

ALKOR-Berichte

Student cruise: Observing techniques for Physical Oceanographers

Cruise No. AL541

07.08.2020 – 10-08.2020

Kiel (Germany) – Kiel (Germany)

MNF-Pher-110

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2020

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1 Cruise Summary

1.1 Summary in English

The main purpose of the ALKOR cruise AL541 was the training of students in observational techniques used in physical oceanography. The students who participated in the trip attend the module "Measurement Methods of Oceanography" which is offered in the Bachelor program "Physics of the Earth System" at CAU Kiel. During the AL541 the students were instructed in instrument calibration and in the interpretation of measurement data at sea. In addition, the students had the opportunity to learn about working and living at sea and to explore and study the impact of physical processes on the western Baltic Sea, the sea at their doorstep. In addition, the students had the opportunity to learn about working and living at sea and to explore and investigate the effects of physical processes in the western Baltic Sea, the sea on their doorstep. Due to the COVID situation, only day trips could be made, to the Fehmarn Belt and to the time series station Boknis Eck. In the Fehmarn Belt, two sections were made (on 07 & 10.08.) and the tripod mooring could be recovered and deployed again. Measurements were taken at the Boknis Eck time series station and a section was acquired in the deep channel west of Kiel Bay.

1.2 Zusammenfassung

Die ALKOR-Reise AL541 diente vorrangig der Ausbildung von Studierenden in Bezug auf Beobachtungsmethoden die von physikalischen Ozeanographen angewandt werden. Die Studierenden die an der Reise teilnahmen belegen das Modul Messmethoden der Ozeanographie das im Bachelor-Studiengang "Physik des Erdsystems" an der CAU Kiel angeboten wird. Während der AL541 wurden die Studierenden in Instrumentenkalibration und in die Interpretation von Messdaten auf See eingewiesen. Zudem bekamen die Studierenden die Möglichkeit das Arbeiten und Leben auf See kennenzulernen und das Wirken von physikalischen Prozessen in der westlichen Ostsee, dem Meer vor ihrer Haustür, zu erforschen und zu untersuchen. Aufgrund der COVID Situation konnten nur Tagestouren durchgeführt werden, in den Fehmarn Belt und zur Zeitserienstation Boknis Eck. Im Fehmarnbelt wurden zwei Schnitte gefahren (am 07.08.2020 und 10.08.2020) und die Dreibeinverankerung konnte geborgen und wieder ausgelegt werden. An der Boknis Eck Zeitserienstation wurden Messungen durchgeführt und ein Schnitt wurde in der tiefen Rinne westlich der Kieler Bucht durchgeführt.

2 Participants

2.1 Principal Investigators

Name	Institution
Karstensen, Johannes, Dr.	GEOMAR

2.2 Scientific Party

Name	Discipline	Institution
Schmidtke, Sunke, Dr.	FL; Physical Oceanography	GEOMAR
Tuchern, Franz Phillip	Physical Oceanography	GEOMAR
Roch, Marisa	Physical Oceanography	GEOMAR
Link, Rudi	Technician	GEOMAR
Damke, Paula	Student	CAU
Friedrich, Berit	Student	CAU
Garden, Pia	Student	CAU
Hocke, Nana	Student	CAU
Holzappel, Martin	Student	CAU
Kirch, Felix	Student	CAU
Knoop, Thorben	Student	CAU
Lauther, Jonna	Student	CAU
Melzer, Hannah	Student	CAU
Mock, Leon-Cornelius	Student	CAU
Rupf, Franziska	Student	CAU
Stockmayer, Vera	Student	CAU

2.3 Participating Institutions

GEOMAR	Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR)
CAU	Christian-Albrechts-Universität zu Kiel

3 Research Program

3.1 Description of the Work Area

The cruise operated in the western Baltic region, from little east of the Fehmarn Belt and to the time series station Boknis Eck at the entrance of the Eckernförder Bay. The Fehmarn Belt, which is key region for the water exchange for the Baltic Sea, was surveyed twice to capture short term variability at the section. A section along the deepest ridge from the Small Belt towards Kiel captured the southwest (upper layer) and northeast (lower layer) spreading of the outflowing low salinity and inflowing North Sea water.

