

Leibniz Institute for Baltic Sea Research Warnemünde

Cruise Report

r/v "Elisabeth Mann Borgese"

Cruise - No. EMB140

Engineering Trial
19 – 29 September 2016
Skagerrak to Kiel Bight

This report is based on preliminary data

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1. **Cruise No.:** EMB140
2. **Dates of the cruise:** 19. – 29. September 2016
3. **Particulars of the research vessel:**
Name: Elisabeth Mann Borgese
Nationality: Germany
Operating Authority: Baltic Sea Research Institute (BSRI) Warnemünde
4. **Geographical area in which ship has operated:**
Skagerrak to Kiel Bight
5. **Dates and names of ports of call**
./.
6. **Purpose of the cruise**

Engineering trial – test of oceanic equipment:

The objective of this engineering trial with RV ELISABETH MANN BORGESE was to test a new 75 kHz ADCP in water depths of about 500 m and to perform a drift experiment based on three Directional Waverider MKIII Buoys, three Miniature Wave Buoys and three floating wave ellipsoids.

Both, the ADCP test as well as the drift experiment were carried out within the Skagerrak (area A, as indicated below). The ADCP investigations were conducted on defined ship tracks orientated from south to north and from east to west or vice versa. Due to the bin size of the ship mounted ADCP a water depth of about 500 m was required. In order to study environmental impacts on ADCP measurements the runs were carried out by different ship velocities. Corresponding tests started on September 21st, 11:05 UTC, with the 75 kHz ADCP near point A11 at 58°19.91' N / 010°03.57' E and ended on September 23rd, 06:03 UTC, near point A16 at 58°17.36' N / 009°53.99' E.

In parallel to the ADCP study three Directional Waverider MKIII Buoys, three Miniature Wave Buoys and three floating wave ellipsoids were deployed by RV ELISABETH MANN BORGESE to study their drift characteristics within area A. The drift experiment started on September 22nd at 05:55 UTC near point A13 at 58°16.98' N / 009°55.97' E and ended on September 23rd at 58°17.83' N / 009°59.17' E at 08:21 UTC.

The whole experiment in area A ended on September 23rd at 58°17.83' N / 009°59.06' E at 08:25 UTC.

In addition to the above mentioned measurements the following activities were carried out:

- CTD measurements to obtain temperature, salinity and sound velocity profiles by an OTS 43 probe and an underway CTD
- Attenuation measurements by a WETLabs AC 9 Plus system and Secchi disks to study water clarity and its local variability

7. **Crew:**

Name of master: U. Scholz
Number of crew: ./.

8. **Research staff:**

Chief scientist: Dr. J. Förster, AFM 130

Scientists: ./.

Engineers: Benecke, Jens, AF 130
Ehlers, Malte, AF 130
Lühder, Ralf, GF 410
Fürl, Daniel, GF 310

Technicians: ./.

9. **Co-operating institutions:** ./.

10. **Scientific equipment**

CTD ProbeOTS 43, WETLabs AC 9 Plus and Secchi disks, three Directional Waverider MKIII Bouys, three Miniature Wave Bouys, three floating wave ellipsoids, 75 kHz ADCP RDI Ocean Surveyor, Vaisala WXT 520 weather probe

11. **General remarks and preliminary result** (ca. 2 pages)

Appendix: map and list of stations



Fig. 1 Experimental area A

The experiment area A in the Skagerrak was characterized by four corner coordinates:

Table 1: Corner coordinates of area A

Position	Latitude	Longitude
A01	58°20.0'N	009°50.0'E
A02	58°20.0'N	010°19.0'E
A03	58°03.0'N	010°10.0'E
A04	58°03.0'N	009°50.0'E

Due area restrictions only the Norwegian area within area A was allowed to be used for the experiment (dark red area):

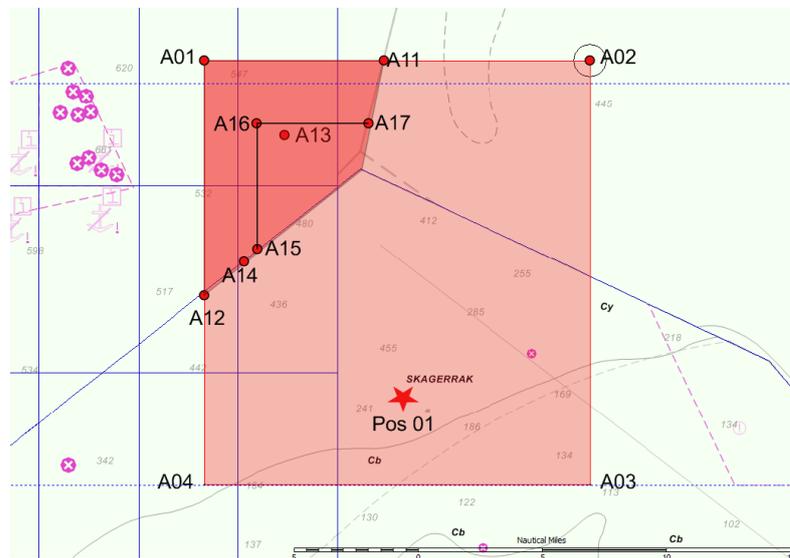


Fig. 2 Relevant points (coordinates) within the restricted experimental area A

Relevant coordinates within the experimental area A as shown in Fig. 2 are given in Table 2:

Table 2: Relevant coordinates within area A

Position	Latitude	Longitude
A11	58°20.0'N	010°03.5'E
A12	58°10.5'N	009°50.0'E
A13	58°17.0'N	009°56.0'E
A14	58°12.0'N	009°53.0'E
A15	58°12.5'N	009°54.0'E
A16	58°17.5'N	009°54.0'E
A17	58°17.5'N	010°02.4'E

Sensor systems used during the trial:

1. ADCP RDI Ocean Surveyor 75 kHz:



Fig. 3 ADCP RDI Ocean Surveyor 75 kHz before integration (left) and during integration (right) onboard EMB

2. Waverider Buoys, wave ellipsoids and Miniature Wave Buoys:

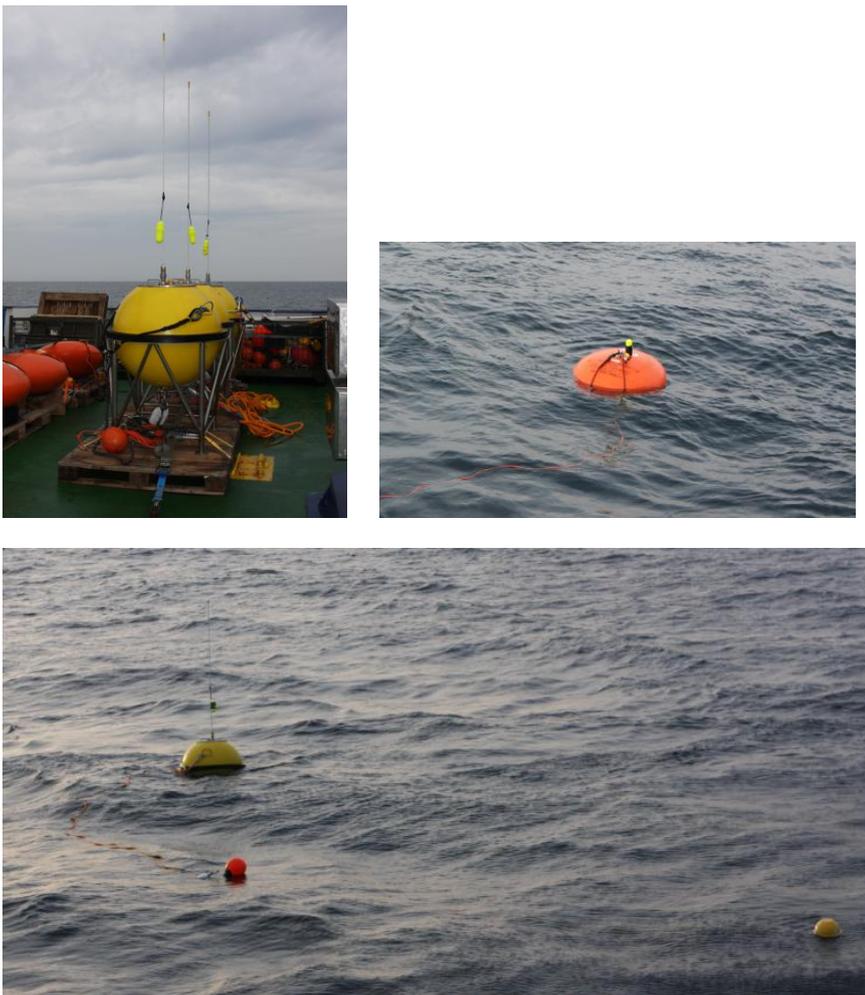


Fig. 4 Three Waverider Buoys MKIII and three floating wave ellipsoids onboard EMB (upper left), a wave ellipsoid (upper right) and a Waverider Buoy MKIII together with a Miniature Wave Buoy during operation (lower).

