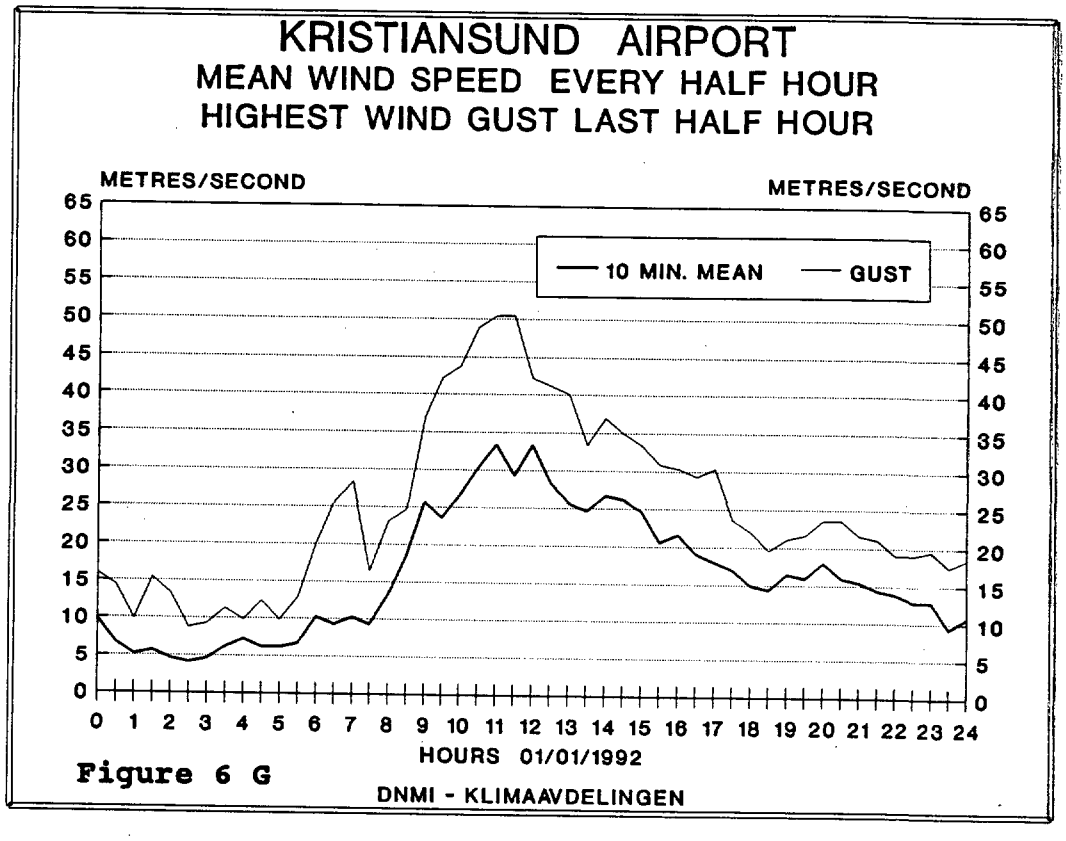

Figure 6 G

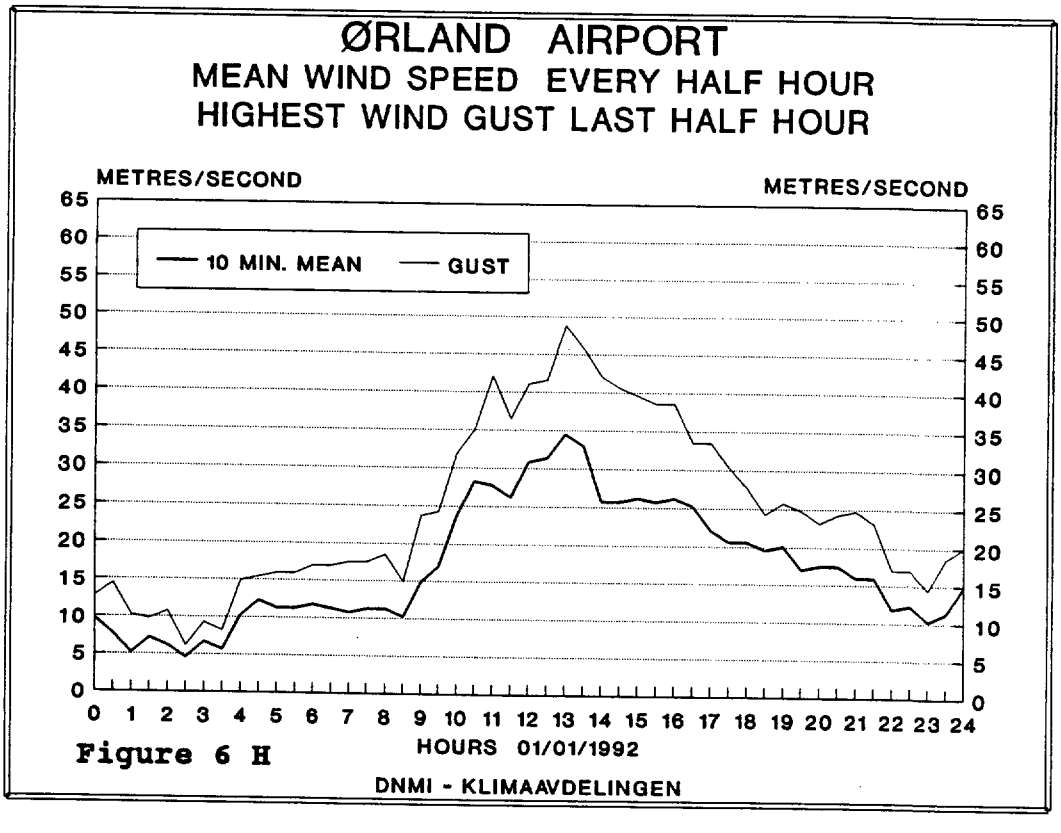

Figure 6 H

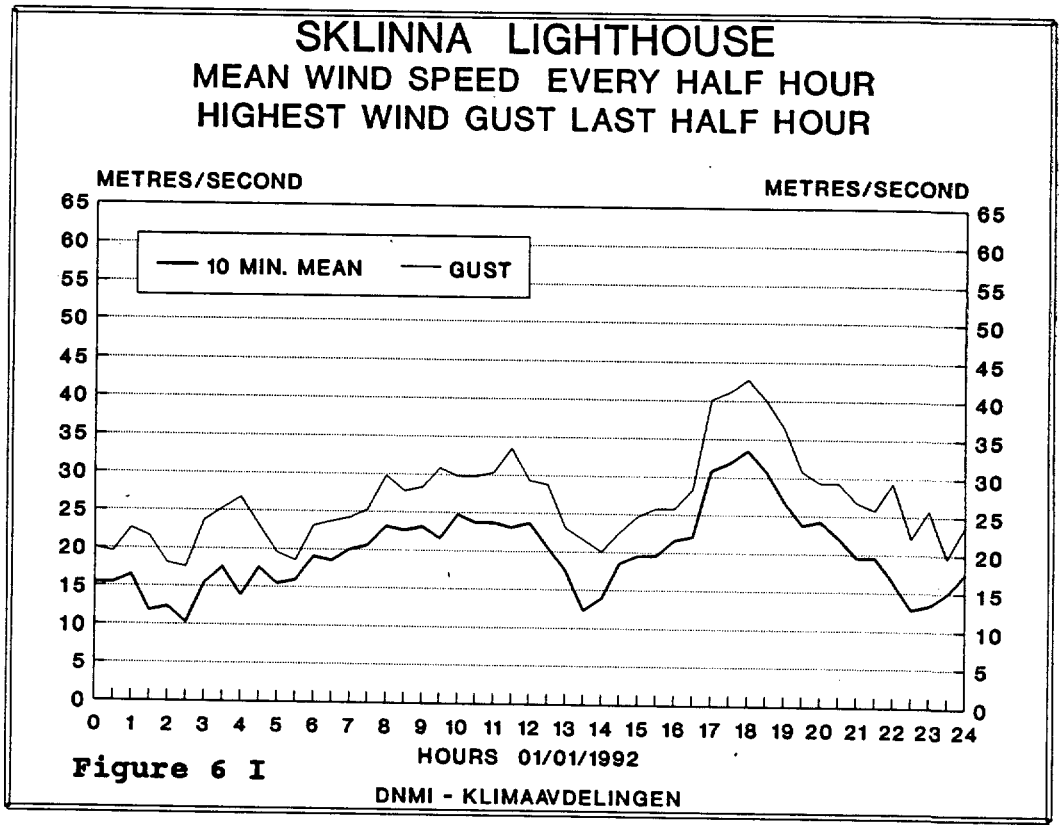
SKLINNA LIGHTHOUSE
MEAN WIND SPEED EVERY HALF HOUR
HIGHEST WIND GUST LAST HALF HOUR
METRES/SECOND
METRES/SECOND
10 MIN. MEAN
GUST
65
60
55
50
45
40
35
30
25
20
15
10
5
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
HOURS 01/01/1992
DNMI - KLIMAAVDELINGEN

