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Open Access Earth System Science Data Discussions

Meteorological buoy measurements in the Iceland Sea 2007–2009

Guðrún Nína Petersen[1]

[1][Icelandic Meteorological Office, Bústaðavegi 9, 108 Reykjavík, Iceland

Correspondence to: Guðrún Nína Petersen (gnp@vedur.is)

Abstract. The Icelandic Meteorological Office (IMO) conducted meteorological buoy measurements in the central Iceland Sea in the time period 2007–2009, specifically in the Northern Dreki Area on the southern segment of the Jan Mayen Ridge. Due to difficulties in deployment and operations in-situ measurements in this region are sparse. Here the buoy, deployment and measurements are described with the aim of giving a future user of the data set as comprehensive information as possible. The data set has been quality checked, suspect data removed and the data set made publicly available from Pangaea Data Publisher (doi:10.1594/PANGAEA.876206).

1 Introduction

The Icelandic Meteorological Office (IMO) conducted measurements in the central Iceland Sea in the time period 2007–2009, specifically in the Northern Dreki Area on the southern segment of the Jan Mayen Ridge. The deployment was a part of a governmental preparation project for the potential exploration for oil and gas on the Icelandic continental shelf and the purpose of the measurements was to obtain information on the local weather. The measurements were conducted with a meteorological buoy making basic in situ meteorological measurements as well as some oceanographic measurements. After the end of the deployment the government phased out the project and the data remained untouched and unused for several years.

Lately the data have become of interest to the scientific community. One reason is the discovery of the North Icelandic Jet (Jonsson and Valdimarsson, 2004), a deep-reaching ocean current hypothesized to originate in the Iceland Sea (Våge et al., 2013) although the exact source and related water mass transformation processes are not known. The Iceland Sea is a local heat flux minimum and thus the oceanic deep convection is not driven by the the average large scale atmospheric circulation (Moore, 2012). However, Harden et al. (2015) used the buoy data presented here to examine the surface meteorological condition in the central Iceland Sea and concluded that although on average the heat flux was low, on shorter time scales the Iceland Sea frequently experienced high heat flux events in the wintertime.

The buoy measurements are unique due to the sparsity of in situ observations over the ocean, especially in this region, and Dukhovskoy et al. (2017) used it in an evaluation of ocean surface winds from reanalysis data sets and scatterometer derived gridded products.

Although measurements from the data set have been used in both Harden et al. (2015) and Dukhovskoy et al. (2017) they have not been made publicly available earlier. However, now the data set has been quality checked, suspect data removed and made publicly available from the Pangea Data Publisher.

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Figure 1. The meteorological buoy on board The Icelandic Marine Research Institute's vessel Bjarni Sæmundsson on 22 November 2007, the day before deployment. Photo: Sighvatur K. Pálsson.

The purpose of this article is to give a full description of the buoy, deployment and measurements for any future users of the data set.

In the following section there is a description of the buoy, parameters measured and the deployment. Sect. 3 contains information on the measurements, the availability of data and, where possible, reasons for periods of missing data. Lastly, final remarks are in Sect. 4.

2 The buoy and the deployment

The buoy was a SEAWATCH wavescan wave buoy from Fugro OCEANOR that measured wave, current and meteorological parameters (Fugro OCEANOR, 2017). The hull was discus shaped with a keel mounted at the bottom to prevent capsizing of the buoy. The meteorological sensors and the antennae were mounted on a mast, see Figure 1. The hull had a diameter of 2.8 m and total height (mast to keel) of 6.75 m. It had solar panels and a sealed lead acid backup batteries. Due to the low sun radiation condition during winter at the measurement site the buoy was also supplied with lithium batteries.

The buoy was deployed in the Northern Dreki Area[1] on the southern segment of the Jan Mayen Ridge, anchored at 68.47°N, 9.27°W from 23 November 2007 to 21 August 2009, see Figure 2, drifting inside a circle with a diameter of approximately 2 km. It was serviced once during the deployment, on 7 June 2008. The GPS sensor failed on 17 April 2009 between 08 and 09 UTC. Thus after that time the exact location of the buoy is not known and there are no measurements of current speed and direction. After the GPS sensor's failure the buoy broke free. Using the locations of the satellites retrieving information from the buoy it can be seen that this happened in May and the buoy then started drifting northward. It was rescued by The Marine

[1]Dreki is Icelandic for dragon and thus the buoy is known by the Icelandic meteorological and oceanographic community as the dragon buoy.

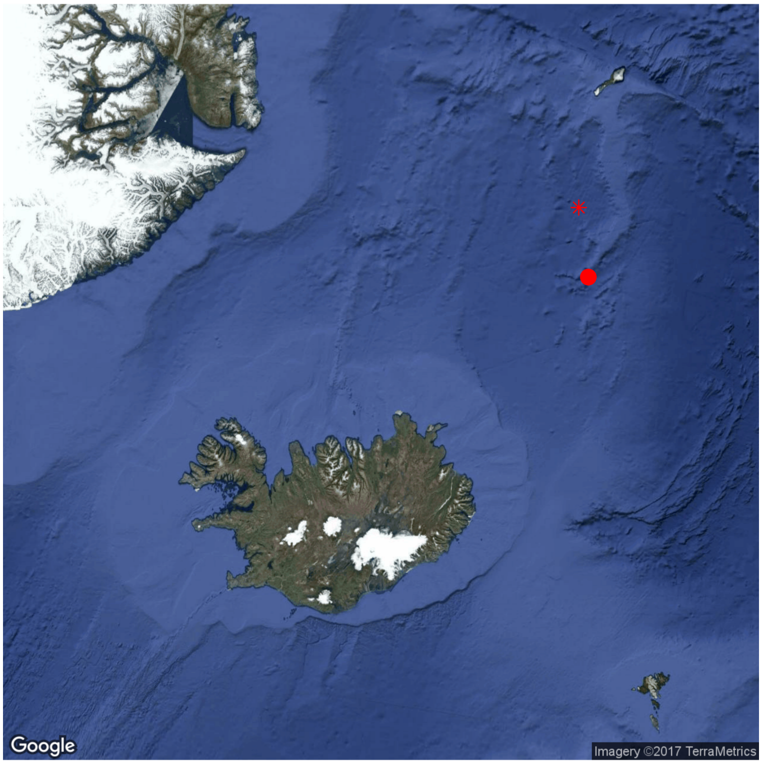

Figure 2. The location of the buoy November 2007 – April 2009. The retrieval location on 21 August 2009 is marked with a star.

Research Institute on 21 August 2009 at 69.40°N, 9.62°W, having drifted about 104 km to the north from the mooring location, see location in Figure 2.

3 The measurements

Table 1 contains a list of measurements conducted, units, resolution and short names in the data set. The data was recorded every hour.