3.2 Aims of the Cruise

The main purpose of the ALKOR cruise AL541 was the training of students in observational methods of physical oceanographers. Undergraduate students in the Bachelor program "Physik des Erdsystems" at the CAU Kiel are introduced into modern observational techniques in physical oceanography, including instrument calibration and interpretation of observations. The course (MNF-Pher- 110b) is part of the "Messmethoden" lecture. The cruise will give the students an opportunity to experience the work and life at sea and also to explore and investigate physical oceanography processes in the western Baltic Sea, the ocean at their backyard. The scientific motivation of the cruise is to obtain a rather synoptic picture of the hydrography and water movement in the western Baltic.

3.3 Agenda of the Cruise

The cruise operated as four 1-day trips from/to Kiel and into the Fehmarn Belt area and to the time series station Boknis Eck at the entrance of the Eckernförder Bay. In the Fehmarn Belt, two sections were made (on 07 & 10.08.) and the tripod mooring could be recovered and deployed again (Fig. 3.1). A section in the western Baltic, from Small Belt southward, was intended to provide the base for a description of the vertical structure of the western Baltic Sea. In particular it nicely shows the decreasing influence of North Sea water towards the eastern Baltic proper. The second section was crossing the Fehmarn Belt perpendicular to the topography. This section was carried out on the 08th and on the 10th August with the intention to show the high temporal variability of stratification in the region.

The work at the different stations should mimic a "real" expedition, including active interactions with the ships crew (CTD stations, mooring operations). At the eastern exit of the Fehmarn Belt a tripod-mooring is installed, located at the periphery of the restricted area "Marienleuchte". The students participate in recovery or deployment and in the data recovery and sensor handling. The time series are discussed (seasonal cycles etc.).

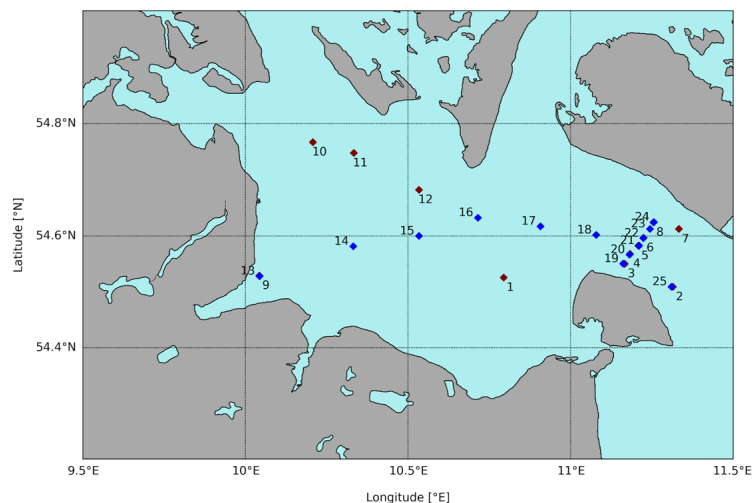


Fig. 3.1 Track chart of R/V ALKOR Cruise AL541. CTD stations along the zonal section (big blue dots) and the strait section along the Fehmarn Belt and the Kattegat Rinne (green dots). The red dot marks the position the bottom shield mooring at the southern exit of the Fehmarn Belt.

4 Narrative of the Cruise

(Sunke Schmidtke)

Our Multiday research cruise 541 on RV ALKOR was scheduled to take place 7.-10. August 2020. Due to external COVID-19 related mandatory restrictions of number of participants we opted for four day-cruises from Kiel with two groups of students. The first group on Friday and Saturday, the second group on Sunday and Monday.

On Friday, 07.08.2020, we were greeted with perfect sailing conditions, which prevailed throughout the research cruise AL541. Calm seas, low winds with temperatures around 24°C at sea, while those on land suffered heat up to 30°C. We checked in at 7:00 on board and left the pier ahead of time shortly after. The security instructions were accompanied by a first snack of donuts hinting at the perfect catering we were able to enjoy over the next days.

Our test station at 10:00 showed apart from some leaking Niskin bottles and wrongly set valves, thus we postponed the collection of substandard water to our next station. At noon we arrived at mooring location V431 at marine restricted area Marienleuchte. Via hydrophone we immediately had contact with the releaser, mooring was released and retrieved and safely on deck within 20 minutes. All instruments looked in good condition with expected biofouling. After another CTD station at the mooring location we steamed a short while back to Fehmarn Belt and made the section with CTD stations at the Standardpoisitions, followed with an ADCP section across Fehmarn Belt, covering the CTD station locations before heading back home to Kiel.

