

Supplement of

Hydrography of intertidal environments in Schleswig-Holstein, Germany

Joachim Schönfeld et al.

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Table S1: Height of data logger sensors at Bottsand and Schobüll

Area	Measuring point	Device	No.	Sensor level (m NHN)
Bottsand	terminal ditch	P/T logger	1	-0.06
		P/T logger	3	-0.07
		C/T logger	2	-0.02
		C/T logger	4	-0.02
	shelter hut	EBI-20T	5	ca. 4
		EBI-20T	6	ca. 4
Schobüll	groyne	P/T logger	7	0.69
		P/T logger	10	0.67
		C/T logger	8	0.94
		C/T logger	9	0.94
	old pier	C/T logger	11	1.83
	salt marsh	EBI-20T	12	ca. 3.7

Table S2: Comparison of observed water levels, and manually measured temperatures and salinities with data-logger recorded values at Bottsand lagoon.

Date and time (CET)	Water level observed (m NHN)	Water level recorded (m NHN)	Difference (m NHN)	Temperature measured (°C)	Temperature recorded (°C)	Difference (K)	Salinity measured	Salinity recorded	Difference
7-10-21 10:20	-	-		13.4	14.2	0.8	15.9	15.5	0.5
29-10-21 11:05	0.26	0.26	0.00	9.5	9.4	0.1	15.3	14.1	1.2
16-11-21 12:23	0.12	0.10	0.02	6.8	6.6	0.2	17.5	16.7	0.8
23-1-22 12:14	0.25	0.26	0.01	5.4	4.8	0.6	17.1	18.7	1.6
24-0-22 11:20	-0.01	-0.03	0.02	12.2	11.9	0.3	18.6	19.5	0.9
17-5-22 14:20	0.16	0.11	0.05	20.2	20.0	0.2	14.6	14.5	0.1
19-7-22 11:06	0.24	0.19	0.05	23.7	24.8	1.1	16.1	16.0	0.1
19-8-22 13:08	0.25	0.18	0.07	22.8	22.7	0.1	16.6	16.3	0.3
6-10-22 10:54	0.07	0.01	0.06	14.7	14.3	0.4	13.5	14.1	0.6
2-11-22 14:40	0.06	0.02	0.04	11.0	10.9	0.1	17.3	18.2	0.9
30-11-22 14:05	0.08	0.05	0.03	5.2	5.0	0.2	20.5	19.9	0.6
23-1-23 12:03	0.05	0.04	0.01	2.9	2.6	0.3	18.6	19.1	0.5
11-4-23 15:33	0.02	0.02	0.01	10.7	11.0	0.3	16.2	16.0	0.2
8-5-23 13:52	0.02	0.02	0.00	24.4	24.4	0.0	14.8	14.5	0.3
26-6-23 09:32	0.16	0.17	0.01	24.3	25.0	0.7	16.8	17.0	0.2
25-7-23 09:50	0.14	0.14	0.00	19.5	19.3	0.2	16.5	16.6	0.1
5-9-23 10:58	0.19	0.20	0.01	21.3	20.6	0.7	18.7	18.8	0.1
23-10-23 10:25	0.31	0.26	0.05	9.0	8.9	0.1	18.0	17.8	0.2
28-10-23 10:40	0.29	0.28	0.01	9.6	10.0	0.4	16.5	17.7	1.2
27-1-24 09:53	0.10	0.08	0.02	2.9	3.1	0.2	12.1	11.3	0.8
17-4-24 14:42	0.17	0.13	0.04	15.5	15.2	0.3	13.2	12.7	0.5
17-6-24 10:17	0.12	0.09	0.03	17.8	18.1	0.3	12.2	12.0	0.2
19-7-24 10:12	0.14	0.12	0.02	22.3	22.6	0.3	17.5	17.3	0.2
18-8-24 14:18	0.26	0.32	0.06	23.3	22.8	0.5	16.1	16.0	0.1
24-9-24 13:23	0.15	0.12	0.03	19.0	19.2	0.2	14.6	14.6	0.0
12-10-24 10:58	0.04	0.00	0.04	10.0	9.6	0.4	14.4	14.5	0.1
Mean values:			0.03			0.3			0.5

Table S3: Calibration of the WTW LF320 conductimeter (Serial No. 64220119) with a TetraCon 325 probe (Serial No. 12140481) used in the present study. The salinities of the substandards were measured with an Optimare Precision Salinometer on 20 February 2024 by Michael Schlundt, GEOMAR, Kiel.

