BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Department M2 Ocean Physics and Climate

BSH Data File Format Description

In Situ Surface Waves

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Revision History

Date	Changed Chapters	Revision Description	Notes
28.02.2022		Original Document Published	
24.03.2022	2.4, 2.5, 3.2, 3.3	Minor notation changes; changed time format and column order for heave und spectrum; updated references	
21.12.2022	2.4, 2.5, 3.2, 3.3	Change of *.dat to *.csv for heave and spectrum	
24.01.2025	Contact, References	Update of contact persons; update of references	

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
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^2s
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 Acronyms

Table 1: Station acronyms and coordinates

ARK	Arkona Becken (Arkona Basin)	54° 53,10900' N	13° 51,60300' E
BUH	Bunker Hill	54° 47,46120' N	08° 15,90660' E
DAR	Darßer Schwelle (Darss Sill)	54° 41,95320' N	12° 42,15600' E
ELB	Elbe	53° 59,79720' N	08° 06,78600' E
HEL	Helgoland Sued (Helgoland South)	54° 09,56700' N	07° 52,09140' E
HEO	Helgoland Ost (Helgoland East)	54° 12,03300' N	08° 06,03420' E
LTH	Helgoland Nord (Helgoland North)	54° 13,12002' N	07° 49,15002' E
NB2	Nordseeboje II (North Sea Buoy II)	54° 59,89998' N	06° 21,09000' E
NB3	Nordseeboje III (North Sea Buoy III)	54° 40,96998' N	06° 44,97000' E
WES	Sylt	54° 54,51960' N	08° 13,28760' E
FN1	FINO1	54° 00,86520' N	06° 35,12400' E
FN2	FINO2	55° 00,28980' N	13° 09,51720' E
FN3	FINO3	55° 11,55060' N	07° 09,56520' E
AV0	alpha ventus (1D RADAC)	54° 00,35340' N	06° 36,76800' E
AVF	alpha ventus (DWR)	54° 00,35340' N	06° 36,76800' E
BO1	BARD Offshore 1	54° 21,38700' N	05° 56,02998' E
BUD	Butendiek	55° 01,49700' N	07° 47,14200' E
DBU	Deutsche Bucht	54° 18,17548' N	05° 47.16349' E
NO1	Nordsee One	53° 59,12700' N	06° 50,23260' E
NOO	Nordsee Ost	54° 26,00000' N	07° 41,00000' E
NOR	Nordergründe (Nordergruende)	53° 50,10000' N	08° 10,08333' E

2 File Format DWR (Directional Waverider Buoy)

General information on the measuring system and format specification:

Table 2: DWR format specifics

Name	Waverider buoy Datawell DWR-MKIII
Delimiter	Tab
Fill value	-999.000
Decimal separator	point
Time	yyyyMMddHHmm, UTC

Each parameter has

- a detailed_quality_flag (DQF) consisting of a 16-digit number string and
- a final_quality_flag (FQF) consisting of a 1-digit integer

That means: after the first column with the time stamp (UTC), the triple

<Parameter> <Parameter_DQF> <Parameter_FQF>

always follows. The sequence corresponds to the sequence in the following tables.

Please note: the battery status k is not checked for quality; k_DQF (=0000000000000000) and k_FQF (=0) are only carried along to ensure the regularity of the table.

Please note: The italic marked parameters are not yet included in Copernicus Marine In Situ Tac Data Management Team (2024). The long names, standard names and CMEMS codes assigned to them are therefore suggestions and are only used in the BSH database.

2.1 <STATION>_DWR_*_HIS*.dat

More information about the parameters and their definition is found in Table 8 and Table 9.

Table 3: Spectral parameters in DWR HIS

#	CMEMS / OceanSITES Code	Description	Unit
1	VHM0	Significant wave height	m
2	VTPK	Peak period	s
3	VTM02	Zero-upcrossing period	s
4	VPED	Peak direction	degree
5	VPSP	Peak spread	degree
6	TEMP	Water temperature	degrees_C
7	*k*	Battery status	-
8	*VTM20*	Integral period	s
9	VTM01	Mean period	s
10	*VTM24*	Crest period	s
11	*VTPC*	Calculated peak period	s
12	*VTNU*	Band width parameter	-
13	*VTES*	Bandwidth parameter (spectral)	-
14	*VPQP*	Goda's peakedness parameter	-
15	*VSTS*	Significant steepness	-

2.2 <STATION>_DWR_*_HIW*.dat

More information about the parameters and their definition is found in Table 10.