The measurement time period is 23 November 2007 03 UTC – 21 August 2009 20 UTC and table 2 contains a list over times when some or all of the measurements were missing and the reason when known. In addition other obvious errors were removed, such as spurious longitude $= 0°$.

Table 3 contains averages for most of the meteorological parameters measured, and maxima and minima where appropriated and Table 4 averages for the main oceanic parameters. The daily values, average, maximum and minimum values, are calculated and then the monthly averages of the daily values. In addition to measured values the dew point, T_d, the vapour pressure, P_v, and the difference between the water temperature and the air temperature are calculated and the mean values included in the table.

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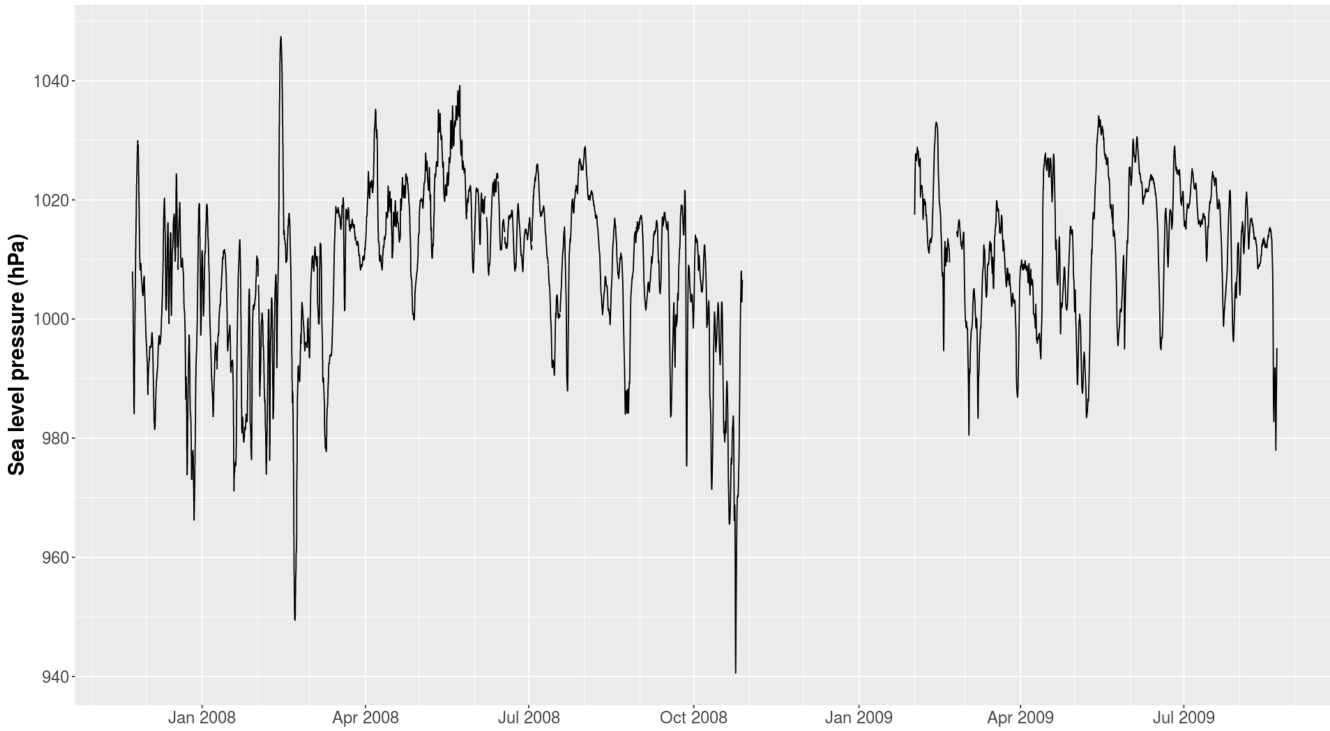

Figure 3. Measurements of mean sea level pressure (hPa). The gap from 28 October 2008–1 February 2009 is due to measurement errors.

3.1 Air pressure

The buoy measurements of mean sea level pressure are shown in Figure 3. During the deployment, the average pressure was 1009 hPa, varying from a minimum of 941 hPa to a maximum of 1047 hPa. Note that the maximum was measured on 13 February 2008 and a local minimum of 950 hPa a week later, on 21 February 2008, emphasizing the variability of the synoptic situation in the region. A comparison of the pressure data to ECMWF operational analysis confirmed the suspicion that the measurements were off for months after the passing of the deepest low, on 24 October 2008, possibly due to water in the sensor inlet. From 1 February 2009 the measurements are in agreement with ECMWF analysis (not shown).