Substandard	Salinity (permil)	LF320 reading	Difference
Target-S 43	43.692	44.1	0.41
Target-S 35	34.723	34.9	0.18
Target-S 27	26.969	27.0	0.03
Target-S 20	19.989	20.0	0.01
Target-S 10	9.760	10.0	0.24
Target-S 5	4.906	5.0	0.09
Mean:			0.16

Table S4: Statistical parameters of salinity, temperature and water level measurements from Bottsand. Sens. dev.: mean value of sensor deviation, i.e. difference between the highest and lowest value of parallel measurements with different data loggers.

Period from to (CET)	Parameter	Salinity	Water temperature (°C)	Air temperature (°C)	Water level (m NHN)	Lunar year from to (CET)
1-10-21 00:00 30-9-22 23:40	n	26215	26280	26280	25519	6-10-21 12:05
	Mean	15.3	12.1	11.1	0.14	25-9-22 22:54
	1-sigma	2.1	7.7	7.1	0.16	(Lunations
	Min.	5.4	-0.7	-8.4	-0.08	1222-1234)
	Max.	21.3	30.6	41.7	1.51	
	Sens. dev.	1.2	1.3	0.1	0.03	
22-10-22 00:00 21-10-23 23:40	n	25427	26280	26280	25510	25-10-22 11:48
	Mean	16.9	12.4	11.2	0.13	14-10-23 18:55
	1-sigma	1.9	7.7	7.3	0.15	(Lunations
	Min.	7.5	-0.2	-9.9	-0.05	1235-1247)
	Max.	22.3	31.1	33.7	1.26	
	Sens. dev.	0.7	0.5	0.1	0.02	
9-10-23 00:00 8-10-24 23:40	n	26352	26352	26352	25491	14-10-23 18:55
	Mean	14.7	12.6	11.3	0.19	2-10-24 19:50
	1-sigma	2.3	7.5	6.9	0.21	(Lunations
	Min.	8.1	0.00	-7.8	-0.09	1247-1259)
	Max.	20.4	31.8	33.6	1.67	
	Sens. dev.	0.7	0.6	0.2	0.04	

Table S5: Statistical parameters of salinity, temperature and water level measurements from Schobüll. MP: measuring point, Sens. dev.: mean value of sensor deviation, i.e. difference between the highest and lowest value of parallel measurements with different data loggers, *data obtained from the private weather station Schobüll (<https://www.schobuell-wetter.de/monats-jahresdaten-02.php#a4232>, last access: 12 March 2025).

Period from to (CET)	Parameter	High water salinity, MP groyne	High water temperature, MP groyne (°C)	High water salinity, MP old pier	High water temperature, MP old pier (°C)	Daily mean air tempera- ture at Schobüll* (°C)	High water level (m NHN)	Lunar year from to (CET)
1-10-21 00:00 30-9-22 23:40	n	692	702	244	244	365	682	6-10-21 12:05
	Mean	26.4	10.8	23.6	11.0	9.9	1.78	25-9-22 22:54
	1-sigma	3.4	6.7	4.0	6.7	5.9	0.47	(Lunations
	Min.	6.5	-2.6	6.1	-0.1	-6.1	0.76	1222-1234)
	Max.	34.2	26.2	31.1	29.7	24.1	5.18	
	Sens. dev.	0.9	0.4				0.05	
	Mean neap						1.53	
	Mean spring						1.98	
22-10-22 00:00 21-10-23 23:40	n	686	687	244	244	363	679	25-10-22 11:48
	Mean	27.2	11.4	25.3	11.6	10.1	1.80	14-10-23 18:55
	1-sigma	3.1	6.8	4.1	7.0	6.3	0.4	(Lunations
	Min.	12.9	-1.3	6.8	-0.3	-5.6	0.80	1235-1247)
	Max.	33.6	32.5	33.5	29.4	23.0	3.62	
	Sens. dev.	0.6	0.3				0.08	
	Mean neap						1.58	
	Mean spring						1.94	
9-10-23 00:00 8-10-24 23:40	n	689	688	306	306	366	679	14-10-23 18:55
	Mean	24.0	11.3	21.2	10.7	10.2	1.86	2-10-24 19:50
	1-sigma	3.5	6.5	4.6	6.9	6.2	0.46	(Lunations
	Min.	6.1	-2.0	4.8	-0.4	-10.2	0.69	1247-1259)
	Max.	30.8	26.9	31.5	29.2	22.6	4.15	
	Sens. dev.	0.8	0.6				0.03	
	Mean neap						1.68	
	Mean spring						2.00	

Table S6: Inundation frequencies at Bottsand and Schobüll during the the observation period. The cumulative salt marsh submergence times are given in percent of the respective lunar year. Dates and times of the lunar years are given in Table S5.

