Physical oceanography data from the Jan Mayen Channel mooring during the NORSE experiment, 26 October 2022 – 19 November 2023

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1 Background

The data set described herein was collected as a part of the Northern Ocean Rapid Surface Evolution (NORSE) experiment, which is an Office of Naval Research Departmental Research Initiative focusing on characterizing the key physical parameters and processes that govern the predictability of upper-ocean rapid evolution events occurring in the ice-free high latitudes. The overall objective of NORSE is to demonstrate improvements in the predictability of the upper ocean physical fields associated with acoustic propagation over the course of the study.

Four moorings were deployed across the Jan Mayen Channel to support the NORSE experiment (Figure 1). Two of these moorings formed the acoustic observation system, with acoustic data collection on the southern side of the channel, on the Jan Mayen Ridge, and the acoustic source located on bathymetric rise on the north side of the channel. Two oceanographic moorings included one on the crest of the ridge (University of Washington, USA), near the 425 m isobath and the Jan Mayen Channel mooring, located on the 1585 m isobath (University of Bergen, Norway). This report summarizes the details of the Jan Mayen Channel mooring, instrument setups and processing, and gives an overview of the data collected.

The Jan Mayen Channel mooring data set covers the period from 26 October 2022 14:25 to 19 November 2023 12:10, and includes time series of ocean temperature, salinity and currents. The data are openly available from the Norwegian Marine Data Centre, from https://doi.org/10.21335/ NMDC-683103695, under a CC BY 4.0 license.

The Norwegian contribution to the program was supported by the Office of Naval Research Global, award number N62909-22-1-2023.

This report is an attachment for the data set:
Fer, Ilker and Brakstad, Ailin (2025), Physical oceanography data from the Jan Mayen Channel mooring during the NORSE experiment, 26 October 2022 – 19 November 2023 [dataset] *Norwegian Marine Data Centre*. https://doi.org/10.21335/ NMDC-683103695

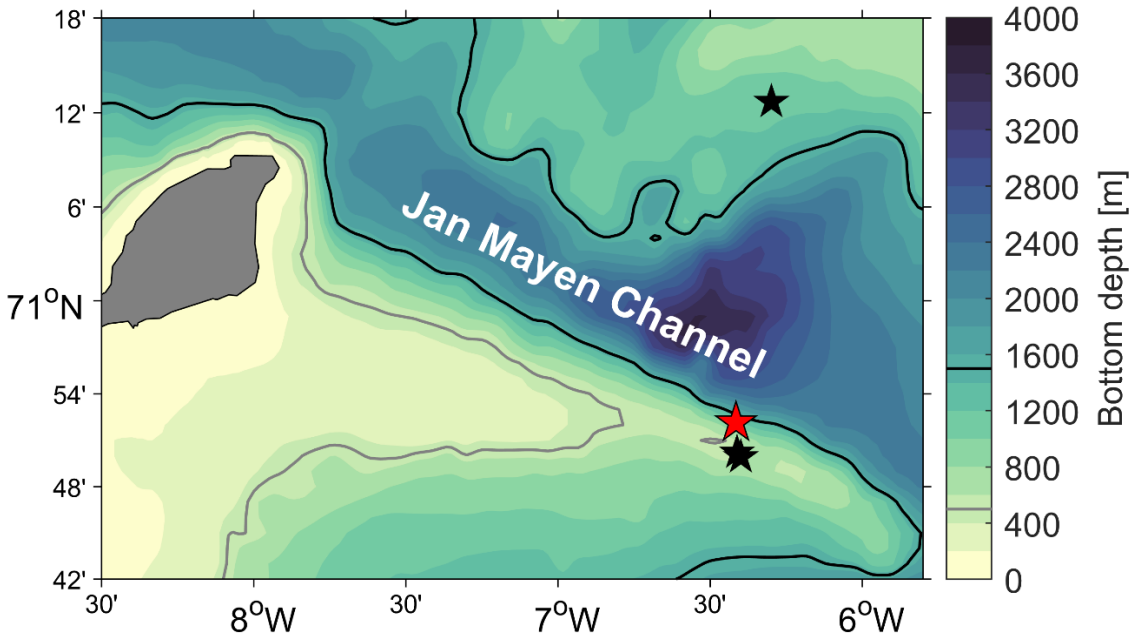

Figure 1. Map showing the location of the Jan Mayen Channel mooring (red star) and the three other moorings (black stars) deployed during the NORSE experiment.

2 Mooring overview

The Jan Mayen Channel mooring was deployed anchor last from NRV Alliance on 26.10.2022 14:25:00 UTC and recovered from RV Kronprins Haakon (cruise number 2023007019) on 19.11.2023 12:15:00 UTC. The location of the mooring was 70.869161˚ N and 6.415010˚ W, and the bottom depth was 1585 m. The mooring diagram is shown in Figure 2, while an overview of the instruments mounted on the mooring is given in Tables 1 and 2.

Temperature, and in some instruments salinity and pressure, were measured using Sea-Bird Scientific (SBE) instruments (MicroCats, unpumped SBE37 and temperature loggers, SBE39 and SBE56). Additionally, the current profilers and meters had temperature and pressure sensor, and two Aanderaa SeaGuards were equipped with conductivity sensors.

Ocean currents were measured using ADCPs from RDI and Nortek, at different frequencies and two current meters (Aanderaa SeaGuards). Two Nortek Signature ADCPs were mounted on the same flotation approximately at 416 m (Signature S55 facing downward and S100 facing upward). A RDI 75kHz Workhorse Long Ranger ADCP was mounted in a spherical flotation facing downward at 1081 m, and an RDI 300kHz Workhorse Sentinel ADCP deployed upward facing at 137 m depth. Detailed sampling setup for each instrument is described in the corresponding sections.

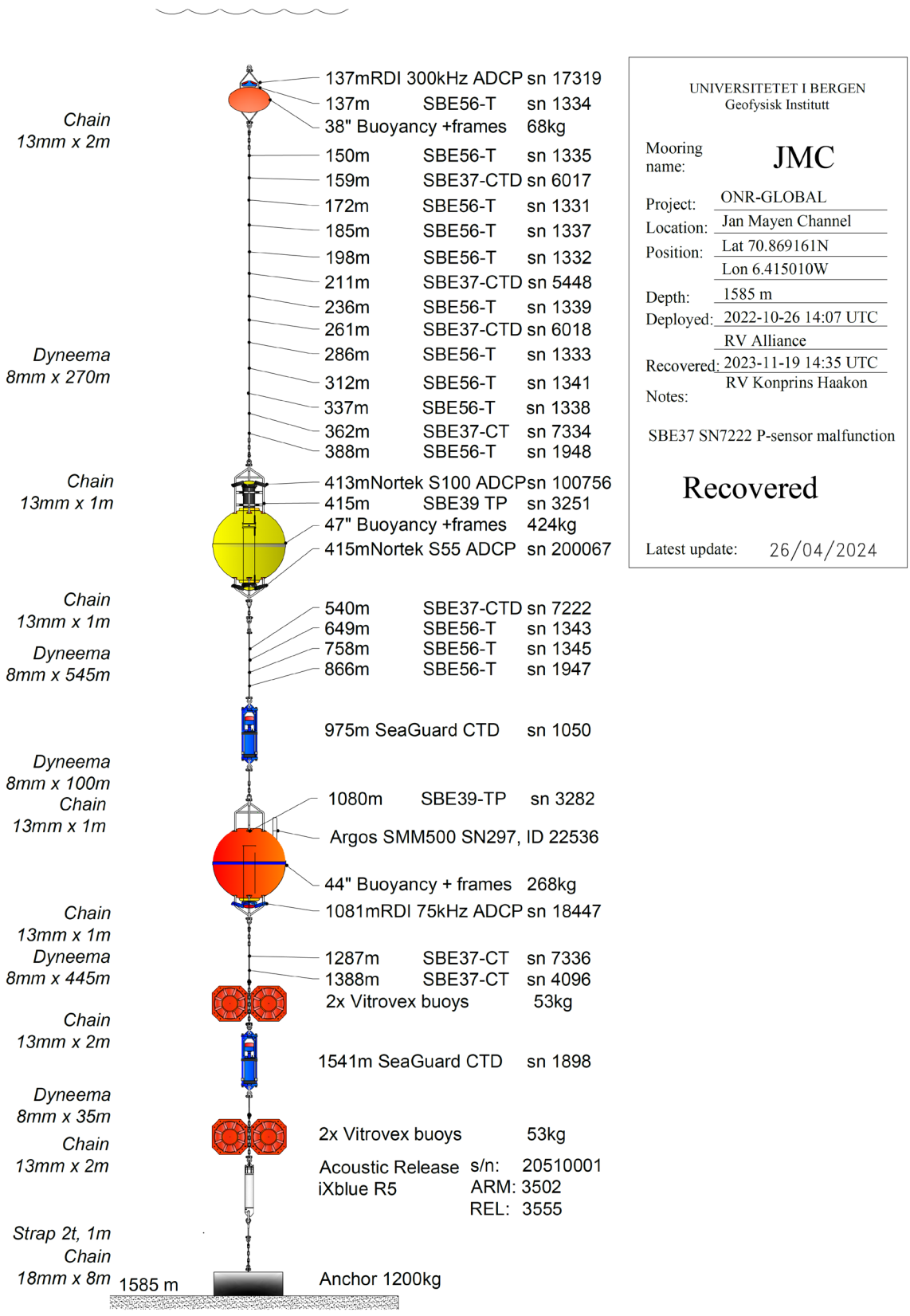

Figure 2. Mooring diagram. Instrument types are explained in relevant sections.

3 Data collection and data processing

3.1 Instrument nominal depth estimates

Target depths are best estimated using mooring line lengths and pressure records from the instruments. When pressure (or depth) record is available, we use the lowest 5th percentile of the pressure (or depth) records and convert to saltwater depth using the UNESCO 1983 algorithm and the mooring latitude to assign a time-averaged target depth. Only including the lowest 5th percentile ensures that the time-averaged target depth represent the instrument depth with minimal mooring blowdown. Measurement uncertainty can be large, especially for large pressure-rated instruments, e.g. the 1500 m rated RDI 75kHz. In some cases, we adjusted the target depth to fit the intended mooring design. Using the piecewise known target depth for these instruments and the mooring construction details, we estimate the target depth of the remaining instruments.

Statistics of measured depth from instruments equipped with pressure sensors are given in Table 1. Final estimates of the target depth for each instrument are listed in Table 2 for temperature and/or salinity measurements, and in Table 3 for current meters and current profilers.

Table 1: Statistics of depth in m (converted from pressure) from instruments with pressure sensor.