A NDR film team who was waiting for us documented our passing of Lighthouse Friedrichsort. They visited us onboard after arrival at Westufer GEOMAR pier at 19:30 and collected research footage as well as performed an interview. The day ended at 23:00 with a cold beer with hot fries at the Kielline, ideal to endure the still very warm temperature ashore. On Saturday morning August 7th 2020 we arrived as scheduled at 7:30 on board and left port heading towards Boknis Eck. Next to our standard sampling on student education cruises, at Boknis Eck we took samples for CH₄, N₂O and Nutrient measurements for the GEOMAR RD2.

Afterwards the ALKOR was heading towards Small Belt starting a hydrographic section along the northern trough in Kiel Bay direction Fehmarn Belt, monitoring the saltiest North Sea Water in this area. After the completion of the stations we headed back to Kiel and had an earlier stop compared to the day before, moored at GEOMAR Westshore pier at 16:30. The next day, Sunday, August 8th, was the first day for the second group of 6 students. We boarded the ALKOR shortly after 7:00 and left port at 7:30 towards Boknis Eck again. While leaving Kiel we were greeted by small group of porpoises in the inner Kiel Fjord just north of the Kiel Canal locks. After the Boknis Eck monitoring station we made a CTD section in central Kiel Bay towards Fehmarn Belt to monitor the distribution of salty North Sea water in the Bay. As it was Sunday the cook treated us with a tasty soup followed by marvelous Sunday roast and ice cream for desert.

On the last day of our four daily cruises we left as soon as all were onboard shortly after 7:30, heading straight towards Fehmarn Belt. We performed a similar hydrographic section as on day one and made an extended ADCP section from near coast Northeast towards southwest, before heading to the mooring deployment location in marine restricted area Marienleuchte. On location a smooth deployment of the new mooring tripod with a Nortek

500 Signature was done. The tripod will substitute the trawl resistant bottom shield equipped with a RDI 600kHz instrument. Use of the oxygen optode-logger and MicroCat will be continued. The tripod was lowered to the bottom on a wire and release with a Benthos release 1.5m above the bottom. Before heading back to Kiel a final check and successful disable was send to the EdgeTec release by hydrophone. We unloaded most equipment on the eastshore, before ending our last cruise day successfully at the Satori & Berger pier in Kiel at 19:30.

5 Preliminary Results

5.1 Conductivity Temperature Depth (CTD) Sonde

During AL541 a Hydro-bios Multi Water Sampler (MWS 12 SLIMLINE) was used. The device is stationed at the R/V ALKOR and maintained by RD3 of the GEOMAR. The sampler is a rosette system with sample bottles and a CTD that hosts additional sensors (oxygen, fluorescence). The rosette is operated via inductive cable and a control unit from the ship's lab.

The temperature sensor is PT-100 type with 150ms response time and nominal accuracy of 0.005°C, the conductivity a 7-pole cell with 100ms response time and accuracy of 0.01 mS/cm. The pressure sensor is a piezo resistive with nominal accuracy of <0.1%. Oxygen sensor is a Clarke electrode with an accuracy of 1% of measured value and response time of 3sec (60%) and 10 sec (90%). The fluorescence sensor is a Dr. Haardt Chlorophyll A Fluorometer. The CTD system samples with 1 Hz. Temperature, Oxygen and Florescence are not calibrated with discrete samples during AL541 and only salinity (see respective section below).

The Fehrmanbelt Section - C Section

The Fehmarnbelt section (also called “C section”) was occupied twice during the cruise, on 07.08. and on the 08.08.2020, with six CTD casts (Fig. 5.1). Both occupations took place in a period of very clam conditions and as such the vertical structure did not changed much.

Overall both sections show fresh and cold water overlaying warm and salty water, so the typical two-layer Baltic Sea stratification. The interface depth, defined here where the strong salinity gradient is located, is inclined. At the first the upper layer is deepest in the north (15m), for the second occupation the inclination reversed, the gradient sharpened and was in the southern part of the section at 20 m depth. Oxygen and Chlorophyll (not shown) are both very homogenous for both occupations.

The driving factor for density differences, stratification and the general pattern of the section is salinity. For the first occupation salinity varied from 14 up to 24. The pattern resample the density/stratification. For the second occupation the salinity changes closer to the surface suggest some redistribution connected to the dominant winds.

