Weather forecasts received on board *ALP Forward* 3 and 4 August

SafeVoyage
Stavanger to Malta
Transocean Winner & ALP Forward

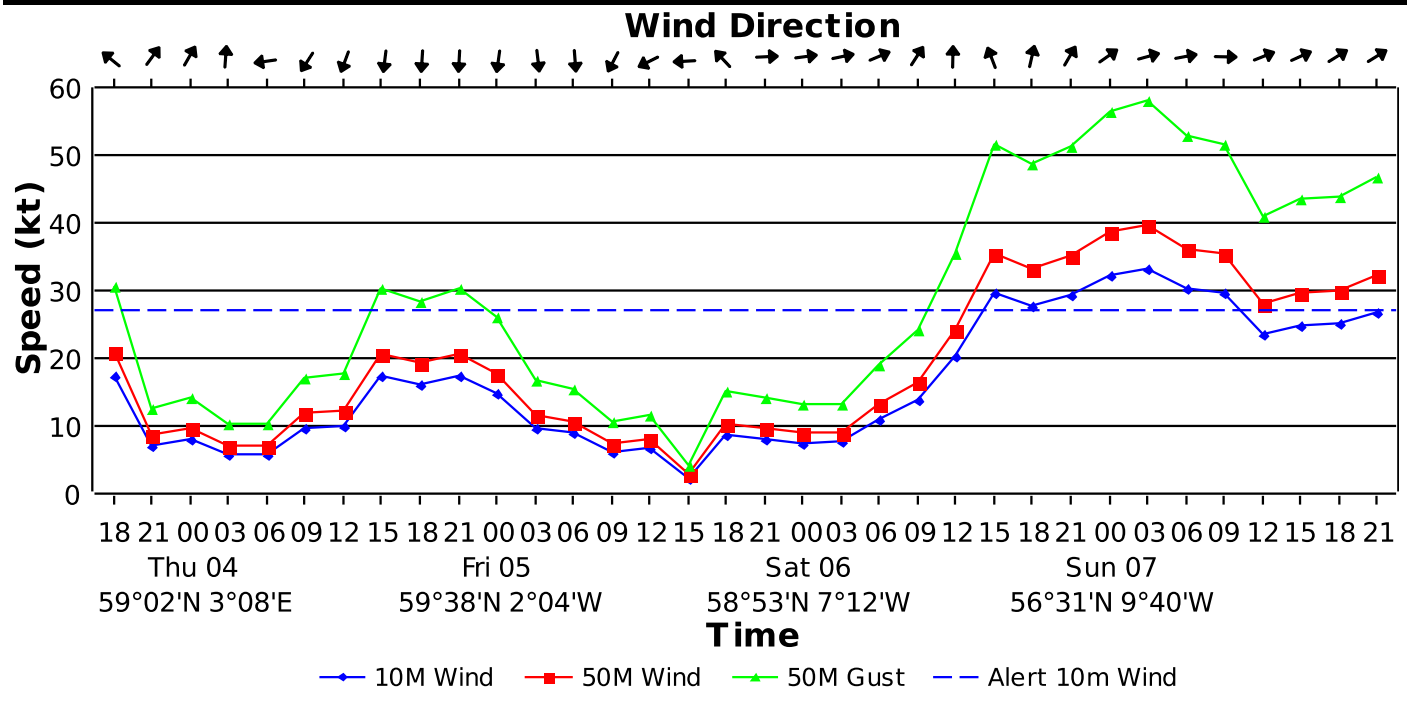
General situation	Forecaster guidance
Low centred over Scotland on Wednesday afternoon, moves NE across the North Sea to become slow moving over southern Scandinavia by Friday with a ridge building north to the west of the UK. The ridge topples SE across the UK and surrounding waters through the weekend with a complex, slow moving low becoming centred west of the Faeroes.	High confidence becoming Medium Thursday due to uncertainties over the exact track of the low. Forecast based on departure at 1145 UTC at 7KT from Stavanger following the Fair Isle gap route as requested. Please keep us informed of your plans.

Confidence	HIGH becoming Medium on Thursday. Please see Guidance text.	**Forecaster**	[redacted]
Lightning risk	3 (moderate) occasionally 2 (high) at first.	**Issued**	03.08.2016 16:54

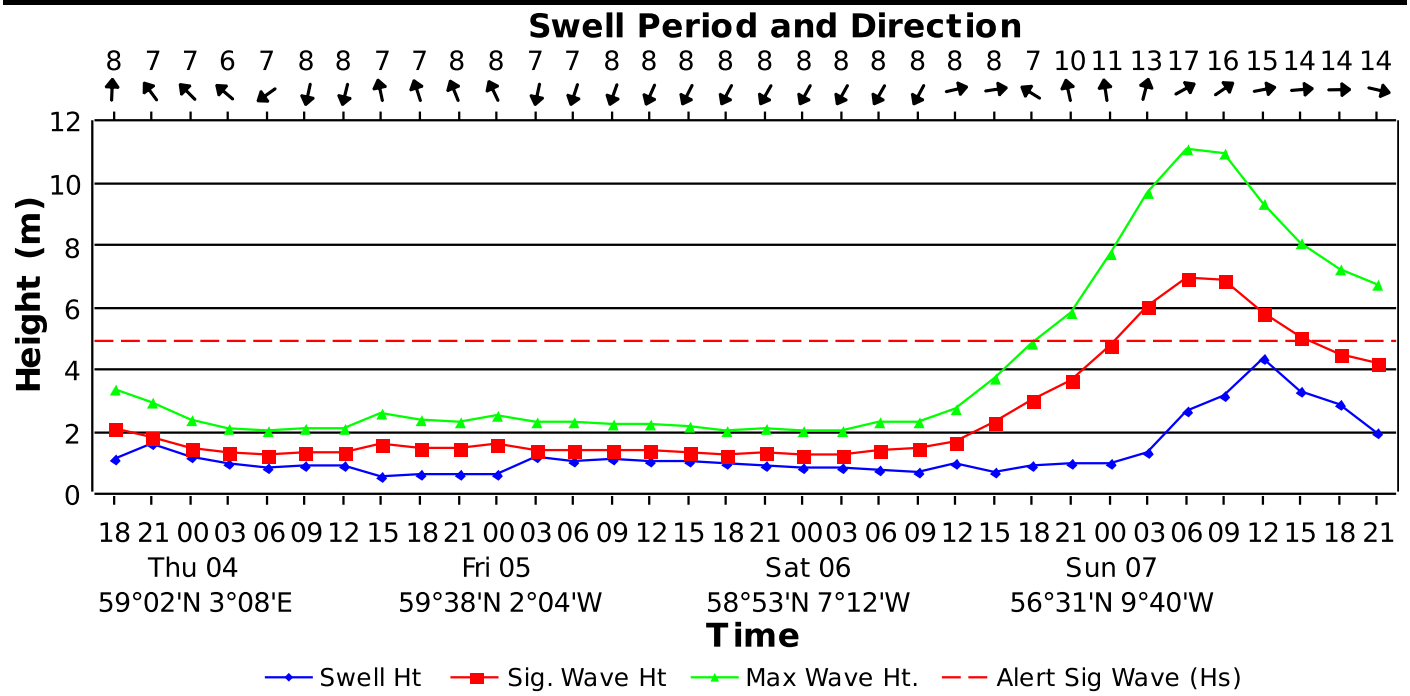
Time (UTC)	Winds					Waves						Weather	Visibility
	Dir	10m		50m		Sig Hgt (m)	Max Hgt (m)	Sig Per	Swell				
		Speed (kt)	Gusts (kt)	Speed (kt)	Gusts (kt)				Dir	Hgt (m)	Per		
Wed 03 Aug, 2016 From 59°00'N 4°30'E to 59°02'N 3°08'E													
18:00	SE	17	24	21	31	2.1	3.3	5	S	1.2	8	SHOWERS	5000m
21:00	SW	7	10	9	13	1.8	3.0	5	SE	1.6	7	SHOWERS	10km+
Thu 04 Aug, 2016 From 59°02'N 3°08'E to 59°38'N 2°04'W													
00:00	SSW	8	11	10	14	1.5	2.4	6	SE	1.2	7	SHOWERS	10km+
03:00	S	6	8	7	10	1.3	2.1	6	SE	1.0	6	SHOWERS	9km
06:00	E	6	8	7	10	1.3	2.1	6	NE	0.9	7	SHOWERS	8km
09:00	NNE	10	14	12	17	1.3	2.1	6	NNE	0.9	8	SHOWERS	4500m
12:00	NNE	10	14	12	18	1.3	2.1	5	NNE	0.9	8	DRY	10km+
15:00	N	17	24	21	30	1.6	2.6	4	SSE	0.5	7	DRY	10km+
18:00	N	16	23	19	28	1.5	2.4	4	SSE	0.6	7	DRY	10km+
21:00	N	17	24	21	30	1.5	2.3	4	SSE	0.6	8	DRY	10km+
Fri 05 Aug, 2016 From 59°38'N 2°04'W to 58°53'N 7°12'W													
00:00	N	15	21	18	26	1.6	2.6	5	SSE	0.6	8	DRY	10km+
03:00	N	10	13	12	17	1.4	2.3	5	NNE	1.2	7	DRY	10km+
06:00	N	9	13	11	16	1.4	2.3	5	NNE	1.1	7	DRY	10km+
09:00	NNE	6	8	7	11	1.4	2.3	6	NNE	1.2	8	DRY	10km+
12:00	ENE	7	9	8	12	1.4	2.2	6	NNE	1.1	8	DRY	9km
15:00	E	2	3	3	4	1.3	2.1	7	NNE	1.0	8	RAIN	10km+
18:00	SE	9	12	10	15	1.3	2.1	7	NNE	1.0	8	RAIN	8km
21:00	W	8	11	10	14	1.3	2.1	6	NNE	0.9	8	RAIN	10km+
Sat 06 Aug, 2016 From 58°53'N 7°12'W to 56°31'N 9°40'W													
00:00	W	8	11	9	13	1.3	2.1	6	NNE	0.9	8	DRY	10km+
03:00	WSW	8	11	9	13	1.3	2.0	6	NNE	0.8	8	DRY	10km+
06:00	WSW	11	15	13	19	1.4	2.3	5	NNE	0.8	8	DRY	10km+
09:00	SSW	14	19	17	24	1.5	2.4	5	NNE	0.7	8	RAIN	10km+
12:00	S	20	28	24	35	1.7	2.7	4	WSW	1.0	8	DRIZZLE	4000m
15:00	SSE	30	41	35	52	2.3	3.7	5	W	0.7	8	DRIZZLE	4500m
18:00	SSW	28	39	33	49	3.0	4.8	5	ESE	0.9	7	DRIZZLE	6km
21:00	SSW	29	41	35	51	3.6	5.8	6	SSE	1.0	10	DRIZZLE	7km
Sun 07 Aug, 2016 From 56°31'N 9°40'W to 54°08'N 10°41'W													
00:00	SW	32	45	39	57	4.8	7.7	7	S	1.0	11	DRIZZLE	6km
03:00	WSW	33	46	40	58	6.0	9.7	8	SSW	1.3	13	SHOWERS	8km
06:00	W	30	42	36	53	6.9	11.1	9	WSW	2.7	17	SHOWERS	9km
09:00	W	30	41	35	52	6.9	11.0	9	SW	3.2	16	SHOWERS	10km+
12:00	WSW	23	33	28	41	5.9	9.4	9	W	4.3	15	DRY	10km+
15:00	WSW	25	35	30	43	5.0	8.1	8	W	3.3	14	DRY	10km+
18:00	WSW	25	35	30	44	4.5	7.2	8	W	2.9	14	DRY	10km+
21:00	WSW	27	38	32	47	4.2	6.8	7	WNW	1.9	14	DRY	10km+

Tel: 0370 900 0100 www.metoffice.gov.uk
For access to a forecaster: +44(0)1224 629803
Communications Manager: +44(0)1224 629805 Email: aberdeen@metoffice.gov.uk

Wind Speed and Direction



Wave Graph



Maximum Wave Height is defined as the average of the highest 1% of all waves.

SafeVoyage
Stavanger to Malta
Transocean Winner & ALP Forward

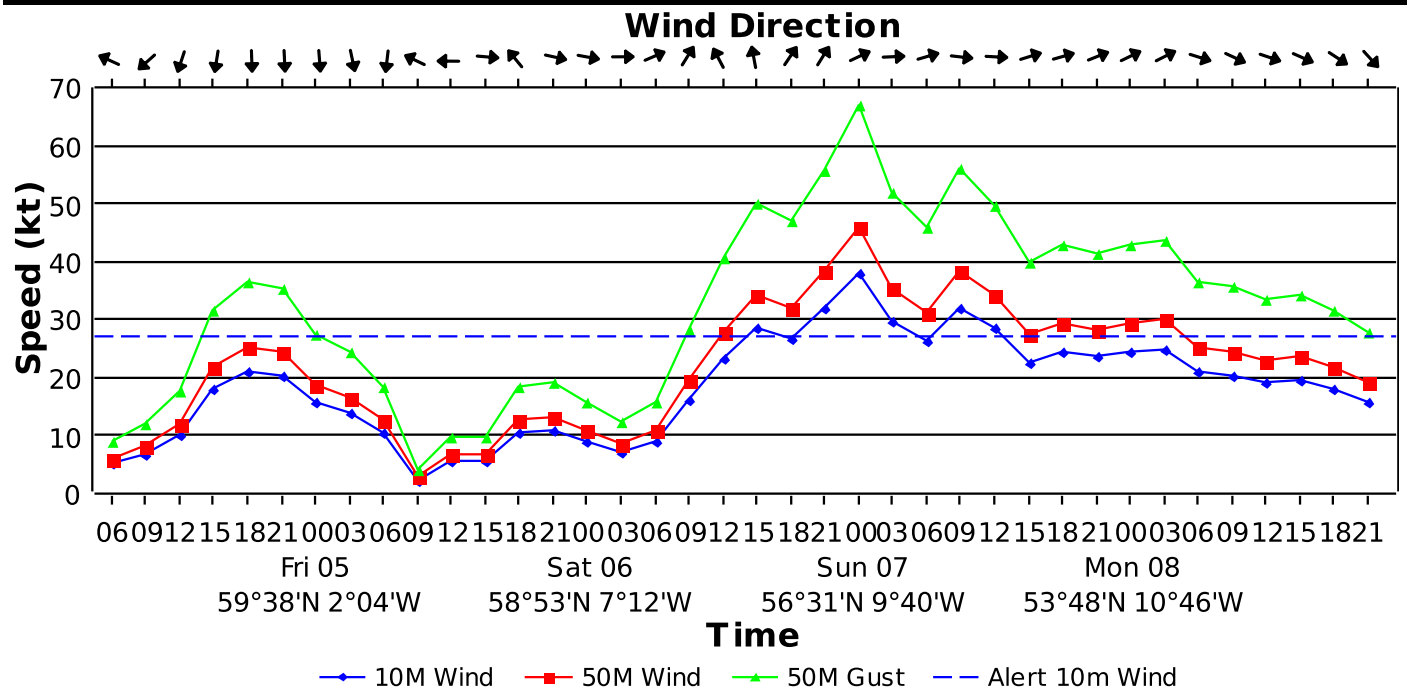
General situation	Forecaster guidance
Low centred just east of Scotland on Thursday morning continues to track E across the North Sea to become slow moving over southern Scandinavia by Friday with a ridge building across the UK. The ridge declines SE through the weekend as a deep Atlantic low moves NE (reaching the Faeroes by Sunday), which extends frontal troughs across your route.	Medium confidence due to uncertainties over the exact track of the low. confidence lowers on Sunday due to Atlantic low passing close to your route. Forecast based on departure at 1145 UTC at 7KT from Stavanger following the Fair Isle gap route as requested. Please keep us informed of your plans.