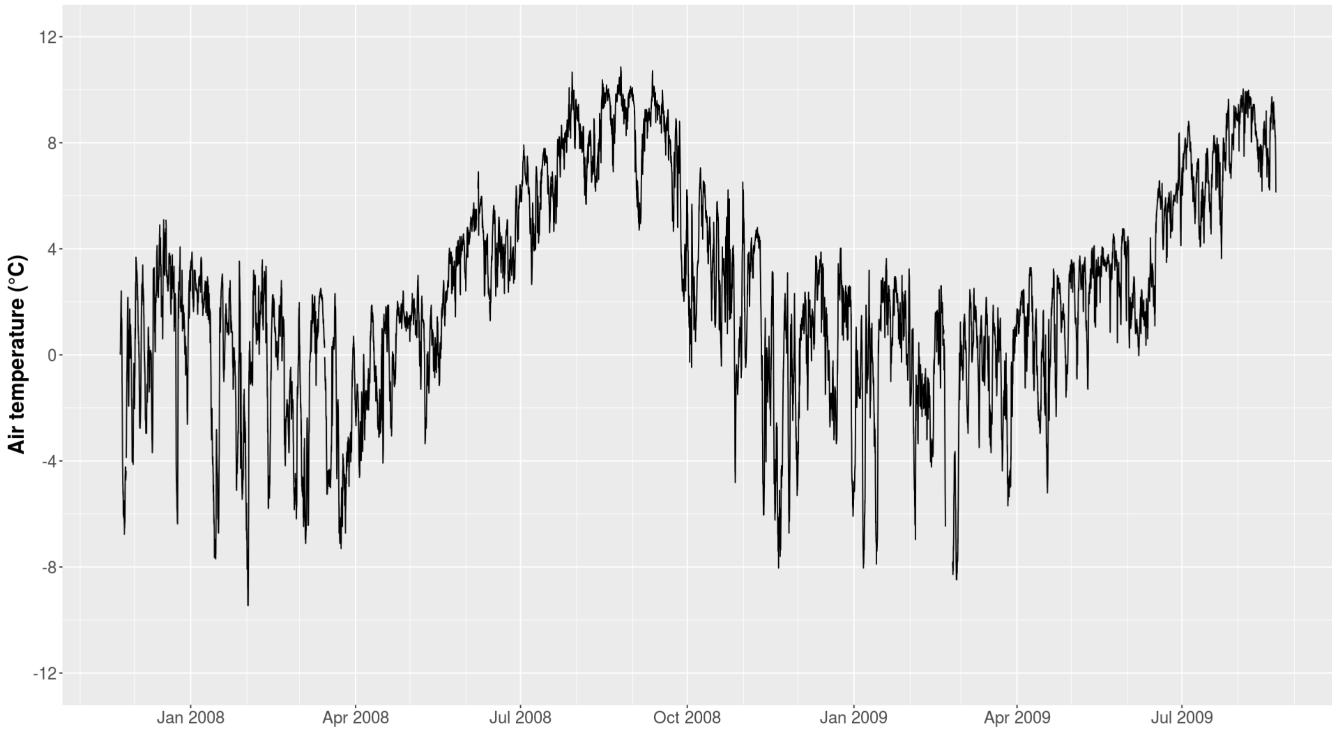

Figure 4. Measurements of air temperature (°C) at 3.5 m height.

3.2 Air temperature

Air temperature was measured at 3.5 m height. The lowest temperature measurement was -9.5°C and the highest 10.9°C, a span of about 20°C, see Figure 4. During late autumn, winter and spring the temperature variations were much greater than during the summer and early autumn. The temperature variations during the cool seasons are related to the variation in weather regimes, from northerly cold air outbreaks to warm air advection by synoptic cyclones moving into the area from the south (Harden et al., 2015). The highest temperatures were measured in late summer, mainly in August and September 2008, while temperatures below -5°C were measured most frequently in February, followed closely by January and March.

3.3 Wind speed and wind direction

The wind speed, wind gust and wind direction were measured at 4 m height. The maximum measured wind was 19.3 m/s and the maximum gust 29.8 m/s. The gust factor was in general below 1.5. There was a significant lower wind speed during the summer months than the winter months, see Figure 5. The monthly mean wind speed was the highest in February 2008 and lowest in June 2009, see Table 3.

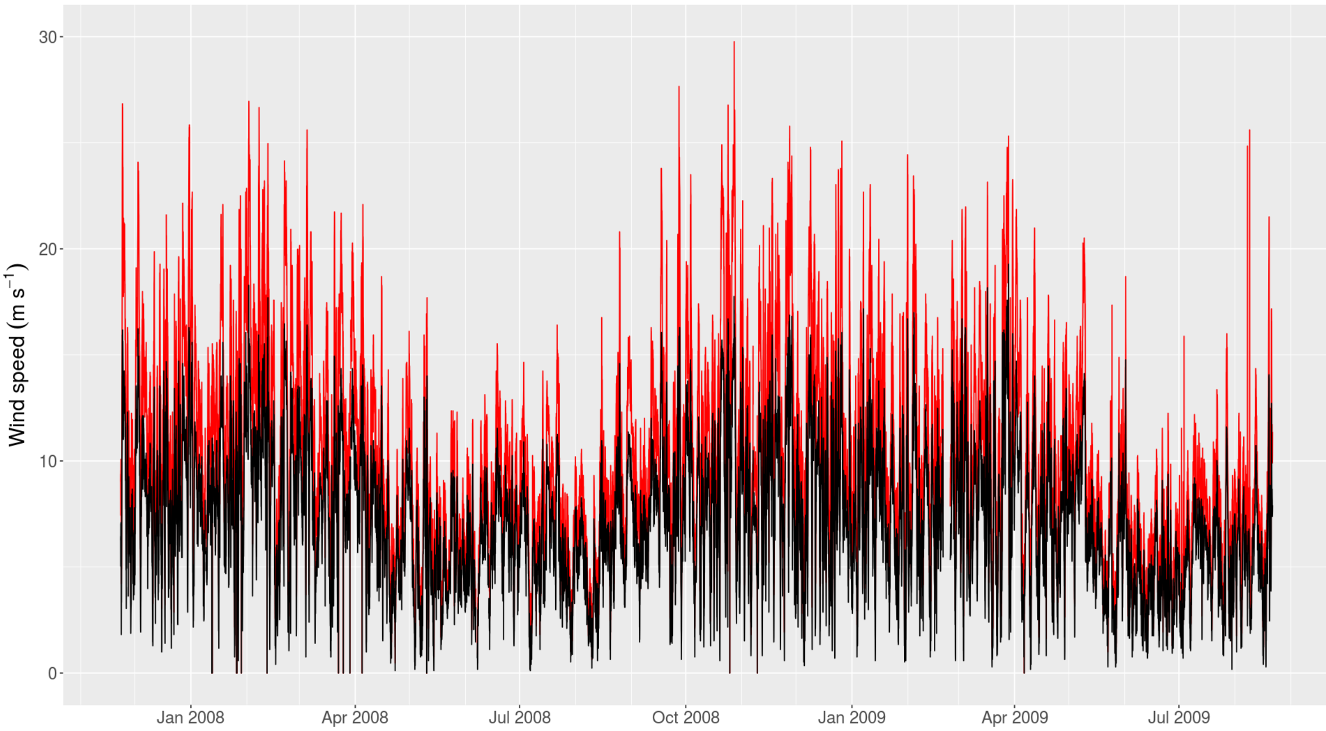

Figure 5. Measurements of wind speed and wind gust (m/s) at 4 m height.

The wind rose in Figure 6 shows that the most common wind directions were northerly to northeasterly, approximately 30% of the time, and the least common wind directions were westerly to northwesterly. This is in accordance with wind directional frequency in Iceland (not shown).

3.4 Relative humidity

The relative humidity was measured at 3.5 m height. As the measurements were made over the sea the relative humidity was in general high with the lowest measurement at 50%, see Figure 7. In all cases of relative humidity below 55% the air temperature was below freezing and in most cases winds were light. The mean relative humidity was 87%.