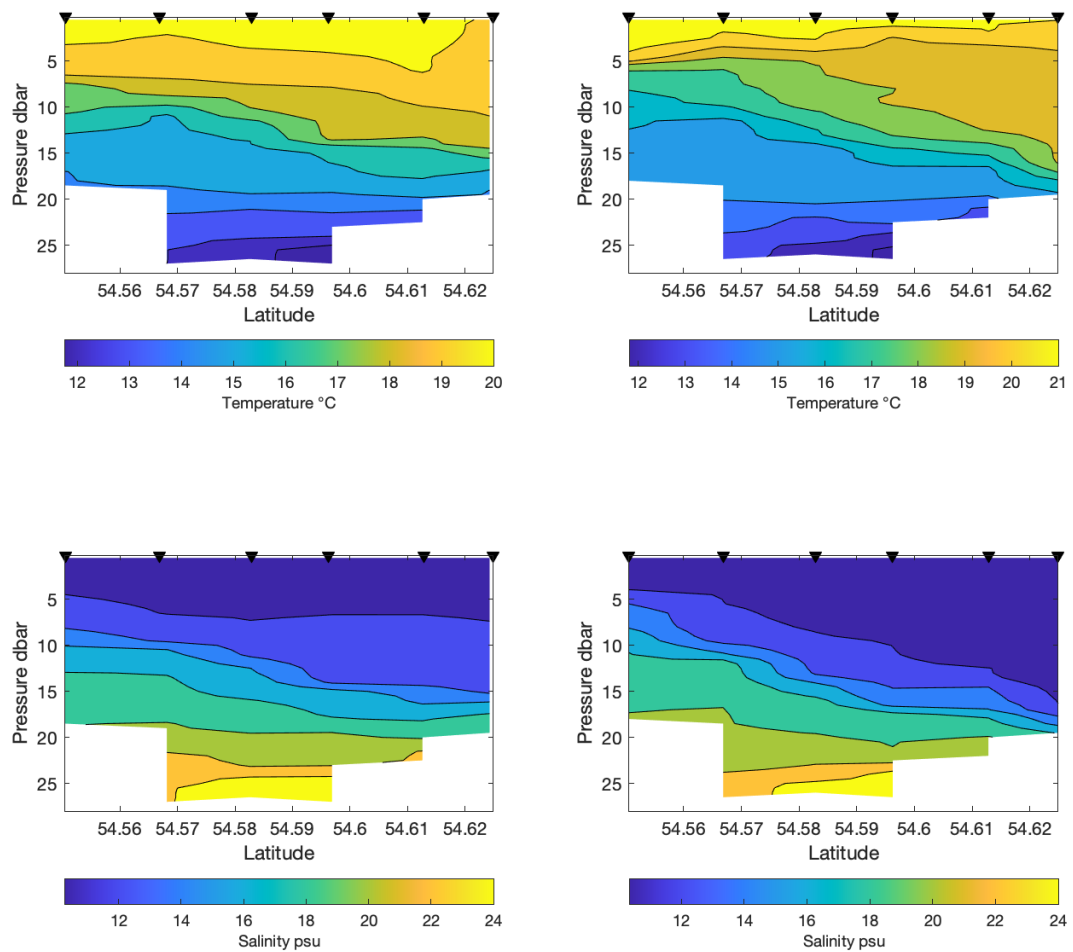


Fig. 5.1 (upper) Potential Temperature, (middle) salinity, (lower) Sigma Theta along the Fehmarn Belt section for the first occupation (left) and the second occupation (right) during AL451. See respective colorscales.

The Zonal Section - L Section

The zonal or “L-Section” was surveyed not strictly consecutive (as the C-Section) but as a composite of stations acquired between 07.10. and 09.10.2019. (Fig. 5.2). The bottom near spreading of North Sea water can be seen in all properties except Chlorophyll. The temperature maximum is even higher in the deeper waters of the Arkona basin, indicating that towards the west the mixing with surface water already eroded the signal but also the signal may originate from an earlier inflow event. The salinity supports this view, showing high values near the bottom in the west and a different maximum at the bottom in the Arkona basin. The gradient in salinity with high values in the west to low values in the east can clearly be seen as well. Since the density mainly derives from the salinity, it shows a similar pattern.