Instrument	Sn	5 percentile	Median	95 percentile	Mean	STD
RDI 300kHz U	17319	136.7	139.1	151.3	141.0	6.7
SBE37	6017	159.2	161.2	172.9	163.1	6.5
SBE37	5448	210.8	212.8	224.3	214.7	6.3
SBE37	6018	261.3	263.1	273.9	264.8	5.7
S100 U	100756	413.0	414.0	417.5	414.5	1.6
SBE39	3251	414.7	415.7	419.1	416.1	1.6
S55 D	200067	415.2	416.1	419.5	416.6	1.6
SBE37	7222	537.5	540.1	543.6	540.2	2.0
SeaGuard RCM	1050	975.2	975.9	977.6	976.1	1.8
SBE39	3282	1079.7	1080.4	1081.6	1080.5	0.6
RDI 75kHz D	18447	1088.8	1089.6	1091.2	1089.8	0.8
SeaGuard RCM	1898	1541.4	1541.9	1542.4	1541.9	0.3

Table 2: List of C/T/D instruments from top to bottom. Target depth is estimated as described in the text. C = conductivity, T = temperature, D = depth (P = pressure). Bottom depth is 1585m.

C/T/D instrument	Serial number	Target depth [m]	Variables
SBE56	1334	137	T, time
SBE56	1335	150	T, time
SBE37	6017	159	T, P, C, time
SBE56	1331	172	T, time
SBE56	1337	185	T, time
SBE56	1332	198	T, time
SBE37	5448	211	T, P, C, time
SBE56	1339	236	T, time
SBE37	6018	261	T, P, C, time
SBE56	1333	286	T, time
SBE56	1341	312	T, time
SBE56	1338	337	T, time
SBE37	7334	362	T, C, time
SBE56	1948	388	T, time
SBE39	3251	415	T, P, time
SBE37	7222	540	T, P, C, time
SBE56	1343	649	T, time
SBE56	1345	758	T, time
SBE56	1947	866	T, time
SBE39	3282	1080	T, P, time
SBE37	7336	1287	T, C, time
SBE37	4096	1388	T, C, time

Table 3: List of current instruments from top to bottom. Target depth is estimated as described in the text. Bottom depth is 1585 m

Instrument	Serial number	Target depth [m]
RDI 300kHz ADCP, up looking	17319	137
Nortek S100 ADCP, up looking	100756	413
Nortek S55 ADCP, down looking	200067	415
Aanderaa SeaGuard RCM with CTD	1050	975
RDI 75kHz ADCP, down looking	18447	1081
Aanderaa SeaGuard RCM with CTD	1898	1541

3.2 Temperature and salinity measurements

SBE37s and SBE39s sampled every 5 min and SBE56s measured at 1 min intervals, all starting from 15 Oct 2022 0900 UTC. The data were downloaded, converted and exported using the manufacturers' standard software. All SBE C/T/P instruments measured as scheduled throughout the yearlong deployment, apart from one SBE37 (serial number 7222). This sensor had a malfunctioning pressure sensor after 19 Dec

2022 1215 UTC, affecting the salinity. The salinity was recalculated using target pressure.

In an initial treatment of the data (for quality screening, despiking etc.), all SBE measurements were time averaged to a common 5-min time array. After comparing the data to shipboard CTD profiles, no correction to temperature was necessary; however small offsets to salinity were applied.

In this 5-min resolution data set, temperature and pressure records were free from outliers and spikes. From the salinity records outliers were removed by imposing instrument dependent hard limits by inspecting the time series, and then despiked. The resulting records were inspected and short segments of suspect data (time ranges detected manually) were replaced with NaNs. The data are provided in the SBE_CTPrecorder.NC file. The data file also includes the original practical salinity record (PSAL_meas), before quality screening, despiking and offset correction.

Monthly averaged temperature and salinity profiles were inspected to confirm that the profiles were consistent and no additional offset was needed for a particular instrument.

Salinities obtained from the Aanderaa SeaGuards' conductivity sensors showed substantial differences from the SBE records that could not be corrected and should not be used for scientific purposes. In Figure 3, the temperature and salinity records from the SeaGuards (SG) are compared to the reliable records from the nearest SBE MicroCats (SBE37 SN7336, 200 m below SG SN1050, and SBE37 SN4096, 250 m above SG SN1898). These paired instruments are far away for comparison; however, the variability at these depths is small. While the temperature records were found reliable, the salinities obtained from the SeaGuards showed substantial differences from the SBE records, including nonstationary trends and numerous jumps, to the extent that a reliable correction was not possible. We provide the salinity values in the data files but advise caution against using them.

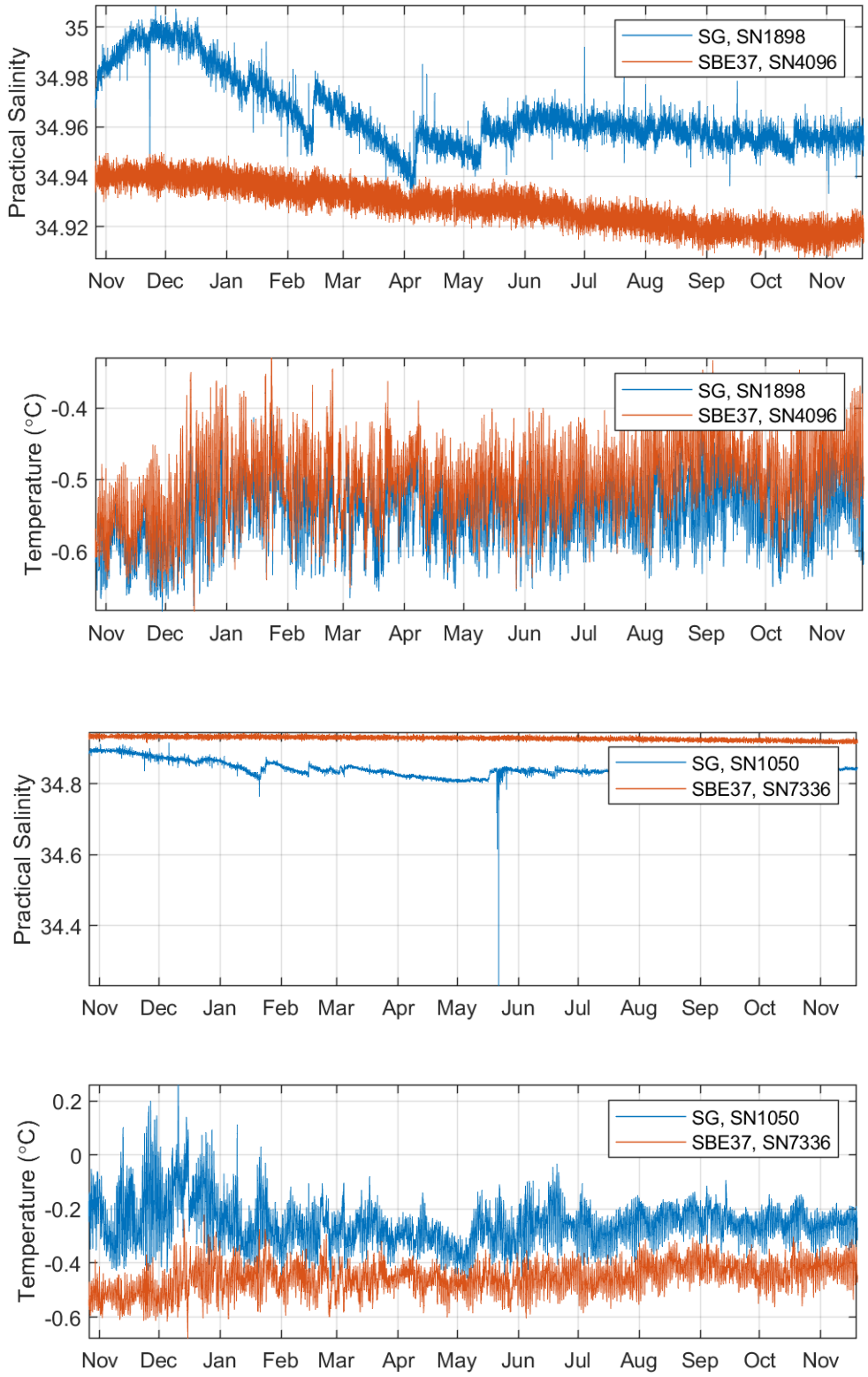

Figure 3. Comparison of salinity and temperature records from the SeaGuards (SG) with the nearest SBE37 MicroCats. Salinity measurements from the SeaGuards are not reliable.

4 Comparison with shipboard CTD

Measurements from the seven SBE37 CTDs were compared to nearby shipboard CTD stations from the mooring recovery cruise onboard RV Kronprins Haakon (cruise number 2023007019). The quality-controlled shipboard CTD data (t23KH019.kva) were provided by the Norwegian Marine Datacenter. Based on location and time, we identified three nearby shipboard CTD stations that were used for the comparison (Figure 4). The temperature and salinity from these stations compared to the SBE37 measurements are shown in Figure 5. No corrections were necessary for the temperature data, while constant salinity offsets were applied to each individual SBE37 time series as indicated in Table 4. An overview of the monthly averaged salinity and density profiles from the SBE37s after correction is given in Figure 6. Overall average CTD profiles from all Seabird instruments on the moorings (including also the T-loggers) are shown in Figure 7.

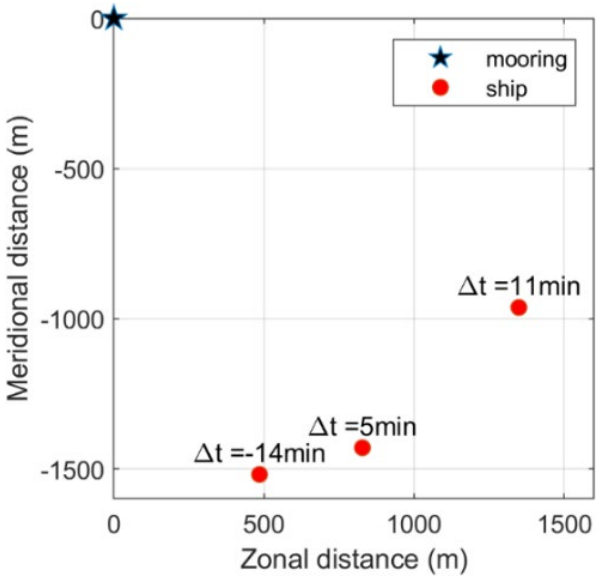

Figure 4. Location of the shipboard CTD stations (red dots) relative to the mooring location (blue star). The time difference between each ship station and the mooring sample time is indicated by Δt.

Table 4: List of SBE37 instruments and corresponding salinity offset. The salinity offset was estimated by comparing the SBE37 data to nearby shipboard CTD profiles (Figure 5).