Table 4: Zero-crossing parameters in DWR HIW

#	CMEMS / OceanSITES Code	Description	Unit
1	VZMX	Height of the highest wave	m
2	VTZM	Period of the highest wave	s
3	VH110	Average height of 10% highest waves	m
4	VT110	Average period of 10% highest waves	s
5	VAVH	Average height of 33% highest waves	m
6	VAVT	Average period of 33% highest waves	s
7	VHZA	Average height of all waves	m
8	VTZA	Average period of all waves	s
9	*VZNW*	Number of waves	-
10	*VTZC*	Bandwidth parameter (zero crossing)	-

2.3 <STATION>_DWR_*_GPS*.dat

The file also contains the status of the GPS file of the DWR buoy. A status of 3 means OK. The status has no DQF or FQF information.

Table 5: GPS parameters in DWR GPS

#	CMEMS / OceanSITES Code	Description	Unit
1	LATITUDE	Latitude of each location	degree_north
2	LONGITUDE	Longitude of each location	degree_east

2.4 <STATION>_DWR_*_heave*.csv

The waverider buoy stores the measurement of the heave in its *.raw file. When exporting this data, the content of the *.raw file is passed on and the information Time, despiked, DQF (detailed quality flag) and FQF (final quality flag) is added. The despiked heave is the output time series of the Spike Test (Test 4) of the automatic data quality control, see BSH (2025)

Format:

Time heave north west status despiked DQF FQF

Time: timestamp yyyy-MM-ddTHH:mm:ss.SSSZ, UTC

heave: water surface displacement (m)

north: north displacement (m)

west: west displacement (m)

status: buoy status

- 0: correct
- 1: transmission error, repaired
- 2: transmission error, not repaired
- 3: all-0 or all-1 vector
- 4: synchronizing
- 5: = 4 + 1
- 6: = 4 + 2
- 7: = 4 + 3

despiked: despiked heave (m)

DQF: detailed quality flag, 16 digits

FQF: final quality flag, 1 digit

2.5 <STATION>_DWR_*_SPECTRUM*.csv & <STATION>_DWR_*_SPEC*.csv

The waverider buoy stores the computed spectral data in the *.spt file. When exporting this data, the header of the *.spt file which contains aggregated data is passed on in <STATION>_DWR_*_SPECTRUM*.csv, and the information DQF (detailed quality flag) and FQF (final quality flag), derived from the quality control of the power density spectrum, are added. The rest of the *.spt file which contains the power density spectrum is passed on in <STATION>_DWR_*_SPEC*.csv, and the information frequency bin width δf (DELTA_FREQUENCY) is added. Where possible, the CMEMS code is used, see Copernicus Marine In Situ Tac Data Management Team (2024).

Format <STATION>_DWR_*_SPECTRUM*.csv:

Time: timestamp yyyy-MM-ddTHH:mm:ss.SSSZ, UTC
tn: transmission index (1 to 8)
VHM0: significant wave height (m)
VTM02: zero-upcrossing period (s)
VEPK: maximum of the power spectrum density S(f) (m^2s)
Tref: reference temperature (degrees_C)
TEMP: Sea surface temperature (degrees_C)
Bat: Battery status (0 = empty to 7 = full)
Av: offset of the vertical accelerometer
Ax: offset of the x-accelerometer
Ay: offset of the y-accelerometer
Ori: buoy orientation (degree)
Incli: magnetic inclination (degree)
DQF: detailed quality flag, 16 digits
FQF: final quality flag, 1 digit

Format <STATION>_DWR_*_SPEC*.csv:

Time: timestamp yyyy-MM-ddTHH:mm:ss.SSSZ, UTC
FREQUENCY: wave frequency (Hz)
DELTA_FREQUENCY: wave frequency bin width (Hz)
VSPEC1D: power spectrum density (m^2s)
THETA1: wave direction (degree)

STHETA1: directional spread (degree)

VSPEC1D / VEPK: relative power spectral density (-)

Skew(f): skewness of the directional distribution (-)

Kurt(f): kurtosis of the directional distribution (-)

DQF: detailed quality flag, 16 digits

FQF: final quality flag, 1 digit

3 File Format RADAC & RADAC SINGLE (Wave Radar)

General information on the measuring system and format specification:

Table 6: RADAC format specifics

Name	Directional Radac / Uni-directional Radac
Delimiter	Tab
Fill value	-999.000
Decimal separator	point
Time	yyyyMMddHHmm, UTC

Each parameter has

- a detailed_quality_flag (DQF) consisting of a 16-digit number string and
- a final_quality_flag (FQF) consisting of a 1-digit integer

That means: after the first column with the time stamp (UTC), the triple

<Parameter> <Parameter_DQF> <Parameter_FQF>

always follows. The sequence corresponds to the sequence in the following tables.