Figure 6 I

January 1. 1992 gave periods with strong gale (Beaufort Force 9, windspeeds 20.8 - 24.4 m/s) or stronger wind over the coast from Færder in the Oslo Fjord to Bodø in the north, violent storm (Beaufort Force 11, wind speeds 28.5 - 32.6 m/s) or stronger from the Hardanger Fjord to Sklinna Lighthouse, and hurricane (Beaufort Force 12, wind speeds higher than 32.56 m/s) between Stad and Vikna.

The wind in the fjords inside the west coast was generally weaker but very turbulent because of the topography. It therefore showed great variations both in time and space. Places where the topography strengthened the wind had periods with wind speeds up to hurricane force and/or wind gusts above 50 m/s. Other places close by were sheltered and had much smaller wind speeds. The result was very complicated wind patterns.

Mapping these patterns and finding danger areas will require a detailed storm climatology study.

It was storm in the high mountain areas in southern Norway, and exposed places in low-laying areas of the eastern parts had gale squalls with gusts above 20 m/s.

cont. page 12.

The highest mean wind speeds (10 minutes average speeds) and wind gusts (3-5 seconds speeds) between 0100 - 1900 hours on January 1. 1992 for the following meteorological observation stations (Figure 5) were:

	Mean wind m/s	Wind gust m/s	Remarks
1. Hellisøy Lighthouse	30	43	1
2. Sandane Airport - Anda	18	51	1
3. Svinøy Lighthouse	46	62	1
4. Ålesund Airport - Vigra	36	55	1
5. Molde Airport - Årø	-	54	2, 1
6. Kristiansund Airport - Kvernberget	33	50	1
7. Skalmen Lighthouse	46	62	1
8. Ørland Airport	37	49	1
9. Sklinna Lighthouse	33	43	1
10. Færder Lighthouse	22	28	
11. Toungen Lighthouse	25	-	2
12. Oksøy Lighthouse	23	-	2
13. Lista Lighthouse	21	29	
14. Utsira Lighthouse	28	38	
15. Ona	45	-	3, 4
16. Halten Lighthouse	40	55	1
17. Nordøyan Lighthouse	41	-	3, 4

Remarks:

1. Extrapolated data above graph limit.
2. Mean wind speed registration failed.
3. Mean wind speed registration failed. Interpolated values.
4. Station does not observe wind gust.

4. RETURN PERIODS

Extreme wind speed (10 min. average or gust(3-5 sec.)) above a particular value will have a certain probability, p, of occurence in any arbitrary year. This wind speed (U_T) is on average reached or exceeded each T=1/p year in a long data record. T is called the return period and U_T is the extreme wind speed with return period of T years.