3.5 Water temperature

Water temperature was measured at 1.5 m depth, in direct connection to the the current sensor. After 17 April 2009 all measurements from the current sensor were invalid. The water temperature measurements were thus made over 16 consecutive months. The lowest temperature was measured in spring and the highest from the end of July til mid-September. The rise in temperature during late spring and early summer was slower then the fall in the autumn, see Figure 8. The lowest and highest monthly means were in April and August 2008. The air temperature is also shown in the figure. The amplitude of the water

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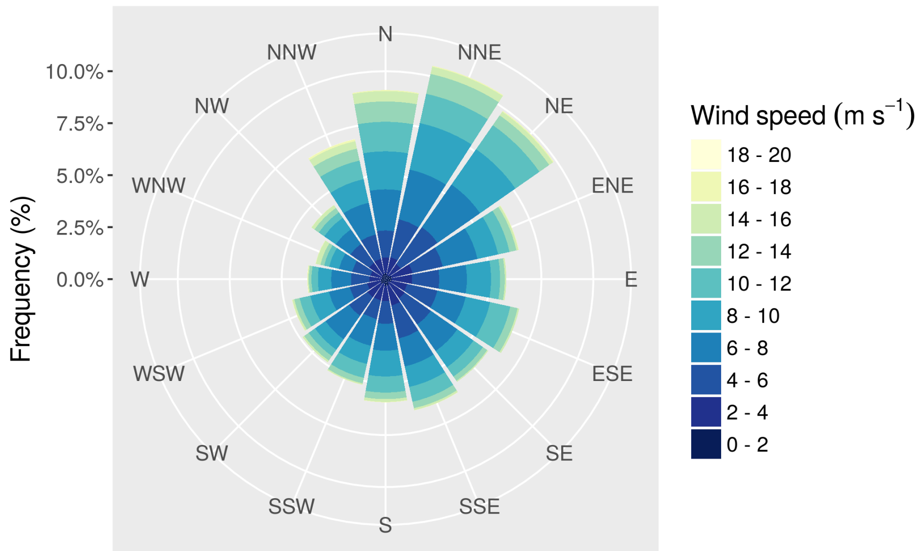

Figure 6. A wind rose, showing the frequency (%) and wind speed (m/s) for different wind directions at 4 m height (22.5° bins).

temperature variations is much less than that of the air temperature. The differences between the water temperature and the air temperature were calculated and on a monthly basis the difference varied between 0.5°C and 3.3°C, with the least difference during summer months but large variation during the winter months, related to different air mass impacting the area.

3.6 Current speed and direction

Current speed and direction were measured at 1.5 m depth. As mentioned earlier, after the GPS sensor broke down on 17 April 2009 all current measurements are missing. The mean current speed was 13 cm/s and the maximum 52 cm/s. The monthly mean current speed varied from 8.8 cm/s in May 2008 to 17.2 cm/s in February 2008. By convention, current directions are defined opposite to wind directions; northerly current moves toward north while northerly wind is coming from north. The most common current directions were southwesterly (toward southwest) and easterly directions (toward east) least common, see Figure 10.

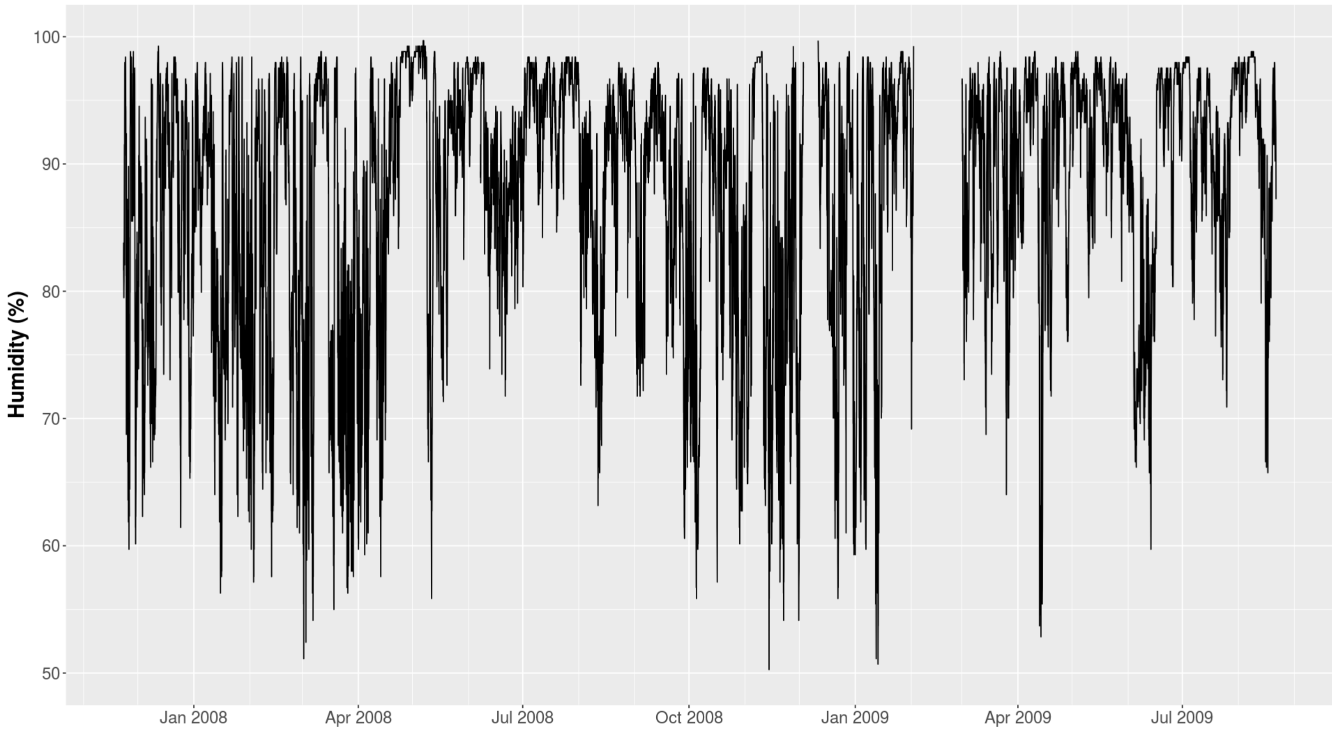

Figure 7. Measurements of relative humidity (%) at 3.5 m height.

3.7 Wave parameters

Figure 11 shows the frequency of wave directions. By convention, wave directions are defined in the same way as wind directions. The most common directions were northeasterly to east-northeasterly, a slight clockwise rotation from the most common wind directions, see Figure 6. The least common wave direction was northwesterly. Figure 12 shows the significant wave height (the mean height of the highest one-third of the waves) and the spectral peak period (the wave period with the highest energy) and Figure 13 the highest wave height and the mean wave period (the mean of all wave periods). All measurement have an annual variation with minimum during summer and maximum during winter, as well as more variability. The monthly mean significant wave height varied from 1.2–3.9 m and the monthly mean maximum wave height 1.7–5.9 m.

