BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Department M2 Ocean Physics and Climate

BSH Station and Sensor List

In Situ Surface Waves

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Revision History

Date	Changed Chapters	Revision Description
12.11.2020		Original Document Published
07.01.2021	1, 2	Included more information about the sea state portal; Included new station OWP Nordsee Ost
17.11.2021	1, Table 1	Updated information about the sea state portal and Table 1
07.12.2021	1, Table 1	Included new station OWP Deutsche Bucht
25.08.2023	1, Table 1, Table 5	Included new station OWP BARD Offshore 1; updated information about latitude, longitude, availability; included information about the new directional wave radars at FINO1, FINO2 and FINO3
05.10.2023	1, Table 1, Abbreviation	Included new stations Stohl and Heiligenhafen operated by LKN.SH
04.12.2023	Table 5	Included information about the directional wave radar at OWP Deutsche Bucht
15.02.2024	1, Table 5	Updated information about the stations; included information about the directional wave radar at OWP Nordsee Ost
15.03.2024	1	Included information about changed set mounting height for wave radar at OWP Nordsee Ost
26.07.2024	Table 5	Removal of the dates (installation periods) for the wave radars at the FINO stations, as the 1D RADACs will be reactivated.
08.08.2024	1	Include a new table to show date and time of when the mounting heights for the 3D-RADACs were correctly set.
24.01.2025	Contact, References	Update of contact persons; update of references
17.06.2025	1	Included Station Norderney See operated by NLWKN

Abbreviation

Name	Description
ADCP	Acoustic Doppler current profiler
AWAC	Acoustic wave and current profiler
BSH	Bundesamt für Seeschifffahrt und Hydrographie / Federal Maritime and Hydrographic Agency
CF	Climate and Forecast Metadata Conventions
CMEMS	Copernicus Marine Environment Monitoring Service
DWR	Directional waverider (buoy)
FINO	Forschungsplattformen in Nord- und Ostsee / Research platforms in the North Sea and Baltic Sea
LKN.SH	Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Schleswig-Holstein / Schleswig-Holstein State Agency for Coastal Protection, National Park and Marine Conservation
MARNET	Marines Umweltbeobachtungsmessnetz / Marine environmental monitoring network
OWP	Offshore wind park
RADAR	Wave radar
RAVE	Research at alpha ventus

Nomenclature

Name	Description	Unit
Dir_P	Wave principal direction at spectral peak	degree
f	Wave frequency	Hz
f_P	Peak wave frequency	Hz
H_{max}	Maximum zero crossing wave height	m
H_{m0}, H_S	Significant wave height, $H_{m0}=4*sqrt(m_0)$	m
m_0	0^{th} moment of the power density spectrum	m^2
$S(f)$	Power density spectrum	m^2/Hz
Spr_P	Wave directional spreading at spectral peak	degree
T_{m02}	Spectral moments (0,2) wave period	s
T_P	Peak period	s
T_{sea}	Water temperature	°C

1 Station List for Sea State Measurement

Please note:

- more information about the measuring instruments, their computation of the wave parameters, and their timestamp assignment can be found in Chapter 2 of this document and in the current version of the data quality control manual "Manual_RTDQC_Sea_State_V*.pdf", which can be found in the sea state portal under “Documents”.
- the sea state portal is still under development. Before June 2019, solely the main sea state parameters H_{m0}, T_P, Dir_P, Spr_P, T_{m02}, H_{max}, T_{sea} were loaded into the database. Since June 2019, the complete sea state parameters are loaded into the database and, since June 2020, the newly developed data quality control with the so-called detailed quality flag is performed. We are currently working on post-processing the historical data with the new data quality control and reloading the complete data sets into the database.
- we added two sea state stations operated by LKN.SH: "Stohl" and "Heiligenhafen". Although they are waverider buoys of the type DWR MKIII from Datawell, the output format is different. Therefore we get only the following parameters: VHM0, VTM20, VTM01, VTM02, VTM24, VTPK, VPQP, Latitude, Longitude, TEMP. See Table 7 for the parameter definitions.
    - Furthermore, it is important to note that unlike the other BSH DWR buoys, the definition of the time stamp for the above parameters is as follows: start time of the measurement. Please also refer to the notes on page 10.
    - The LKN.SH plans to update the measurement software so that the output format corresponds to the output format used by the BSH. This would make the parameters and time stamp definitions identical.
- Table 2 shows an overview of when the mounting heights of the 3D-RADAC wave radars were correctly measured. From then on, the sea level is correctly measured.
    - For station NO1, the accuracy could only be specified to the nearest centimeter. It was therefore rounded up to 21.940 m.
    - The calibration for the alpha ventus station is currently ongoing.