Confidence	MEDIUM becoming low for detail by Sunday, please see Guidance text.	**Forecaster**	[redacted]
Lightning risk	4 (low).	**Issued**	04.08.2016 05:17

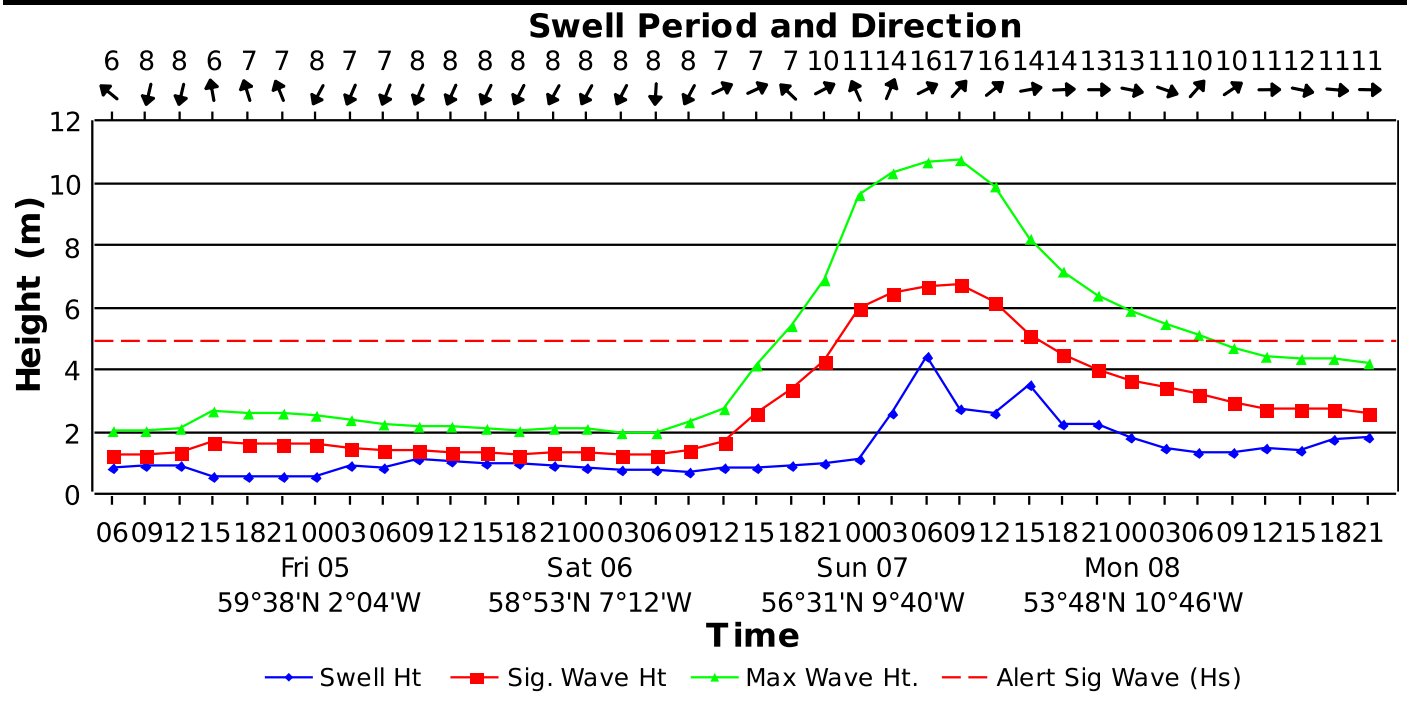
Time (UTC)	Winds					Waves						Weather	Visibility
	Dir	10m		50m		Sig Hgt (m)	Max Hgt (m)	Sig Per	Swell				
		Speed (kt)	Gusts (kt)	Speed (kt)	Gusts (kt)				Dir	Hgt (m)	Per		
Thu 04 Aug, 2016 From 59°03'N 1°47'E to 59°38'N 2°04'W													
06:00	ESE	5	7	6	9	1.3	2.0	6	SE	0.8	6	SHOWERS	10km+
09:00	NE	7	10	8	12	1.3	2.1	6	NNE	0.9	8	DRIZZLE	6km
12:00	NNE	10	14	12	18	1.3	2.1	6	NNE	0.9	8	SHOWERS	10km+
15:00	N	18	25	22	32	1.7	2.7	4	S	0.5	6	SHOWERS	9km
18:00	N	21	29	25	37	1.6	2.6	4	SSE	0.5	7	DRY	10km+
21:00	N	20	28	24	36	1.6	2.6	4	SSE	0.6	7	DRY	10km+
Fri 05 Aug, 2016 From 59°38'N 2°04'W to 58°53'N 7°12'W													
00:00	N	16	22	19	27	1.6	2.6	4	NNE	0.5	8	DRY	10km+
03:00	NNW	14	19	17	24	1.5	2.4	5	NNE	0.9	7	DRY	10km+
06:00	N	11	15	13	18	1.4	2.3	5	NNE	0.8	7	DRY	10km+
09:00	ESE	2	3	3	4	1.4	2.2	6	NNE	1.1	8	RAIN	10km+
12:00	E	6	8	7	10	1.4	2.2	6	NNE	1.1	8	RAIN	10km+
15:00	W	6	8	7	10	1.3	2.1	7	NNE	1.0	8	RAIN	10km+
18:00	SE	11	15	13	19	1.3	2.0	6	NNE	1.0	8	DRIZZLE	5500m
21:00	WNW	11	15	13	19	1.3	2.1	5	NNE	0.9	8	RAIN	10km+
Sat 06 Aug, 2016 From 58°53'N 7°12'W to 56°31'N 9°40'W													
00:00	W	9	13	11	16	1.3	2.1	5	NNE	0.8	8	DRY	10km+
03:00	W	7	10	9	12	1.2	2.0	6	NNE	0.8	8	DRY	10km+
06:00	WSW	9	13	11	16	1.2	2.0	5	N	0.8	8	DRY	10km+
09:00	SSW	16	23	19	28	1.4	2.3	5	NNE	0.7	8	RAIN	10km+
12:00	SSE	23	33	28	41	1.7	2.7	4	WSW	0.9	7	RAIN	10km+
15:00	S	29	40	34	50	2.6	4.1	5	WSW	0.8	7	SHOWERS	9km
18:00	SW	27	38	32	47	3.4	5.4	6	SE	0.9	7	SHOWERS	9km
21:00	SSW	32	45	38	56	4.3	6.9	7	WSW	1.0	10	SHOWERS	9km
Sun 07 Aug, 2016 From 56°31'N 9°40'W to 53°48'N 10°46'W													
00:00	WSW	38	53	46	67	6.0	9.6	8	SSE	1.2	11	DRIZZLE	6km
03:00	W	30	41	36	52	6.5	10.3	8	SSW	2.6	14	RAIN	10km+
06:00	WSW	26	37	31	46	6.7	10.7	10	WSW	4.4	16	RAIN	10km+
09:00	W	32	45	38	56	6.7	10.7	9	SW	2.7	17	DRY	10km+
12:00	W	28	40	34	50	6.2	9.9	9	SW	2.6	16	DRY	10km+
15:00	WSW	23	32	27	40	5.1	8.2	8	W	3.5	14	DRY	10km+
18:00	WSW	25	34	29	43	4.5	7.1	8	W	2.2	14	DRY	10km+
21:00	WSW	24	33	28	41	4.0	6.4	7	W	2.2	13	DRY	10km+
Mon 08 Aug, 2016 From 53°48'N 10°46'W to 51°21'N 10°58'W													
00:00	WSW	24	34	29	43	3.7	5.9	7	WNW	1.8	13	DRY	10km+
03:00	WSW	25	35	30	44	3.4	5.5	6	WNW	1.5	11	DRY	10km+
06:00	WNW	21	29	25	37	3.2	5.1	6	SW	1.3	10	DRY	10km+
09:00	WNW	20	29	25	36	2.9	4.7	6	SW	1.3	10	DRY	10km+
12:00	WNW	19	27	23	33	2.8	4.4	6	W	1.5	11	DRY	10km+
15:00	WNW	20	27	24	34	2.7	4.3	6	WNW	1.4	12	DRY	10km+
18:00	WNW	18	25	22	32	2.7	4.4	6	W	1.8	11	DRY	10km+
21:00	NW	16	22	19	28	2.6	4.2	6	W	1.8	11	DRY	10km+

Tel: 0370 900 0100 www.metoffice.gov.uk
For access to a forecaster: +44(0)1224 629803
Communications Manager: +44(0)1224 629805 Email: aberdeen@metoffice.gov.uk

Wind Speed and Direction



Wave Graph



Maximum Wave Height is defined as the average of the highest 1% of all waves.

SafeVoyage
Stavanger to Malta
Transocean Winner & ALP Forward

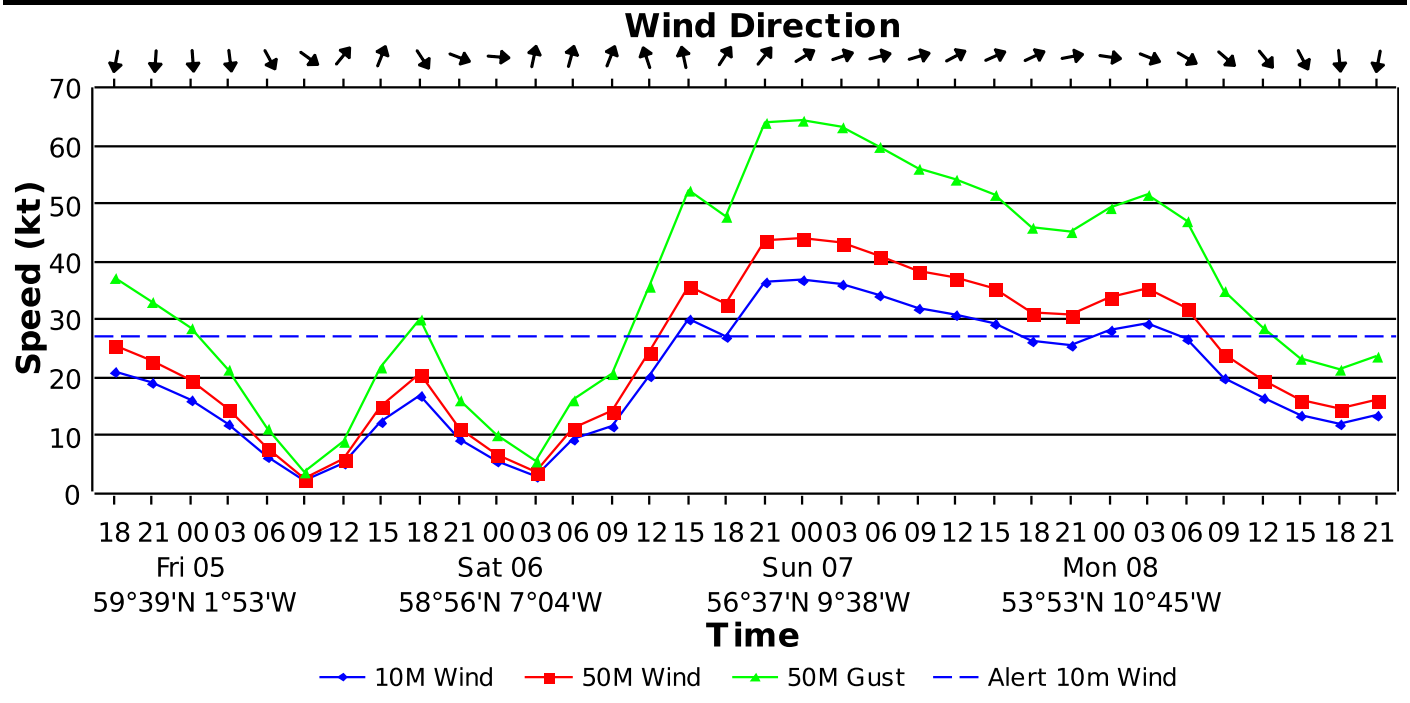
General situation	Forecaster guidance
A depression in the North Sea will move northeast into Scandinavia as a ridge builds west of the UK. The ridge will move east into the UK on Friday and then into the North Sea on Saturday as a deep low tracks northeast towards the Faeroes. The low will move northeast into the Norwegian Sea on Sunday and Norway on Monday. An anticyclone will build to the southwest of Ireland on Tuesday.	Medium confidence due to uncertainties over the exact track of the low. confidence lowers on Sunday due to Atlantic low passing close to your route. Please keep us informed of your latest position.

Confidence	MEDIUM becoming low for detail by Sunday, please see Guidance text.	**Forecaster**	[redacted]
Lightning risk	4 (low).	**Issued**	04.08.2016 17:02