SBE37 serial number	Salinity offset
6017	0.011
5448	0.019
6018	0.036
7334	0.036
7222	0.022
7336	0.031
4096	0.043

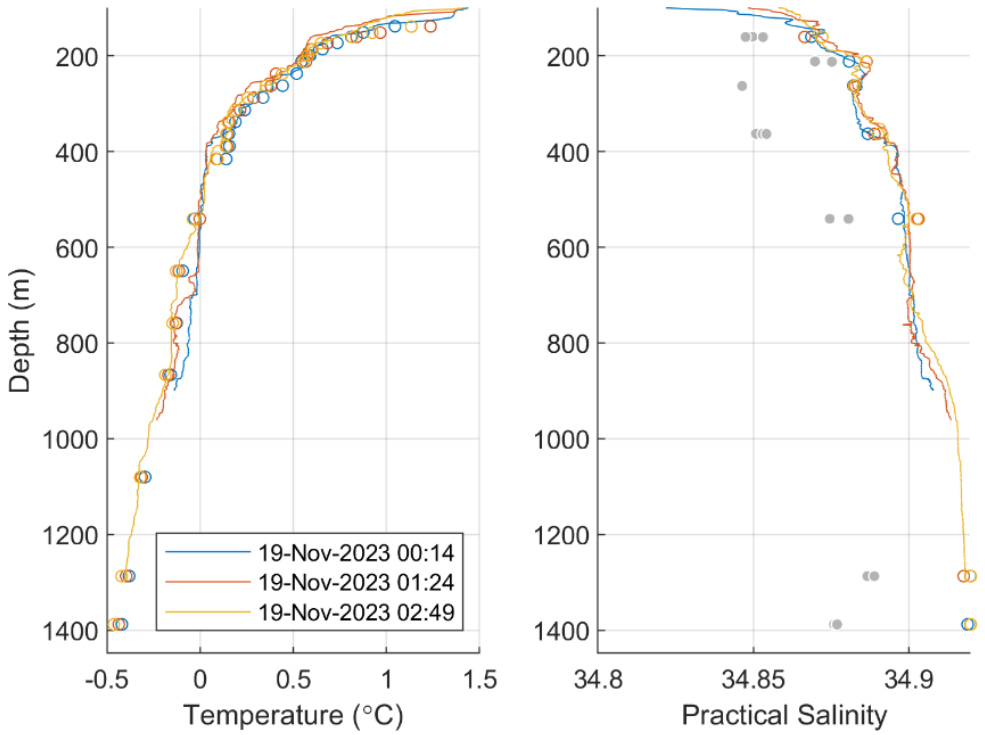

Figure 5. Temperature (left) and salinity (right) from the three shipboard CTD stations (colored lines) compared to the SBE37 CTD instruments (circles). No offset correction was required for temperature. The corrected salinity (colored circles) = uncorrected SBE37 data (gray dots) + salinity offset (Table 4).

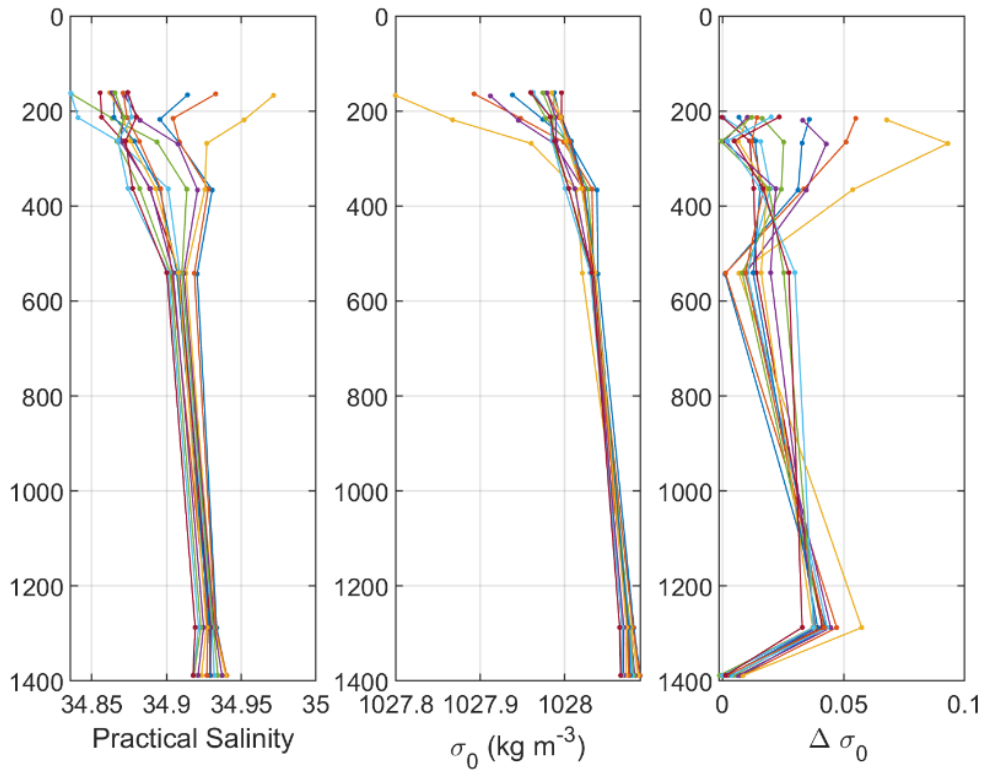

Figure 6. Monthly averaged salinity and potential density profiles from the SBE37 instruments.

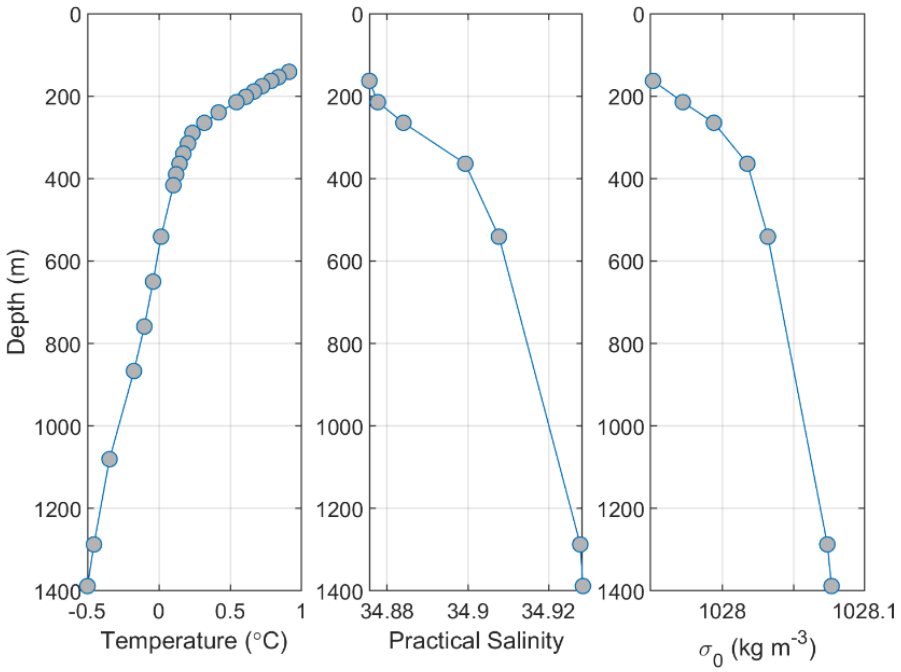

Figure 7. Time averaged profiles of temperature, salinity, and potential density.

4.1 Ocean current measurements

All current measurements are corrected for magnetic declination using the value of -5°. Using the WMM-2020 model at the mooring location the declination on 19 November 2023 was 4.63° W ± 0.60° changing by 0.34° E per year.

RDI ADCPs were configured to record data in broadband mode (short range and high accuracy), in Earth coordinates and perform ensemble averaging internally. Data are exported using the WinADCP software and further treated in MATLAB. An automated quality control flagged velocity measurements collected before deployment and after recovery times, with large tilt (pitch or roll greater than 20deg), with percent good of 3 beam solutions less than 50, with error velocity or velocity components greater than 1 m/s, and in bins within 10% of the range to the sea surface or the seafloor. Additionally, individual bins were flagged after inspection, if echo amplitude or beam correlation values suggested poor data quality. In the edited velocity data, magnetic declination was corrected, and the flagged bad data points were replaced with NaNs. The missing values were then linearly interpolated if temporal gaps were less than 2 hours or vertical gaps less than 3 bins. Finally, fragmentary measurements with lengths less than 6 hours, typically in the outer bins, were removed.

Nortek Signature ADCPs were deployed in the same 47'' spherical flotation, with Signature 100 facing upward and Signature 55 facing downward. Signatures recorded every profile (ping) in beam coordinates and was configured with 8-m thick vertical cells (bins). We post-processed the data using the Ocean Contour software. Compass was 2D in situ calibrated during post-processing, using a selection of data giving excellent quality and coverage. During quality screening side lobe interference was removed and

minimum correlation of 50%, maximum acceleration of 2 m/s, max amplitude spike of 50 dB/s and a maximum tilt of 15deg thresholds were applied. In averaging, percent good threshold of 50% and a maximum interpolation gap of 2 were used. Data are exported using the Ocean Contour software and further treated in MATLAB. Coherence and echo amplitude records from both Signatures on the same flotation show that there was inference between the two ADCPs, apparent as distinct slanted rays covering the measurement range in approximately 2 months. This inference is satisfactorily removed during quality control screening. Additionally, individual bins were flagged after inspection, if echo amplitude or beam correlation values suggested poor data quality. Similar to the RDI ADCP, in the edited data, magnetic declination was corrected, the flagged bad data points were replaced with NaNs, missing values were interpolated, and short fragmentary measurements were removed. Final ensemble averaging was done in Earth coordinates as 30 min averages.

RDI 75 kHz Workhorse Long Ranger ADCP, serial number 18447. It was deployed with transducers facing downward in a 44'' spherical flotation at 1081 m depth. The instrument was configured to collect an ensemble of 40 profiles (pings) at 3 s intervals every one hour, starting on 15 Oct 2022 0900 UTC (i.e. profiled for the first 3 minutes, starting on the hour). It profiled in 8-m thick vertical cells (bins). Single ping standard deviation is 1.2 cm/s. The first bin has bad data due to ringing effect and bins 22 and 23 are slightly obstructed by a SBE37 recorder, at about 190 m range. Depth record is offset by -8 m so that its time average matches the instrument depth.

RDI 300 kHz Workhorse Sentinel ADCP, serial number 17319. It was deployed with transducers facing upward in a 38'' elliptical flotation at 137 m depth. The instrument was configured to collect an ensemble of 35 profiles (pings) at 2 s intervals every 20 min, in 4-m thick vertical cells (bins). The start time was, 15 Oct 2022 0903 UTC, 3 minutes past the hour to avoid interference with the other ADCPs. Single ping standard deviation is 0.6 cm/s. The first bin was flagged. Direction of the current from this instrument does not agree with the Nortek Signature 100 kHz, which overlapped with the Sentinel. A satisfactory compass correction could not be obtained. We do not include the Sentinel velocity data in the combined, gridded mooring data.

Nortek Signature 100 kHz ADCP, serial number 100756. It was deployed at 413 m depth with transducers facing upward. The instrument has 4 beams. Each 30 min ensemble average included 73 samples. For this instrument bins [1 5 6 16 17 22 23] were flagged. An additional small heading correction (constant in time) of -3.5deg was applied to match the nearest good bin with that from the downward pointing S55, which was on the same flotation.