3. CTD probe OTS 43:



Fig. 5 CTD probe OTS 43 during deployment procedure.

4. UCTD (Underway CTD probe):

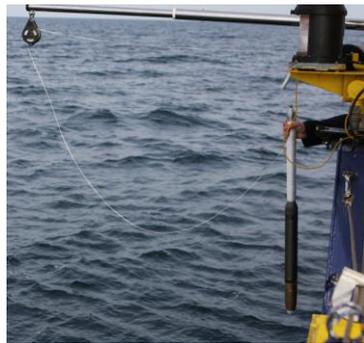


Fig. 6 UCTD onboard EMB during deployment procedure

5. WETLabs and Secchi-Disk:

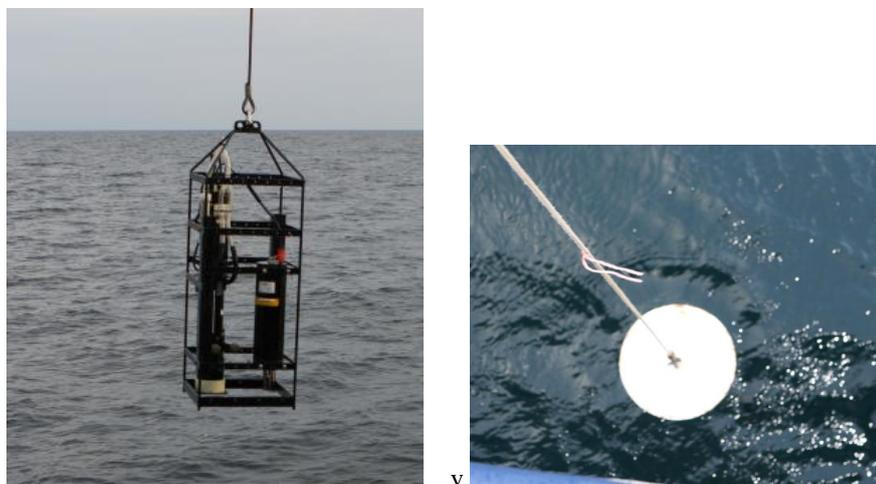


Fig. 7 Autonomously operating attenuation probe WETLabs AC9 plus and Secchi-Disk

Diary

2016-09-20 (Tu)

Transit EMB Kiel Bight → Skagerrak Area A
Testing Waverider bouys
Starting measurements with ADCPs 150 kHz (EMB) and 75 kHz (WTD71)

2016-09-21 (We)

EMB Transit → Skagerrak Area A

- Arrival test area A
- Arrival at Pos. A11
- CTD measurement CTD001 at Pos. A11
- ADCP run start at Pos. A11 to Pos. A01 (E → W) by v=5 kn, broad band
- UCTD measurements 001-003
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A11 (W → E) by v=5 kn, broad band
- Arrival at Pos. A11
- ADCP run start at Pos. A11 to Pos. A01 (E → W) by v=10 kn, broad band
- UCTD measurements 004
- Arrival at Pos. A01
- CTD measurement CTD002 at Pos. A01
- ADCP run start at Pos. A01 to Pos. A12 (N → S) by v=5 kn, broad band
- Arrival at Pos. A12
- ADCP run start at Pos. A12 to Pos. A01 (S → N) by v=5 kn, broad band
- Stop ADCP measurements broad band
- Start ADCP measurements narrow band
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A11 (W → E) by v=10 kn, narrow band
- Arrival at Pos. A11
- ADCP run start at Pos. A11 to Pos. A01 (E → W) by v=10 kn, narrow band
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A12 (N → S) by v=10 kn, narrow band
- Arrival at Pos. A12
- ADCP run start at Pos. A12 to Pos. A01 (S → N) by v=10 kn, narrow band
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A11 (W → E) by v=8 kn, narrow band

2016-09-22 (Th)

- Arrival at Pos. A11
- ADCP run start at Pos. A11 to Pos. A01 (E → W) by v=8 kn, narrow band
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A12 (N → S) by v=8 kn, narrow band
- Arrival at Pos. A12
- ADCP run start at Pos. A12 to Pos. A01 (S → N) by v=8 kn, narrow band
- Arrival at Pos. A01
- ADCP run start at Pos. A01 to Pos. A12 (N → S) by v=10 kn, narrow band
- Arrival at Pos. A12
- End ADCP-measurements narrow band
- CTD measurement CTD003 at Pos. A12
- Sailing to Pos. A13
- Deployment of Waverider Buoy 02 with Miniature Wave Buoy
- Deployment of drift ellipsoid 01

- WETLabs, Secchi Station W001_A13, S001_A13
- ADCP 150 kHz bottom track test
- UCTD measurements 005
- ADCP 150 kHz bottom track test A01 (W←→E)
- Recovery of Waverider Buoy 02 with Miniature Wave Buoy
- Recovery of drift ellipsoid 01
- Sailing to Pos. A14
- CTD measurement CTD004 at Pos. A14
- Deployment of Waverider Buoy 02 with Miniature Wave Buoy WB404 near Pos. A14
- Deployment of Waverider Buoy 03 with Miniature Wave Buoy WB403 near Pos. A14
- Deployment of Waverider Buoy 01 with Miniature Wave Buoy WB402 near Pos. A14
- Sailing to Pos. A16
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A15 (N → S) by v=5 kn, broad band, bottom track
- Arrival at Pos. A15
- ADCP run start at Pos. A15 to Pos. A16 (S → N) by v=5 kn, broad band, bottom track
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A17 (W → E) by v=5 kn, broad band, bottom track
- Arrival at Pos. A17
- ADCP run start at Pos. A17 to Pos. A16 (E → W) by v=5 kn, broad band, bottom track
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A15 (N → S) by v=10 kn, broad band, bottom track
- Arrival at Pos. A15
- ADCP run start at Pos. A15 to Pos. A16 (S → N) by v=10 kn, broad band, bottom track

2016-09-23 (Fr)

- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A17 (W → E) by v=10 kn, broad band, bottom track
- Arrival at Pos. A17
- ADCP run start at Pos. A17 to Pos. A16 (E → W) by v=10 kn, broad band, bottom track
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A15 (N → S) by v=8 kn, broad band, bottom track
- Arrival at Pos. A15
- ADCP run start at Pos. A15 to Pos. A16 (S → N) by v=8 kn, broad band, bottom track
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A17 (W → E) by v=8 kn, broad band, bottom track
- Arrival at Pos. A17
- ADCP run start at Pos. A17 to Pos. A16 (E → W) by v=8 kn, broad band, bottom track
- Arrival at Pos. A16
- ADCP run start at Pos. A16 to Pos. A15 (N → S) by v=4 kn, broad band, bottom track
- Arrival at Pos. A15
- ADCP run start at Pos. A15 to Pos. A16 (S → N) by v=4 kn, broad band, bottom track
- Arrival at Pos. A16
- Stop ADCP measurements
- CTD measurement CTD005 at Pos. A16
- WETLabs, Secchi Station W002_A16, S002_A16
- Recovery of Waverider Buoy 03 with Miniature Wave Buoy WB403
- Recovery of Waverider Buoy 01 with Miniature Wave Buoy WB402
- Recovery of Waverider Buoy 02 with Miniature Wave Buoy WB404
- End of the engineering trial in Skagerrak area A
- Transit EMB → Kiel Bight