Table 1: BSH Station List for Sea State Measurement

	Abbreviation	Station (InSiDa Name)	Station	Measuring System	Water Depth (m)	Latitude	Longitude	Provider	Available from
MARNET	ARK	Arkona	Arkona Becken (Arkona Basin)	DWR	40,0	54° 53,10900' N	13° 51,60300' E	BSH	2002
	BUH	BunkerHill1	Bunker Hill	DWR	10,0	54° 47,46120' N	08° 15,90660' E	HZG/LKN	2011
	DAR	Buoy Darsser Schwelle1	Darßer Schwelle (Darss Sill)	DWR	22,0	54° 41,95320' N	12° 42,15600' E	BSH	1991
	ELB	ElbeWR	Elbe	DWR	25,0	53° 59,79720' N	08° 06,78600' E	BSH	1990
	HEL	Helgoland	Helgoland Sued (Helgoland South)	DWR	25,0	54° 09,56700' N	07° 52,09140' E	BSH	1989
	HEO	Helgoland Ost	Helgoland Ost (Helgoland East)	DWR	27,0	54° 12,03300' N	08° 06,03420' E	BSH	2021
	HHF	Heiligenhafen Buoy	Heiligenhafen	DWR	10,0	54° 23,79960' N	10° 55,80000' E	LKN	2020
	LTH	Helgoland-Nord	Helgoland Nord (Helgoland North)	DWR	25,5	54° 13,12002' N	07° 49,15002' E	BSH	2008
	NB2	NSBII	Nordseeboje II (North Sea Buoy II)	DWR	42,0	54° 59,89998' N	06° 21,09000' E	BSH	1993
	NB3	NSBIII	Nordseeboje III (North Sea Buoy III)	DWR	39,5	54° 40,96998' N	06° 44,97000' E	BSH	2010
	STO	Stohl Buoy	Stohl	DWR	8,0	54° 29,22600' N	10° 12,07620' E	LKN	2020
	WES	Sylt	Sylt	DWR	13,0	54° 54,51960' N	08° 13,28760' E	LKN	1989
	SEE	Norderney See Buoy	Norderney See	DWR	15,0	53° 44,971'N	07° 07,119 'E	NLWKN	2023
FINO	FN1	FINO1 Platform	FINO1	RADAR, AWAC	28,0	54° 00.60000' N	06° 34.80000' E	BSH	2013, 2004
	FN1	FINO1	FINO1	DWR	28,0	54° 00,86520' N	06° 35,12400' E	BSH	2003
	FN2	FINO2 Platform	FINO2	RADAR, AWAC	25,0	55° 00,00000' N	13° 09,00000' E	BSH	2013
	FN2	FINO2	FINO2	DWR	25,0	55° 00,28980' N	13° 09,51720' E	BSH	2011
	FN3	FINO3 Platform	FINO3	RADAR, AWAC	22,0	55° 11.40000' N	07° 09.00000' E	BSH	2011
	FN3	FINO3	FINO3	DWR	22,0	55° 11,55000' N	07° 09.40002' E	BSH	2011
RAVE	AV0	AlphaVentus	alpha ventus	RADAR	29,0	54° 00.00000' N	06° 36.00000' E	BSH	2012
	AVF	AlphaVentus	alpha ventus	DWR, AWAC	29,0	54° 00,35340' N	06° 36,76800' E	BSH	2012
	BO1	BARD Offshore 1 Buoy	BARD Offshore 1	DWR, AWAC	41,0	54° 21,38700' N	05° 56,02998' E	BSH	2023
	BUD	Butendiek	Butendiek	DWR, RADAR	18,0	55° 01,49700' N	07° 47,14200' E	BSH	2018
	DBU	Deutsche Bucht	Deutsche Bucht	RADAR	38,0	54° 18,17548' N	05° 47.16349' E	BSH	2021
	DBU	Deutsche Bucht Buoy	Deutsche Bucht	DWR, AWAC	38,0	54° 17.79840' N	05° 47.66820' E	BSH	2022
	NO1	Nordsee One	Nordsee One	DWR, RADAR, AWAC	30,0	53° 59,12700' N	06° 50,23260' E	BSH	2017
	NOO	Nordsee Ost	Nordsee Ost	DWR, RADAR, AWAC	25,0	54° 26,00000' N	07° 41,00000' E	BSH	2021
	NOR	Nordergruende	Nordergründe (Nordergruende)	RADAR	10,0	53° 50,10000' N	08° 10,08333' E	BSH	2020

Table 2: Overview of when the mounting heights of the 3D-RADAC wave radars were set correctly.