Nortek Signature 55 kHz ADCP, serial number 200067. It was deployed at 415 m depth with transducers facing downward in a 47'' spherical flotation. The instrument has 3 beams. Each 30 min ensemble average included 50 samples.

Aanderaa SeaGuard Recording Current Meters. The mooring was equipped with two SeaGuards (SG), each with conductivity, temperature and pressure sensors. The SG SN1050 was at 975 m and SN 1898 was at 1541 m depth. Both instruments sampled every 20 minutes, starting on 15 Oct 2022 0900 UTC, averaging 200 pings in burst mode. Data recorded by the instrument was converted to physical units and exported using the manufacturer's software. Additionally, we removed the measurements collected before deployment and after recovery times, and corrected the horizontal velocities for the magnetic declination (5W). No further despiking or interpolation was applied. The temperature and salinity records from the SGs were compared to the reliable records from the nearest SBE MicroCats (Figure 3). While the temperature records were found reliable, the salinities obtained from the SGs showed substantial differences from the SBE records. A reliable correction was not possible. We provide the salinity values in the data file but advise caution against using them.

5 Construction of the gridded data file

We used the cleaned, quality controlled, and corrected data files (5-min averaged temperature/salinity data set, SBE_CTPrecorders.NC, and instrument specific ADCP and SeaGuard NC files). Records from all instruments are bin-averaged and interpolated to a common time array.

The time-constant target depth list (with minimal mooring blowdown) is then used to vertically interpolate, at each time step, the instrument positions in a time-variable depth level (using the time-variable depth record with instruments equipped with pressure sensors). This results in profiles every hour, with a vertical range that varies with the mooring blowdown.

The vertical grid is 5-m resolution between 90 m and 1540 m depth. For pressure and temperature records, we used measurements from the sensors of SBEs and SeaGuards. ADCPs typically had adjacent SBE T-recorders, therefore we used the reliable SBE records. For salinity we used only the SBE records. For velocity, we excluded the RDI 300 kHz Sentinel ADCP, the range of which was covered by the Nortek Signature 100 kHz ADCP.

In this hourly, 5-m gridded data set, short gaps with less than 6 hour are interpolated linearly in time.

6 Acknowledgment

This work was supported by Office of Naval Research Global, N62909-22-1-2023. We thank Helge Bryhni for his support with mooring design and logistics, and the captain, crew, and NORSE participants for their assistance during the deployment and recovery cruises.

7 Overview of data

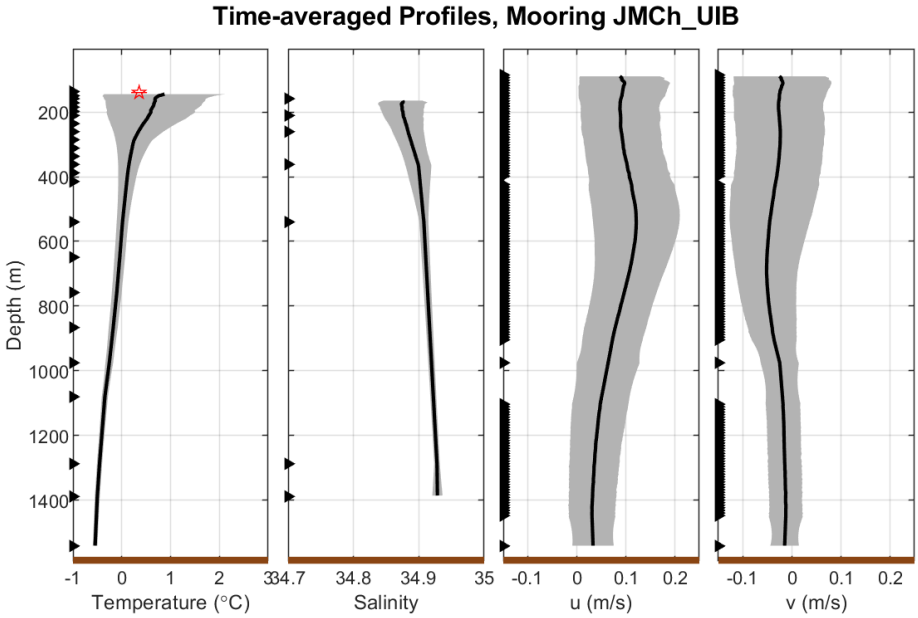

Figure 8. Time averaged profiles of temperature, salinity, eastward velocity (u), and northward velocity (v). The black triangles indicate measurement depths.

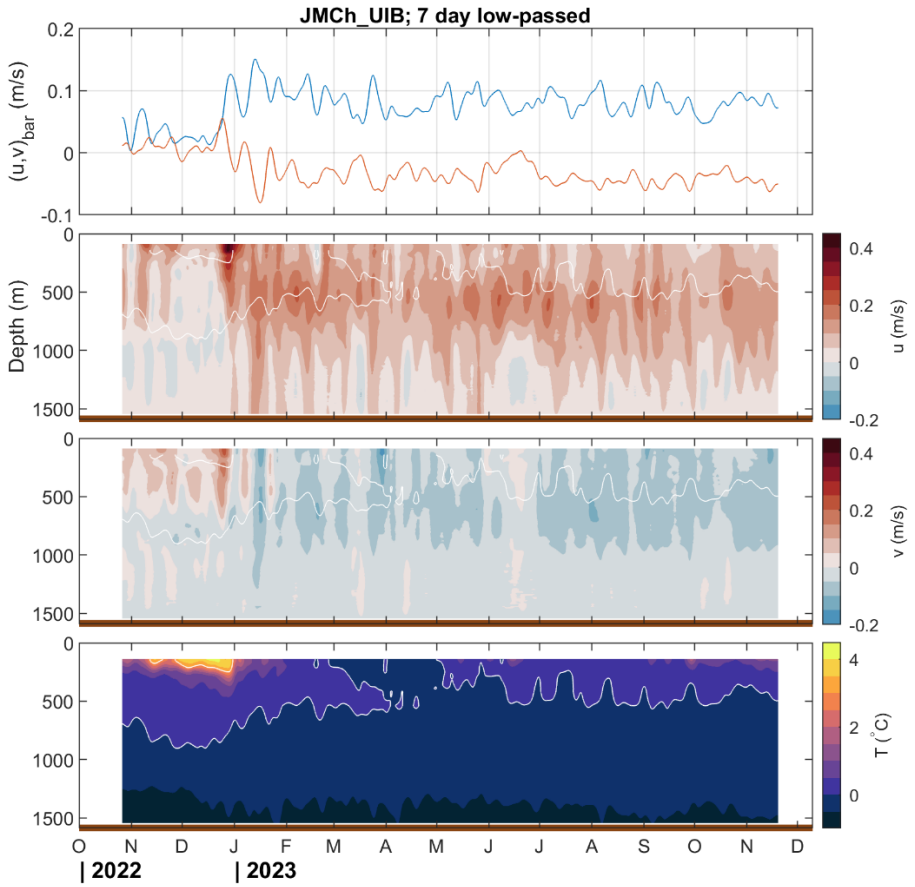

Figure 9. Evolution of depth-averaged velocity, eastward velocity (u), northward velocity (v), and temperature (T) filtered by a 7-day low-passed filer. The white contour marks the 0 ˚C isotherm.

8 Summary plots of time series from the gridded data file

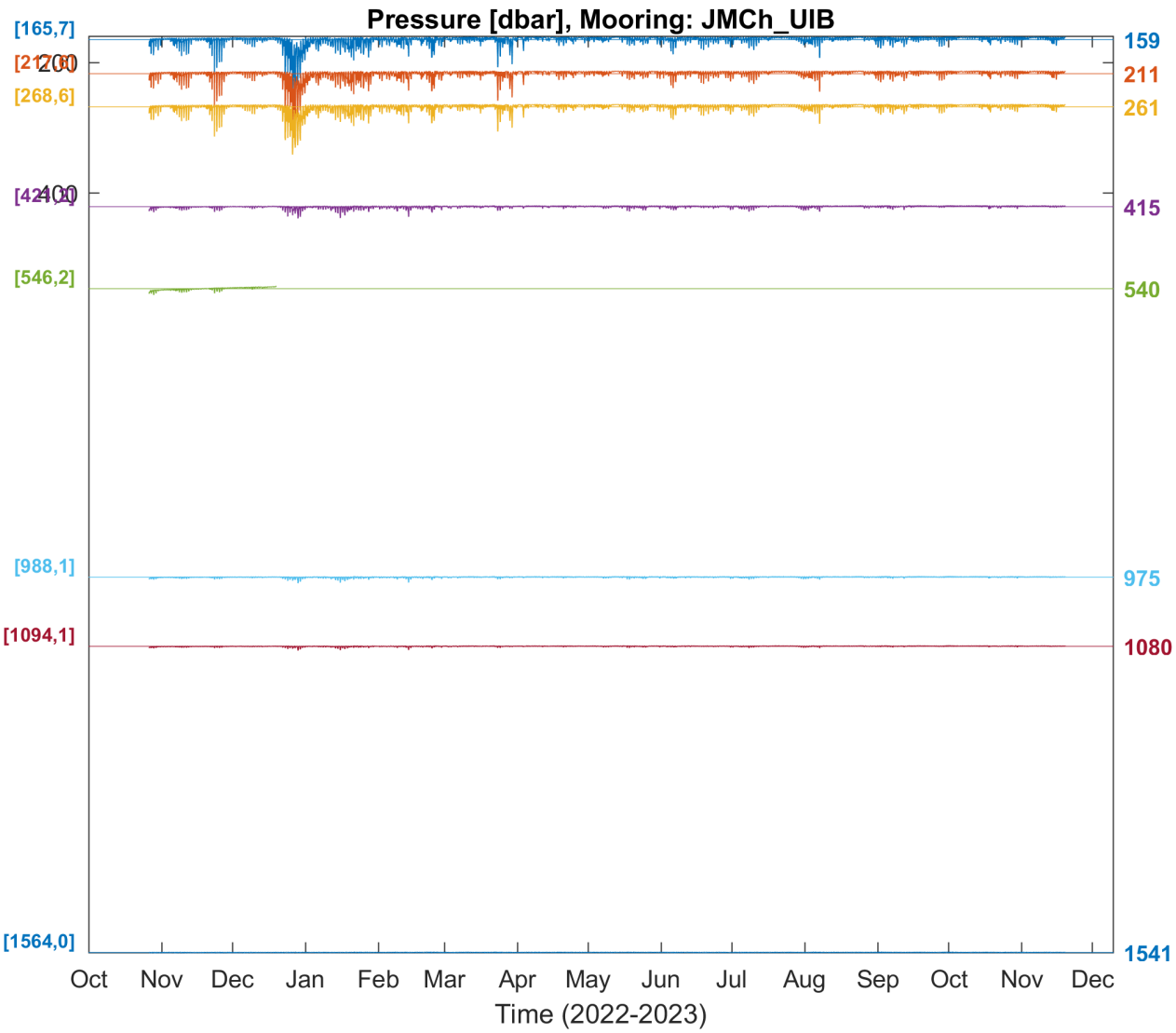

Figure 10. Time series of pressure. Numbers on the right (and the reference line) are the target depths. Numbers on the left show the time-averaged and 1 standard deviation values for the pressure records.