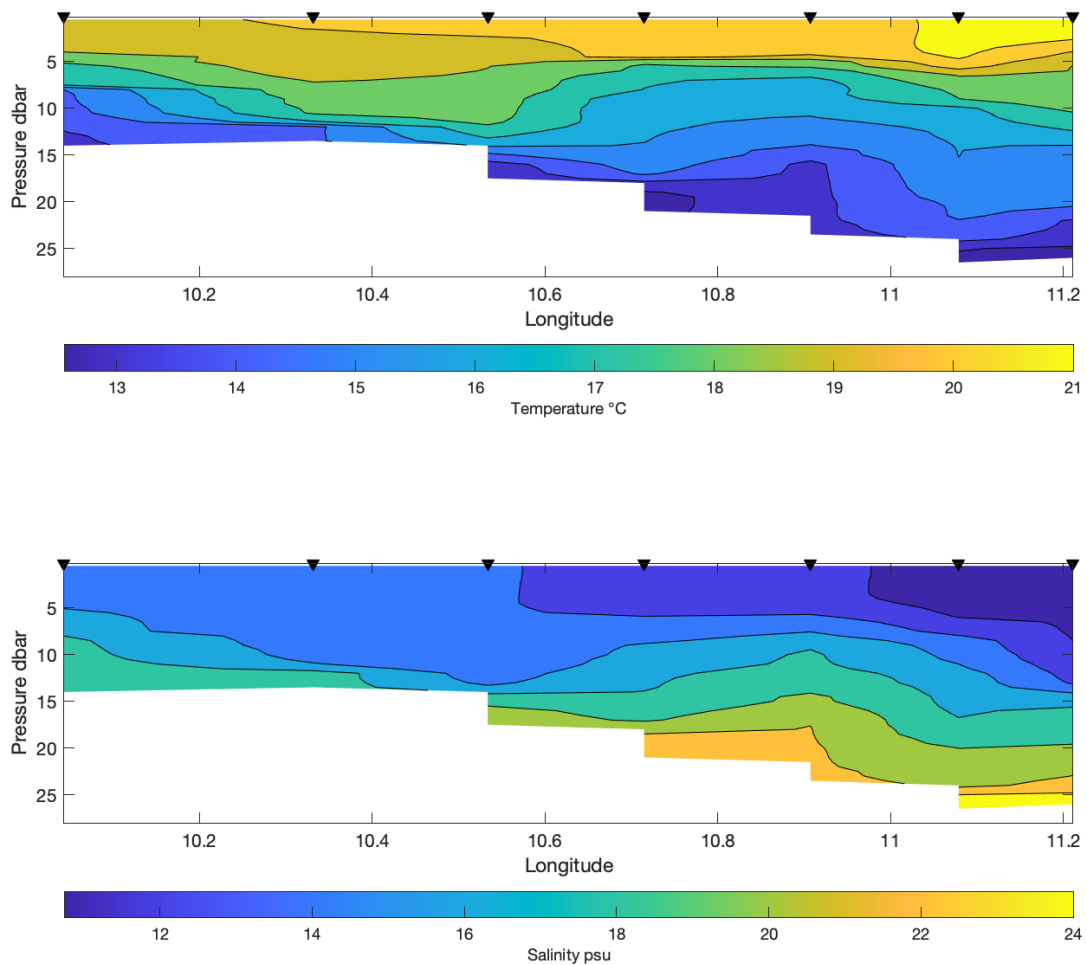


Fig. 5.2 (from upper to lower and left to right) Potential Temperature, salinity, Sigma Theta, Chlorophyll, oxygen and salinity (again) for the zonal section during AL541. Values see respective color scales, similar to Fig. 5.1

5.2 Underway data DSHIP

The R/V ALKOR is equipped with a meteorological sensor package maintained by the Deutsche Wetterdienst (DWD). It consists of sensors for air temperature (PT-100; 1/3 DIN B resolution) and a humidity sensor (voltage reading 0-100mV) both mounted in a Young-cage at 27m, air pressure (0.1 hPa resolution) is mounted underneath the bridge, water temperature (PT-100; 1/3 DIN B resolution) recorded at 3m water depth, wind direction (resolution 2.5°) and speed (resolution 0.3m/s) mounted at top of mast at (29m). The IR- and SW radiation is recorded with Eppley PIR and a Kipp & Zonen CM11, respectively. A Thermosalinograph (TSG) is a SeaBird SBE21 with remote temperature sensor SBE38, a Valeport SV+T Sonde and a Wetlabs ECO-FLRT.

The weather during the cruise was primarily impacted by an extensive high pressure system over Scandinavia that lead to light winds and warm air temperatures. The water temperature also was warm as a result of the net heat uptake of the ocean over summer (Fig. left). Clear sky and calm seas were experienced. The large-scale atmospheric patterns are also reflected in the underway weather observations recorded during the AL541 cruise (Fig. 5.6).