2016-09-23 (Fr)

- Transit EMB → Kiel Bight → Kiel MArS Arsenal Kiel Birthplace MC
- End of engineering trial EMB 140 (Skagerrak part)

Table 3: Activities in Area A – 19.09. - 21.09.2016

Date / Time	Protocol text	Latitude	Longitude	Category
19.09.2016 07:30	EMB arrival in Kiel - Loading, installing and testing of scientific equipment	54°29.1026N	009°57.7415E	General
20.09.2016 05:56	Start Transit EMB MARS Kiel --> Skagerrak	54°19.5800N	010°09.9277E	General
20.09.2016 18:02	ADCP 75kHz Start: WTD75kHzBB_ET2016_001, Binsize:8m, Bins:10, Broadband	56°03.2694N	011°06.6380E	ADCP
20.09.2016 18:10	ADCP 150kHz Start: EMB150kHzBB_ET2016_001, Binsize:8m, Bins:10, Broadband	56°04.5998N	011°07.6443E	ADCP
21.09.2016 05:37	ADCP 75kHz Stop: WTD75kHzBB_ET2016_001, Binsize:8m, Bins:10, Broadband	57°49.5757N	010°45.3473E	ADCP
21.09.2016 05:39	ADCP 150kHz Stop: EMB150kHzBB_ET2016_001, Binsize:8m, Bins:10, Broadband	57°49.9318N	010°45.0630E	ADCP
21.09.2016 05:46	ADCP 75kHz Start: WTD75kHzBB_ET2016_002, Binsize:8m, Bins:65, Broadband	57°51.1922N	010°44.0245E	ADCP
21.09.2016 05:47	ADCP 150kHz Start: EMB150kHzBB_ET2016_002, Binsize:8m, Bins:65, Broadband	57°51.3055N	010°43.9194E	ADCP
21.09.2016 06:40	ADCP 150kHz Stop: EMB150kHzBB_ET2016_002, Binsize:8m, Bins:65, Broadband	58°00.1225N	010°35.7590E	ADCP
21.09.2016 06:54	ADCP 75kHz Stop: WTD75kHzBB_ET2016_002, Binsize:8m, Bins:65, Broadband	58°02.6016N	010°33.8590E	ADCP
21.09.2016 07:27	ADCP 75kHz Start: WTD75kHzBB_ET2016_003, Binsize:8m, Bins:65, Broadband	58°08.3729N	010°29.6790E	ADCP
21.09.2016 07:27	ADCP 150kHz Start: EMB150kHzBB_ET2016_003, Binsize:8m, Bins:65, Broadband	58°08.3813N	010°29.6718E	ADCP
21.09.2016 10:17	Arrival Station A11, preparation CTD-Station CTD001_A11 by OTS43	58°20.0150N	010°03.5800E	CTD
21.09.2016 10:28	CTD-Station CTD001_A11 Start, File: O2109001.raw	58°20.0350N	010°03.4111E	CTD
21.09.2016 10:46	CTD-Station CTD001_A11 Stop, measurement depth: 435m, thermocline in 25m, salinity: 28-35psu, temperature: 7-17°C	58°20.0010N	010°03.5532E	CTD
21.09.2016 11:03	CTD Station CTD001_A11 End	58°19.9140N	010°03.5738E	CTD
21.09.2016 11:05	continue zonal ADCP track in west direction towards A01 v = 5kn	58°19.9145N	010°03.5725E	ADCP
21.09.2016 11:20	UCTD Test 001 Start	58°20.0000N	010°01.4091E	UCTD
21.09.2016 11:24	UCTD Test 001 End	58°20.0018N	010°00.6564E	UCTD
21.09.2016 12:06	UCTD Test 002 Start	58°19.9984N	009°54.0911E	UCTD
21.09.2016 12:12	UCTD Test 002 End	58°19.9987N	009°53.0470E	UCTD
21.09.2016 12:26	UCTD Test 003 End	58°19.9993N	009°50.7490E	UCTD
21.09.2016 12:29	Arrival A01, 180° turn in opposite direction 5 kn towards east to A11	58°19.9998N	009°50.1577E	ADCP
21.09.2016 14:01	Arrival A11, 180° turn in opposite direction 10 kn towards west to A01	58°20.0012N	010°03.6410E	ADCP
21.09.2016 14:11	UCTD Test 004 Start	58°19.9984N	010°01.6575E	UCTD
21.09.2016 14:20	UCTD Test 004 End	58°20.0000N	009°58.8437E	UCTD
21.09.2016 14:48	Arrival A01, stop ship, preparation CTD-Station CTD002_A01 by OTS43	58°19.9961N	009°49.9857E	ADCP
21.09.2016 15:00	CTD-Station CTD002_A01 Start, File: O2109002.raw	58°20.1407N	009°49.8592E	CTD
21.09.2016 15:17	CTD-Station CTD002_A01 Stop, measurement depth: 434m, thermocline in 25m, salinity: 28-35psu, temperature: 7-17°C	58°20.1147N	009°49.8553E	CTD
21.09.2016 15:31	CTD Station CTD002_A01 End	58°20.0985N	009°49.9237E	CTD
21.09.2016 15:34	Start meridional track at A01 in southern direction (180°) v = 5kn towards A12	58°20.0690N	009°49.9356E	ADCP
21.09.2016 16:23	Position lost bottom track ADCP150kHz	58°16.0020N	009°50.0022E	ADCP
21.09.2016 17:29	End of meridional ADCP track in southern direction (180°) v = 5kn towards A12	58°10.5088N	009°50.0040E	ADCP
21.09.2016 17:37	Start meridional track at A12 in northern direction (0°) v = 5kn towards A01	58°10.4822N	009°50.0144E	ADCP
21.09.2016 19:24	End ADCP measurements in broadband mode	58°19.2777N	009°49.9993E	ADCP
21.09.2016 19:32	Start ADCP measurements in narrowband mode	58°19.9655N	009°49.9876E	ADCP
21.09.2016 19:36	End of meridional track at A01 in northern direction (0°) v = 5kn	58°20.0349N	009°49.7778E	ADCP
21.09.2016 19:42	Start zonal track at A01 in eastern direction (90°) v = 10kn towards A11	58°20.0070N	009°49.8815E	ADCP
21.09.2016 20:27	Arrival A11 turn in opposite direction 10 kn towards west to A01	58°19.9539N	010°03.7591E	ADCP
21.09.2016 21:15	Arrival A01, 90° turn in southern direction (180°) v = 10 kn towards A12	58°19.7094N	009°49.9576E	ADCP
21.09.2016 22:10	Arrival A12, turn to northern direction, meridional track at A12 in northern direction (0°) v = 10 kn towards A01	58°10.5686N	009°50.0497E	ADCP
21.09.2016 23:08	Arrival A01, turn to eastern direction, zonal track at A01 in eastern direction (90°) v = 8kn towards A11	58°19.7906N	009°49.9874E	ADCP