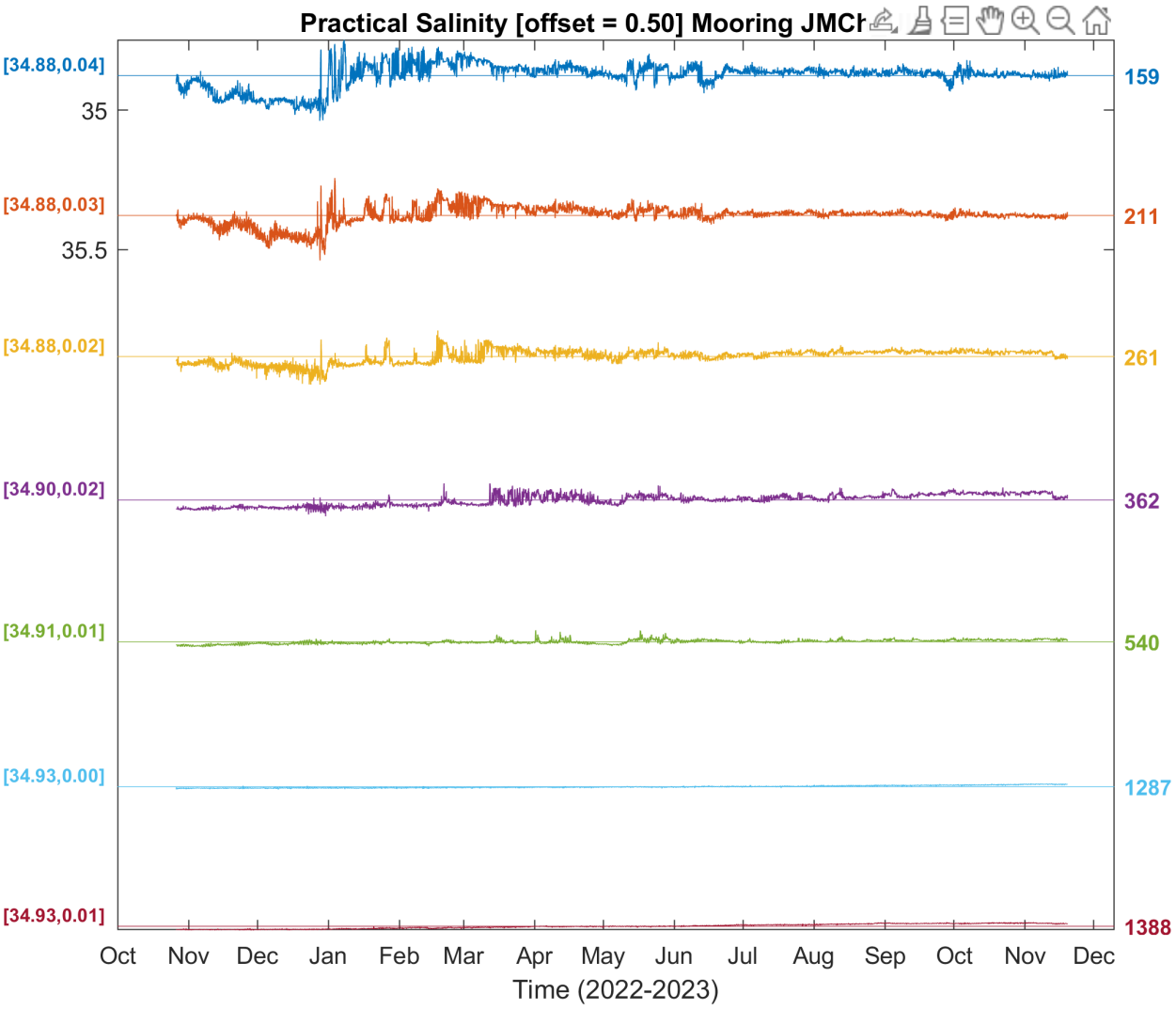

Figure 11. Time series of salinity. Numbers on the right (and the reference line) are the target depths. Numbers on the left show the time-averaged and 1 standard deviation values for the salinity records. The salinity records are shifted vertically by an offset of 0.50 for visualization purposes.

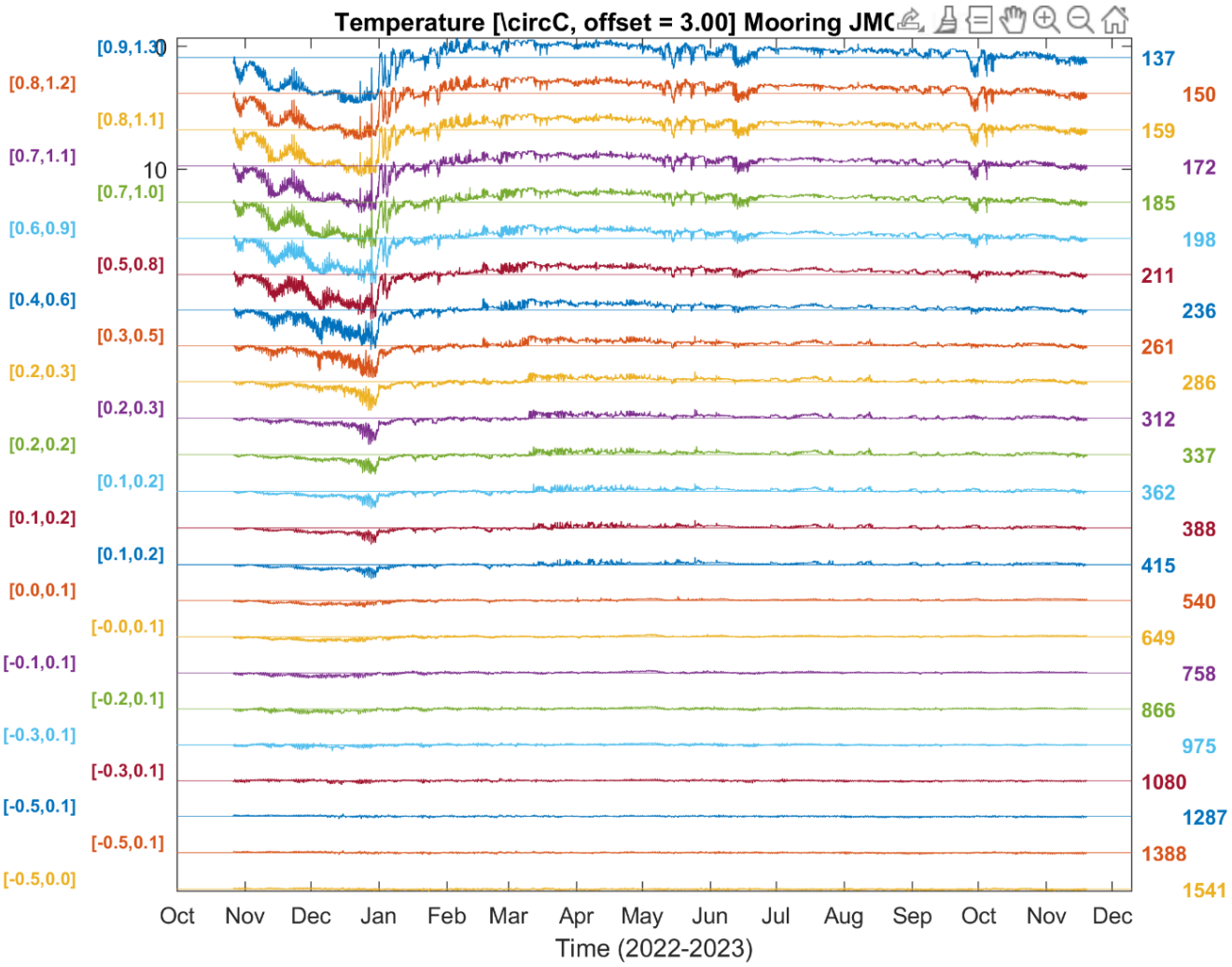

Figure 12. Time series of temperature. Numbers on the right (and the reference line) are the target depths. Numbers on the left show the time-averaged and 1 standard deviation values for the temperature records. The temperature records are shifted vertically by an offset of 3.00˚C for visualization purposes.

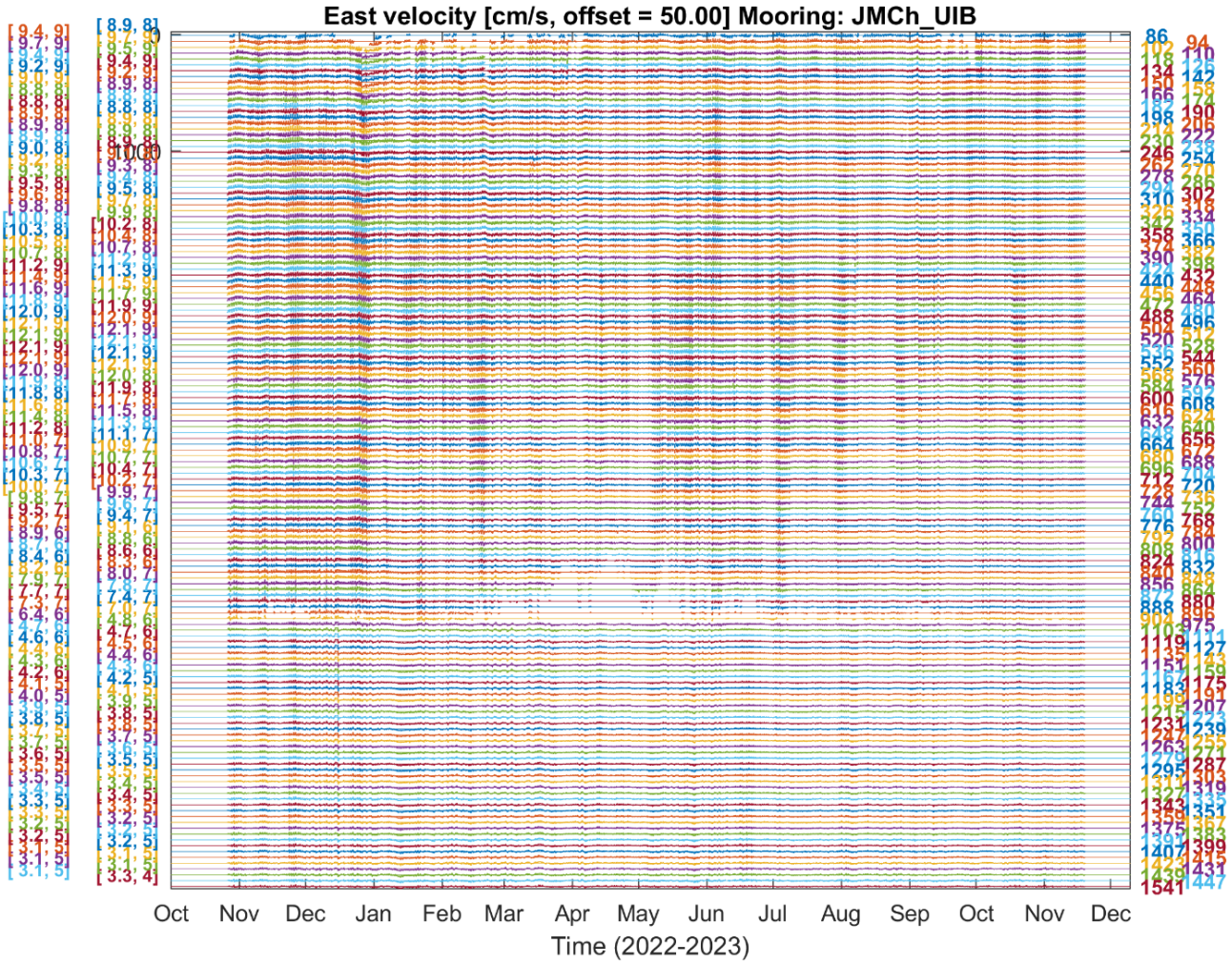

Figure 13. Time series of eastward velocity. Numbers on the right (and the reference line) are the target depths. Numbers on the left show the time-averaged and 1 standard deviation values for the velocity records. The velocity records are shifted vertically by an offset of 50.00 cm/s for visualization purposes.