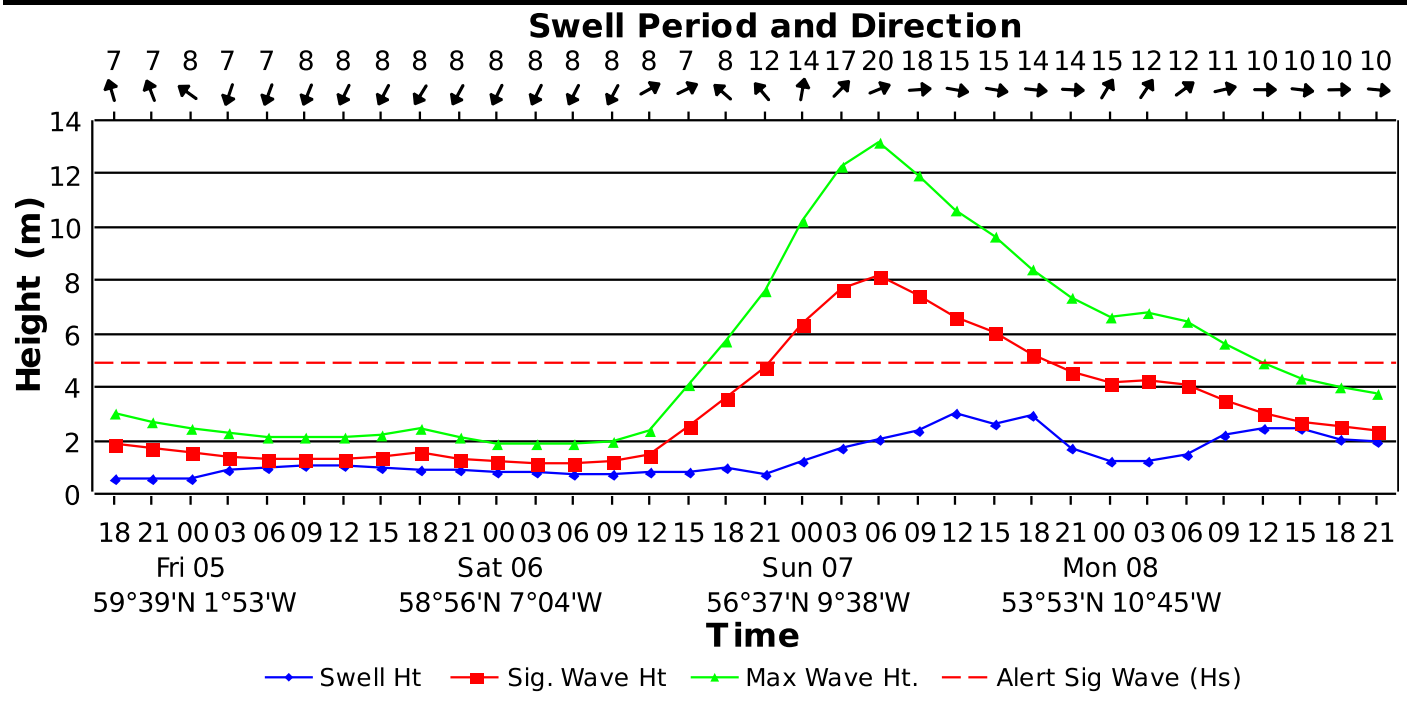
Time (UTC)	Winds					Waves						Weather	Visibility
	Dir	10m		50m		Sig Hgt (m)	Max Hgt (m)	Sig Per	Swell				
		Speed (kt)	Gusts (kt)	Speed (kt)	Gusts (kt)				Dir	Hgt (m)	Per		
Thu 04 Aug, 2016 From 59°32'N 0°35'W to 59°39'N 1°53'W													
18:00	N	21	30	25	37	1.9	3.0	5	SSE	0.6	7	DRY	10km+
21:00	N	19	27	23	33	1.7	2.7	4	SSE	0.6	7	DRY	10km+
Fri 05 Aug, 2016 From 59°39'N 1°53'W to 58°56'N 7°04'W													
00:00	N	16	23	20	29	1.6	2.5	4	SE	0.6	8	DRY	10km+
03:00	N	12	17	15	21	1.4	2.3	5	NNE	0.9	7	DRY	10km+
06:00	NNW	7	9	8	11	1.3	2.1	6	NNE	1.0	7	DRY	7km
09:00	NW	2	3	3	4	1.3	2.1	6	NNE	1.1	8	DRY	10km+
12:00	SW	5	7	6	9	1.3	2.1	6	NNE	1.1	8	DRY	10km+
15:00	SSW	12	17	15	22	1.4	2.2	5	NNE	1.0	8	RAIN	9km
18:00	NNW	17	24	21	30	1.5	2.4	5	NNE	0.9	8	SHOWERS	10km+
21:00	WNW	9	13	11	16	1.3	2.1	5	NNE	0.9	8	RAIN	10km+
Sat 06 Aug, 2016 From 58°56'N 7°04'W to 56°37'N 9°38'W													
00:00	W	6	8	7	10	1.2	1.9	6	NNE	0.9	8	DRY	10km+
03:00	SSW	3	4	4	6	1.2	1.9	6	NNE	0.8	8	DRY	10km+
06:00	SSW	9	13	11	16	1.2	1.9	6	NNE	0.8	8	DRY	10km+
09:00	SSW	12	16	14	21	1.2	2.0	5	NNE	0.7	8	RAIN	10km+
12:00	SSE	20	29	24	36	1.5	2.4	4	WSW	0.8	8	DRIZZLE	3500m
15:00	SSE	30	42	36	52	2.6	4.1	5	WSW	0.8	7	DRIZZLE	6km
18:00	SSW	27	38	33	48	3.6	5.7	6	SE	1.0	8	SHOWERS	9km
21:00	SW	37	51	44	64	4.7	7.6	7	SE	0.8	12	SHOWERS	8km
Sun 07 Aug, 2016 From 56°37'N 9°38'W to 53°53'N 10°45'W													
00:00	WSW	37	51	44	64	6.4	10.2	8	S	1.2	14	RAIN	8km
03:00	WSW	36	50	43	63	7.7	12.3	9	SW	1.7	17	DRY	10km+
06:00	WSW	34	48	41	60	8.2	13.1	10	WSW	2.1	20	DRY	10km+
09:00	WSW	32	45	38	56	7.5	12.0	10	W	2.3	18	DRY	10km+
12:00	WSW	31	43	37	54	6.6	10.6	9	W	3.0	15	DRY	8km
15:00	WSW	29	41	35	52	6.0	9.7	9	W	2.6	15	DRY	10km+
18:00	WSW	26	37	31	46	5.2	8.4	8	W	2.9	14	DRY	10km+
21:00	W	26	36	31	45	4.6	7.4	8	W	1.7	14	DRY	10km+
Mon 08 Aug, 2016 From 53°53'N 10°45'W to 51°27'N 10°58'W													
00:00	W	28	39	34	49	4.2	6.7	7	SSW	1.2	15	DRY	10km+
03:00	WNW	30	41	35	52	4.2	6.8	7	SSW	1.2	12	DRY	10km+
06:00	WNW	27	38	32	47	4.1	6.5	7	SW	1.5	12	DRY	10km+
09:00	NW	20	28	24	35	3.5	5.6	7	WSW	2.2	11	DRY	10km+
12:00	NW	16	23	20	29	3.0	4.9	7	W	2.5	10	DRY	10km+
15:00	NNW	13	19	16	23	2.7	4.4	7	W	2.4	10	DRY	10km+
18:00	N	12	17	15	21	2.5	4.0	7	W	2.0	10	DRY	10km+
21:00	N	14	19	16	24	2.4	3.8	7	W	2.0	10	DRY	10km+

Tel: 0370 900 0100 www.metoffice.gov.uk
For access to a forecaster: +44(0)1224 629803
Communications Manager: +44(0)1224 629805 Email: aberdeen@metoffice.gov.uk

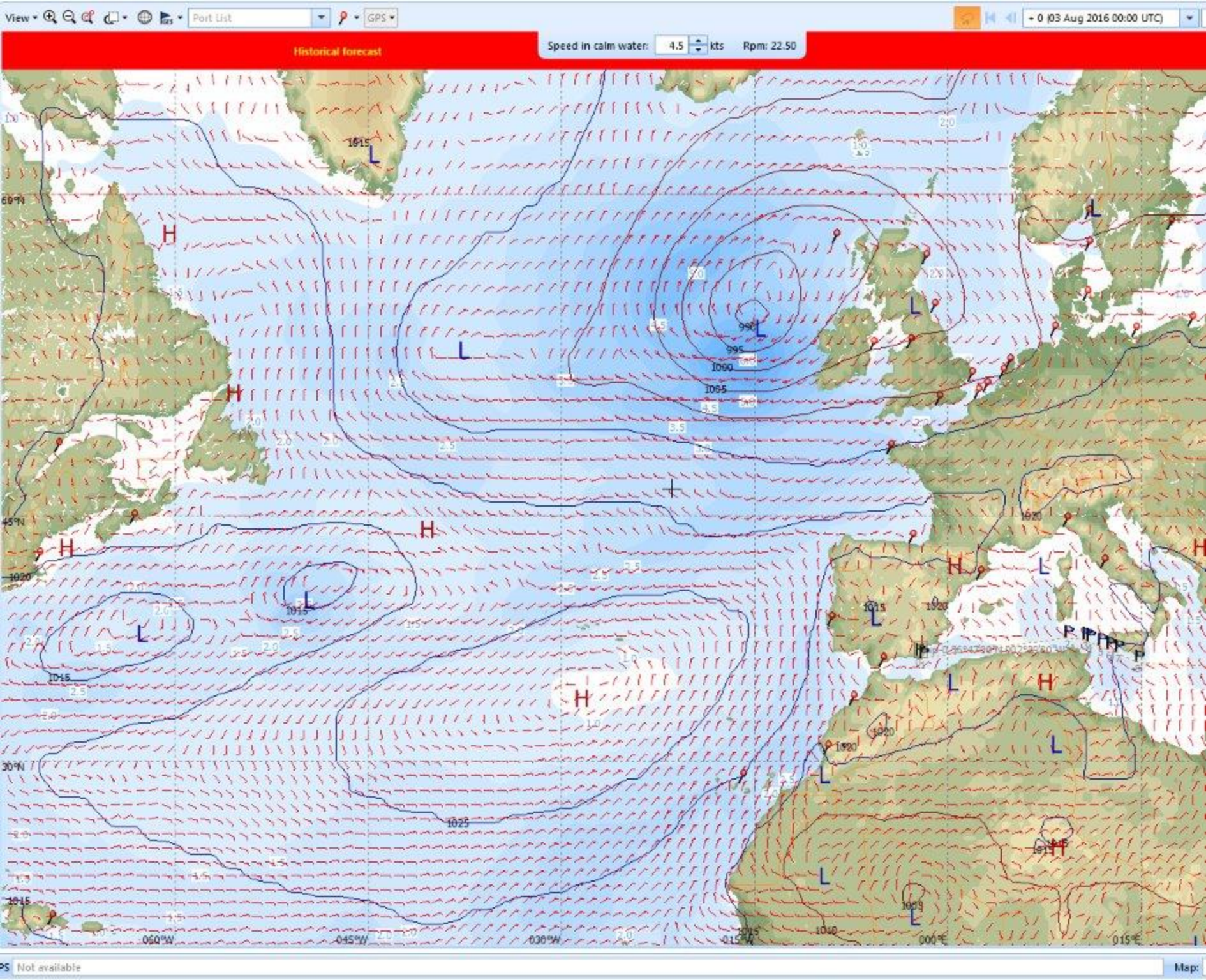
Wind Speed and Direction

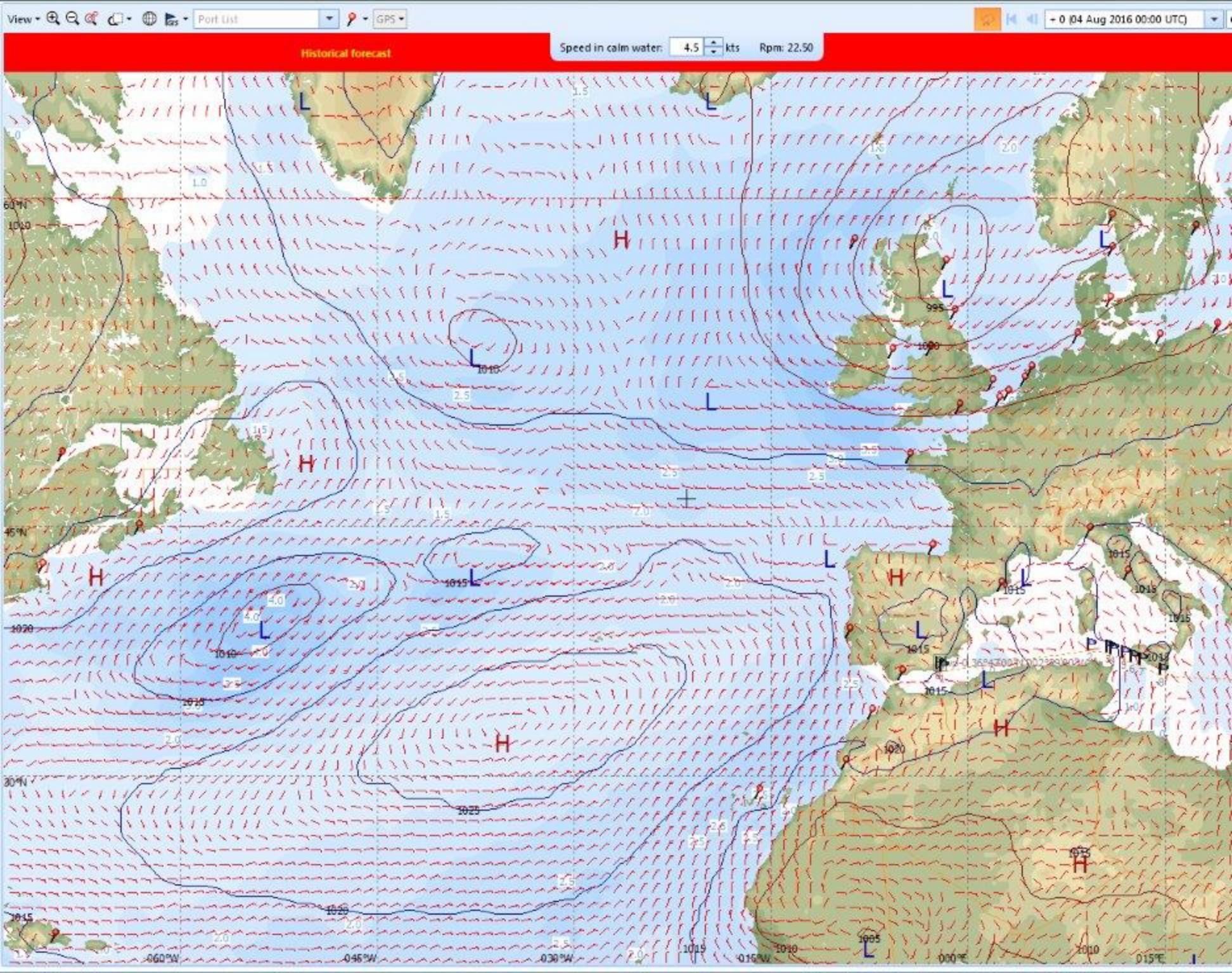


Wave Graph



Maximum Wave Height is defined as the average of the highest 1% of all waves.


View
Port List
GPS
+ 0 (03 Aug 2016 00:00 UTC)
Historical forecast
Speed in calm water:
4.5
kts
Rpm: 22.50
60°N
45°N
30°N
060°W
045°W
030°W
015°W
000°E
015°E
Not available
Map:


View
Port List
GPS
+ 0 (04 Aug 2016 00:00 UTC)
Historical forecast
Speed in calm water:
4.5
kts
Rpm: 22.50
60°N
45°N
30°N
060°W
045°W
030°W
015°W
000°E
015°E

Marine weather data report compiled for MAIB (Marine Accident Investigation Branch), Vessel: TRANSOCEAN Winner Location: West of Hebrides Incident date: 6th to 8th August 2016, Met Office

Vessel: TRANSOCEAN Winner

Location: West of Hebrides

Incident date: 6th to 8th August 2016

Marine weather data report compiled for

MAIB (Marine Accident Investigation Branch)

Author: [redacted]

Senior Scientist: Marine Legal

Met Office reference: msc/08/16/056

Report date: 30th August 2016

Contents

Prepared by:	[redacted]
Reviewed and authorised for issue by :	[redacted]

1.0 Terms of engagement

1.1 To provide a marine weather data hindcast for the platform: Transocean Winner along a route to the west of the Hebrides. The dates of interest extend from the 6th to the 8th August 2016. The hindcast was requested by [redacted] from the Marine Investigation Branch (MAIB) of Southampton, SO15 1GH [redacted]

.

2.0 Data and information sources

2.1 Hindcast data from the Met Office's UK 4 operational third generation wave model archive, tabulated in Section 4.0

2.2 VOS from the Met Office Marine database, presented in section 5.0

2.3 Analysis charts from the Met Office Atmospheric dispersion branch, presented in Appendix C

2.4 Tidal data from the Met Office, AMM (Atlantic Margin Model), presented in Tables 4.1 to 4.3

2.5 ASCAT satellite wind radar data courtesy of NOAA NESDIS, presented in Appendix B

2.6 K5 buoy data presented in section 6.0

3.0 Points to note

3.01 Weather data are collected and exchanged internationally according to universal Time Co-ordinated (UTC) convention. Unless otherwise stated, the times referred to in this report are UTC, which is Greenwich Mean Time (GMT).

3.02 The hindcast is a data hindcast and is a tabulation of model data given at the nearest grid point in the Met Office Global operational wave model archive at hourly UTC time steps, which has a resolution of 4 km. The data lists hourly 10 minute mean wind speed and direction and significant wave height, Hs. Remaining wave components consist of wind wave and swell components: Hs0, Hs1, Hs2, Hs3. Wave periods are Peak periods or Tp. Peak period is that period of a wave train which has the highest energy. Tp (adjacent to significant wave height), represents the peak period for the whole wave spectrum modelled at that grid point. Peak period of wind wave and swell and are given adjacent to their respective components. Zero upcrossing periods (Tz) are also given for significant wave height.

3.03 The wave heights (crest to trough) given in the assessment are defined as the average of the highest third of all waves within the wave train, also known as the significant wave height and in this case the resultant wave height. The resultant wave height is the total obtained from the individual wave and swell components. It is considered to be the equivalent of the significant wave height that would be measured by a wave recorder, to which it is also accepted that visual observations of wave height approximate. **Naturally individual wave heights will vary around these average conditions and the maximum wave height may be around two times the quoted significant wave height.** There may be further variations in these heights close to the coast due to tidal and shallow water effects.
When the significant wave height is discussed using descriptive terminology, the term sea state is often used. Refer to appendix A to see the WMO Sea State scale (WMO stands for the World Meteorological Organisation).

3.04 Wind waves, often called “windsea”, are generated by the local winds blowing over the surface of the ocean.

3.05 Swell represents wind waves that have either travelled out of the area in which they were generated, or can no longer be sustained by the winds in the generating area. The direction is that from which the swell is running. It is possible that there may be swells from one or more than one direction.

3.06 Resultant or significant wave height can be considered as the combination of wind wave and swell wave. When two or more wave trains are combined, the resultant wave height is determined from the square root of the sum of the squares of the heights of the separate trains. This is

because wave energy is proportional to the square of the wave height and it is the energy which is additive.