4 Conclusions

The Icelandic Meteorological Office deployed a meteorological buoy in the Northern Dreki Area on the southern segment of the Jan Mayen Ridge for 21 months, from 23 November 2007 to 21 August 2009. This is a region of the North Atlantic with few in situ measurements and thus the data set unique. The data set has been quality checked and is now publicly available. This short paper presents the data set, which parameters were measured and at which height as well as the data gaps and reasons

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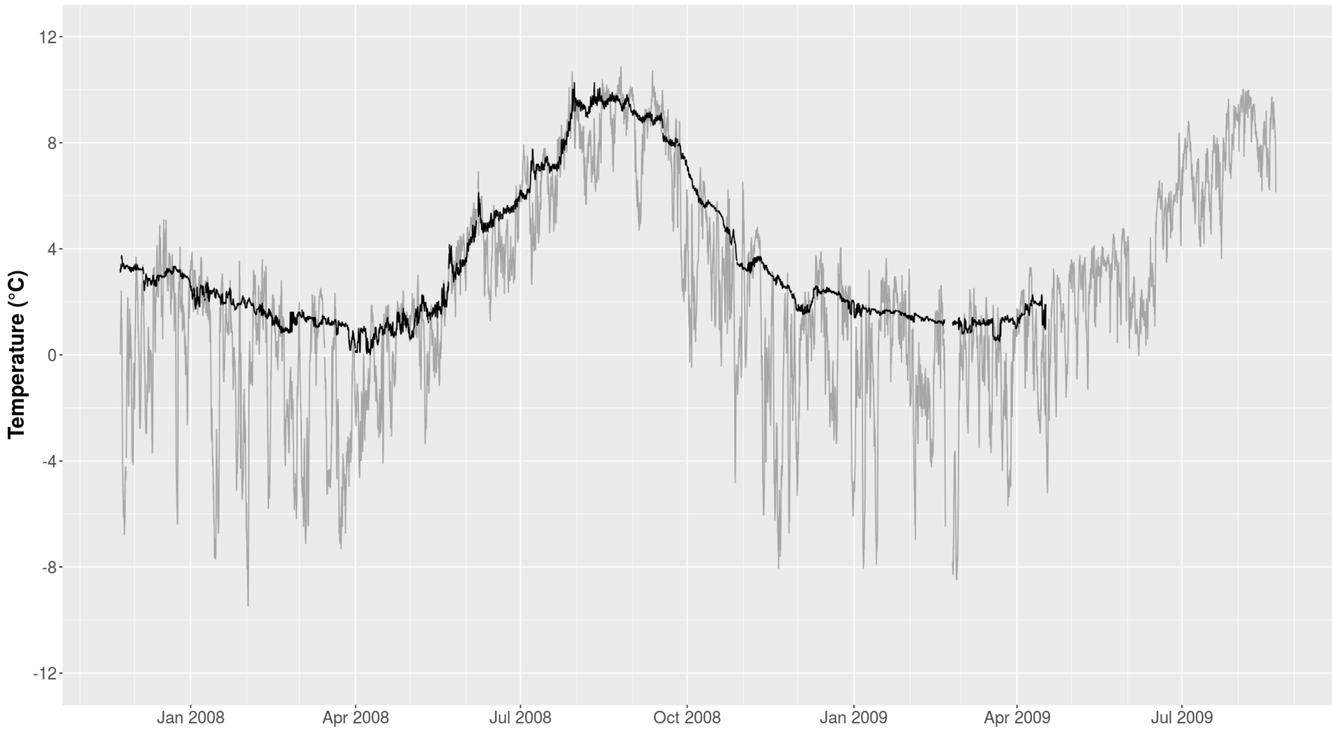

Figure 8. Measurements of water temperature (°C) at 1.5 m depth. Air temperature is shown in the background.

for them were known. The figures in this paper are meant to give a potential user of the data set a quick view of the data. It is the hope of the author that the measurements can be of use for scientists studying the meteorology and oceanography of the northern North Atlantic as well.

5 Data availability

The processed data set is publicly available from the Pangea Data Publisher (doi:10.1594/PANGAEA.876206).

Author contributions. G. N. Petersen prepared the manuscript and figures as well as processing and quality checking the data set.

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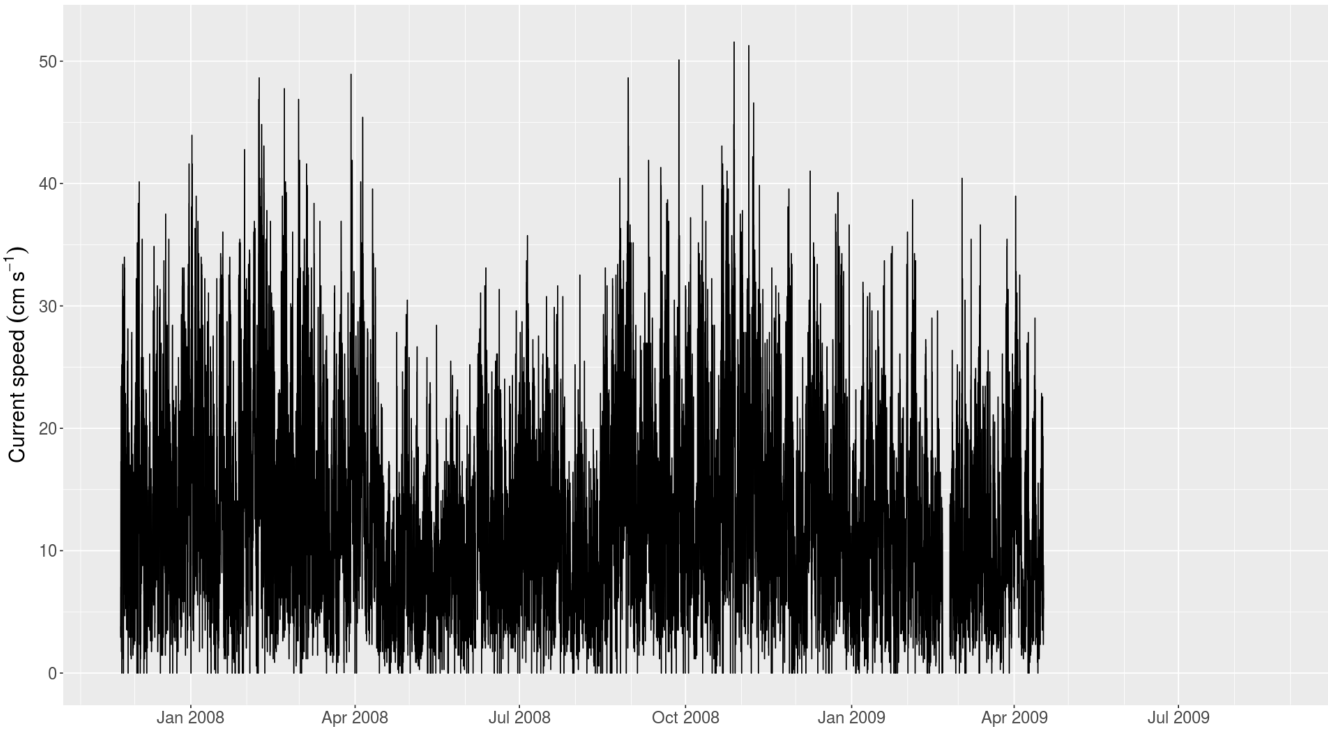

Figure 9. Measurements of current speed (cm/s) at 1.5 m depth.