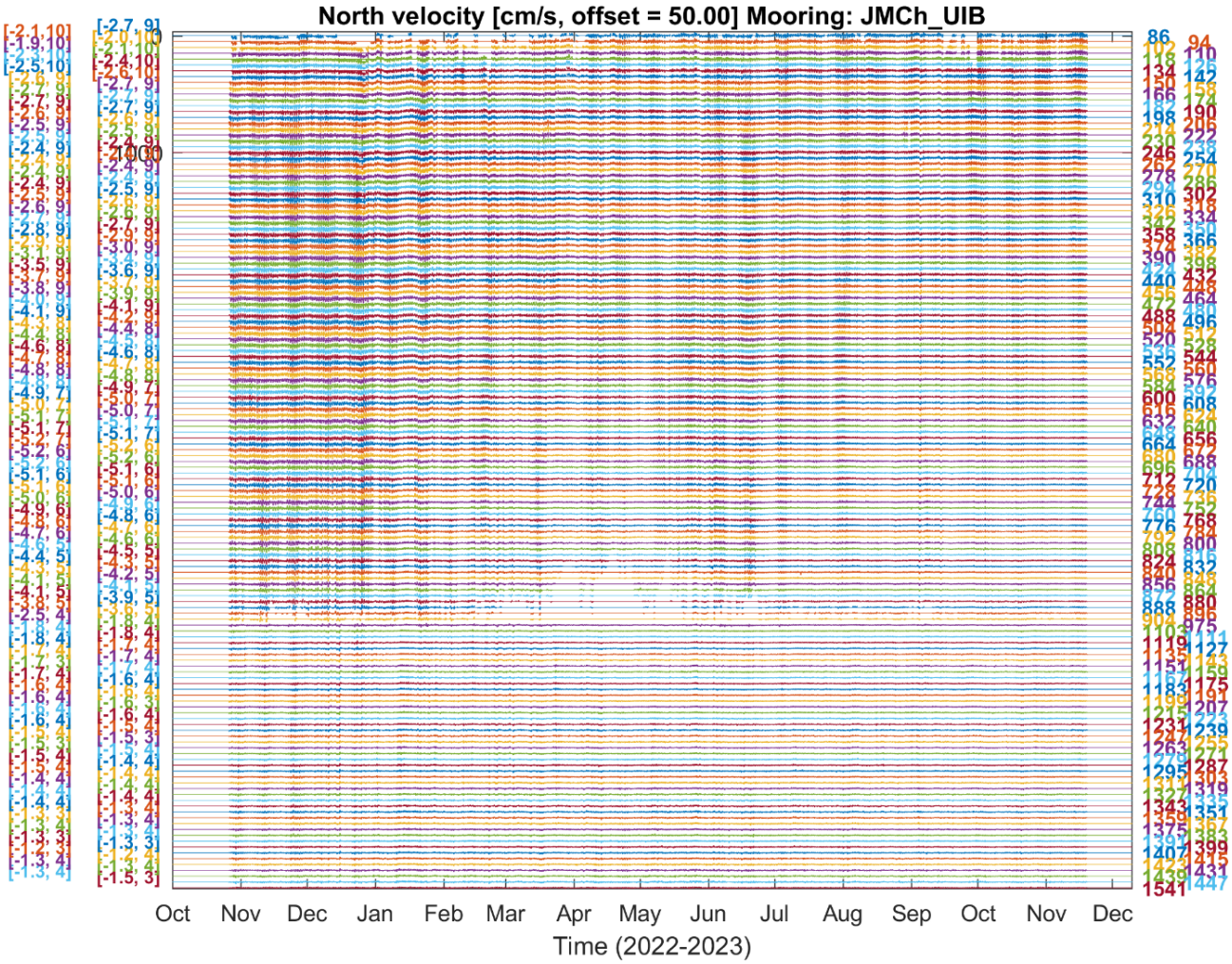

Figure 14. Time series of northward velocity. Numbers on the right (and the reference line) are the target depths. Numbers on the left show the time-averaged and 1 standard deviation values for the velocity records. The velocity records are shifted vertically by an offset of 50.00 cm/s for visualization purposes.

9 Overview plots from the instrument data files

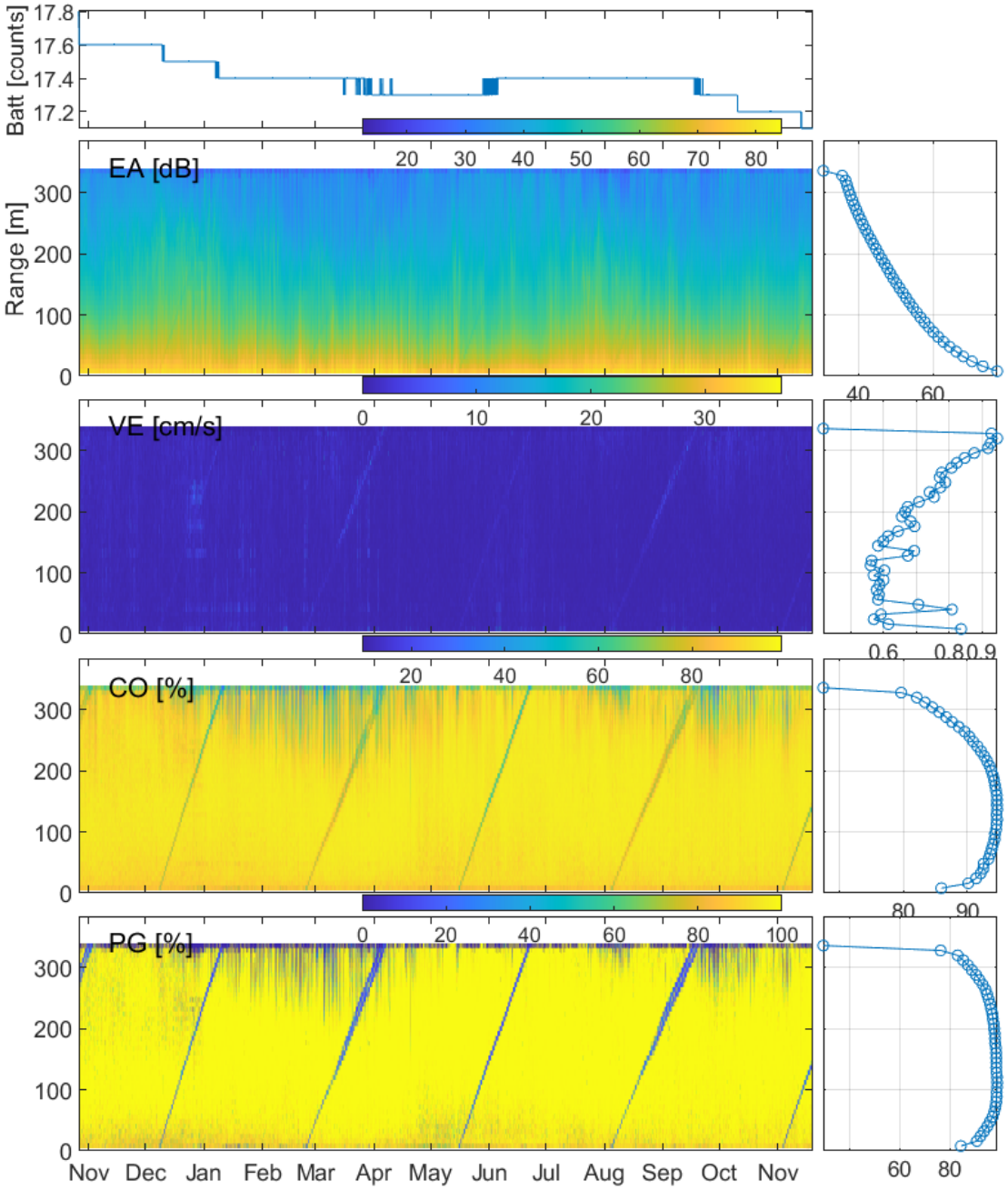

Figure 15. Time series of battery, average echo amplitude (EA), error velocity (VE), average correlation (CO), and percent good (PG) for **Nortek instrument SN100756**. The panels on the right show the time-averaged distribution.

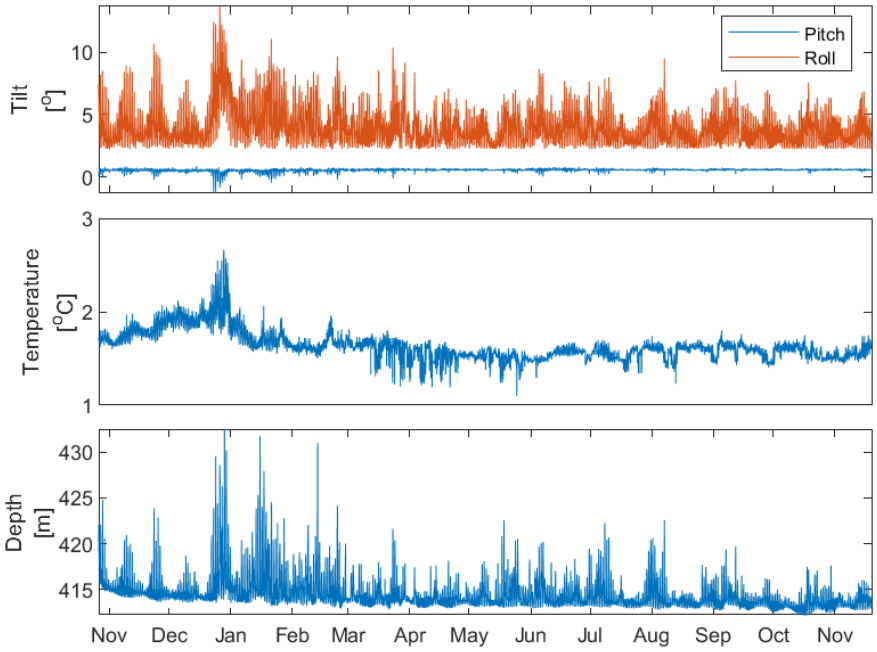

Figure 16. Time series of tilt (pitch and roll), temperature, and depth for **Nortek instrument SN100756**.