3.07 Over the sea, gusts can be expected to approximately 1.4 times the assessed strength of the mean wind at 10 metres. Therefore, a mean wind speed of 22 knots may be accompanied by gusts of 31 knots.

3.08 The Atlantic Margin Model (AMM) has been used for tidal currents. The operational Shelf Seas model is a three-dimensional model capable of representing the effects of temperature and salinity and able to resolve vertical current structure both on the shelf and at the shelf break and beyond. It operates on a 7 km grid. The current presented in Tables 4.1 is the vector derived from model tidal current and model wind driven current.

3.09 When the area of interest falls outside the ASCAT satellite return swathe, then images are not presented in Appendix B

4.10 Table of Waypoints

Ref	Time	LAT	LON
A	19:11:40	57 46.717 N	009 03.320 W
B	23:37:01	57 51.179 N	009 03.429 W
C	23:48:07	57 51.117 N	009 02.542 W
D	08:02:21	58 04.740 N	008 28.545 W
E	08:35:54	58 06.796 N	008 26.660 W
F	16:29:12	58 21.979 N	007 30.129 W
G	00:11:38	58 25.383 N	006 55.901 W
H	01:31:05	58 24.179 N	006 52.474 W

Table 3.1 Listing of Way points as supplied by MAIB

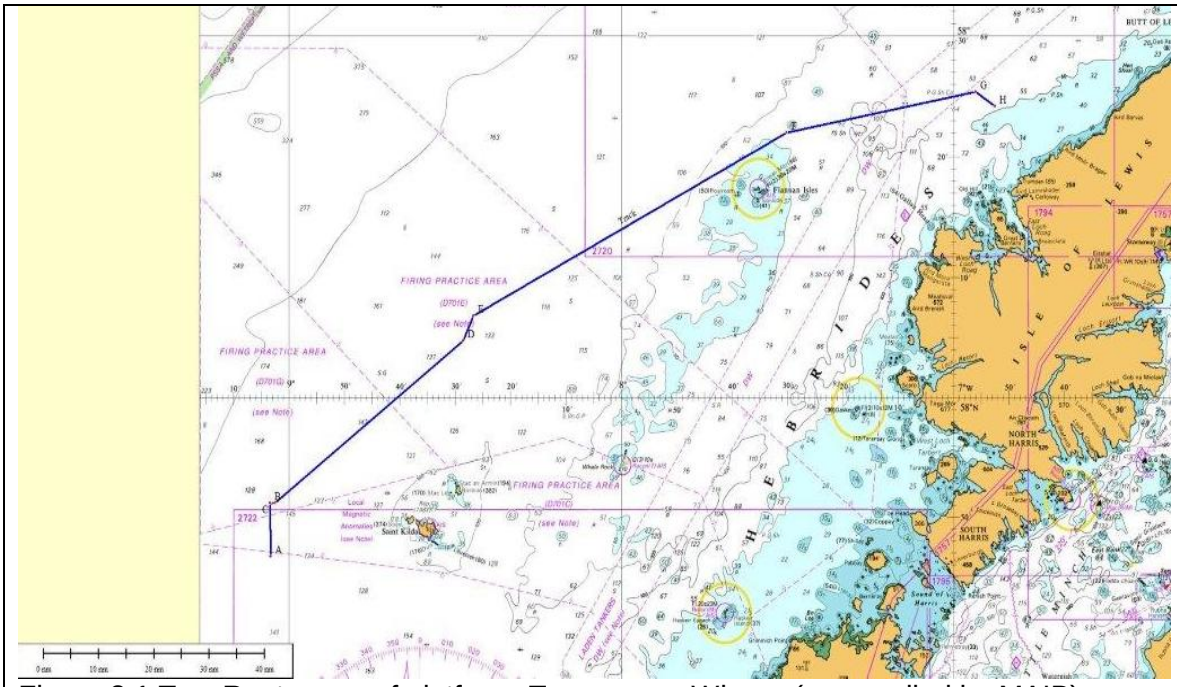


Figure 3.1 Tow Route map of platform: Transocean Winner (as supplied by MAIB)

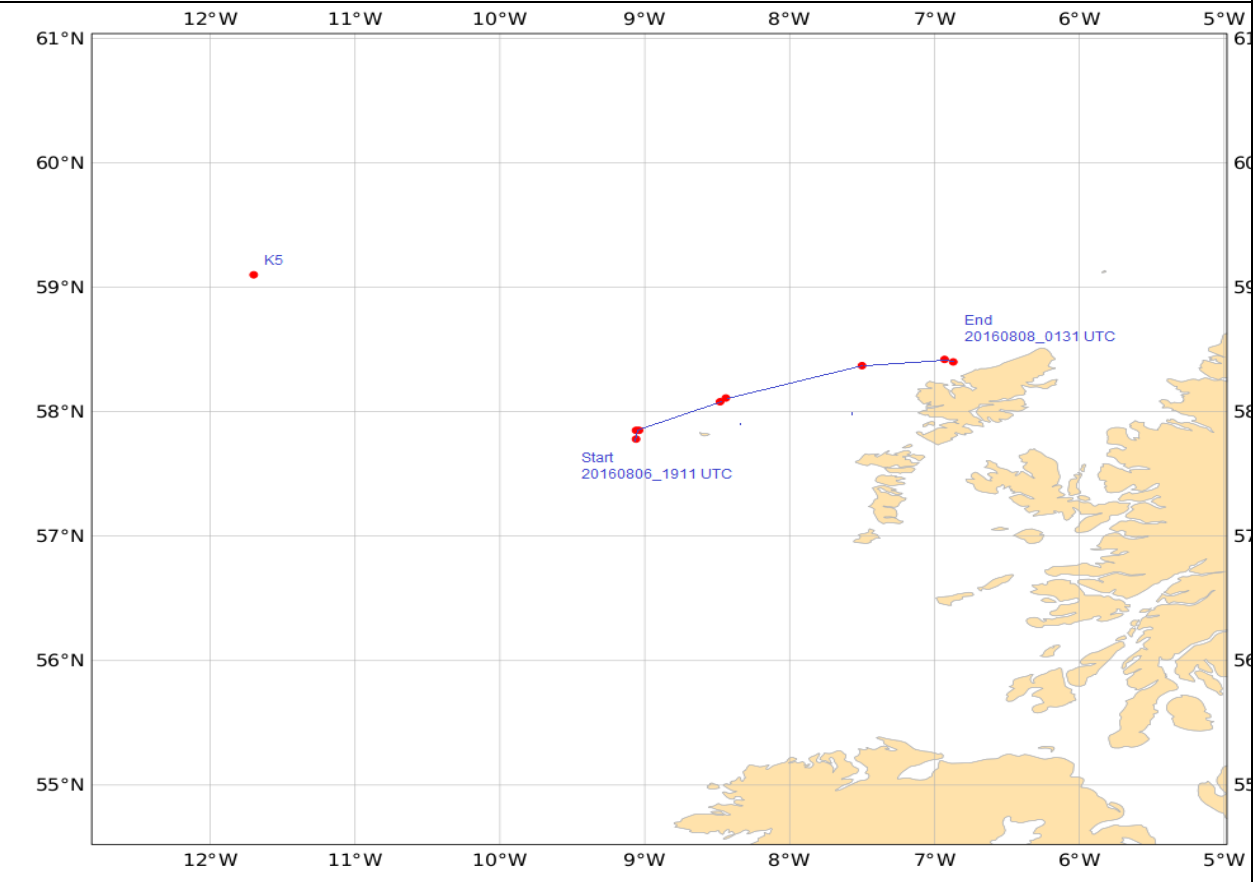


Figure 3.2 Map showing location of Buoy K5 and route of Transocean Winner

4.0 Marine Data Tables

Marine weather and current data follow in Table 4.1 to 4.4

Marine Weather table of wind and seas along the route of interest

Refer to Appendix A for Beaufort Force (BF) and qualitative wave ranges and definitions

Date		Location		*Current*		Wind			Sig wave (model)			Wind Wave Comp			Swell Wave Comp 1			Swell Wave Comp 2			Swell Wave Comp 3		
				Going to		Dir	10 metres	BF	Hs	Tp	Tz	Hs0	Tp	dir	Hs1	Tp	dir	Hs2	Tp	dir	Hs3	Tp	dir
	UTC			*°true*	*knots*	°true	knots		m	s	s	m	s	°true	m	s	°true	m	s	°true	m	s	°true
6 Aug	12																						
	13			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	17			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	18			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	19	57.78	-9.06	46	0.9	196	29	7	3.3	8	6	3.2	8	201	0.8	9	191	0.3	17	203	0.3	8	26
	20	57.79	-9.06	55	1.0	197	30	7	3.6	8	6	3.4	8	203	0.8	10	202	0.4	17	203	0.3	8	26
	21	57.81	-9.06	65	0.9	203	30	7	3.8	9	6	3.7	9	207	0.9	11	171	0.3	18	202	0.3	8	27
	22	57.83	-9.06	79	0.7	206	30	7	4.0	9	7	3.9	9	210	0.9	12	168	0.3	18	202	0.3	8	27
	23	57.84	-9.06	102	0.6	212	31	7	4.3	9	7	4.2	9	214	0.9	11	171	0.3	18	199	0.2	8	27

Table 4.1 Marine weather on the evening of 6th August 2016.

Waypoint A is given in the Date column adjacent to the nearest timing

Marine Weather table of wind and seas: along the route of interest

Refer to Appendix A for Beaufort Force (BF) and qualitative wave ranges and definitions

Date		Location		*Current*		Wind			Sig wave (model)			Wind Wave Comp			Swell Wave Comp 1			Swell Wave Comp 2			Swell Wave Comp 3		
				Going to		Dir	10 metres	BF	Hs	Tp	Tz	Hs0	Tp	dir	Hs1	Tp	dir	Hs2	Tp	dir	Hs3	Tp	dir
	UTC			*°true*	*knots*	°true	knots		m	s	s	m	s	°true	m	s	°true	m	s	°true	m	s	°true
B/C	00	57.86	-9.03	125	0.4	217	32	7	4.7	10	7	4.6	10	218	1.0	12	153	0.3	18	196	0.0	0	0
	01	57.89	-8.96	162	0.4	220	31	7	4.9	10	7	4.8	10	221	1.1	12	188	0.3	17	196	0.0	0	0
	02	57.91	-8.89	172	0.4	223	33	7	5.2	10	8	5.1	10	224	1.0	14	193	0.1	18	194	0.0	0	0
	03	57.94	-8.82	173	0.3	226	33	7	5.6	11	8	5.5	11	227	1.1	13	203	0.1	18	193	0.0	0	0
	04	57.97	-8.75	182	0.2	228	34	G8	6.0	11	8	5.9	11	229	1.1	13	223	0.1	18	193	0.0	0	0
	05	58	-8.68	77	0.1	227	35	G8	6.3	11	8	6.2	11	231	1.2	13	252	0.0	0	0	0.0	0	0
7 Aug	06	58.02	-8.62	43	0.4	226	36	G8	6.7	12	8	6.6	12	231	1.3	14	270	0.0	0	0	0.0	0	0
	07	58.05	-8.55	40	0.6	228	37	G8	7.1	12	9	7.0	12	232	1.2	14	258	0.0	0	0	0.0	0	0
D/E	08	58.08	-8.48	40	0.8	231	36	G8	7.4	13	9	7.3	13	233	1.3	14	223	0.0	0	0	0.0	0	0
	09	58.13	-8.40	41	1.0	233	37	G8	7.7	13	9	7.6	13	234	1.4	16	197	0.0	0	0	0.0	0	0
	10	58.16	-8.28	41	1.1	233	39	G8	7.9	14	9	7.8	14	235	1.2	16	220	0.0	0	0	0.0	0	0
	11	58.19	-8.16	38	1.3	232	42	SG9	8.1	14	9	8.1	14	235	1.0	17	261	0.0	0	0	0.0	0	0
	12	58.22	-8.04	39	1.3	233	42	SG9	8.3	14	9	8.3	14	236	1.0	18	264	0.0	0	0	0.0	0	0

Table 4.2 Marine weather on the morning of the 7th August 2016

Waypoints: B/C,D/E are given in the Date column adjacent to the nearest timing

Marine Weather table of wind and seas: along the route of interest

Refer to Appendix A for Beaufort Force (BF) and qualitative wave ranges and definitions

Date		Location		*Current*		Wind			Sig wave (model)			Wind Wave Comp			Swell Wave Comp 1			Swell Wave Comp 2			Swell Wave Comp 3		
				Going to		Dir	10 metres	BF	Hs	Tp	Tz	Hs0	Tp	dir	Hs1	Tp	dir	Hs2	Tp	dir	Hs3	Tp	dir
	UTC			*°true*	*knots*	°true	knots		m	s	s	m	s	°true	m	s	°true	m	s	°true	m	s	°true
7 Aug	13	58.25	-7.92	35	1.3	233	41	SG9	8.4	14	10	8.3	14	237	1.0	17	283	0.0	0	0	0.0	0	0
	14	58.29	-7.8	36	1.3	233	40	G8	8.2	15	10	8.1	15	239	1.0	18	300	0.0	0	0	0.0	0	0
	15	58.32	-7.68	68	1.2	236	39	G8	8.1	15	10	8.1	15	240	0.8	7	306	0.0	0	0	0.0	0	0
	16	58.35	-7.56	98	1.0	239	37	G8	7.5	14	9	7.5	14	241	0.9	7	249	0.0	0	0	0.0	0	0
F	17	58.37	-7.46	91	0.9	243	37	G8	7.3	14	9	7.2	14	241	1.1	9	187	0.0	0	0	0.0	0	0
	18	58.38	-7.39	101	1.0	247	36	G8	6.9	14	9	6.8	14	242	1.3	18	183	0.0	0	0	0.0	0	0
	19	58.38	-7.32	86	0.7	255	32	7	6.6	14	9	6.3	14	245	2.2	17	199	0.0	0	0	0.0	0	0
	20	58.39	-7.24	67	0.9	293	30	7	6.1	14	9	3.8	11	271	4.8	14	227	0.0	0	0	0.0	0	0
	21	58.4	-7.17	68	0.7	306	33	7	5.7	13	8	3.6	10	282	4.5	14	229	0.0	0	0	0.0	0	0
	22	58.41	-7.09	56	0.8	312	36	G8	5.6	13	8	3.8	9	291	4.0	14	232	0.0	0	0	0.0	0	0
	23	58.41	-7.02	53	0.4	315	36	G8	5.5	13	7	4.2	8	298	3.6	13	235	0.4	5	230	0.0	0	0
8 Aug	00	58.42	-6.95	343	0.1	318	37	G8	5.5	13	7	4.4	8	304	3.3	13	237	0.4	5	235	0.0	0	0
G/H	01	58.41	-6.90	236	0.5	314	36	G8	5.8	12	8	5.1	9	307	2.8	13	239	0.6	6	249	0.0	0	0
	02																						

Table 4.3 Marine weather on the afternoon and evening of 7th August

Waypoints: F,G/H are given in the Date column adjacent to the nearest timing

5.0 VOS reports

Key

DD = wind direction ° true: 210=210° =SW: the wind is coming from the northwest
FF = wind speed (knots) (45= 45 knots = severe gale force 9)
WP = wind wave period in half seconds10 = 5 seconds
WH = wind wave height in half metres 1 = 0.5 metres
SDD = swell direction in degrees 270 = 270° (coming from the W)
SP = swell period in half seconds 14 =7 seconds
SH = swell height in half metres 9 = 4.5 metres
SHIPS DATA: RES = resultant wave in 1/10ths metres (equivalent to significant wave height): 64 = 6.4 metres