Table 3: Activities in Area A – 22.09.2016

Date / Time	Protocol text	Latitude	Longitude	Category
22.09.2016 00:03	Arrival A11, turn to western direction, zonal track at A11 in western direction (270°) v = 8kn towards A01	58°19.9399N	010°03.9132E	ADCP
22.09.2016 00:58	Arrival A01, turn to southern direction, meridional track at A01 in southern direction (180°) v = 8kn towards A12	58°19.9934N	009°50.3262E	ADCP
22.09.2016 02:11	Arrival A12, turn to northern direction, meridional track at A12 in northern direction (0°) v = 8kn towards A01	58°10.5137N	009°50.1300E	ADCP
22.09.2016 03:27	Arrival A01, turn to southern direction, meridional track at A01 in southern direction (180°) v = 10kn towards A12	58°20.1119N	009°50.0973E	ADCP
22.09.2016 04:30	Arrival A12, preparation CTD-Station CTD003_A12, ADCP-File WTD75kHzNB_ET2016_001 und EMB150kHzNB_ET2016_001 Narrowband mode	58°10.6490N	009°50.0036E	ADCP
22.09.2016 04:34	CTD-Station CTD003_A12 Start, File: O2209001.raw	58°10.5725N	009°49.9957E	CTD
22.09.2016 04:50	CTD-Station CTD003_A12 Stop, measurement depth: 437m, thermocline in 25m, salinity: 30-35psu, temperature: 7-17°C	58°10.5074N	009°50.0608E	ADCP
22.09.2016 05:05	CTD Station CTD003_A12 End, sailing to A13	58°10.5003N	009°50.0882E	ADCP
22.09.2016 05:47	End ADCP recording, ADCP-File WTD75kHzNB_ET2016_001 and EMB150kHzNB_ET2016_001 Narrowband mode	58°16.1370N	009°55.1845E	ADCP
22.09.2016 05:49	Start ADCP recording, ADCP-File WTD75kHzBB_ET2016_005 und EMB150kHzBB_ET2016_005 Broadband mode	58°16.4969N	009°55.5303E	ADCP
22.09.2016 05:55	Arrival A13, preparation of Waverider Buoys and Ellipsoids for deployment	58°16.9769N	009°55.9663E	General
22.09.2016 05:58	Deployment Waverider 02 and Miniature-Wave-Buoy	58°16.9974N	009°55.9700E	Waverider MKIII
22.09.2016 06:02	Deployment Ellipsoid 01	58°17.0665N	009°55.9686E	Waverider MKIII
22.09.2016 06:20	Deployment WETLabs W001_A13	58°16.9793N	009°56.1530E	WetLabs
22.09.2016 06:33	WETLabs W001_A13 measurements	58°17.0225N	009°56.0043E	WetLabs
22.09.2016 06:36	Secchi S001_A13 measurements	58°17.0409N	009°55.9853E	Secchi
22.09.2016 07:58	End ADCP recording, ADCP-File WTD75kHzBB_ET2016_005 und EMB150kHzBB_ET2016_005	58°17.8841N	009°55.9197E	ADCP
22.09.2016 08:03	Bottom track-Tests ADCP 150kHz EMB without recording, EMB sailing along zonal tracks starting at A01 until bottom track signal is present in 150kHz ADCP back and forth	58°17.9612N	009°55.7363E	ADCP
22.09.2016 09:14	UCTD Test 005 Start	58°20.0149N	009°56.3563E	UCTD
22.09.2016 09:22	UCTD Test 005 End	58°20.0050N	009°57.6586E	UCTD
22.09.2016 10:46	Start ADCP recording, File: WTD75kHzBB_ET2016_006 und EMB150kHzBB_ET2016_006, Broadband mode, EMB sailing along zonal tracks starting at A01 until bottom track signal is present in 150kHz ADCP back and forth	58°20.0008N	009°50.8968E	ADCP
22.09.2016 11:16	ADCP result: no current to eastern direction in 30m depths by max. 50cm/s, but miss measurement of the ADCP at the thermocline	58°20.0075N	009°55.8296E	ADCP
22.09.2016 11:43	Alternating east and west courses along zonal track A01-A11	58°20.0611N	009°59.6617E	ADCP
22.09.2016 12:41	End ADCP recording, File: WTD75kHzBB_ET2016_006 und EMB150kHzBB_ET2016_006, Broadband mode, Bottom track test along A01-A11	58°20.0002N	009°50.5510E	ADCP
22.09.2016 12:41	End Bottom track tests along A01-A11	58°20.0003N	009°50.5482E	ADCP
22.09.2016 13:14	Recovery Waverider 02 and Miniature-Wave-Buoy	58°19.7188N	009°56.6762E	Waverider MKIII
22.09.2016 13:31	Recovery Ellipsoid 01	58°20.2439N	009°57.0297E	Waverider MKIII
22.09.2016 13:33	Start ADCP recording, File: WTD75kHzBB_ET2016_007 und EMB150kHzBB_ET2016_007, Broadband mode, EMB sailing to A14 for CTD-CTD004_A14 and deployment of buoys	58°20.2428N	009°57.1530E	ADCP
22.09.2016 14:47	CTD-Station CTD004_A14 Start, File: O2209002.raw	58°12.0193N	009°53.0545E	CTD
22.09.2016 15:04	CTD-Station CTD004_A14 Stop, measurement depth: 437m, thermocline in 25m, salinity: 30-35psu, temperature: 7-17°C	58°11.9908N	009°53.0047E	CTD
22.09.2016 16:33	Deployment Waverider 02 and Miniature-Wave-Buoy WB404	58°12.0206N	009°53.0166E	Waverider MKIII
22.09.2016 16:40	Deployment Waverider 03 and Miniature-Wave-Buoy WB403	58°11.9800N	009°52.9981E	Waverider MKIII
22.09.2016 16:44	Deployment Waverider 01 and Miniature-Wave-Buoy WB402	58°11.9659N	009°53.0597E	Waverider MKIII
22.09.2016 18:07	EMB sailing to Station A16; Start point for meridional and zonal ADCP-tracks between Stations A16, A15 and A17	58°13.4961N	009°53.4944E	ADCP
22.09.2016 18:32	End ADCP recording, File: WTD75kHzBB_ET2016_007 und EMB150kHzBB_ET2016_007, Broadband mode, Bottom track, EMB sailing to A16, then start of zonal and meridional ADCP tracks between A16, A15 and A17	58°16.7030N	009°53.5826E	ADCP
22.09.2016 18:34	Start ADCP recording, File: WTD75kHzBB_ET2016_008 und EMB150kHzBB_ET2016_008, Broadband mode, Bottom track (max.500m), water depths: 551m	58°17.0434N	009°53.5797E	ADCP
22.09.2016 18:41	Arrival A16, turn to southern direction, meridional track at A16 in southern direction (180°) v = 5kn towards A15, Bottom track	58°17.5847N	009°53.8740E	ADCP
22.09.2016 19:47	Arrival A15, turn to northern direction, meridional track at A15 in northern direction (0°) v = 5kn towards A16, Bottom track	58°12.3974N	009°53.8381E	ADCP
22.09.2016 20:53	Arrival A16, turn to eastern direction, zonal track at A16 in eastern direction (90°) v = 5kn towards A17, Bottom track	58°17.5876N	009°53.9698E	ADCP
22.09.2016 22:02	Arrival A17, turn to western direction, zonal track at A17 in western direction (270°) v = 5kn towards A16, Bottom track	58°17.4681N	010°02.4027E	ADCP
22.09.2016 22:55	Arrival A16, turn to southern direction, meridional track at A16 in southern direction (180°) v = 10kn towards A15, Bottom track	58°17.4969N	009°54.2418E	ADCP
22.09.2016 23:27	Arrival A15, turn to northern direction, meridional track at A15 in northern direction (0°) v = 10kn towards A16, Bottom track	58°12.4857N	009°54.0163E	ADCP