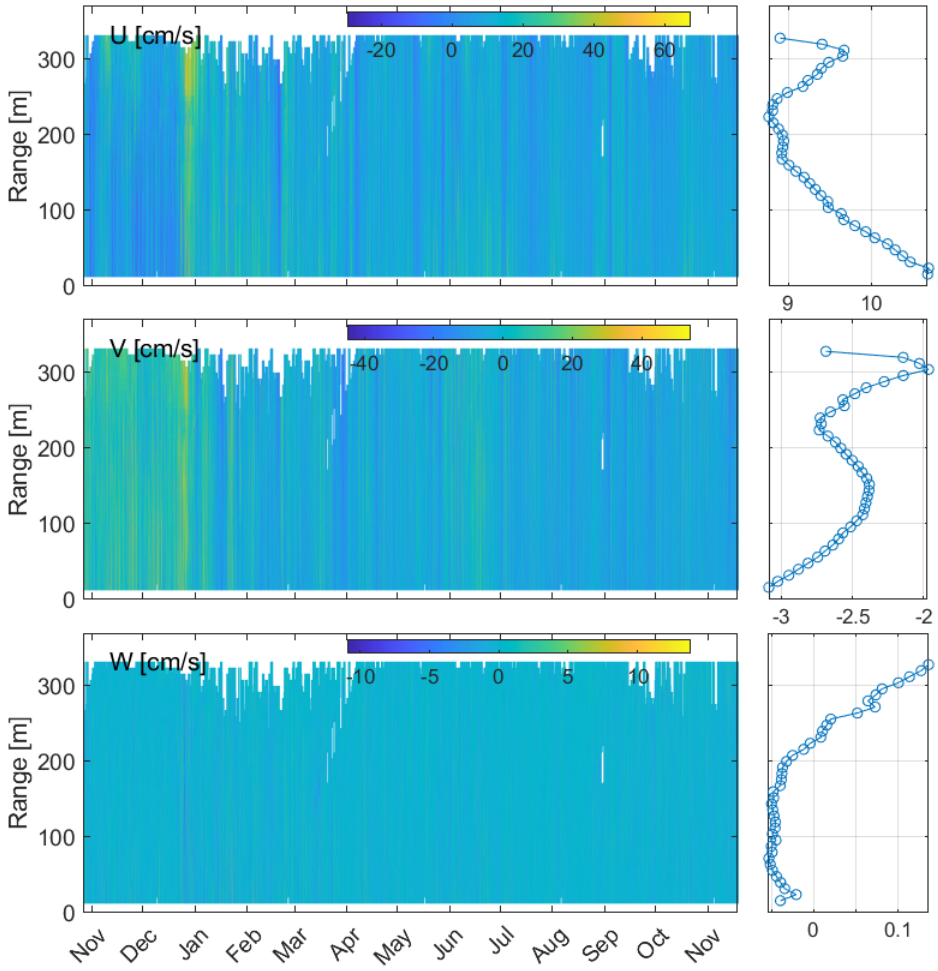

Figure 17. Time series of the eastward (U), northward (V), and vertical (W) velocity components after quality control and interpolation were performed for **Nortek instrument SN100756**. The panels on the right show time-averaged profiles.

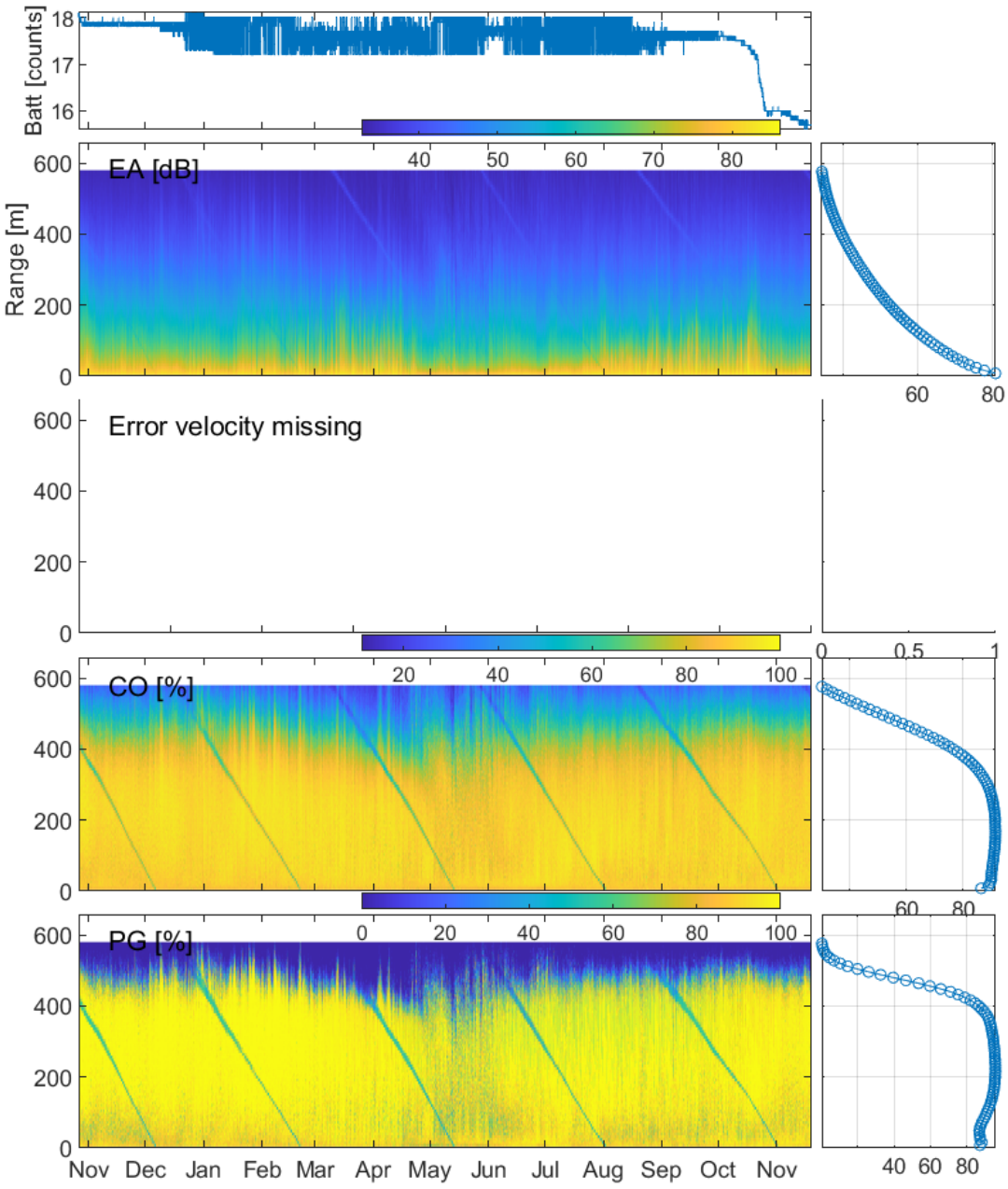

Figure 18. Time series of battery, average echo amplitude (EA), error velocity (missing), average correlation (CO), and percent good (PG) for **Nortek S55 instrument SN200067**. The panels on the right show the time-averaged distribution.

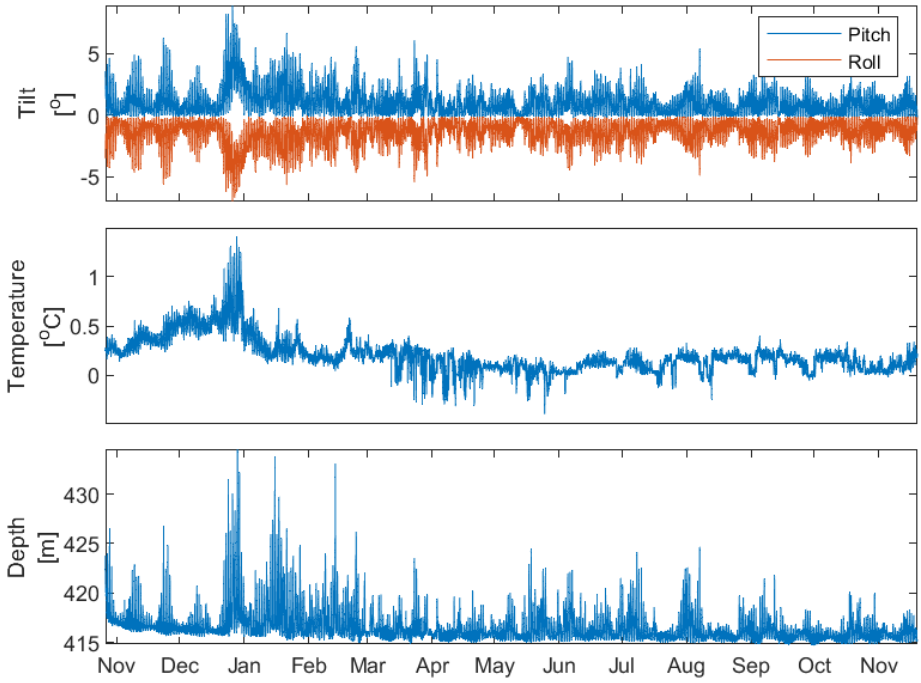

Figure 19. Time series of tilt (pitch and roll), temperature, and depth for **Nortek S55 SN200067**.