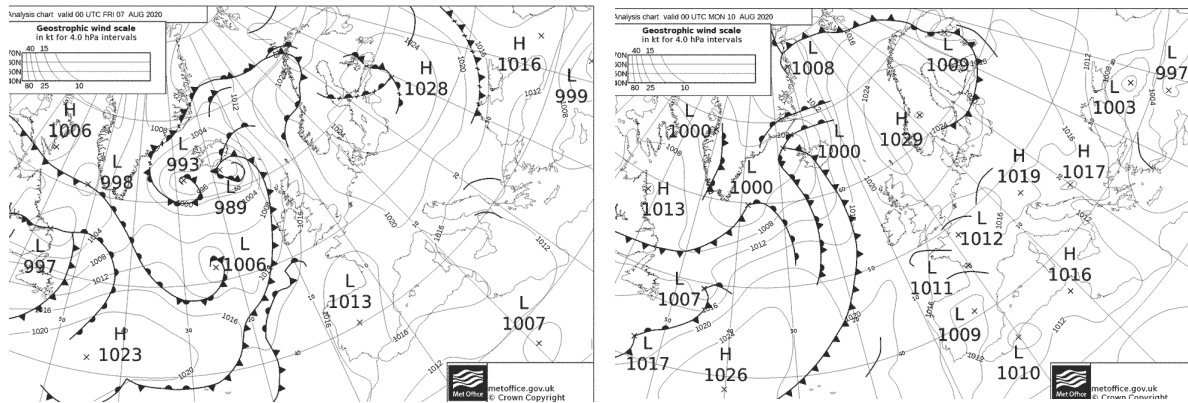


Fig. 5.3 Surface air pressure maps and fronts for the (left) Aug. 07, 2020 and (right) Aug. 10, 2020, AL541 (downloaded from the www.wetter3.de archive).

The air temperature (Fig. 5.4) was between 18°C and more than 28°C (in Kiel Fjord) while sea surface temperature varied between 18°C and more than 22°C. Shortwave as well as backward longwave radiation (Fig. 5.5) show nearly cloud free conditions on the 7th & 8th August, while the impact of clouds is nicely seen on August 9th. No data is available on the 10th. The maximum in SW was about 800W/m², and net long wave back radiation is about 10% of that. The relative humidity (not shown) is over the open sea 70% and 90% and dropped when approaching Kiel Fjord. Wind speed (not shown) was very slow, between 2 and 5 Bft and from easterly directions (not shown).

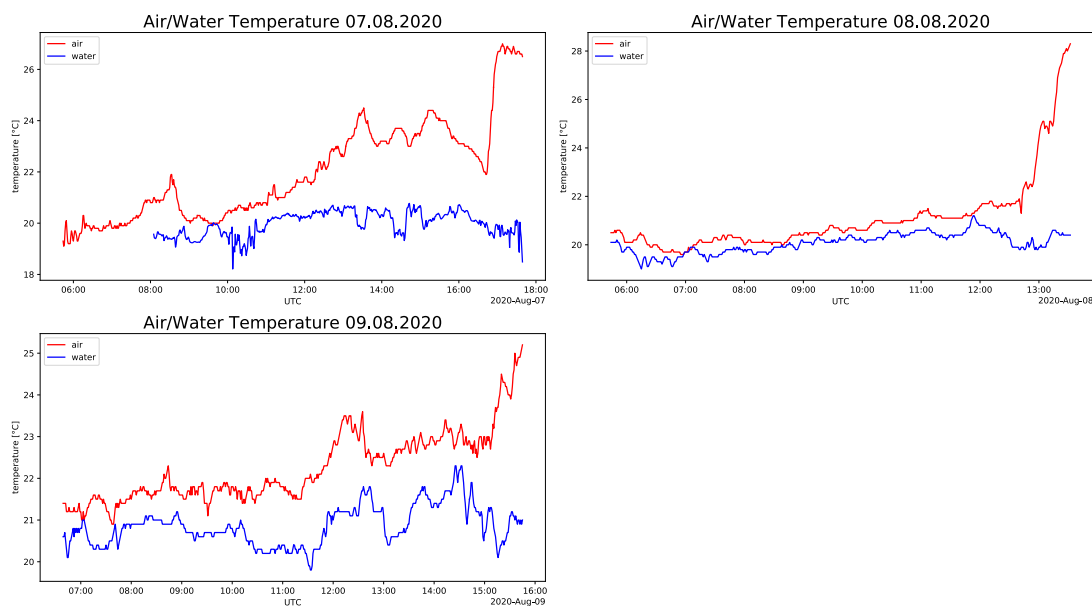


Fig. 5.4 Air temperature (red) and sea surface temperature at the TSG intake (blue) for the AL541 cruise.