Table 3: Activities in Area A – 23.09.2016

Date / Time	Protocol text	Latitude	Longitude	Category
23.09.2016 00:00	Arrival A16, turn to eastern direction, zonal track at A16 in eastern direction (90°) v = 10kn towards A17, Bottom track	58°17.3780N	009°53.9970E	ADCP
23.09.2016 00:28	Arrival A17, turn to western direction, zonal track at A17 in western direction (270°) v = 10kn towards A16, Bottom track	58°17.4714N	010°02.3832E	ADCP
23.09.2016 00:58	Arrival A16, turn to southern direction, meridional track at A16 in southern direction (180°) v = 8kn towards A15, Bottom track	58°17.4928N	009°54.6331E	ADCP
23.09.2016 01:38	Arrival A15, turn to northern direction, meridional track at A15 in northern direction (0°) v = 8kn towards A16, Bottom track	58°12.4544N	009°54.1154E	ADCP
23.09.2016 02:17	Arrival A16, turn to eastern direction, zonal track at A16 in eastern direction (90°) v = 8kn towards A17, Bottom track	58°17.2746N	009°53.9920E	ADCP
23.09.2016 02:53	Arrival A17, turn to western direction, zonal track at A17 in western direction (270°) v = 8kn towards A16, Bottom track	58°17.4630N	010°02.4947E	ADCP
23.09.2016 03:28	Arrival A16, turn to southern direction, meridional track at A16 in southern direction (180°) v = 4kn towards A15, Bottom track	58°17.4975N	009°54.4147E	ADCP
23.09.2016 04:46	Arrival A15, turn to northern direction, meridional track at A15 in northern direction (0°) v = 4kn towards A16, Bottom track	58°12.4810N	009°53.9962E	ADCP
23.09.2016 06:02	End ADCP recording and shut down WTD75kHz-ADCP, File: WTD75kHzBB_ET2016_008	58°17.3594N	009°53.9917E	ADCP
23.09.2016 06:04	Arrival A16, preparation CTD-CTD005_A16	58°17.5022N	009°53.9922E	ADCP
23.09.2016 06:19	CTD-Station CTD005_A16 Start, File: O2309001.raw	58°17.5898N	009°54.1046E	CTD
23.09.2016 06:34	CTD-Station CTD005_A16 Stop, measurement depth: 435m, thermocline in 25m, salinity: 30-35psu, temperature: 7-17°C	58°17.5101N	009°54.0132E	CTD
23.09.2016 06:49	CTD Station CTD005_A16 End, preparation WetLabs W002_A16	58°17.4724N	009°53.9747E	CTD
23.09.2016 06:56	WetLabs W002_A16 measurements	58°17.4457N	009°53.9563E	WetLabs
23.09.2016 06:58	Secchi S002_A16 measurements	58°17.4401N	009°53.9514E	Secchi
23.09.2016 07:27	End ADCP recording EMB150kHz-ADCP, File: EMB150kHzBB_ET2016_008 Broadband mode	58°17.4675N	009°56.9608E	ADCP
23.09.2016 07:27	Start ADCP recording both ADCPs, File: WTD75kHzBB_ET2016_009 und EMB150kHzBB_ET2016_009, Broadband mode, Bottom track (max.500m)	58°17.4715N	009°57.2180E	ADCP
23.09.2016 07:54	Recovery Waverider Buoy 03 and Miniature-Wave-Buoy WB403	58°17.8537N	010°00.1959E	Waverider MKIII
23.09.2016 08:08	Recovery Waverider Buoy 01 and Miniature-Wave-Buoy WB402	58°17.7923N	009°59.6824E	Waverider MKIII
23.09.2016 08:21	Recovery Waverider Buoy 02 and Miniature-Wave-Buoy WB404	58°17.8253N	009°59.1740E	Waverider MKIII
23.09.2016 08:25	End engineering trial Skagerrak - Transit EMB Skagerrak --> Kiel	58°17.8254N	009°59.0574E	General
23.09.2016 12:28	End ADCP recording both ADCPs, File: WTD75kHzBB_ET2016_009 und EMB150kHzBB_ET2016_009, Broadband mode, Bottom track (max.500m)	57°43.9726N	010°50.5422E	ADCP
24.09.2016 10:48	EMB Arrival Kiel MARS // EMB at birth place in Kiel	54°19.6337N	010°09.9842E	General

Weather Report RV EMB

Eng. Test 2016 WXT05 21.09.2016

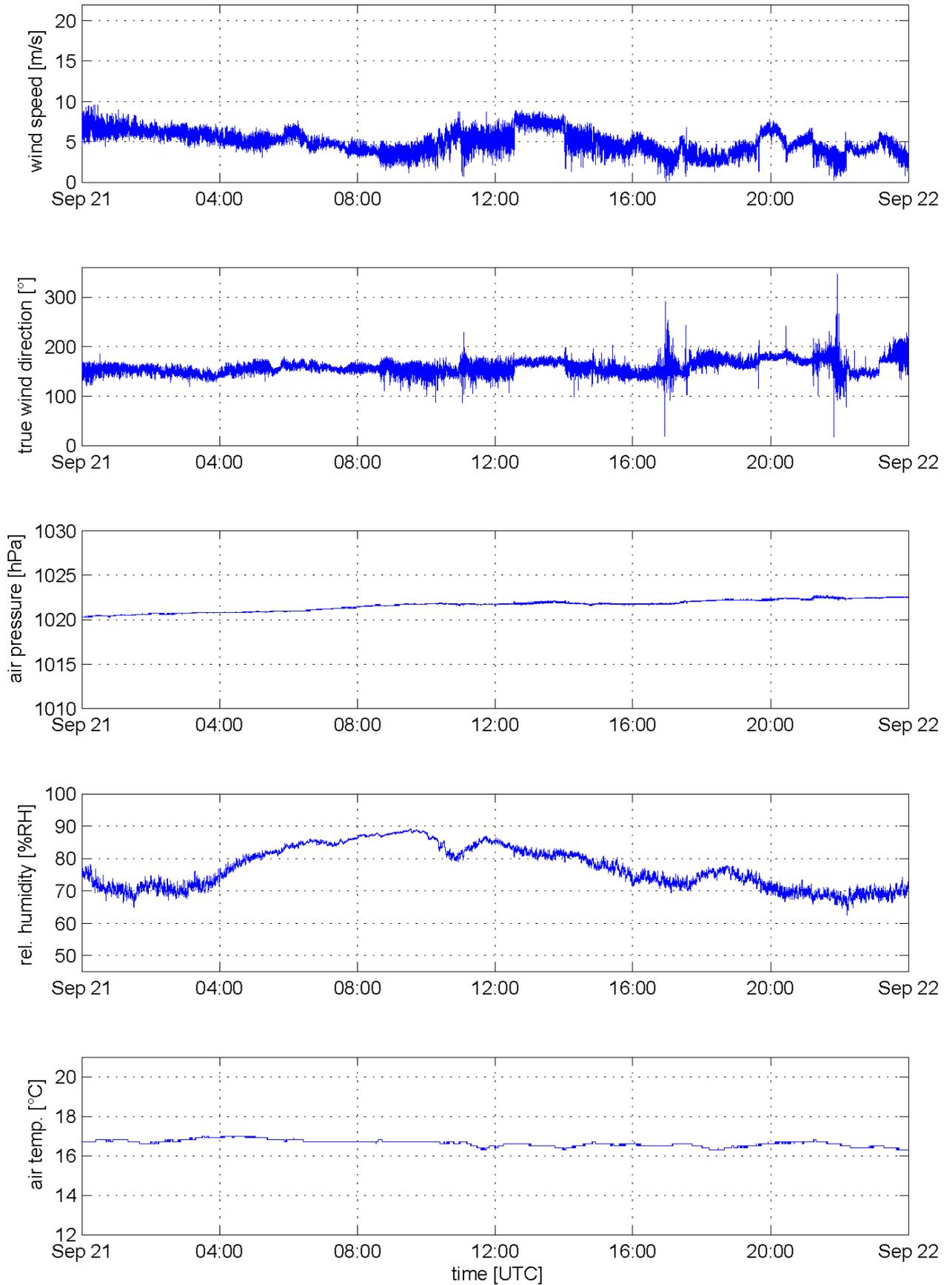


Fig. 9 Meteorological conditions onboard EMB on Sept. 21st 2016. Time series are based on VAISALA WXT520 probe and are related to the following parameter: (a): wind speed, (b): wind direction, (c): air pressure, (d): relative humidity and (e): air temperature.