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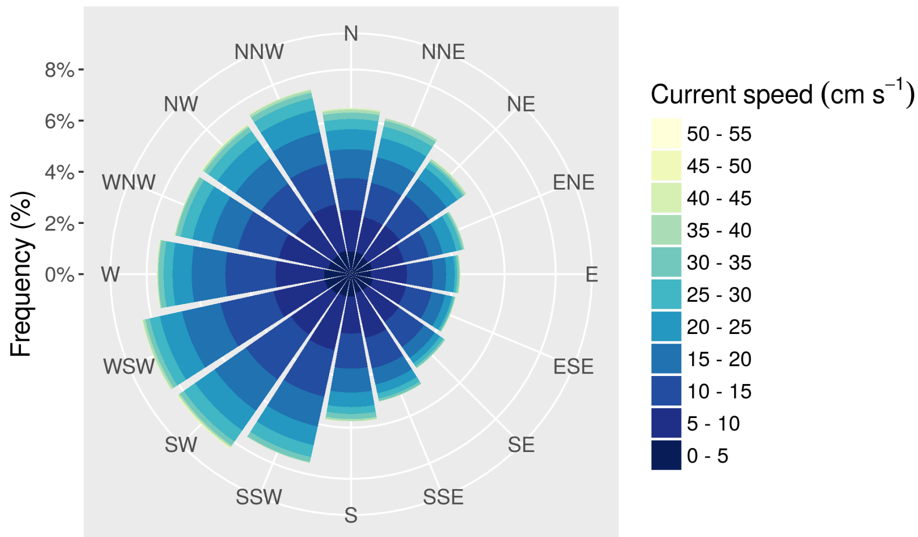

Figure 10. A frequency rose, showing the frequency (%) and current speed (m/s) for different current directions (22.5° bins) at 4 m height. Note that current direction is defined as the direction the current is streaming toward, which is opposite to the convention of wind direction.

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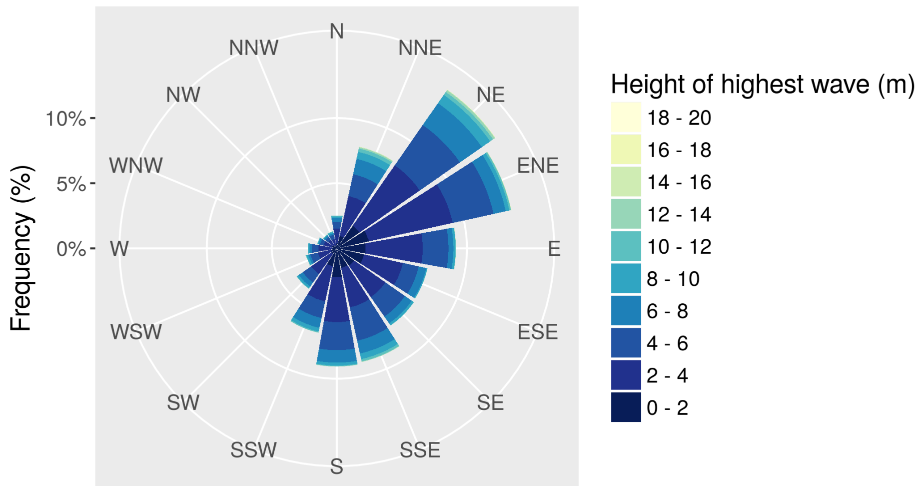

Figure 11. A frequency rose, showing the frequency (%) and height of highest wave (m) for different wave directions (22.5 ° bins), with wave directions defined in the same way as wind directions.

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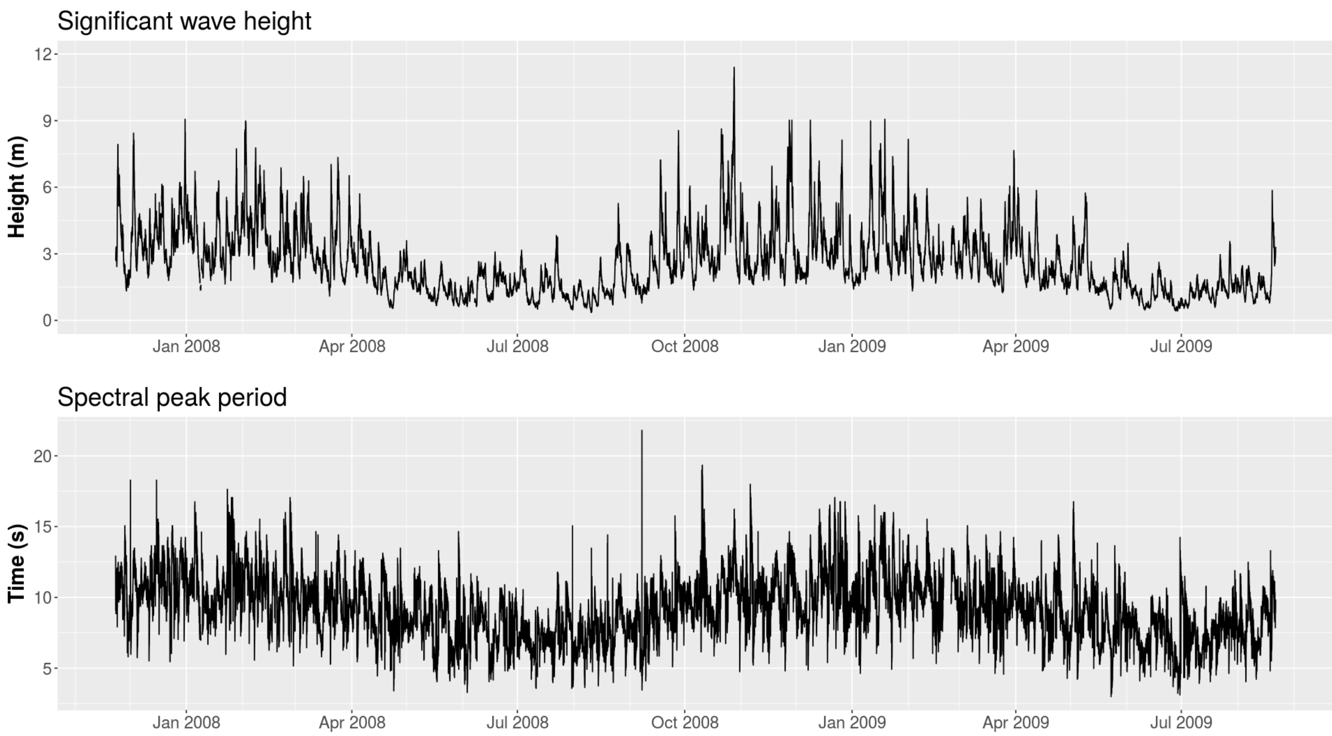

Figure 12. Measurements of significant wave height (m) and the spectral peak period (s).