OBSERVATIONS: SHIPS

AREA RECTANGLE: 60.0N 56.0N 11.6W 6.0W

YEAR	MN	DY	HR	LAT	LON	DD	FF	WW	VIS	AIR	DEW	VAP	REL	SEA	MSLP	WP	WH	SDD	SP	SH	SDD	SP	SH	RES	MP	MH
2016	8	6	6	593	-85	310	6	*	****	****	104	***	***	***	10182	**	**	***	**	**	***	**	**	***	***	***
2016	8	7	0	582	-62	210	45	60	****	130	131	***	***	***	10046	10	1	0	**	**	0	**	**	5	***	***
2016	8	7	3	573	-69	350	30	50	2000	150	119	***	***	***	10106	14	5	***	**	**	***	**	**	25	***	***
2016	8	7	9	582	-62	200	40	80	400	****	100	***	***	***	10012	8	2	0	**	**	0	**	**	10	***	***
2016	8	7	23	579	-62	***	***	58	1000	****	104	***	***	***	9999	12	2	***	**	**	***	**	**	10	***	***
2016	8	8	4	570	-69	350	30	50	2000	150	78	***	***	***	10126	14	5	***	**	**	***	**	**	25	***	***
2016	8	8	9	562	-72	290	38	2	2000	****	80	***	***	***	10180	14	9	270	14	9	***	**	**	64	***	***
2016	8	8	19	588	-61	300	30	*	****	117	50	87	63	129	10185	**	**	***	**	**	***	**	**	***	***	***
2016	8	8	20	589	-65	300	30	*	****	119	45	84	60	130	10196	**	**	***	**	**	***	**	**	***	***	***
2016	8	8	21	589	-68	300	25	*	****	115	52	88	65	132	10201	**	**	***	**	**	***	**	**	***	***	***
2016	8	8	23	589	-76	310	22	*	****	119	67	98	70	129	10212	**	**	***	**	**	***	**	**	***	***	***

Table 5.1 Table of VOS data from 6th to 8th August 2016

6.0 Tables of K5 data

K5 Lat 59.1N Long 11.7W **6 Aug 2016**	Wind direction	Wind speed	Max hourly gust	Measured wave period	Measured wave height
Time UTC	°true	knots	knots	seconds	metres
00	130	5		6	1.0
01	140	6		6	1.0
02	150	6		6	1.0
03	140	7		6	0.9
04	130	9		6	0.9
05	140	10		6	0.9
06	140	11		6	1.0
07	120	14		5	1.1
08	130	15		5	1.2
09	130	16		5	1.4
10	140	16		5	1.3
11	140	21	35	4	1.4
12	130	25	32	4	1.6
13	120	27	36	5	1.9
14	120	28	37	5	2.4
15	140	26	34	5	2.4
16	150	22	34	6	3.2
17	170	21	28	6	2.8
18	160	22	33	6	2.7
19	170	23	34	6	3.1
20	180	25	32	6	3.1
21	180	26	36	7	3.8
22	200	29	39	7	3.9
23	200	29	38	7	4.3

Table 6.1 Hourly wind and wave data recorded at buoy K5 on the 6th August 2016

K5 Lat 59.1N Long 11.7W **7 Aug 2016**	Wind direction	Wind speed	Max hourly gust	Measured wave period	Measured wave height
Time UTC	°true	knots	knots	seconds	metres
00	210	30	42	7	4.5
01	220	31	44	8	5.8
02	220	29	47	8	5.9
03	220	30	42	8	6.3
04	230	28	40	8	5.6
05	220	28	39	8	5.7
06	230	27	37	9	6.4
07	240	25	36	8	5.9
08	240	25	35	8	6.3
09	240	24	36	9	6.4
10	280	13	30	9	5.7
11	270	23	41	10	6.2
12	270	23	29	10	6.1
13	270	25	34	10	7.1
14	280	27	37	10	6.4
15	290	28	42	9	6.3
16	310	30	38	9	6.6
17	320	32	43	8	5.9
18	320	30	43	8	5.8
19	320	31	44	9	7.1
20	330	36	59	8	6.1
21	320	29	46	9	6.4
22	320	26	39	9	6.3
23	310	21	35	9	6.0

Table 6.2 Hourly wind and wave data recorded at buoy K5 on the 7th August 2016

K5 Lat 59.1N Long 11.7W **8 Aug 2016**	Wind direction	Wind speed	Max hourly gust	Measured wave period	Measured wave height
Time UTC	°true	knots	knots	seconds	metres
00	300	21	28	8	6.4
01	300	21	28	9	6.7
02	290	20	27	9	6.1
03	290	18	26	8	5.1
04	300	15		9	5.8
05	340	11		8	5.4
06	320	12		8	4.8
07	320	14		8	4.6
08	320	15		8	4.9
09	320	14		7	4.0
10	310	13		8	4.3
11	300	13		8	4.4
12	290	14		8	4.5
13	300	14		8	4.3
14	300	13		8	4.6
15	300	16		8	3.9
16	300	17		8	3.9
17	300	18	25	8	3.7
18	300	19		7	3.8
19	300	18	25	7	4.0
20	300	17	27	8	4.0
21	300	18		7	3.8
22	300	19	25	8	4.2
23	300	17		8	4.1

Table 6.3 Hourly wind and wave data recorded at buoy K5 on the 8th August 2016

Comparison of Buoy K5 observations and model

Date	Wind speed Offset (obs-model) Hourly data	Wind speed SD (Standard deviation)	Wave height offset (obs-model) hourly data	Wave height SD (Standard deviation)
2016	Knots	+/- knots	metres	+/-metres
6 Aug	-1.6	2.8	-0.2	0.3
7 Aug	-3.6	3.5	-0.2	0.6
8 Aug	-2.4	1.8	0.4	0.3

A negative offset indicated that the model is over predicting winds speed and/ or wave height (assuming observations represent 'ground' truth)
A positive offset indicated that the model is under predicting winds speed and/ or wave height (assuming observations represent 'ground' truth)

Table 6.4 Summary of daily comparison statistics from K5

7.0 Discussion

7.1 **General situation**: Refer to Appendix C

At 0600 UTC on 6th August, a depression 987 hPa was analysed in the east Atlantic the depression deepened to 985 hPa by 0000 UTC on the 7th August after crossing 60th parallel on its east-northeast trajectory. Further deepening occurred to 981 hPa by 1200 UTC on the 7th August as the low headed towards the Faeroes. On tracking further east towards the Norwegian Sea the depression filled slightly to 983 hPa by 0000 UTC beginning the 8th August.

7.2 **Wind and wave:** Refer to Tables 4.1 to 4.3 and 6.1 to 6.3

Wind: Strong south or southwest winds were modelled at the start of the tow (Waypoints A to C) during the evening of the 6th August. During the early hours of the 7th August, the modelled winds increased southwest gale force 8 and continued during the early morning as far as Waypoints D and E. Thereafter the southwest wind increased severe gale force 9 for a time during the midday period of the 7th August, before veering west-southwest gale force 8 as the platform reached Waypoint F, throughout the afternoon of the 7th. The winds veered to the west and decreased strong for a time before veering to the northwest and increasing gale force 8 towards Waypoints G and H during the midnight hours beginning the 8th August.

Gusts: maximum gusts could have occurred in the southwest severe gales to 59 knots during the midday period of the 7th August. Gusts may have reached 59 knots in the northwest gales during the late evening of the 7th, as evidenced by the observations from K5 between the hours of 1900 and 2000 UTC, even though the ratio of 1.4 was exceeded.

Waves: initially rough, total seas (significant wave height) increased into the very rough category by the late evening of the 6th August, towards Waypoints B and C. By daybreak of the 7th August, total sea increased into the high category. Between Waypoints C and D, total sea remained high throughout the 7th August between Waypoints E and F before decreasing very rough during the evening of the 7th, towards Waypoint G. Modelled significant wave height culminated at approximately 8.4 metres at 1300 UTC on the 7th August with a zero upcrossing period of 10 seconds. An individual maximum wave height of 16.8 metres could have been experienced at this time during a 3 hour sampling time.

7.3 **Currents:** from Tables 4.1 to 4.3 currents were modelled generally 1.0 knots or less, but 1.1 to 1.3 knots between 1000 UTC and 1500 UTC on the 7th. During this time, currents were broadly aligned in direction with wind wave, making for less steep seas.
Currents may have been in opposition during the end of the tow at Waypoint G. However, at this time, currents were modelled as being very weak.

7.4 **Observations**, refer to Tables 6.4 and 5.1 Overall there was good correlation between recorded wind speed and wave on the 6th, 7th and 8th August. Standard deviation results indicate lightly more uncertainty in both model wind and wave on the 7th. With reference to Appendix B, Figure B1, ASCAT indicates a wind of northwest of approximately 30 knots at the location of K5. Model winds at the same location, (data not presented in the report) were offset between 0 and 5 knots at 2000 and 2100 UTC respectively. As a result, it is thought that the model provided good guidance to the hindcast.
Table 5.1 has been presented for reference only. A ship report at 0900 UTC on the 8th (after the Tow cessation) was thought to be over reporting wind speed and resultant wave height after comparison with ASCAT and also noting that a swell wave of 4.5 metres, period 7 seconds was identical with wind wave.
.
7.5 **Summary:** All the available evidence indicates that the platform Transocean Winner encountered gale or severe gales from both the southwest and then the northwest on the 7th August and into the 8th August. Total sea was generally rough or very rough, increasing high for a time during daylight hours of the 7th.
Modelled significant wave height peaked at approximately 8.4 metres at 1300 UTC beginning the 7th August with a zero upcrossing period of 10 seconds. An individual maximum wave height of 16.8 metres could have been experienced at this time during a 3 hour sampling time.

8.0 Quality Statement

8.1 The Met Office is the national meteorological service for the United Kingdom and is a leading member of the World Meteorological Organisation (WMO), which is an agency of the United Nations. In addition to national responsibilities (such as the issue of Shipping Forecasts for waters around UK), the Met Office also has a wide range of global weather analysis and forecasting commitments, for land applications, aviation and the maritime community.

Appendix A: Glossary of terms

Table A1 WAVE DEFINITIONS

SEA STATE – WMO Code 3700

Code	Description	Height in metres
0	Calm – glassy	0
1	Calm – rippled	0.1 or less
2	Smooth – wavelets	Over 0.1 to 0.5
3	Slight	Over 0.5 to 1.25
4	Moderate	Over 1.25 to 2.5
5	Rough	Over 2.5 to 4.0
6	Very rough	Over 4.0 to 6.0
7	High	Over 6.0 to 9.0
8	Very high	Over 9.0 to 14.0
9	Phenomenal	Over 14.0

Table A2 SWELL WAVES

Description	Height in metres
Very low	1 or less
Low	Over 1 to 2
Moderate	Over 2 to 4
Heavy	Over 4

FURTHER COMMENT ON THE DEFINITIONS

In relation to the **state of sea (sea state)** code above, the following guidance is provided is provided within the WMO Manual on Codes (Volume I.1, Part A):

> "These values refer to well-developed wind waves of the open sea. While priority shall be given to the descriptive terms, these height values may be used for guidance by the observer when reporting the total state of agitation of the sea resulting from various factors such as wind, swell, currents and angle between swell and wind, etc"

While sentence one states that the sea state code relates to wind waves, the remainder of the paragraph suggests that it can be used to describe the resultant wave heights associated with both wind waves and swell. As such the above description of **state of sea (sea state)** is considered to be the same as the **significant wave height** and indicates the wave height resulting from the combined effect of wind waves and swell waves. Further information can be found in section 2.

Table A3	BEAUFORT SCALE OF WIND: EQUIVALENT SPEEDS

FORCE	DESCRIPTION	EQUIVALENT SPEED (KNOTS)	
		MEAN	LIMITS
0	CALM	0	Less than 1
1	LIGHT AIR	2	1 – 3
2	LIGHT BREEZE	5	4 – 6
3	GENTLE BREEZE	9	7 – 10
4	MODERATE BREEZE	13	11 – 16
5	FRESH BREEZE	19	17 – 21
6	STRONG BREEZE	24	22 – 27
7	NEAR GALE	30	28 – 33
8	GALE	37	34 – 40
9	STRONG GALE	44	41 – 47
10	STORM	52	48 – 55
11	VIOLENT STORM	60	56 – 63
12	HURRICANE	--	64 and over

FURTHER COMMENT ON THE DEFINITIONS

1 knot = 0.515 metres sec = 1.85 km hour = 1.16 statute miles hour

A **Gale (Force 8)** is a mean wind speed in the range 34 to 40 knots. In general, the term 'gale' implies a mean wind speed of 34 knots or above over a period of at least 10 consecutive minutes. The term **Strong Gale (Force 9)** is used when the mean wind speed lies in the range 41 to 47 knots, over a period of at least 10 consecutive minutes.

Visibility	nm	km
Good	>5 nm	>9.3 km
Moderate	2 nm to 5 nm	3.7 to 9.3 km
Poor	0.5 nm to 2 nm	1 km to 3.7 km
Fog	<0.5 nm	< I km

Table A4

Appendix B ASCAT Imagery

Described in this page are the data products derived from the Advanced Scatterometer (ASCAT) observations, which include:

- ASCAT Ocean Surface Wind Vectors data of 25km resolution

The ASCAT ocean surface winds are a 10 meter neutral stability wind. These products are processed by NOAA/NESDIS utilizing measurements from ASCAT aboard the EUMETSAT METOP satellite. The current geophysical model function (GMF) being used is CMOD5.5, where the GMF relates the normalized radar cross-section to the ocean surface wind speed and direction.

The wind vector retrievals flagged as potentially being corrupt according to the KNMI quality flag are colored in black. For closer examination of the wind fields, a data image is further divided into 30x20 degree bins between latitudes 80N to 80S and longitudes 180W to 180E, forming a HTML link map for the regions of interest. Just click on the desired geographical location and a closer look should be provided.

In Europe, KNMI is responsible for the ASCAT wind products, and additional information can be found at the EUMETSAT Ocean and Sea Ice Satellite Application Facility (OSI SAF).

The global wind images display the available data from the previous 22 hours up to the image creation time. Click here for the ocean surface winds from the near real-time (NRT) observation data.

For additional information about the EUMETSAT METOP or ASCAT programs, please visit the EUMETSAT Polar System (EPS).