Eng. Test 2016 WXT05 22.09.2016

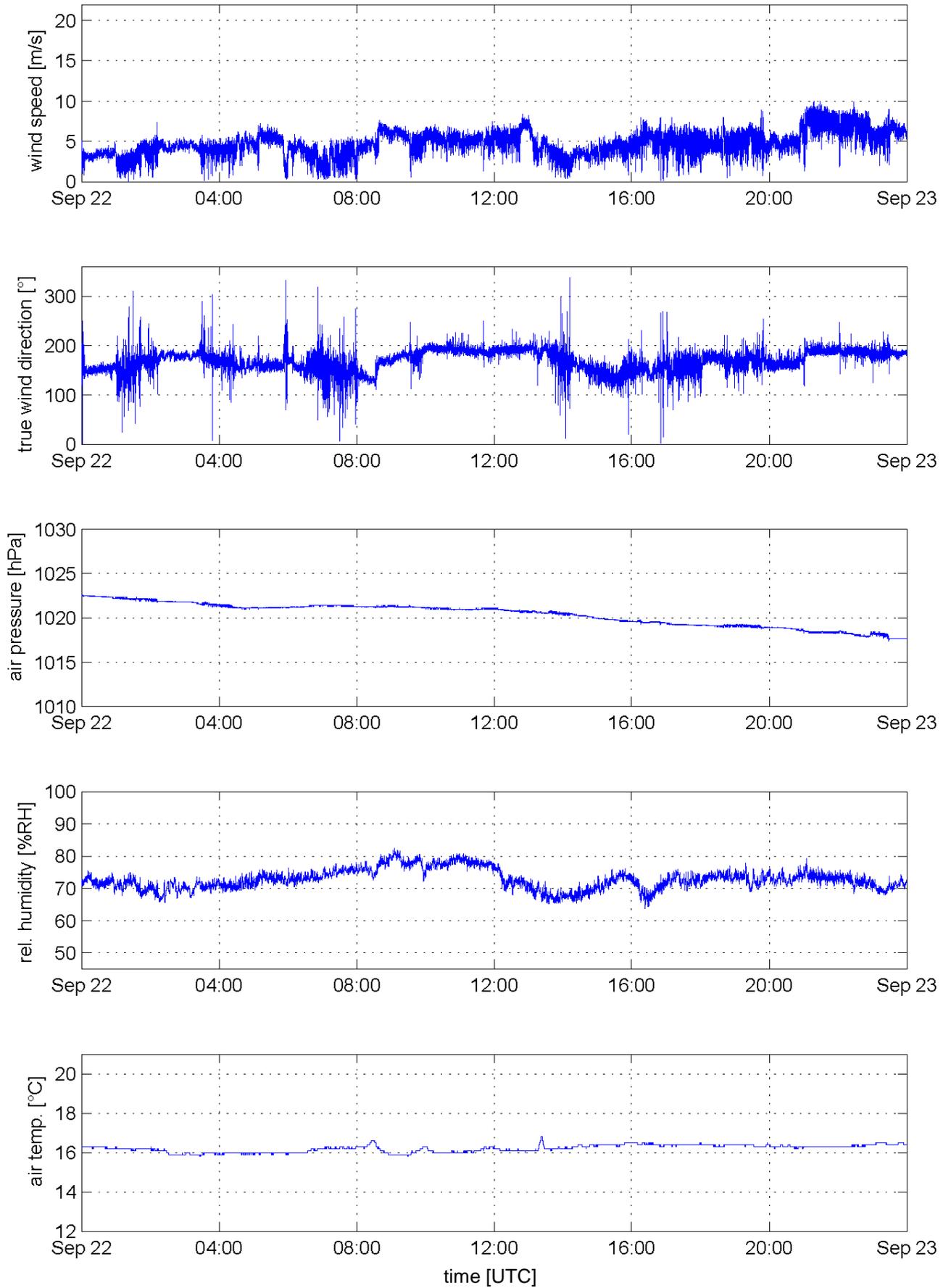


Fig. 10 Meteorological conditions onboard EMB on Sept. 22nd 2016 Time series are based on VAISALA WXT520 probe and are related to the following parameter: (a): wind speed, (b): wind direction, (c): air pressure, (d): relative humidity and (e): air temperature.

Eng. Test 2016 WXT05 23.09.2016

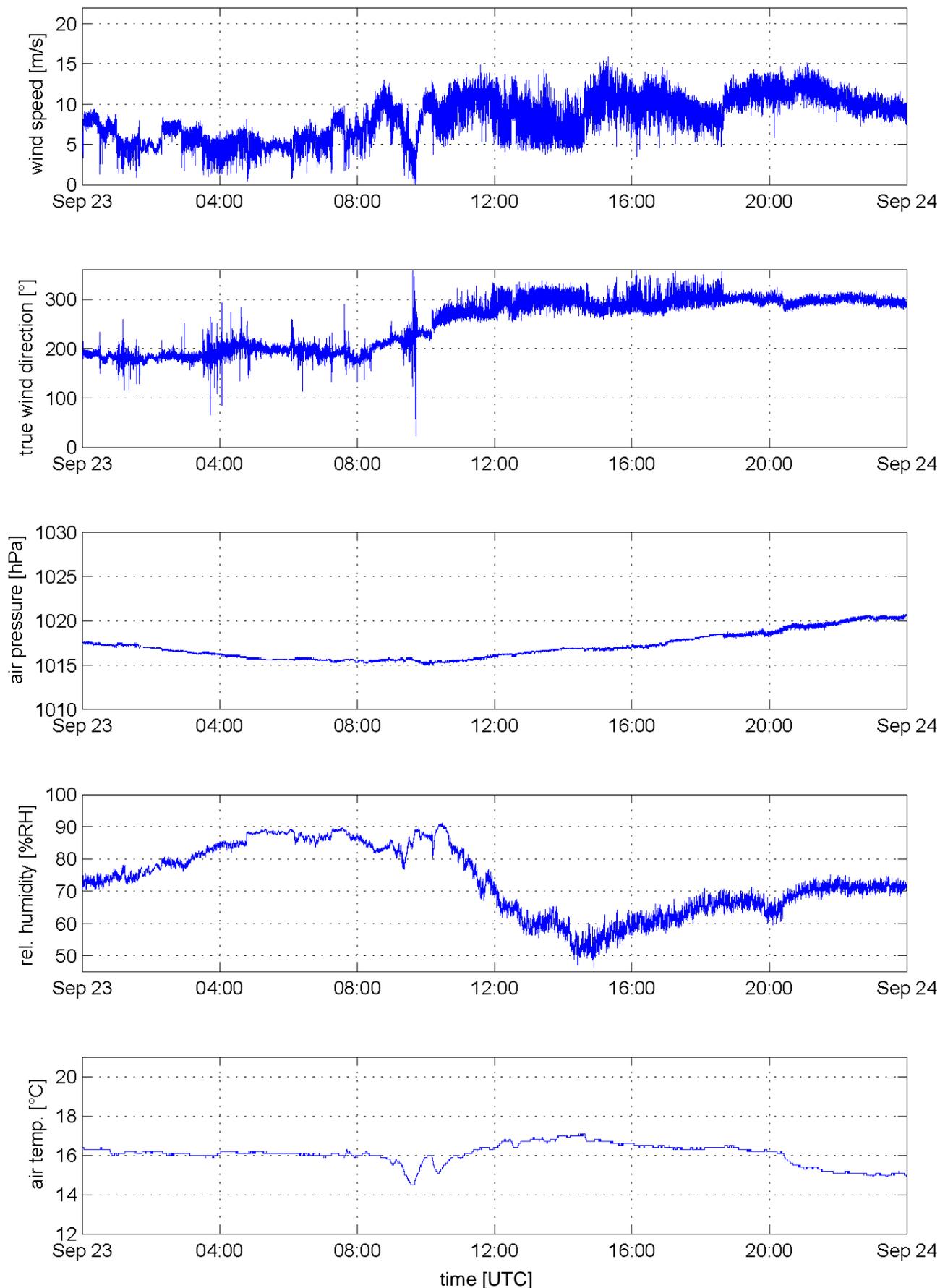
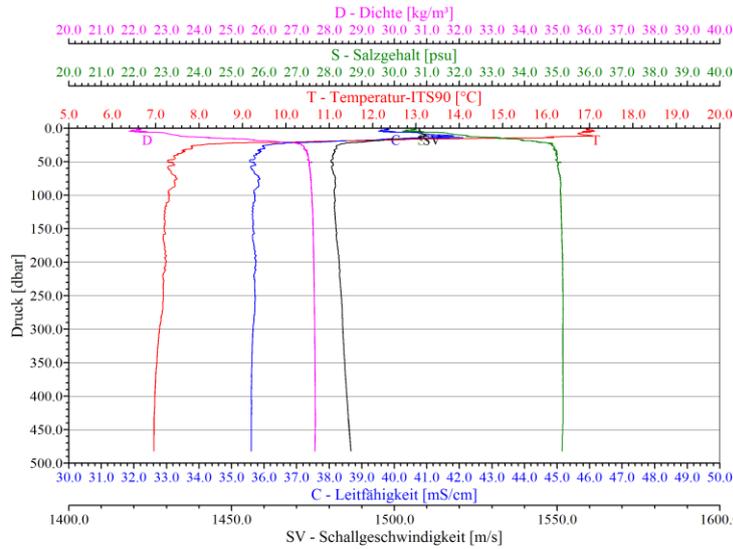