T and U_T can be calculated for a given locality when we have a representative series of n annual wind speed maxima from the same locality, using WMO (Word Meteorological Organization) - recommended statistical methods. Commonly used is the double exponential distribution - the Gumbel method ("Guide to Climatological Practices", WMO - No.100, Geneva 1983). The number of years n should be at least 15 years. For shorter series, the data can be linked to a nearby, well exposed reference station with a long data record.

By comparing the January 1. 1992 wind speed values at some stations with the calulated extreme values for the same stations, we can get an idea of how extreme the storm was in different areas. The values are given below and a chart that is shown in Figure 7, has been drawn. The annual maxima for 1959/60 - 1991/92 for the station Ålesund Airport - Vigra are given in Figure 8.

	Mean wind speed	Gust	Return period
Hellisøy Lighthouse	30 m/s	43 m/s	50 years*
Ålesund Airport - Vigra	36 m/s	55 m/s	200 years
Sandane Airport - Anda	18 m/s	50 m/s	200 years**
Ørland Airport	37 m/s	49 m/s	100 years
Sklinna Lighthouse	33 m/s	43 m/s	10 years

*The return period for Hellisøy Lighthouse refers to wind from sector SW-W (210-290°), for all directions the return period is only 5 years.

**Extremely gusty wind, return period refer to wind gust.

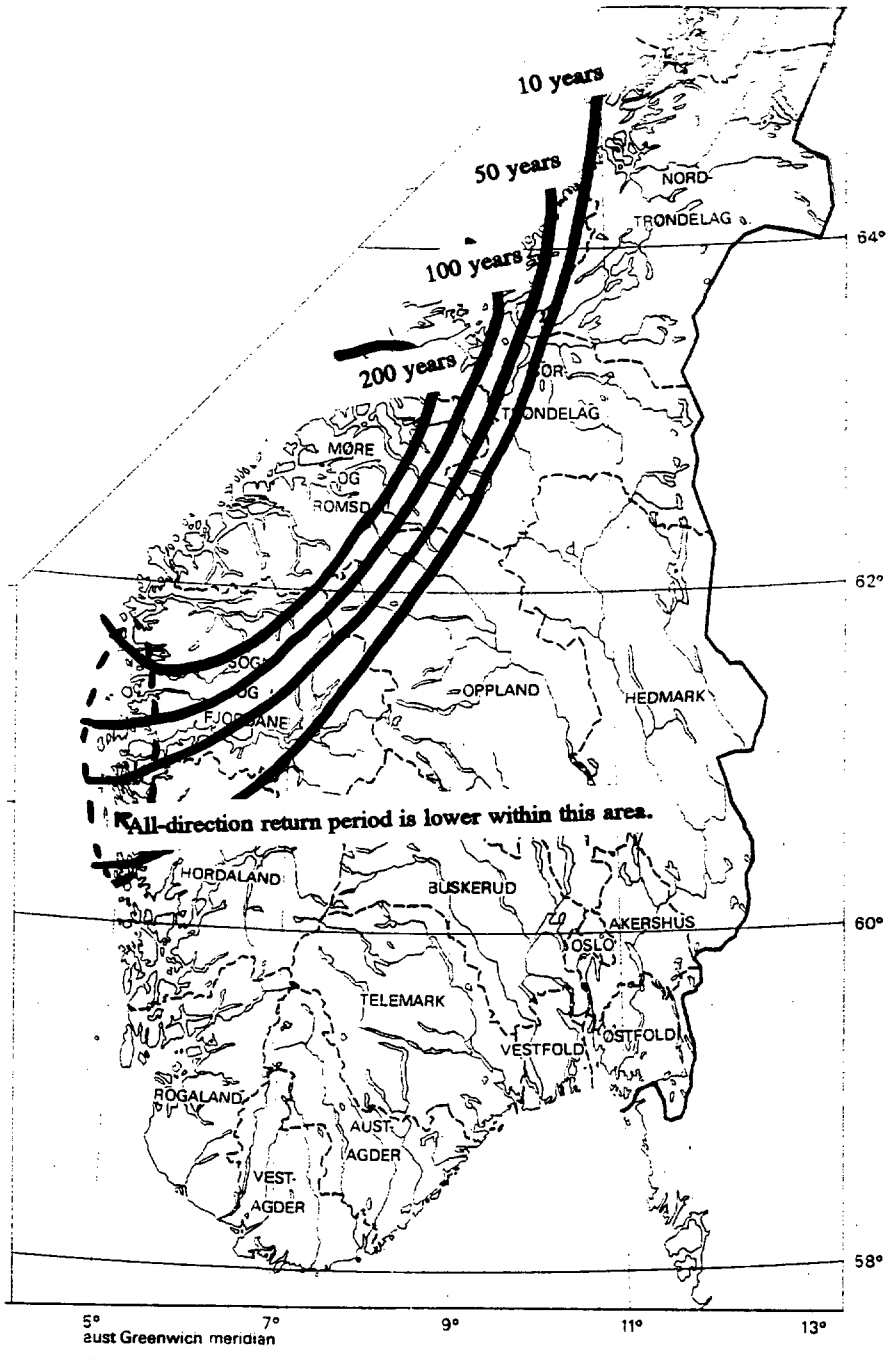

Figure 7. Geographical distribution of the gust return periods for areas exposed to wind fields from southwest to west, January 1. 1992.