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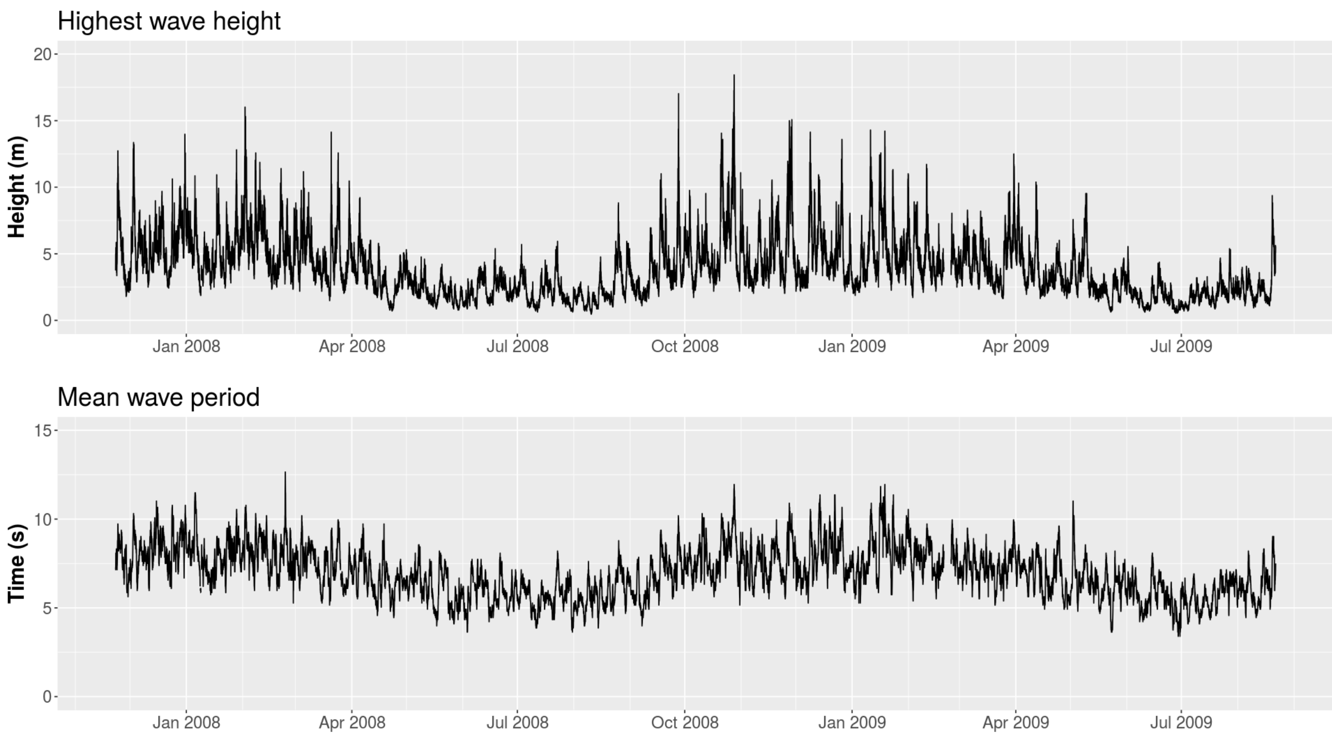

Figure 13. Measurements of the highest wave height (m) and the mean wave period (s).

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Table 1. Buoy measurements, units, resolution and short names used in the hourly data set.

Name	Parameter	Units	Resolution	Short name in data set
Location				
Latitude	lat	degrees	0.01	Latitude
Longitude	lon	degrees	0.01	Longitude
Meteorological				
Sea level pressure	P	hPa	0.1	PPPP
Air temperature at 3.5 m height	T	°C	0.001	TTT
Relative humidity at 3.5 m height	RH	%	0.01	RH
Wind direction at 4 m height	Wdir	degrees	0.01	dd
Wind speed at 4 m height	WSP	$m\,s^{-1}$	0.001	ff
Wind gust at 4 m height	WGS	$m\,s^{-1}$	0.001	ff gust
Oceanographic				
Water temperature at 1.5 m depth	T_w	°C	0.01	Temp
Current direction at 1.5 m depth	Cdir	degrees	0.1	DIR
Current speed at 1.5 m depth	CSP	$cm\,s^{-1}$	0.001	V
Height of highest wave	H_s	m	0.001	Wave h max
Period of the highest wave	T_{H_s}	0.001	s	PwPw
Heave parameters computed from spectral analysis				
Significant wave height (Hs), estimate	H_s	m	0.001	Wave h
Significant wave height (Hs), estimate lower frequency band	H_{sa}	0.001	m	Wave h
Significant wave height (Hs), estimate mid frequency band	H_{sb}	m	0.001	Wave h
Mean wave period (Tz), estimate 1	T_{z1}	s	0.001	PwPw
Mean wave period (Tz), estimate 2	T_{z2}	s	0.001	PwPw
Mean wave period (Tz), estimate 2, lower frequency band	T_{z2a}	s	0.01	PwPw
Mean wave period (Tz), estimate 2, mid frequency band	T_{z2b}	s	0.001	PwPw
Period of spectral peak	T_p	s	0.001	Time
Directional wave parameters computed from spectral analysis				
Mean spectra wave direction	Mdir	degrees	0.01	Wave dir spr
Mean spectra wave direction, lower frequency band	$Mdir_a$	degrees	0.01	Wave dir spr
Mean spectra wave direction, mid frequency band	$Mdir_b$	degrees	0.01	Wave dir spr
Directional wave parameters				
High frequency mean wave period	T_{hhf}	s	0.01	Time
Wave spreading at spectral peak period	SPS_{T_p}	degrees	0.001	Wave dir spr

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Table 2. List of periods where measurements are missing or clearly erroneous, parameters affected and reasons.

Time	Parameter	Reason
2007-12-31 00 UTC – 2008-06-06 18 UTC	Location	Errors in location records
2008-06-06 19 UTC – 2008-06-07 12 UTC	All data	The buoy was serviced
2008-10-28 01 UTC – 2009-02-01 UTC	P	The pressure measurements were too high[a]
2008-11-27 12 UTC – 2008-11-27 16 UTC	Relative humidity	Relative humidity $> 100\%$
2008-12-03 09 UTC – 2008-12-11 10 UTC	Relative humidity	Relative humidity $> 100\%$
2008-12-12 18 UTC	Location	Errors in location records
2009-02-02 08 UTC – 2009-03-01 02 UTC	Relative humidity	Relative humidity $> 100\%$
2009-02-20 12 UTC – 2009-02-24 09 UTC	All data	Measurements were missing
2009-04-17 09 UTC – end of deployment	Location and current parameters	GPS sensor failed
2009-04-17 09 UTC – end of deployment	Water temperature	Temperature sensor failed

[a] Pressure measurements were compared to ECMWF operational forecasts.