Fig. 11 Meteorological conditions onboard EMB on Sept. 23rd 2016 Time series are based on VAISALA WXT520 probe and are related to the following parameter: (a): wind speed, (b): wind direction, (c): air pressure, (d): relative humidity and (e): air temperature.

CTD Profiles



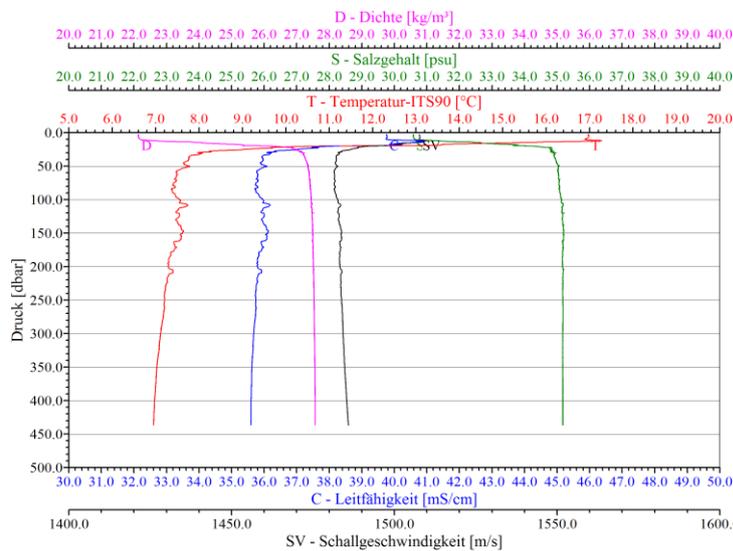
Software by



Profil-Information

Fahrt : ET2016-Geo
 Schiff : RV EMB
 Sonde : OTS43
 Datei : O2109002.RAW
 Datum : 21.09.2016
 Uhrzeit : 15:00:50 (UTC)
 Station : CTD002_A01
 Latitude : 58-20.119N
 Longitude : 009-49.876E

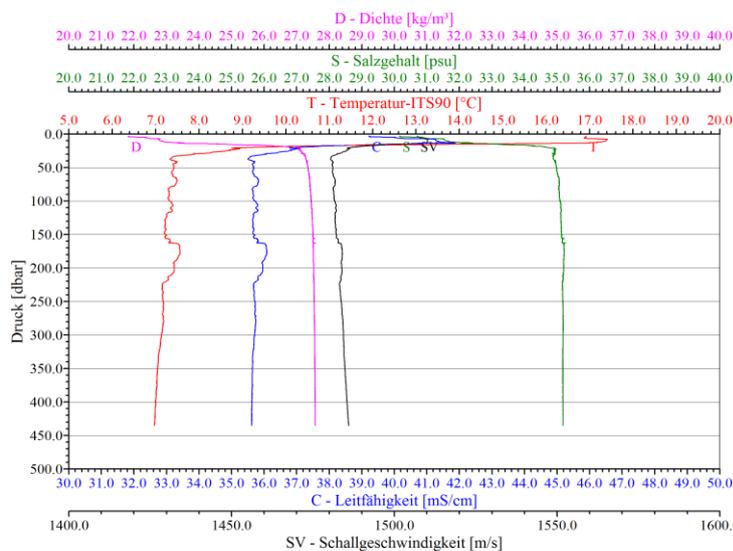
Software by



Profil-Information

Fahrt : ET2016-Geo
 Schiff : RV EMB
 Sonde : OTS43
 Datei : O2209002.RAW
 Datum : 22.09.2016
 Uhrzeit : 14:47:53 (UTC)
 Station : CTD004_A14
 Latitude : 58-12.002N
 Longitude : 009-53.025E

Software by



Profil-Information

Fahrt : ET2016-Geo
 Schiff : RV EMB
 Sonde : OTS43
 Datei : O2309001.RAW
 Datum : 23.09.2016
 Uhrzeit : 06:19:03 (UTC)
 Station : CTD005_A16
 Latitude : 58-17.540N
 Longitude : 009-54.035E

Fig. 12 Examples of CTD OTS 43 profiles at Pos. A01, A14 and Pos. A16 (refer Fig. 2 and Fig. 8) of temperature (red), conductivity (blue,) salinity (green), density (pink) and sound velocity (black)

Drift trajectories

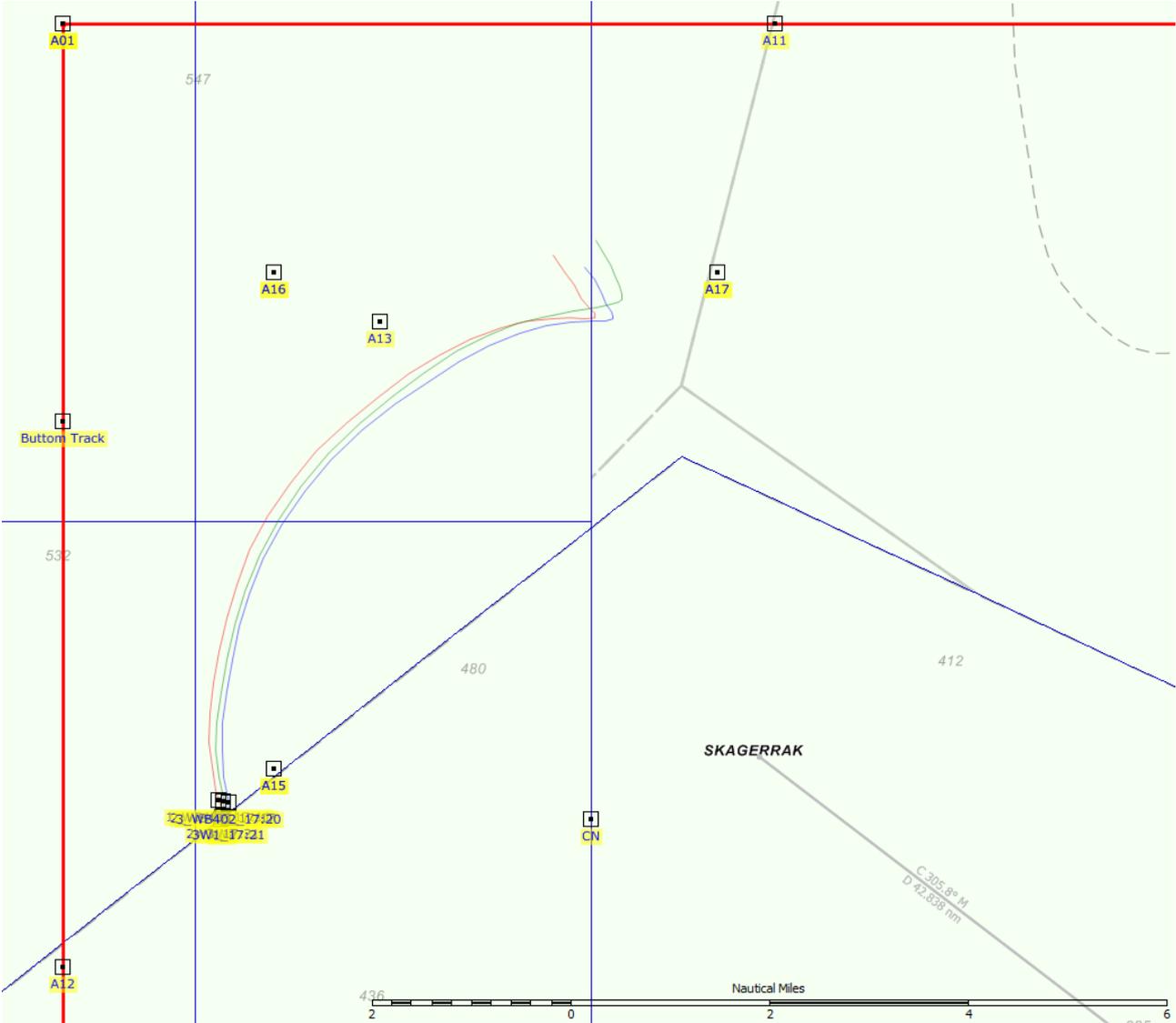
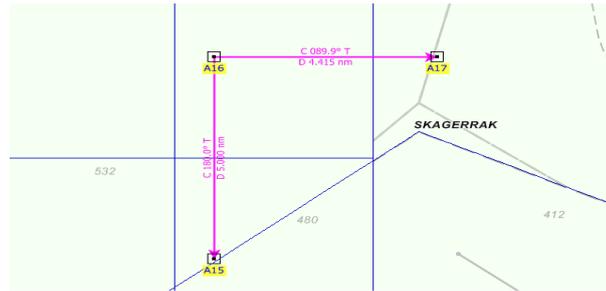