Station	Date	Time in UTC	Old Mounting Height [m]	New Mounting Height [m]		Difference Mounting Height Old-New [m]
				actual value	target value	
FN3	21.03.2023	13:48:00				
FN1	21.03.2023	13:51:00				
FN2	10.04.2023	13:37:00				
NOO	10.10.2023	09:38:00	25.000	23.813	23.813	1.187
DBU	08.08.2024	07:15:00	20.000	22.464	22.464	-2.464
NO1	08.08.2024	07:27:00	21.900	21.940	21.938	-0.040
NOR	08.08.2024	07:35:00	15.590	13.723	13.723	1.867
BUD	08.08.2024	07:52:00	28.965	27.793	27.793	1.172

2 Measuring Instruments, Measured Data and Processing Methodology

Oceanographic measurements are carried out by the BSH with the following sensors:

- directional waverider buoy (DWR-MkIII) by Datawell BV (Datawell, 2025)
- acoustic wave and current profiler (AWAC – 600 kHz) by Nortek AS (NORTEK, 2020)
- wave radar (WaveGuide Hight & Tide, WaveGuide Direction) by RADAC BV (RADAC, 2020)

Table 3 summarises the technical details of the directional waverider buoy, Table 4 summarises the technical details of the acoustic wave and current profiler, and Table 5 summarises the technical details of the wave radar. As different radar systems from RADAC are in use, Table 6 shows an overview of the systems installed depending on the station.

Table 3: Specifications DWR buoy

Manufacturer	Datawell BV
Instrument	DWR-MkIII
Measurement range	± 20 m, 0° - 360°, 1.6 s - 30 s
Wave record length	1800 s (2304 samples at 1.28 Hz)
Wave interval	every 1800 s
Accuracy / resolution (wave height)	< 0.5 % of measured value after calibration / 0.01 m
Resolution (wave direction)	1.4°

Table 4: Specifications AWAC

Manufacturer	Nortek AS
Instrument	AWAC 600 kHz ADCP
Measurement range	± 15 m, 0° - 360°, 0 s - 50 s
Wave record length (wave burst)	1024 s (1024 samples at 1 Hz)
Wave interval	every 3600 s
Accuracy / resolution (wave height)	< 1 % of measured value / 0.01 m
Accuracy / resolution (wave direction)	2° / 0.1°

Table 5: Specifications RADAR

Manufacturer	RADAC BV
Instrument	WaveGuide Height & Tide, WaveGuide Direction
Measurement range	2 m – 75 m to surface (heave), 0 m – 60 m wave height, 1 s – 100 s wave period
Wave record length (wave burst)	1200 s (sampling frequency 2.56 Hz, 5 Hz)
Wave interval	Every 60 s
Accuracy / resolution (wave height)	± 1 cm / 0.01 m
Accuracy / resolution (wave period)	± 50 ms / 0.01 s

Table 6: Overview of the radar systems and their sampling frequency depending on the station

Station	**Radar Product**	**Sampling Frequency Heave**
OWP alpha ventus	WaveGuide Height & Tide	5 Hz
FINO1	WaveGuide Height & Tide	2.56 Hz
FINO2	WaveGuide Height & Tide	2.56 Hz
FINO3	WaveGuide Height & Tide	2.56 Hz
FINO1	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
FINO2	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
FINO3	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
OWP Butendiek	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
OWP Deutsche Bucht	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
OWP Nordergründe	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz
OWP Nordsee One	WaveGuide Direction (Wave Guide 4, WG-DR40-SS)	5 Hz
OWP Nordsee Ost	WaveGuide Direction (Wave Guide 5, WG5-DR-CP)	10 Hz

The measured wave parameters consists of

- the raw data, which is the measured water surface displacement, also called “heave”

- the sea state spectrum (or power density spectrum) $S(f)$, which is computed based on the heave
- the aggregated wave parameters, which are the statistical parameters based on heave and spectrum, for example significant wave height H_{m0}, peak period T_P, etc.

After the measured data is transferred to the BSH, the automatic data quality control is applied, and the data is imported into the in situ data database of BSH.

In Table 7 to Table 9, see Annexe, the measured wave parameters are listed. For more information on the calculation methods of the statistical parameters, please refer to the manuals of the manufacturers.

The timestamps of the wave parameters measured with either the AWAC or RADAC sensor describe the temporal midpoint of the measurement. Example: A measurement interval from 10:00-10:20 has the timestamp 10:10.