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Table 3. Monthly average values, as well as maximum and minimum values where appropriate, for most of the meteorological parameters. The dew point, T_d, and the vapour pressure, P_v, are calculated using equation from WMO (1996). Insufficient data is represented with –.

	$\overline{T}$ °C	$\overline{T_{max}}$ °C	T_{max} °C	$\overline{T_{min}}$ °C	T_{min} °C	$\overline{T_d}$ °C	$\overline{P_v}$ hPa	$\overline{P}$ hPa	P_{max} hPa	P_{min} hPa	$\overline{WSP}$ m/s	WSP_{max} m/s	WGS_{max} m/s
Dec 2007	1.3	2.7	5.1	-0.3	-6.4	-1.0	5.8	999.7	1024.4	966.2	8.7	16.3	25.8
Jan 2008	-0.2	1.1	3.9	-1.3	-7.7	-2.7	5.2	997.3	1019.3	971.1	8.5	16.1	22.9
Feb 2008	-0.6	0.7	3.6	-2.1	-9.5	-3.1	5.1	998.9	1047.4	949.5	9.6	18.3	27.0
Mar 2008	-2.1	-0.8	2.5	-3.4	-7.3	-5.2	4.4	1007.5	1020.4	977.8	8.7	16.4	25.6
Apr 2008	-0.4	0.4	2.4	-1.4	-4.6	-2.4	5.3	1016.7	1035.2	999.8	7.0	14.5	22.1
May 2008	1.6	2.4	4.6	0.8	-3.4	0.3	6.4	1024.2	1039.2	1007.8	5.1	14.0	17.7
Jun 2008	4.3	5.0	6.9	3.5	1.3	2.7	7.5	1016.0	1024.5	1007.4	6.1	11.5	15.5
Jul 2008	6.9	7.6	10.7	6.1	2.7	6.2	9.6	1012.9	1028.5	987.9	5.7	11.2	16.4
Aug 2008	8.7	9.2	10.9	8.0	5.7	6.8	10.0	1009.2	1028.9	984.0	5.9	14.6	20.8
Sep 2008	7.6	8.4	10.7	6.7	2.0	5.5	9.3	1007.6	1021.6	975.3	7.6	16.3	27.7
Oct 2008	2.9	4.3	7.1	1.4	-4.8	0.3	6.6	992.3	1014.1	940.6	9.0	17.8	29.8
Nov 2008	-0.3	1.4	6.1	-2.1	-8.0	-3.2	–	–	–	–	8.8	16.9	25.8
Dec 2008	0.7	1.8	4.0	-0.6	-6.1	-1.7	–	–	–	–	8.2	16.1	25.1
Jan 2009	0.0	1.3	3.6	-1.6	-8.0	-1.9	–	–	–	–	7.6	17.2	24.4
Feb 2009	-2.0	-0.6	2.6	-3.3	-8.5	-2.3	5.3	1026.6	1033.0	994.7	7.9	17.0	23.4
Mar 2009	-0.5	0.8	2.5	-1.8	-5.7	-2.1	5.3	1004.5	1019.9	980.5	8.5	19.3	25.3
Apr 2009	0.7	1.7	3.4	-0.4	-5.2	-0.9	5.9	1010.2	1027.9	993.3	7.4	14.7	21.9
May 2009	2.9	3.6	4.8	1.9	-1.3	2.0	7.1	1010.1	1034.1	983.4	6.6	14.1	20.5
Jun 2009	3.7	4.5	8.4	2.9	0.0	1.6	7.1	1019.7	1030.6	994.9	4.3	14.8	18.7
Jul 2009	7.1	7.9	9.6	6.2	3.6	5.8	9.3	1015.3	1025.2	996.2	5.3	11.6	16.0
Aug 2009*	8.6	9.2	10.0	7.8	6.1	7.3	10.4	1010.4	1021.3	978.0	5.7	14.1	25.6

*Only 21 days as the buoy was retrieved on 21 August at 20 UTC.

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Table 4. Monthly average values for a few of the oceanographic parameters: water temperature, current speed, mean wave period, height of highest wave, significant wave height and period of spectral peak. The parameter $\overline{\Delta(T_w - T)}$ is the monthly averaged difference between the water temperature and the air temperature. Insufficient data is represented with –.

	$\overline{T_{Water}}$ °C	$\overline{\Delta(T_w - T)}$ °C	$\overline{CSP}$ cm/s	$\overline{T_Z}$ s	$\overline{H_{max}}$ m	$\overline{H_s}$ m	$\overline{T_p}$ s
Dec 2007	3.0	1.7	14.7	8.3	5.7	3.9	11.0
Jan 2008	2.2	2.3	14.5	8.0	5.2	3.5	10.8
Feb 2008	1.4	2.0	17.2	8.1	5.9	4.0	10.7
Mar 2008	1.2	3.3	14.7	7.4	4.9	3.3	9.6
Apr 2008	0.8	1.2	11.7	6.7	3.3	2.2	9.0
May 2008	2.2	0.5	8.8	6.1	2.2	1.5	8.2
Jun 2008	5.1	0.8	11.2	5.9	2.3	1.6	7.8
Jul 2008	7.4	0.5	12.0	5.6	2.1	1.5	7.3
Aug 2008	9.5	0.8	13.2	5.8	2.3	1.6	7.6
Sep 2008	8.5	0.9	14.6	6.7	3.8	2.6	8.8
Oct 2008	5.2	2.3	15.8	7.9	5.6	3.9	10.3
Nov 2008	3.0	3.3	15.1	7.6	5.2	3.5	10.3
Dec 2008	2.1	1.4	13.1	7.8	5.0	3.4	10.5
Jan 2009	1.6	1.6	11.2	8.2	5.1	3.5	10.8
Feb 2009	1.3	3.3	10.7	7.8	4.6	3.1	10.5
Mar 2009	1.1	1.6	11.4	7.3	4.5	3.1	9.7
Apr 2009	1.7	1.3	11.1	6.8	3.7	2.5	8.9
May 2009	–	–	–	6.4	3.0	2.0	8.4
Jun 2009	–	–	–	5.6	1.7	1.2	7.1
Jul 2009	–	–	–	5.7	2.0	1.3	7.6
Aug 2009*	–	–	–	6.2	2.5	1.7	8.2

*Only 21 days as the buoy was retrieved on 21 August at 20 UTC.