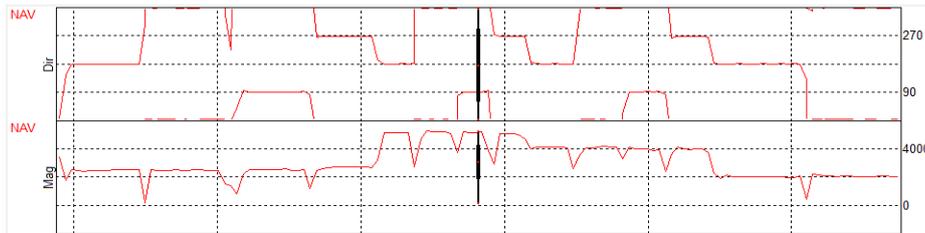
Fig. 13 Drift trajectories of Waverider Buoy 1 (blue curve) and Waverider Buoy 2 (red curve) Waverider Buoy 3 (green curve) deployed on 2016 Sept 22 and recovered on 2016 Sept 23.

ADCP measurements

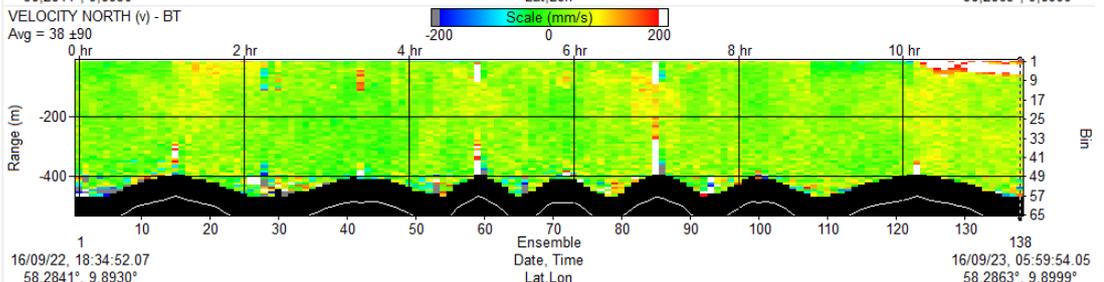
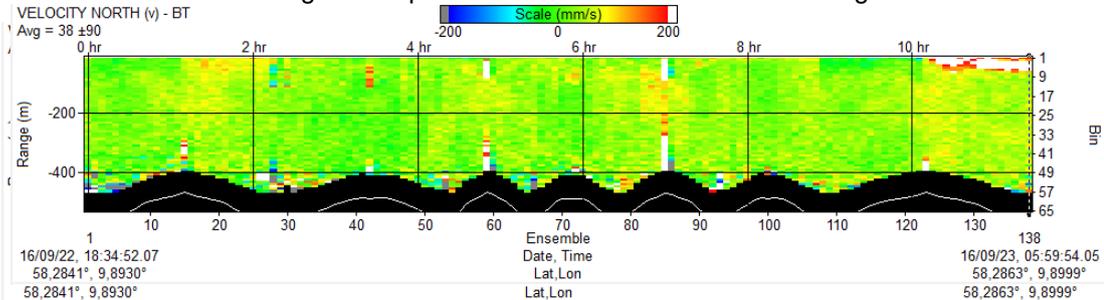
(a) Track of Run008:



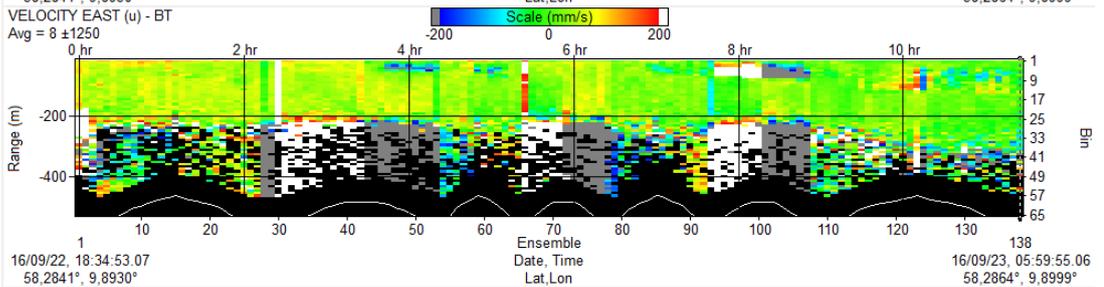
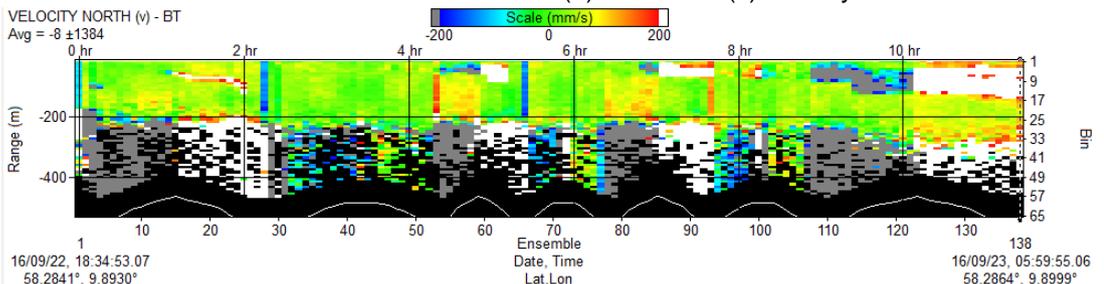
A16→A15→A16→A17→A16→A15→A16→A17→A16→A15→A16→A17→A16→A15→A16



(b) Run008 - 22.09.2016: Heading and ship velocities of RV Elisabeth Mann Borgese



(c) Run008 - 22.09.2016: WTD71 ADCP 75kHz – East (u) and North (v) velocity – Bottom track used



(d) Run008 - 22.09.2016: EMB ADCP 150kHz – East (u) and North (v) velocity – Bottom track used
Fig. 14 ADCP measurements on 2016 September 22th - 23th (22.09.2016 18:34 – 23.09.2016 05:59) onboard RV EMB in test area A with tracks of 5nm length at different ship velocities in zonal and meridional direction. Track pattern (a) with heading and ship velocities of RV EMB (b). Calculated velocities by 75 kHz ADCP for u and v components (c) and calculated velocities by 150 kHz ADCP for u and v components (d).