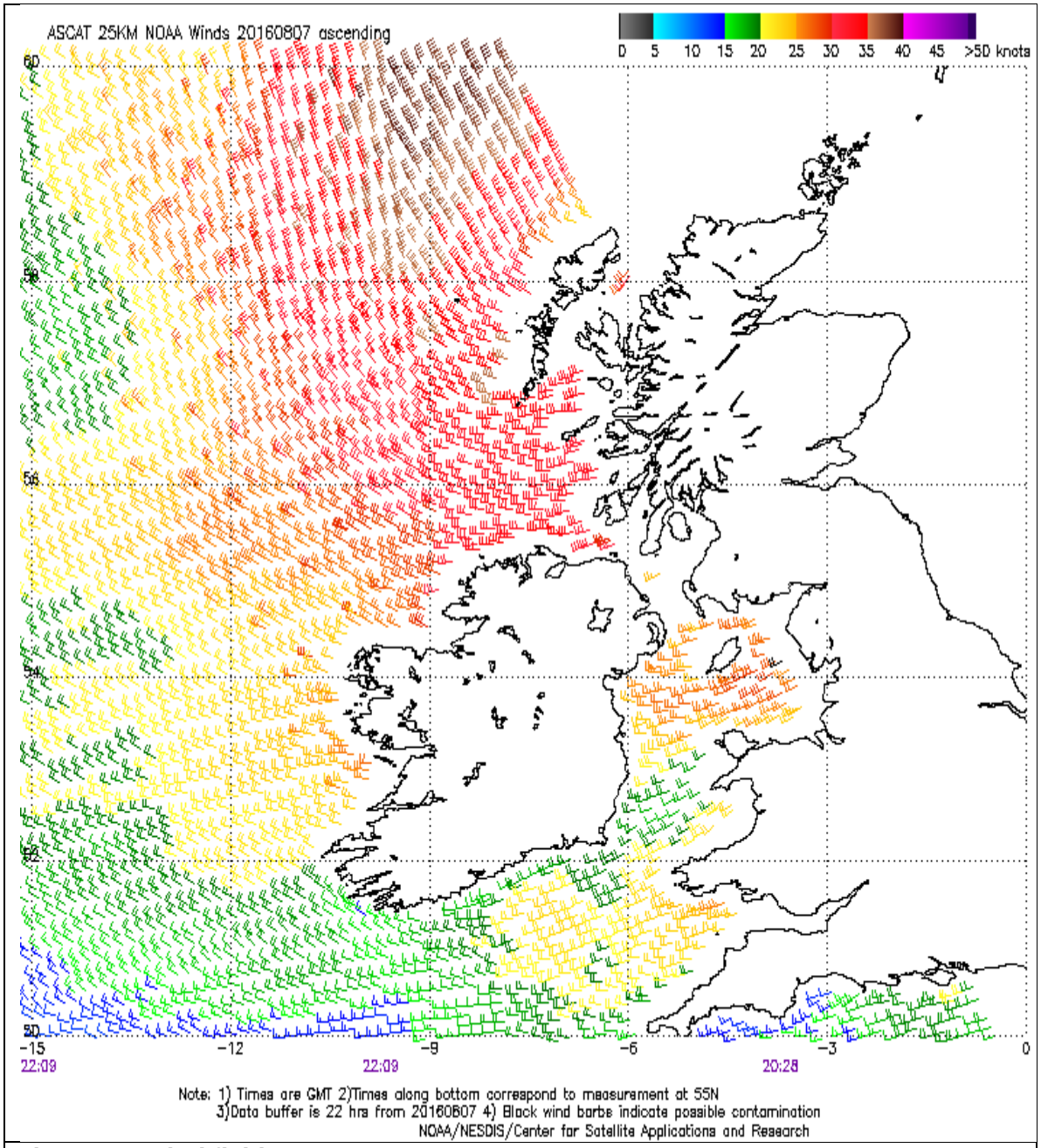


Figure B1 Wind field at 20160807_2028 UTC

Appendix C: Analysis Charts

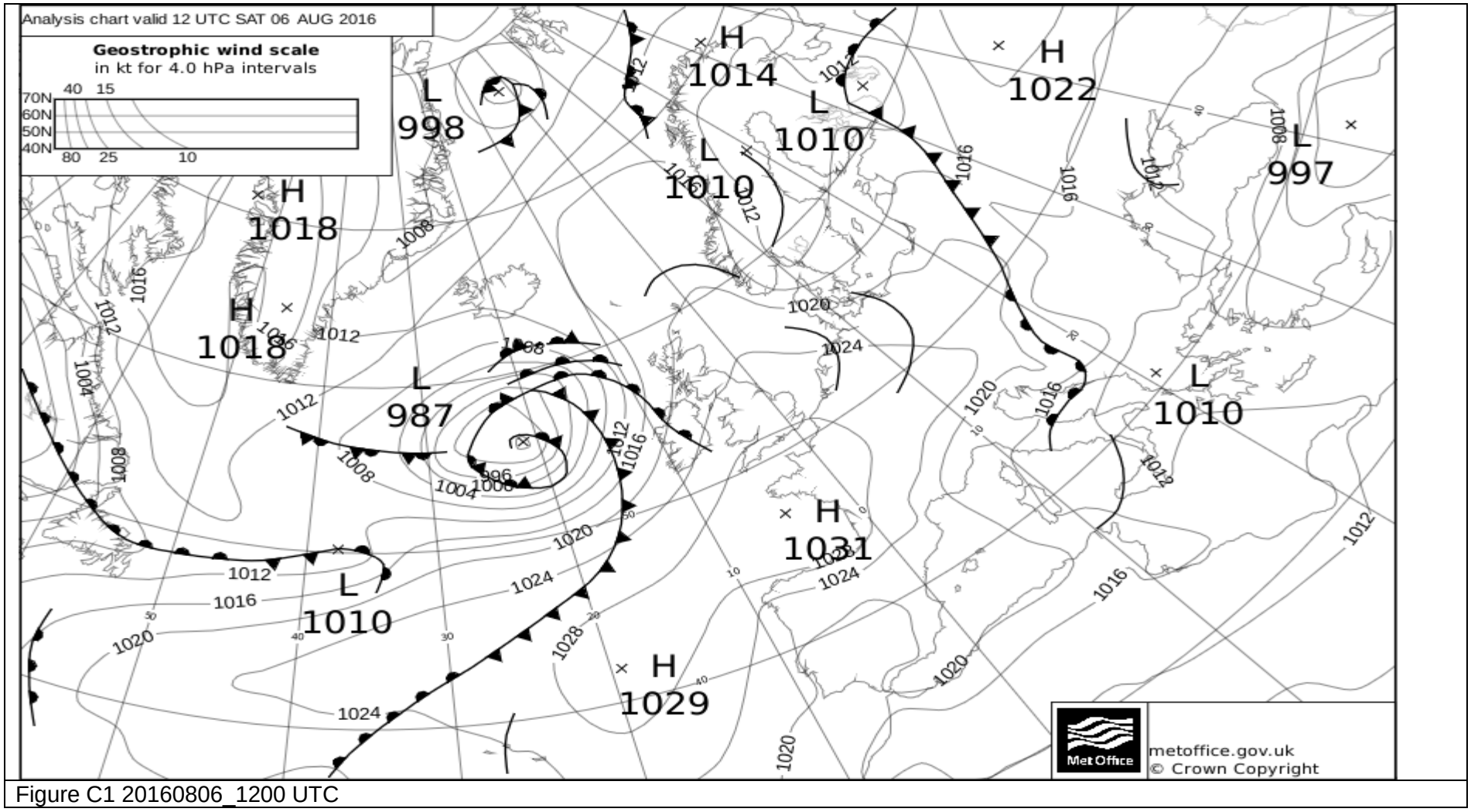


Figure C1 20160806_1200 UTC

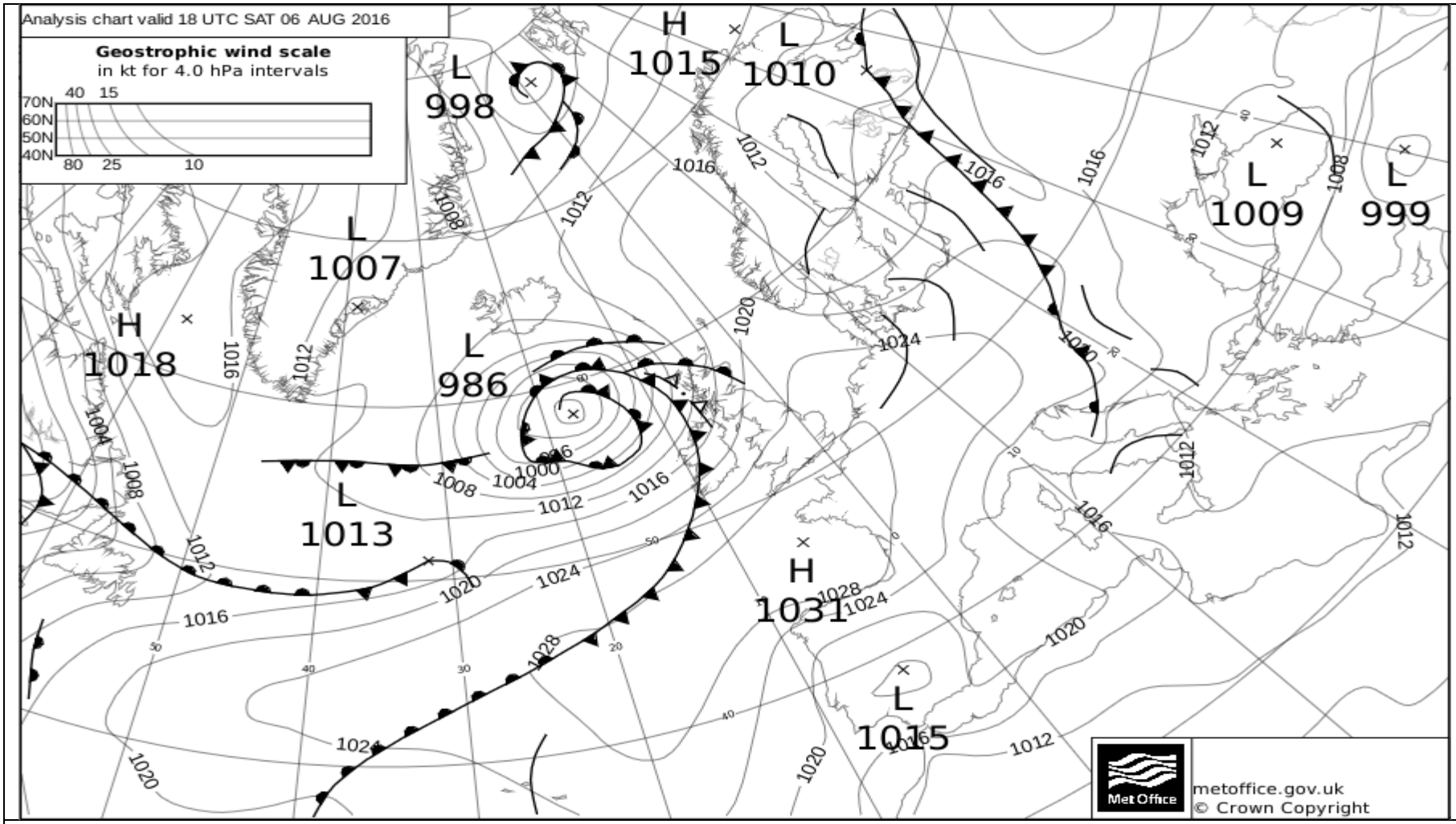


Figure C2 20160806_1800 UTC

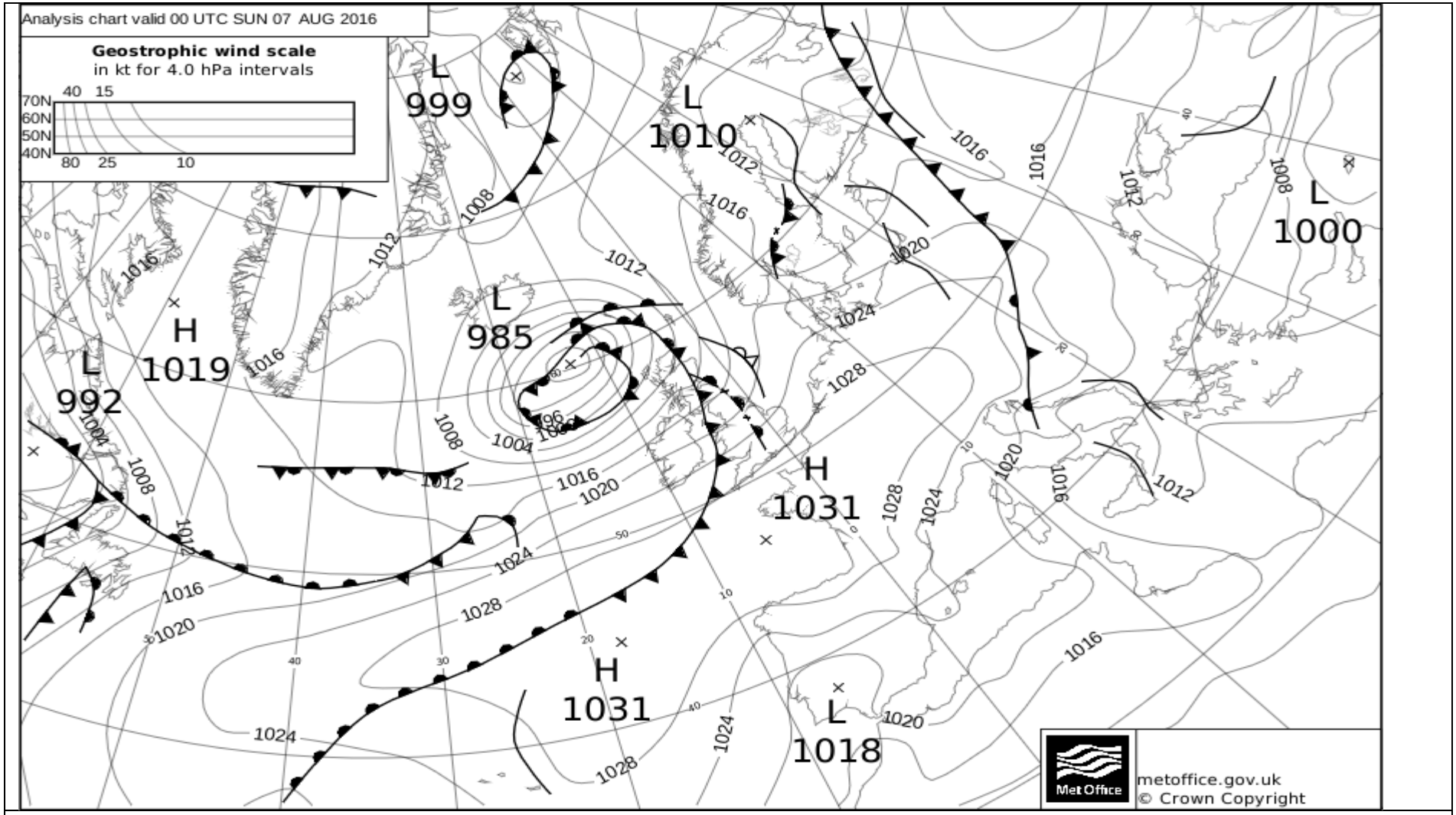


Figure C3 20160807_0000 UTC

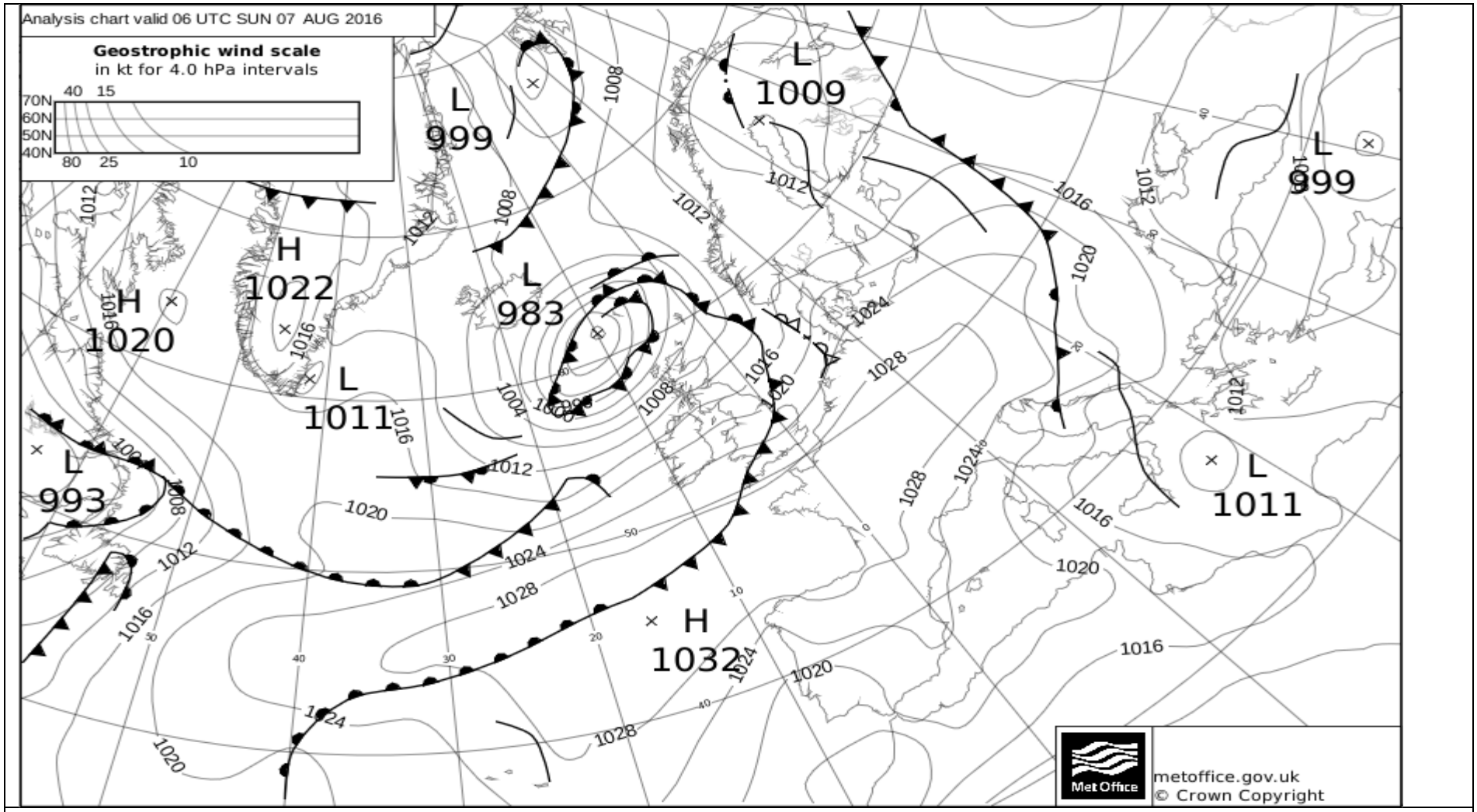


Figure C4 20160807_0600 UTC

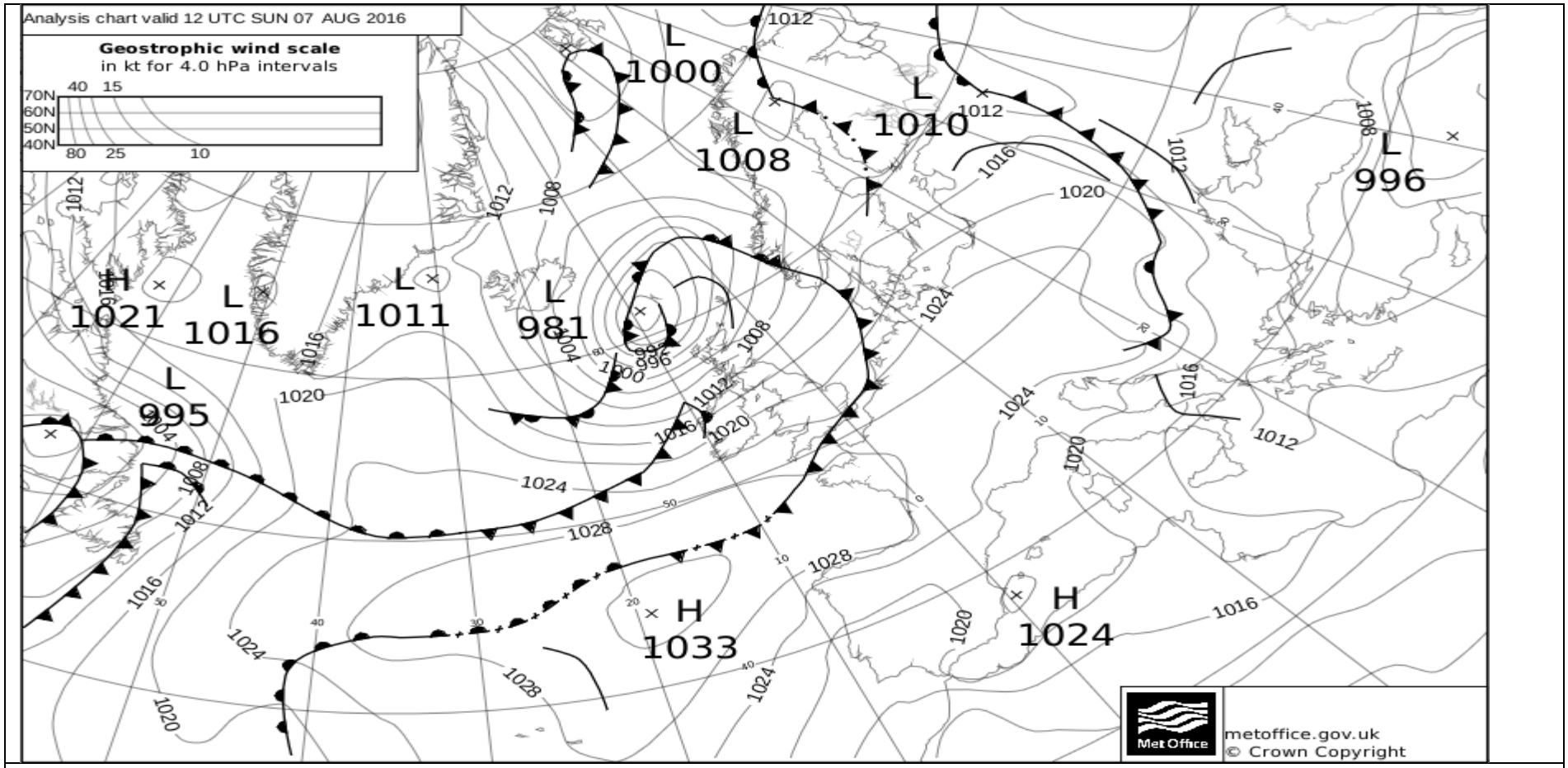


Figure C5 20160807_1200 UTC

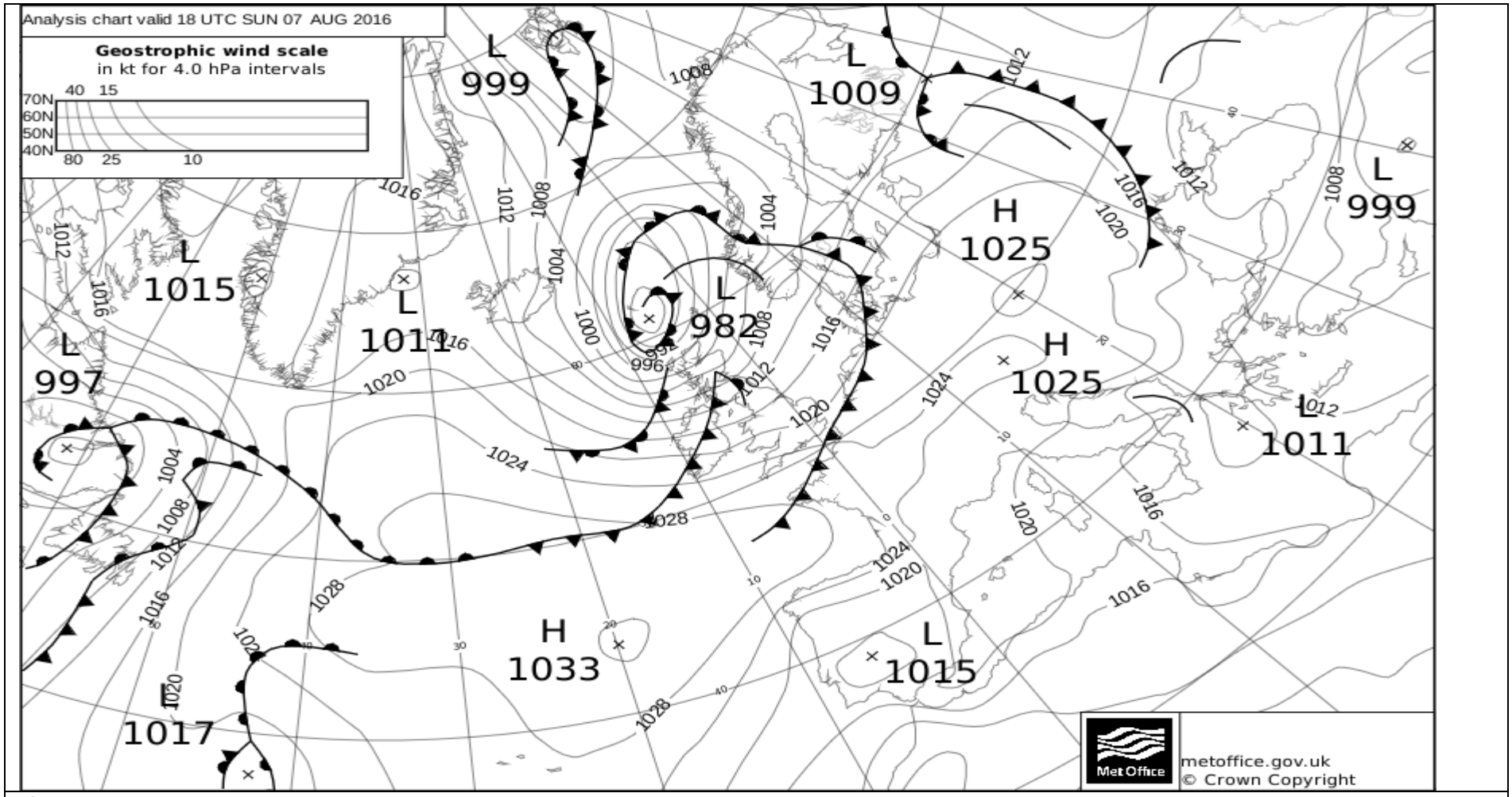


Figure C6 20160807_1800 UTC

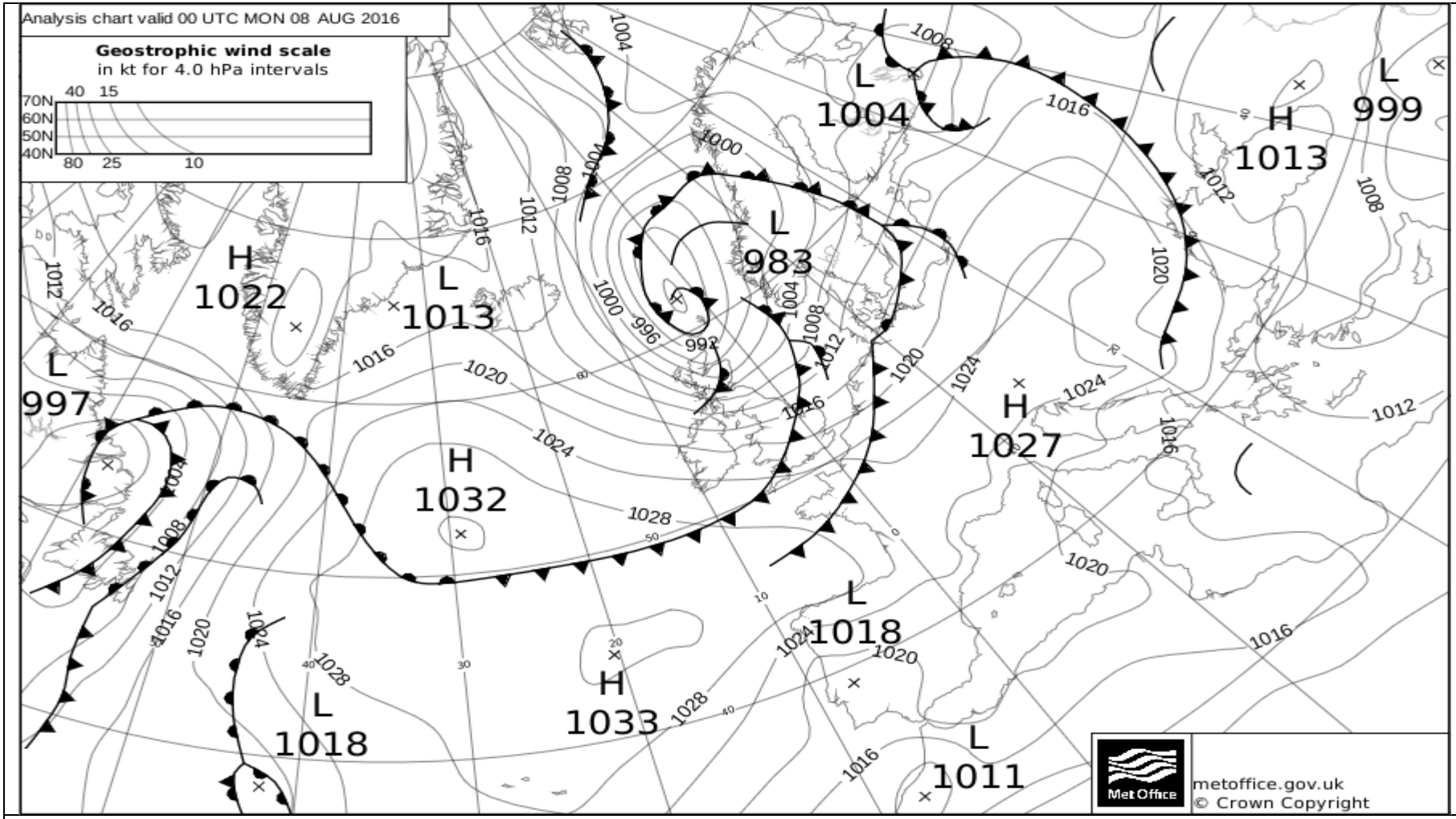