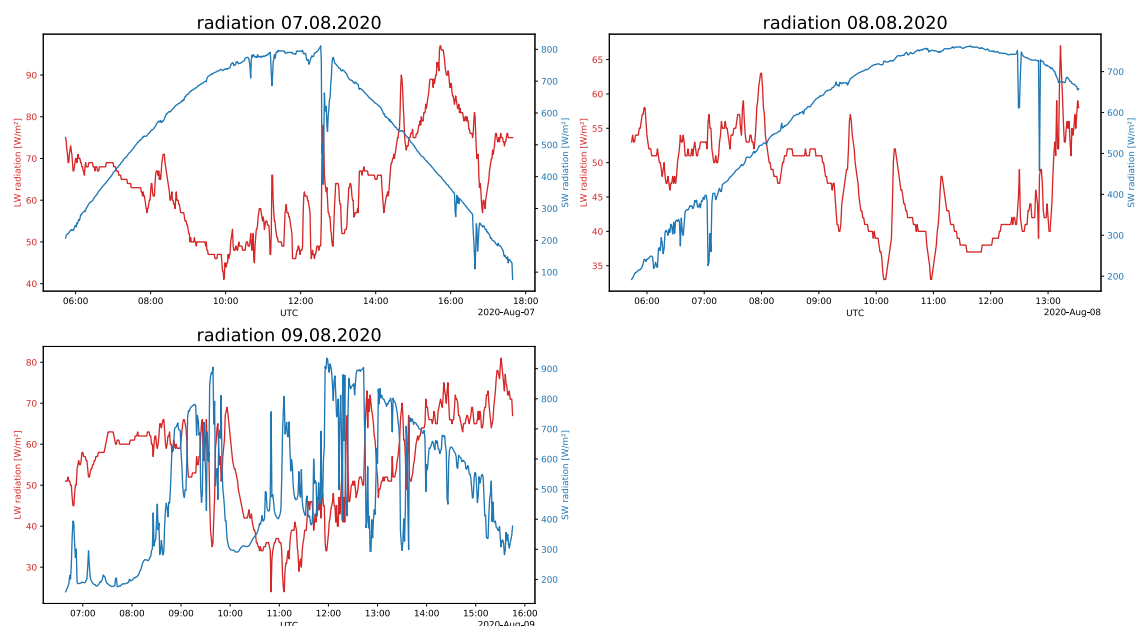


Fig. 5.5 Shortwave and backward long wave radiation during AL541.

5.3 Mooring V431 at Marienleuchte

During the daily tours that compose the AL541 the mooring time series station in the southeastern part of the Fehmarn Belt, at the military exclusion zone “Marienleuchte”, was serviced (Table 5.1). Last service and redeployment of the mooring, that carries the internal code V413, was about 10 month ago, during the student cruise AL529. The service with AL541 was also used to replace the Flotation Technology© TRBM system (Table 5.2; with Teledyne RDI 600kHz ADCP) with a new GEOMAR design tripod system (with a Nortek 500 SIGNATURE). In the new system the GEOMAR oxygen optode-logger and SeaBird MICROCAT SBE37t which are installed to measures the bottom water characteristics. It shall be noted that the mooring V431_31 was recovered about 1 month after AL541 with FK LITTORINA and the system were checked and redeployed.

Table 5.1 Tripod mooring deployment and recovery details

Date;Time (UTC)	Latitude	Longitude	Depth (m)	Comment
10.10.2019 6:00	54°N 30.530'	11°E 18.718'	27.9	V431_30 deployment AL529
07.08.2020 10:32	54°N 30.556'	11°E 18.887'	27.8	recovery V431_30 AL541
10.08.2020 12:10	54°N 30.569'	11°E 18.625'	27.5	V431_31 deployment AL541

Table 5.2 Tripod mooring device list

Component	Recovered system	Serial#	Deployed system	Serial#
type	FT TRBM system	na	GEOMAR Tripod with	na
Releaser	In frame	na	Edge Tec Port-LF SD	56239
ADCP	WH 600	10060	Nortek SIGNATURE 500	101720
MicroCat	SBE-37 IM	7956	SeaBird SBE-37 IM	7956
O2-Logger	AADI 3830	1470	AADI 3830	1470