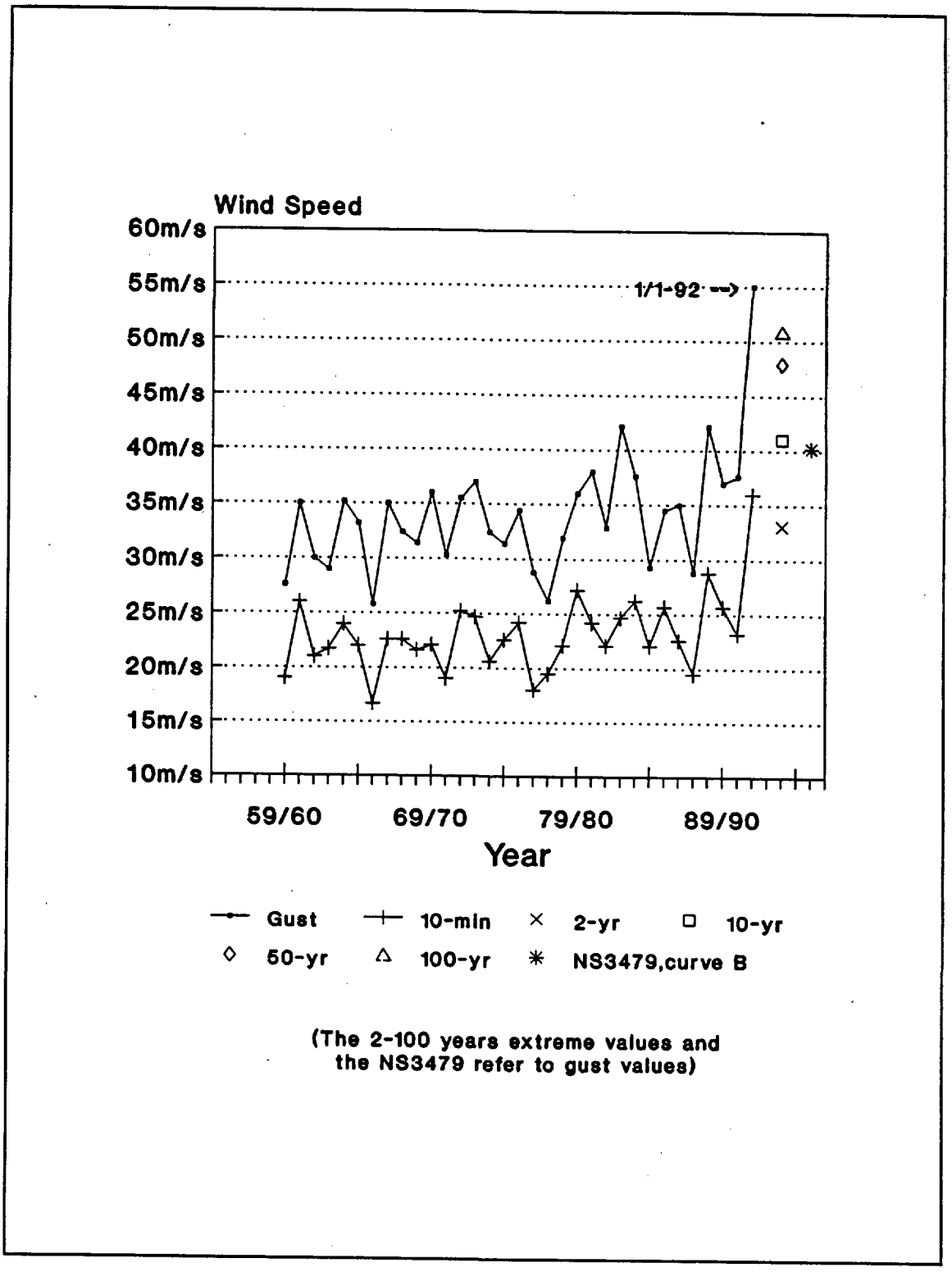

Figure 8. Series of wind speed maxima at Ålesund Airport - Vigra, 1959/60 - 1991/92.
NS3479, curve B is the Norwegian Building Standard for Wind Loads at exposed areas.

5. TOPOGRAPHICAL EFFECTS.

Generally the mean wind speed is considerably lower within the coast than it is at the lighthouses. This is due to frictional forces. Long wide channels, local corner effects and passes between mountains may locally, however, strengthen the wind up to values close to the coastal wind speed.

The wind gusts are also in general weakened inland, but to a lesser degree than the mean wind speeds. When the upper air wind crosses steep mountain ridges, very dangerous wind patterns may occur. The wind gusts may be even higher than the coastal gusts, and complex wind rotors may develop. The local wind direction may deviate strongly and even be contrary to the free wind direction. Gjerdsvika at Gurskøy, Rovde at Vanylven, Hustad at Fræna, Solheim at Tustna and Follfjorden at Aure are a few examples of such dangerous wind areas in Møre og Romsdal with great damages during the storm of January 1. 1992. Gust wind speeds may have exeeced 60 m/s at such places.