Figure C7 20160808_0000 UTC

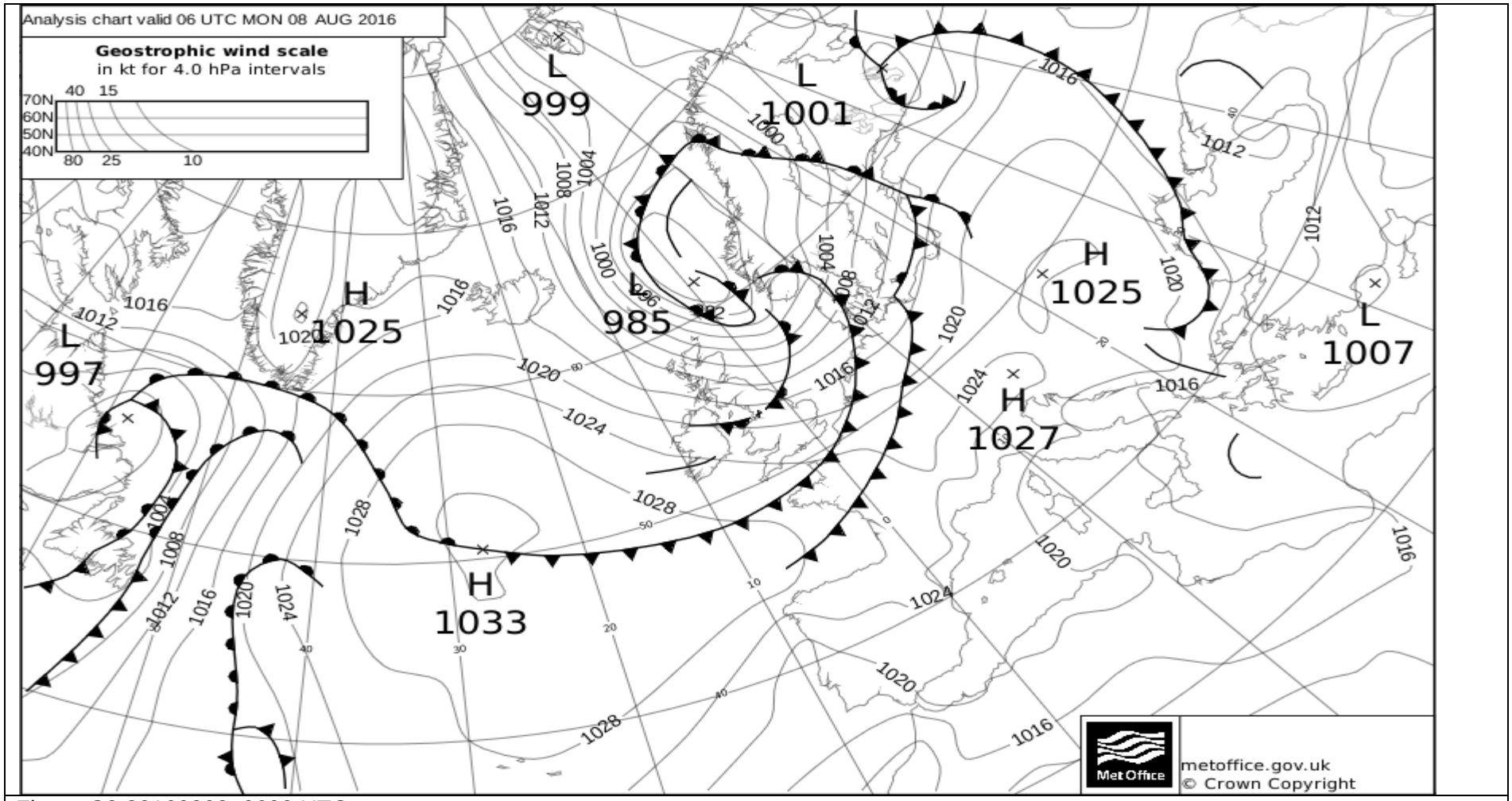


Figure C8 20160808_0600 UTC

Met Office
Fitzroy Road, Exeter
Devon EX1 3PB
United Kingdom

Tel: 0870 900 0100
Fax: 0870 900 5050
enquiries@metoffice.gov.uk
www.metoffice.gov.uk

Discussion and conclusions, extracted from TTI Testing Ltd's report of the inspection and testing of failed tow wire from tug *ALP Forward*

17 Discussion and Conclusions

This report has described the inspection and testing of a number of sections of the failed wire rope from the tug ALP Forward.