The timestamps of the wave parameters measured with the DWR buoy describe the temporal start time of the measurement. Example: A measurement interval from 10:00-10:30 has the timestamp 10:00. Please note that the Datawell software assigns as timestamp for the spectral parameters the reception time of the measurement at the measuring computer. To enable a comparison with the zero-crossing wave parameters, this timestamp has to be computed back to the start time of the measurement. Example: Spectral parameters belonging to the measurement interval 10:00 to 10:30 have a timestamp between 10:31 and 10:59, typically about 10:32.

References

COPERNICUS MARINE IN SITU TAC DATA MANAGEMENT TEAM 2024. Copernicus Marine In Situ TAC - physical parameters list. https://doi.org/10.13155/53381

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Annexe

Table 7: Spectral Wave Parameters (1/2). Please note: The italic marked parameters are not yet included in Copernicus Marine In Situ Tac Data Management Team (2024). Therefore their assigned long names, standard names and CMEMS codes are suggestions and only used in the BSH database.

CMEMS / OceanSITES Code	DWR (MKIII)	RADAR (D)	RADAR (HT)	OceanSITES Unit	long_name / OceanSITES Long Name	Parameter definition
VHM0	Hs	Hm0	Hm0	m	Spectral significant wave height (Hm0)	Hs = 4*sqrt(m0)
VTPK	Tp	1/Fp	1/Fp	s	Wave period at spectral peak / peak period (Tp)	Tp = 1 / fp, the frequency at which S(f) is maximal
VTM02	Tz	Tm02	Tm02	s	Spectral moments (0,2) wave period (Tm02)	Tz = T(0,2) = sqrt(m0 / m2)
VPED	Dirp	Th0_B4		degree	Wave principal direction at spectral peak	the direction at f = fp
VPSP	Sprp	S0bh_B4		degree	Wave directional spreading at spectral peak	the directional spread at f = fp
VTM20	TI			s	*Spectral moments (-2,0) wave period (Tm-20)*	TI = T(-2,0) = sqrt(m[-2] / m0)
VTM01	T1			s	Spectral moments (0,1) wave period (Tm01)	T1 = T(0,1) = m0 / m1
VTM24	Tc			s	*Spectral moments (2,4) wave period (Tm24)*	Tc = T(2,4) = sqrt(m2 / m4)
VTPC	Tpc			s	*Calculated peak period m[-2] * m1 / m0 ^ 2*	Tpc = m[-2] * m1 / m0^2
VTNU	nu			[-]	*Band width parameter sqrt((T1 / Tz) ^ 2 - 1)*	nu = sqrt((T1 / Tz) ^2 -1)
VTES	eps			[-]	*Bandwidth parameter sqrt(1 - (Tc / Tz) ^ 2)*	eps = sqrt(1 - (Tc / Tz) ^2)
VPQP	QP			[-]	*Goda's peakedness parameter 2 * m[1,2] / m0 ^ 2*	QP = 2 * m[1,2] / m0 ^2

Table 8: Spectral Wave Parameters (2/2).

CMEMS / OceanSITES Code	DWR (MKIII)	RADAR (D)	RADAR (HT)	OceanSITES Unit	long_name / OceanSITES Long Name	Parameter definition
VSTS	Ss			[-]	*Significant steepness 2 * pi / g * Hs / Tz ^ 2*	Ss = 2 * pi / g * Hs / Tz ^2
VMDR		Th0		degree	Mean wave direction from (Mdir)	
TEMP	Tsea			degrees_C	Sea temperature	

Table 9: Zero-crossing Wave Parameters.

CMEMS / OceanSITES Code	DWR (MKIII)	RADAR (D)	RADAR (HT)	OceanSITES Unit	long_name / OceanSITES Long Name	Parameter definition
VZMX	Hmax	Hmax	Hmax	m	Maximum zero crossing wave height (Hmax)	
VTZM	T(Hmax)	Thmax	Thmax	s	Period of the highest wave (Thmax)	
VH110	H(1/10)	H1d10	H1d10	m	Average height highest 1/10 wave (H1/10)	
VT110	T(H(1/10))			s	Average period highest 1/10 wave (T1/10)	
VAVH	H(1/3)	H1d3	H1d3	m	Average height highest 1/3 wave (H1/3)	
VAVT	T(H(1/3))	TH1d3	TH1d3	s	Average period highest 1/3 wave (T1/3)	
VHZA	Hav	GGH	GGH	m	Average zero crossing wave height (Hzm)	
VTZA	Tav	GGT	GGT	s	Average zero crossing wave period (Tz)	
VZNW	NumWave	AG2	AG2	[-]	*Number of waves*	
VTZC	eps			[-]	*Bandwidth parameter zero crossing*	