6 Station List AL541

Gear Codes: CTD water: CTD rosette sampling; MOOR: Mooring operations

Station ID	Gear	Time (GMT)	Latitude	Longitude	Water depth (M)
AL202015_1	CTD	07.08.20 08:15	54° 31.562' N	010° 47.669' E	19
AL202015_2	MOORING	07.08.20 10:09	54° 30.540' N	011° 18.786' E	28
AL202015_2	CTD	07.08.20 10:31	54° 30.554' N	011° 18.884' E	28
AL202015_2	CTD	07.08.20 10:43	54° 30.563' N	011° 18.899' E	28
AL202015_3	CTD	07.08.20 11:33	54° 33.023' N	011° 09.997' E	19
AL202015_4	CTD	07.08.20 12:03	54° 34.113' N	011° 10.987' E	28
AL202015_5	CTD	07.08.20 12:33	54° 34.957' N	011° 12.564' E	27
AL202015_6	CTD	07.08.20 12:53	54° 35.839' N	011° 13.472' E	28
AL202015_7	CTD	07.08.20 13:15	54° 36.826' N	011° 14.502' E	23
AL202015_8	CTD	07.08.20 13:33	54° 37.526' N	011° 15.297' E	21
AL202016_1	CTD	08.08.20 07:53	54° 31.774' N	010° 02.586' E	28
AL202016_2	CTD	08.08.20 09:29	54° 46.089' N	010° 12.447' E	26
AL202016_3	CTD	08.08.20 10:16	54° 41.893' N	010° 20.025' E	29
AL202016_4	CTD	08.08.20 11:05	54° 40.939' N	010° 32.082' E	27
AL202017_1	CTD	09.08.20 07:27	54° 31.743' N	010° 02.672' E	28
AL202017_2	CTD	09.08.20 08:44	54° 34.535' N	010° 19.873' E	15
AL202017_3	CTD	09.08.20 09:52	54° 35.977' N	010° 32.003' E	19
AL202017_4	CTD	09.08.20 10:42	54° 37.982' N	010° 42.925' E	22
AL202017_5	CTD	09.08.20 11:32	54° 37.088' N	010° 54.479' E	25
AL202017_6	CTD	09.08.20 12:18	54° 36.140' N	011° 04.627' E	29
AL202019_1	CTD	10.08.20 09:18	54° 33.045' N	011° 09.703' E	19
AL202019_2	CTD	10.08.20 09:34	54° 34.024' N	011° 10.878' E	28
AL202019_3	CTD	10.08.20 09:51	54° 34.965' N	011° 12.563' E	27
AL202019_4	CTD	10.08.20 10:06	54° 35.791' N	011° 13.454' E	28
AL202019_5	CTD	10.08.20 10:20	54° 36.779' N	011° 14.708' E	23
AL202019_6	CTD	10.08.20 10:33	54° 37.531' N	011° 15.420' E	21
AL202019_7	CTD	10.08.20 12:16	54° 30.562' N	011° 18.658' E	28
AL202019_7	MOORING	10.08.20 12:25	54° 30.553' N	011° 18.670' E	28

7 Data and Sample Storage and Availability

In Kiel a joint Datamanagement-Team is active, which stores the data in a web based multiuser-system. The data will be made public by distributing them to national and international data archives through the GEOMAR data management team, but also by sending it to the Deutsches Ozeanographisches Datenzentrum (DOD) at the BSH in Hamburg, Germany.

Table 7.1 Overview of data availability

Type	Database	Available	Free Access	Contact
CTD	DOD	11/2022	11/2022	jkarstensen@geomar.de
mooring	DOD	11/2022	11/2022	jkarstensen@geomar.de

8 Acknowledgements

A big thank to Jan Peter Lass (master) and all crew members of RV ALKOR for a successful and comfortable cruise.

9 Abbreviations

ADCP:	Acoustic Doppler Current Profiler
Bft:	Beaufort scale for wind speed
CTD:	Conductivity Temperature Depth
DOD:	Deutsches Ozeanographisches Datenzentrum
DWD:	Deutscher Wetterdienst
IR:	Infrared
SSS:	Seasurface salinity
SST:	Seasurface temperature
SW:	Shortwave
TSG:	Thermosalinograph