Bottsand				Schobüll			
Level (m NHN)	Lunar year 2021/2022 Submerg. time (%)	2022/2023 Submerg. time (%)	2023/2024 Submerg. time (%)	Level (m NHN)	Lunar year 2021/2022 Submerg. time (%)	2022/2023 Submerg. time (%)	2023/2024 Submerg. time (%)
-0.10	100.0	100.0	100.0	0.70	44.9	41.1	43.0
-0.05	99.7	99.9	96.4	0.80	40.4	39.9	42.6
0.00	88.2	81.3	87.2	0.90	37.3	36.4	40.7
0.04	72.0	66.4	74.8	1.00	34.1	33.2	38.1
0.05	67.5	59.5	72.2	1.03	33.1	32.3	37.2
0.10	48.2	45.9	60.6	1.10	31.1	30.3	34.7
0.15	31.1	33.9	49.1	1.20	27.5	27.2	31.1
0.20	20.9	23.7	38.3	1.30	23.9	24.0	27.7
0.25	15.2	15.9	28.5	1.40	20.1	20.6	24.3
0.30	11.4	10.5	20.4	1.50	16.7	17.0	20.9
0.32	10.2	8.9	17.9	1.60	13.1	13.5	17.3
0.35	8.6	7.0	14.6	1.70	10.1	10.3	14.0
0.40	6.4	4.9	10.8	1.80	7.7	7.5	10.9
0.45	5.1	3.7	8.1	1.90	5.8	5.5	8.3
0.50	4.2	3.0	6.3	2.00	4.3	4.0	6.1
0.55	3.2	2.7	4.8	2.10	3.3	3.1	4.6
0.60	2.5	2.1	3.9	2.20	2.7	2.2	3.5
0.65	2.1	1.5	3.3	2.30	2.1	1.5	2.6
0.70	1.6	1.1	2.8	2.40	1.7	1.1	1.9
0.75	1.3	0.8	2.4	2.50	1.3	0.8	1.4
0.80	1.0	0.6	2.0	2.70	0.8	0.3	0.8
0.85	0.7	0.4	1.7	2.80	0.7	0.2	0.6
0.90	0.6	0.4	1.4	2.90	0.6	0.1	0.4
0.95	0.5	0.3	1.3	3.00	0.5	0.05	0.3
1.00	0.4	0.2	1.1	3.10	0.4	0.03	0.2
1.05	0.3	0.1	1.0	3.20	0.3		0.2
1.10	0.2	0.1	0.8	3.30	0.2		0.13
1.15	0.1	0.1	0.6	3.40	0.14		0.11
1.20	0.1		0.5	3.50	0.12		0.08
1.25	0.1		0.4	3.60	0.11		0.07
1.30	0.1		0.4	3.70	0.09		0.07
1.35	0.1		0.3	3.80	0.07		0.04
1.40			0.3	3.90	0.05		0.02
1.45			0.2	4.00	0.05		0.02
1.50			0.2	4.20	0.04		
1.55			0.2	4.40	0.04		
1.60			0.2	4.60	0.03		
1.65			0.1	4.80	0.02		
1.70				5.00	0.02		

Table S7: Temperature and salinity measurements from 2021 to 2024 taken in the surface water at Boknis Eck time series station (Hepach et al., 2024; this study) and at Bottsand lagoon (this study) compared.