Please note: The italic marked parameters are not yet included in Copernicus Marine In Situ Tac Data Management Team (2024). The long names, standard names and CMEMS codes assigned to them are therefore suggestions and are only used in the BSH database.

3.1 <STATION>_RADAC_*.dat & <STATION>_RADAC_SINGLE*.dat

More information about the parameters and their definition is found in Table 8 to Table 10. Since the 1D wave radar (1D RADAC) does not measure direction information, the corresponding columns in <STATION>_RADAC_SINGLE*.dat are filled with the fill value.

Table 7: Parameters in RADAC and RADAC_SINGLE

#	CMEMS / OceanSITES Code	Description	Unit
1	VHM0	Significant wave height	m
2	VTPK	Peak period	s
3	VTM02	Zero-upcrossing period	s
4	VPED	Peak direction	degree
5	VPSP	Peak spread	degree
6	VZMX	Height of the highest wave	m
7	VTZM	Period of the highest wave	s
8	VH110	Average height of 10% highest waves	m
9	VAVH	Average height of 33% highest waves	m
10	VAVT	Average period of 33% highest waves	s
11	VTZA	Average period of all waves	s
12	VMDR	Average mean direction	degree
13	VHZA	Average height of all waves	m
14	*VZNW*	Number of waves	-
15	*SLEV_H1*	Average height over last 1 minute	m
16	*SLEV_H10*	Average height over last 10 minute	m

3.2 <STATION>_RADAC_*_heave*.csv

The wave radar stores the measurement of the heave in a text file on a daily basis. When exporting this data, the content of the text file is passed on and the information DQF (detailed quality flag) and FQF (final quality flag) is added. In addition, the time stamp is converted from "Time in ms since start of day" to the format "yyyy-MM-ddTHH:mm:ss.SSSZ" (UTC). Since the aggregated sea state parameters are determined every 1-min over a sliding 20-min window, the output of a continuous despiked heave is not possible, in contrast to the waverider buoy.

Format:

Time heave DQF FQF

Time: timestamp yyyy-MM-ddTHH:mm:ss.SSSZ, UTC

heave: water surface displacement (m)

DQF: detailed quality flag, 16 digits

FQF: final quality flag, 1 digit

3.3 <STATION>_RADAC_*_SPEC*.csv

The wave radar stores the computed spectral data (Czz10 =: VSPEC1D) in a text file on a daily basis. When exporting this data, the content of the text file is passed on and the information of the wave frequency, frequency bin width δf (DELTA_FREQUENCY), DQF (detailed quality flag) and FQF (final quality flag) is added. In addition, the time stamp is converted from "Time in ms since start of day" to the format "yyyy-MM-ddTHH:mm:ss.SSSZ" (UTC). Where possible, the CMEMS code is used, see Copernicus Marine In Situ Tac Data Management Team (2024).

Please note, the 51 frequency bins related to Czz10 are:

- bin 1: 0 to 5 mHz
- bin 2: 5 to 15 mHz
- bin 3: 15 to 25 mHz
- …
- bin 51: 495 to 500mHz

In <STATION>_RADAC_*_SPEC*.csv the FREQUENCY is the midpoint of the frequency bins, except for the left (0.00 Hz) and right (0.50 Hz) edges.

Format <STATION>_RADAC_*_SPEC*.csv:

Time: timestamp yyyy-MM-ddTHH:mm:ss.SSSZ, UTC
FREQUENCY: wave frequency (Hz)
DELTA_FREQUENCY: wave frequency bin width (Hz)
VSPEC1D: power spectrum density (m^2s)
THETA1: wave direction (degree)
STHETA1: directional spread (degree)
DQF: detailed quality flag, 16 digits
FQF: final quality flag, 1 digit

References

BSH 2025. Real-Time Data Quality Control In Situ Surface Waves (Version 2.1).

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

Annexe

Table 8: 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 9: 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 10: 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*	