In steep mountain terrain do wind conditions often shift strongly over short distances. It may be very difficult, even for well-experienced meteorologists, to give good wind estimates without measurements or closer knowledge of the actual area. It should however be possible, by collecting all available measurements, using damage statistics and updated theories, to get a better picture of wind extremes and the local geographical distribution of them than we have today.

But such research is both expensive and personnel demanding. The economical and security gains will, however, be considerable. Political, building, insurance and meteorological authorities should therefor join efforts to get better and more detailed knowledge of the wind conditions in the country.

THE BEAUFORT SCALE

FOR 10 MINUTES MEAN WIND SPEEDS

Beaufort force	English description	Norwegian description	Wind speeds m/s
0	Calm	Stille	Less than 0.3
1	Light air	Flau vind	0.3 - 1,5
2	Light breeze	Svak vind	1.6 - 3.3
3	Gentle breeze	Lett bris	3.4 - 5.4
4	Moderate breeze	Laber bris	5.5 - 7.9
5	Fresh breeze	Frisk bris	8.0 - 10.7
6	Strong breeze	Liten kuling	10.8 - 13.8
7	Near gale	Stiv kuling	13.9 - 17.1
8	Gale	Sterk kuling	17.2 - 20.7
9	Strong gale	Liten storm	20.8 - 24.4
10	Storm	Full storm	24.5 - 28.4
11	Violent storm	Sterk storm	28.5 - 32.6
12	Hurricane	Orkan	Above 32.6