Sampling date Boknis Eck	Salinity	Temperature (°C)	Daily mean salinity Bottsand	Daily mean temperature Bottsand (°C)	Salinity difference (Boknis Eck- Bottsand)	Temperature difference (Boknis Eck- Bottsand, K)
6-10-21	17.21	14.68	15.1	13.6	2.12	1.08
3-11-21	20.84	11.72	15.3	8.7	5.50	3.02
2-2-22	19.69	4.61	16.5	3.3	3.14	1.32
2-3-22	21.04	4.30	20.2	4.1	0.88	0.22
12-4-22	13.45	5.61	11.3	8.4	2.12	-2.74
3-5-22	13.94	10.15	14.0	16.9	-0.04	-6.75
12-7-22	13.94	18.31	14.8	22.2	-0.89	-3.91
30-8-22	13.18	19.99	16.3	19.4	-3.13	0.58
28-9-22	13.71	15.40	12.0	12.2	1.70	3.18
11-10-22	17.53	14.43	13.9	12.4	3.66	2.00
9-11-22	22.07	12.64	18.7	10.6	3.33	1.99
8-12-22	14.96	6.03	19.8	1.1	-4.89	4.89
26-1-23	21.35	4.77	17.3	1.0	4.06	3.75
9-2-23	21.20	4.04	14.8	2.4	6.40	1.65
15-2-23	21.03	4.31	16.2	3.5	4.87	0.77
20-3-23	20.35	4.30	17.7	8.6	2.69	-4.26
18-4-23	12.07	7.91	17.3	11.2	-5.27	-3.30
16-5-23	13.79	12.59	15.2	14.9	-1.42	-2.33
7-6-23	13.80	16.06	16.8	22.7	-3.04	-6.65
25-7-23	18.81	16.31	16.9	20.5	1.93	-4.14
30-8-23	17.49	18.34	18.6	19.8	-1.11	-1.45
7-11-23	20.42	11.61	15.0	9.0	5.41	2.65
6-12-23	18.66	5.87	15.6	0.7	3.09	5.13
18-1-24	18.629	3.264	12.0	0.6	6.65	2.65
7-2-24	18.775	4.054	13.5	4.9	5.28	-0.83
6-3-24	18.519	4.633	17.9	5.3	0.61	-0.64
4-4-24	13.724	6.398	11.6	10.1	2.12	-3.69
22-5-24	13.531	14.038	15.3	18.2	-1.79	-4.13
4-6-24	11.895	17.217	13.0	17.6	-1.07	-0.36
2-7-24	14.142	17.818	14.5	18.1	-0.41	-0.31
24-9-24	14.35	17.657	14.6	18.2	-0.21	-0.59

Table S8: Temperature and salinity measurements from 1964 to 1967 at Bottsand lagoon (Lutze, 1968, there Fig. 19; digitised) and in the surface water at Boknis Eck (Bange et al., 2011) compared.

Sampling date Bottsand	Water temperature (°C)	Salinity, Station 381	Sampling date Boknis Eck	Temperature (°C)	Salinity	Time lag (d)	Salinity difference (Boknis Eck- Bottsand)	Temperature difference (Boknis Eck- Bottsand, K)
6-12-64	2.4	17.0	15-12-64	6.4	20.8	9	3.8	4.0
3-1-65	2.3							
16-1-65		15.8	19-1-65	3.9	20.0	3	4.2	
17-2-65	2.4	14.8	17-2-65	1.5	16.2	0	1.4	-0.9
17-3-65	1.0	13.0	16-3-65	1.1	16.4	1	3.4	0.1
24-4-65	7.5	14.6	24-4-65	6.2	13.3	0	-1.3	-1.3
16-5-65	19.0	13.6	11-5-65	7.4	12.2	5	-1.4	-11.6
10-6-65	27.0	12.3	15-6-65	15.5	13.1	5	0.8	-11.5
17-7-65	18.0	15.7	21-7-65	15.9	18.6	4	2.9	-2.1
10-8-65	19.6	16.0	24-8-65	16.7	17.2	14	1.2	-2.9
12-9-65	13.4	15.6	7-9-65	14.9	17.0	5	1.4	1.5
15-10-65	15.8	16.1	5-10-65	14.0		10		-1.8
11-11-65	6.7	15.0	2-11-65	12.0	18.9	9	3.9	5.3
2-12-65	2.0	17.7	7-12-65	4.5	19.0	5	1.3	2.5
6-4-66	5.1	14.2	5-4-66	3.4	20.2	1	6.0	-1.7
8-5-66	11.6	14.2	10-5-66	8.1	14.7	2	0.5	-3.5
4-6-66	24.4	15.0						
24-6-66		14.6	23-6-66	17.4	14.5	1	-0.1	
1-8-66	20.4	13.1	2-8-66	13.3	19.7	1	6.6	-7.1
21-8-66	24.0	16.7						
11-9-66	16.0	15.9	5-9-66	16.1	16.3	6	0.4	0.1
17-10-66	12.9	18.3	31-10-66	9.7	14.0	14	-4.3	-3.2
18-11-66	2.0	14.3	6-12-66	6.6	16.9	18	2.6	4.6
5-1-67	-0.9	11.8	10-1-67	2.5	17.7	5	5.9	3.4
25-5-67		14.2	5-6-67		14.2	11	0.0	

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