As well as visual inspection, samples have been taken for breaking load testing and mechanical testing of the wires.

Inspection of the tug side and bridle samples indicated that the samples were in a similar condition. The IWRC[1] was generally in a very poor state with many wire breaks (typically 100 + in a 1 m length). The IWRC represents about 15% of the metallic cross sectional area, and so it was to be expected that the breaking load samples would be at least 15% down on the original value, and a bit more owing to the broken outer strand wires.

The loss of strength due to the core disintegration was one issue, but another problem is that the damaged core was unable to provide proper support to the outer strands. As the core collapsed, so the outer strands contacted one another leading to a series of breaks in the strand valley positions (see Figures 9.10, 10.42 and 17.1). It is noted that the outer strand outer wires represent about 44% of the metallic sectional area in the wire rope (so each wire is roughly 0.5% of the total area).

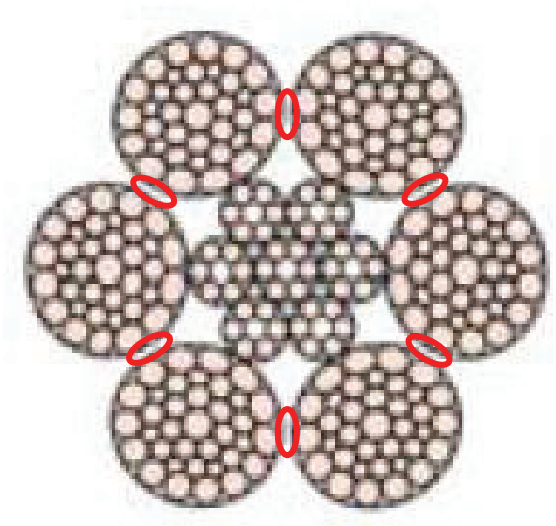


Figure 17.1: Wire rope (6 × 37 + IWRC 'Super Titan') cross-section showing inter strand contact positions exacerbated by an incorrect size (small) or damaged/worn core.

The results of the breaking load tests showed that the strength of the wire rope tug side and bridle side was down by 21.3% (tug side sample) and 23.5% (bridle sample) on the original measured strength.

The results of the mechanical tests on the wires from the drum sample show that the wire stock from which the wire rope was made satisfied the requirements of the Standard API 9A [**1**]. The wires inside the main load bearing strands (second and third layers and core wires) of the tug and bridle samples have largely retained their properties, whilst the outer wires and core wire have suffered as mentioned above.

[1] MAIB Note: IWRC - Independent Wire Rope Core

It is considered that the outer strand outer wires have additionally been affected by the onset of corrosion - the lubricant was generally missing or low/denatured. It is noted that had the wire rope been assessed under the criteria of ISO 4309:2010 [**5**], then it would have been subject to immediate discard.

In fact the condition of the wire rope is so poor as to raise the question of its condition when last inspected in July 2016 [**4**]. It is noted that the wire rope was re-socketed in July 2016 - given the condition of the bridle sample IWRC when terminated for break test, it might prove informative to remove and examine the spelter socket on the wire rope.

Turning to consider the sorts of loads which the wire rope might have experienced during the storm, an approximate calculation assuming a maximum wave height of 16.8 m indicates a load of the order of 599 tonnes. This load is well in excess of the measured tug side sample BL of 389 tonnes, and above the wire rope F_{min} (485 tonnes) and the measured ABL of 494.1 tonnes. Given this estimate, it is not surprising the wire rope failed. It is quite possible that the wire rope would have failed even if it had been as new.

It is noted that the load stated above assumes that the winch drum would not have slipped or rendered. Details of the winch drum are not known, but a data sheet (Figure 17.2) indicates that with 740 m paid out the brake holding load was about 1725 kN or 176 tonnes. It has been reported that the winch had been rendering and loads of 180 - 220 tonnes had been recorded [**3**]. It is possible that a shock load might be applied to the wire rope so quickly that the drum did not have time to accelerate.

In addition to setting the winch to render, another option to help manage the loads on the wire rope would be to extend the scope of the towing line. Whilst it is not ideal to drag a wire rope along the seabed, in cases of extreme need it would be preferable to do this so as to help avoid breaking the line.

In conclusion, this study has shown that the 77 mm wire rope installed on the *ALP Forward* in May 2014 satisfied the requirements of API 9A [**1**]. Although the tow wire log [**4**] states that the line is regularly washed and greased during recovery, it is far from clear that this process is effective - the lubricant on the tug side and bridle samples were very low and the wire rope has started to corrode. (Generally speaking it is preferable to avoid re-greasing a wet wire rope as this can trap moisture in the wire rope accelerating corrosion. It is possible that this has happened to the wire rope examined here.) The condition of the core was very poor.

It is likely that the rope had become further degraded through fatigue damage during the earlier part of the storm, and finally broke due to a one off overload.

Breaking load tests on sections of wire rope from either side of the main failure suggest that at the time of the incident the wire rope strength was down by 21.3% to about 389 tonnes.

21.11.2011

Comm.: 05.7385+88				
Hull No.:	254+255			
Customer: MAN Ferrostaal AG				
E-DD-Towing Winch 1500/3200 + 3000/4000				
drum ø	1000 mm	/ 2800mm		obere Seiltrommel, Seilauflauf oben
rope ø	76 mm	1600m		
drum length	2020 mm			
min drum speed	2,89 min^{-1}	6 Pol / 50 Hz		
max drum speed	8,67 min^{-1}	6 Pol / 150Hz		
drum torque Low Speed	807 kNm	max brake holding torque	1722 kNm	
drum torque High Speed	0 kNm	brake torque whith spring	460 kNm	
max rope layer	12	nicht benötigte Lagen grau hinterlegt		

The data confirm to the rope layer (x)

rope layer (x)	rope length (m)	rope length in layer (x) (m)	rope running on dia (x) mm	rope speed Low Speed (m/min)	rope speed High Speed (m/min)	max time for rope length Low Speed (s)	min time for rope length High Speed (s)	pull Low Speed (kN)	pull High Speed (kN)	brake holding load (kN)	spring holding load (kN)
1	81	81	1076	9,8	29,3	497,5	165,8	1500,0	0,0	3200,7	855,0
2	175	94	1207	11,0	32,9	514,7	171,6	1337,2	0,0	2853,4	762,2
3	280	105	1339	12,2	36,5	518,2	172,7	1205,4	0,0	2572,1	687,1
4	397	117	1470	13,3	40,0	526,0	175,3	1098,0	0,0	2342,9	625,9
5	525	128	1602	14,5	43,6	528,0	176,0	1007,5	0,0	2149,8	574,3
6	665	140	1733	15,7	47,2	533,9	178,0	931,3	0,0	1987,3	530,9
7	816	151	1865	16,9	50,8	535,1	178,4	865,4	0,0	1846,6	493,3
8	979	163	1996	18,1	54,4	539,7	179,9	808,6	0,0	1725,5	460,9
9	1153	174	2128	19,3	58,0	540,4	180,1	758,5	0,0	1618,4	432,3
10	1339	186	2259	20,5	61,5	544,1	181,4	714,5	0,0	1524,6	407,3
11	1537	198	2391	21,7	65,1	547,3	182,4	675,0	0,0	1440,4	384,8
12	1746	209	2522	22,9	68,7	547,7	182,6	640,0	0,0	1365,6	364,8

R:\Konstruktion\Winden\KommisionsNr\2005\05.7385+88\Berechnungen\Pos.1\Seillängenø76mm1600m_150t_neu.xls

Figure 17.2: ALP Forward main winch data sheet (supplied by MAIB).

Summary extract of *Transocean Winner*'s environmental loads and holding calculations,
Vuyk Engineering Rotterdam BV for ALP Maritime Services BV

CALCULATION NOTE

To: ALP Maritime Services BV
Origin: [redacted]
Chkd:
Distr:
Date: 02-Sep-2016
Project: ALP Transocean Winner [redacted]
Subject: Transocean Winner environmental loads and holding calculations

Introduction

ALP Maritime Services BV (ALP) requested Vuyk Engineering Rotterdam BV (Vuyk) to perform holding calculations on the rig 'Transocean Winner'. During a tow operation in unexpected very severe weather, the ALP Forward was not capable of holding the rig, and at long last the tow line failed, probably as a result of damage to the tow line.

During the tow operation, the rig was towed at a draught of 6.5 m. In these calcualtions, also the survival draught of 20.5 m is taken into account to check the environmental loads in this condition, and to analyse if ballasting to this draught would have saved the tow.

References

[01] DNV OS-H101 Marine Operations General, October 2011
[02] ALP, 'Currents.pdf', provided by ALP on 24-Aug-2016,
[03] MeteoGroup, 'ALP Forward towing Transocean Winner 7-8 August 2016', 12 Aug 2016.
[04] GL Noble Denton Guidelines for Marine Transportations 0030_ND Rev_6, 14 Dec 2015

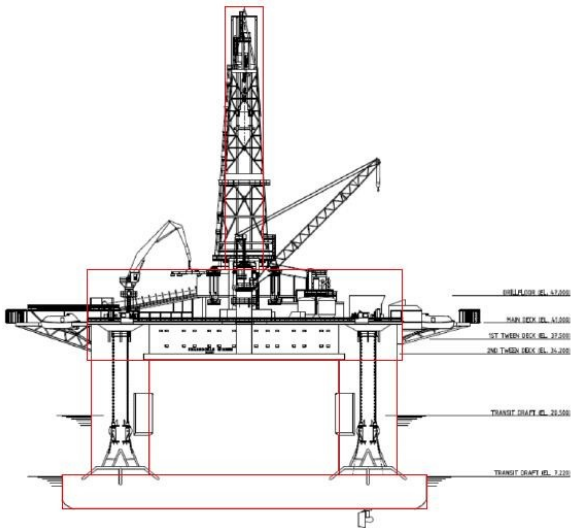
Input and assumptions

Rig

For the estimation of the dimensions and properties of the rig 'Transocean Winner', the specification document as attached in appendix A is used. This data is used as input for the calculations of the exposed areas and lengths. The (estimated) particulars of the rig, relevant for the calculations, are summarized in the table below:

Item	**[m]**
Floater length	80.56
Floater width	16.00
Leg diameter	12.50
Overall height	112.00
Survival draught	20.5
Tow draugth	6.5

The rig is subdivided in the exposed areas as indicated in the sketch below. This data is used as input for the calculations in the appendices B – M. Note that the over the side protruding elements are outside the marked areas. This is compensated by the additional area above main deck.



ALP Forward
The ALP Forward has a BP capacity of 220 t, or 2158 kN

Environmental condition
Based on the meteo data reported in MeteoGroup [03], ALP [02], GL-NDA [04], and input from ALP, the following environmental conditions have been analysed:

Condition	Wind speed @10 m [m/s]	Wind speed @40 m [m/s]	Sign. wave heigth [m]	Current speed [m/s]
1	10.0	12.2	2	0.4
2	15.0	18.3	5	0.4
3	20.0	24.4	5	0.5
4	20.0	24.4	8	0.4
5	25.0	30.5	10	0.4
6	29.5	36.0	10	0.4

Note that condition 3 is the standard GL-NDA [04] weather condition for marine operations in open seas. This dictates that the combined Bollard Pull available must be sufficient to maintain station in the environmental condition 3.

As ALP reported a wind speeds up to 70 knots at the rig during the tow, a 10 minute mean wind speed of 29.5 m/s at 10 m height is used in condition 6. When correcting this value to about 40 m above sealevel (estimated deck level rig), the 10 minute mean wind speed would be 29.5 * 1.22 = 36.0 m/s or 70 knots.

Method
Reporting of both front and side loads
ALP reported that during the severe weather conditions, with a slacked towing line, the rig rotated sideways into the weather, therefore frontal and side load conditions are reported in this document.

Wind loads
The wind loads acting on the rig are calculated according DNV [01]. This method uses the 10 minutes mean wind at reference height 10 metres.

[redacted]

Wave loads
The wave loads are the 2nd order mean wave drift loads acting on the rig. For the tow draught, only the floaters are assumed to be exposed to these wave loads. For the survival draugth, it is assumed that only the legs are exposed to the wave loads.
Current loads
The current loads are assumed to be constant over the draught for both draughts of the rig.

Results
Head and beam seas environmental loads acting on the rig
In the appendices, for each condition, the total loads for each environmental direction *acting on the rig* are included as a radar plot. The results are summarized in the two tables below.
Note that for several conditions the environmental load is above the maximum BP capacity of the vessel. For clarity, these conditions are made *italic*.

The environmental loads acting on the rig in the towing conditions, at a draught of 6.5 m, are given in the table below:

	Frontal loads (head seas)		Side loads (beam seas)	
Condition	**Wind [kN]**	**Total [kN]**	**Wind [kN]**	**Total [kN]**
1	274.7	332.1	269.2	550.6
2	618.0	932.3	605.6	1959.0
3	1098.7	1417.7	1076.7	*2473.5*
4	1098.7	1889.9	1076.7	*4420.7*
5	1716.7	*2948.2*	1682.3	*6863.9*
6	2393.1	*3624.6*	2345.1	*7526.8*

The above results for the tow draught show that for conditions 5 and 6 the total frontal loads are above the BP capacity of the vessel. In condition 3 the side loads are also above the BP capacity. However, it should be noted, that the rig only started to rotate in the severe weather conditions.

The environmental loads acting on the rig in the survival conditions, at a draught of 20.5 m, are given in the table below:

	Frontal loads (head seas)		Side loads (beam seas)	
Condition	**Wind [kN]**	**Total [kN]**	**Wind [kN]**	**Total [kN]**
1	219.8	348.0	221.0	418.6
2	494.5	1048.5	474.8	1108.2
3	879.1	1459.7	844.1	1548.6
4	879.1	*2223.9*	844.1	*2268.2*
5	1373.6	*3448.3*	1318.9	*3472.9*
6	1914.8	*3989.5*	1838.5	*3992.6*

The above results for the survival draught show that for conditions 4, 5 and 6 the total frontal loads are above the BP capacity of the vessel.

The comparison of the results for the towing conditions and the survival conditions show that for the towing conditions, the environmental loads in beam seas are about double of the rig its survival draught condition. As can be seen in the results, this is mainly caused due to the wave loads. The head seas loads for both draughts don't differ significantly. It shall however be noted that even when the rig would have been at survival draught, it is still to be expected that the tow would have become in trouble in these circumstances.

[redacted]

[redacted]

GL-NDA holding case
As specified above, GL-NDA dictates that the combined Bollard Pull available must be sufficient to maintain station in the environmental conditions as stated in condition 3.

Taking into account the GL-NDA [04] tug efficiency of 0.75, the following loads show that the tug would have been capable holding the tow under GL-NDA requirements. Note that in the more severe weather conditions, according to the GL-NDA, the tug efficiency is significantly reduced.

This, in combination with increased environmental loads, means that effectively holding the rig in position in the conditions more severe than the GL-NDA condition would not have been possible. This accounts however for all BP calculations normally performed based on the holding condition.

Environmental heading	**0 degrees**	**10 degrees**
Condition 3, tow draught	193.0	193.0
Condition 3, survival draught	198.0	198.0

Both holding conditions for 10 degrees are included in appendix D and J

[redacted]