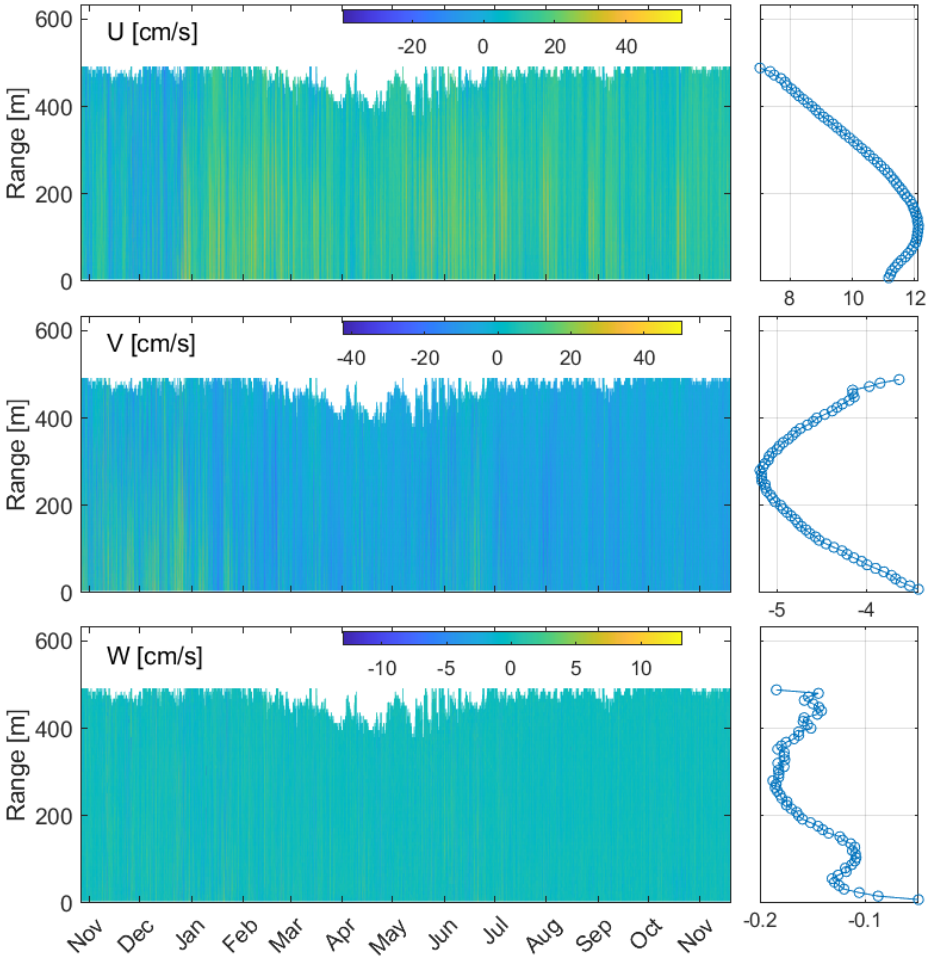

Figure 20. Time series of the eastward (U), northward (V), and vertical (W) velocity components after quality control and interpolation were performed for **Nortek S55 instrument SN200067**. The panels on the right show time-averaged profiles.

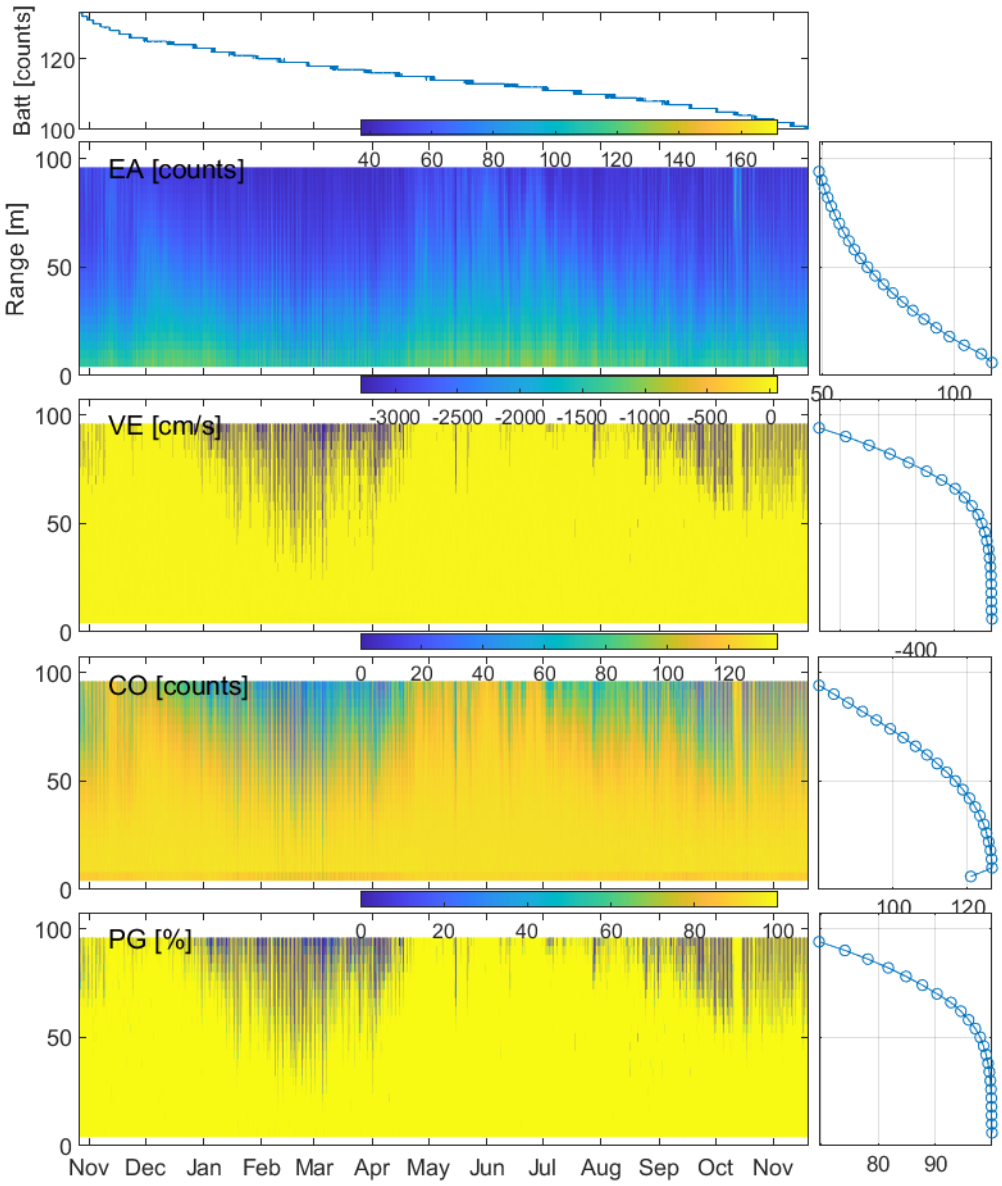

Figure 21. Time series of battery, average echo amplitude (EA), error velocity (VE), average correlation (CO), and percent good (PG) for **RDI 300kHz instrument SN17319**. The panels on the right show the time-averaged distribution.

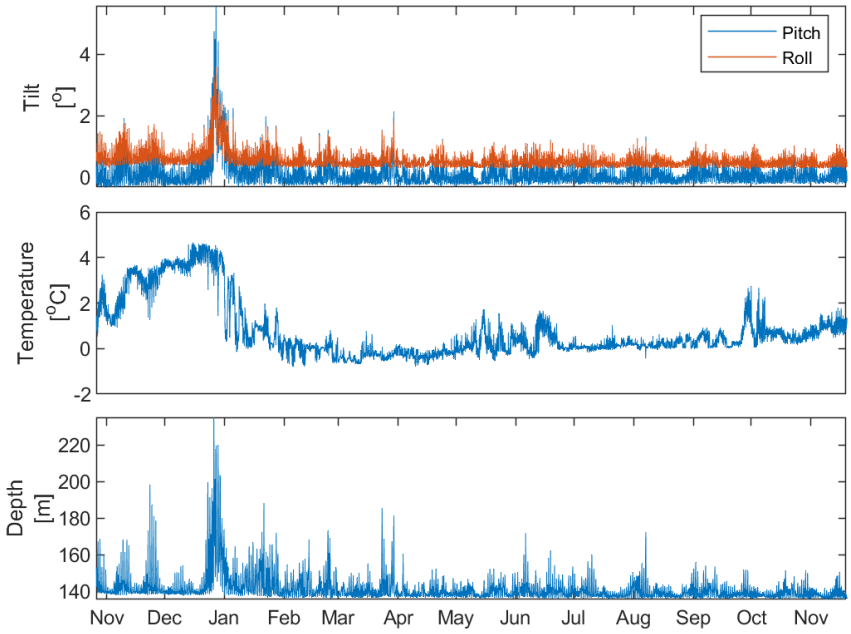

Figure 22. Time series of tilt (pitch and roll), temperature, and depth for **RDI 300kHz instrument SN17319**.

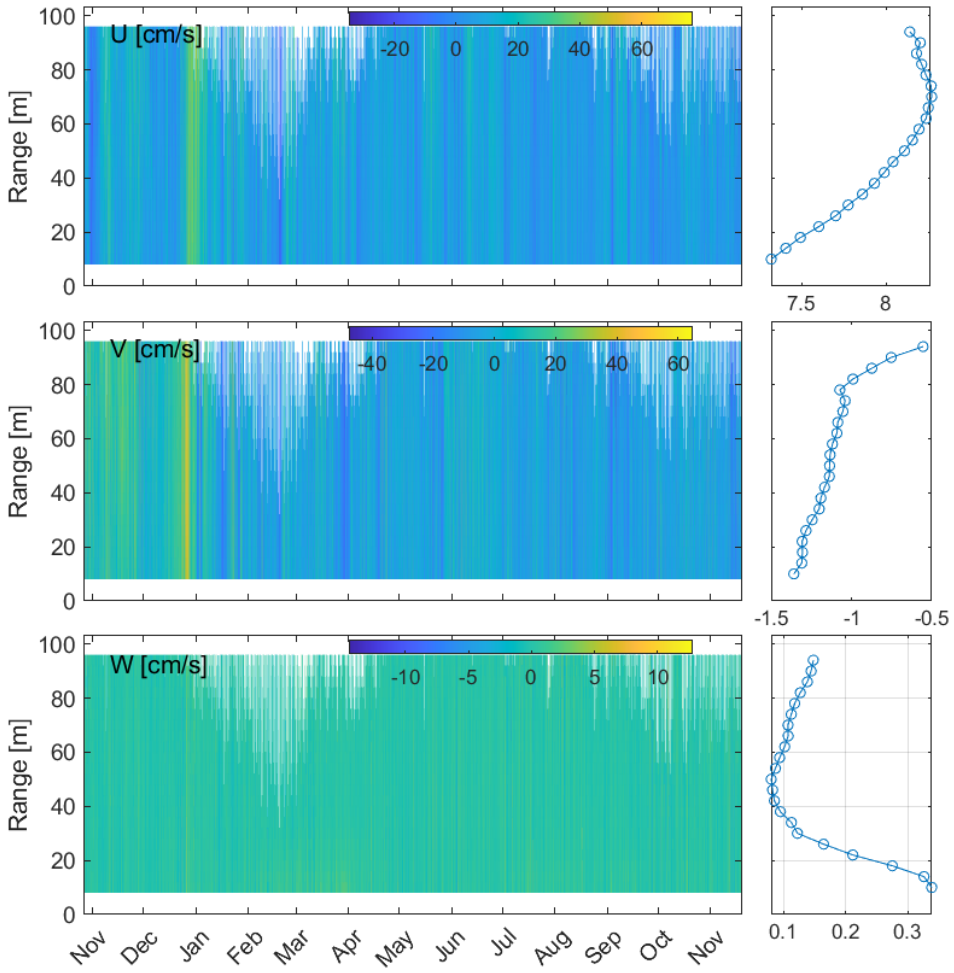

Figure 23. Time series of the eastward (U), northward (V), and vertical (W) velocity components after quality control and interpolation were performed for **RDI 300kHz instrument SN17319**. The panels on the right show time-averaged profiles.

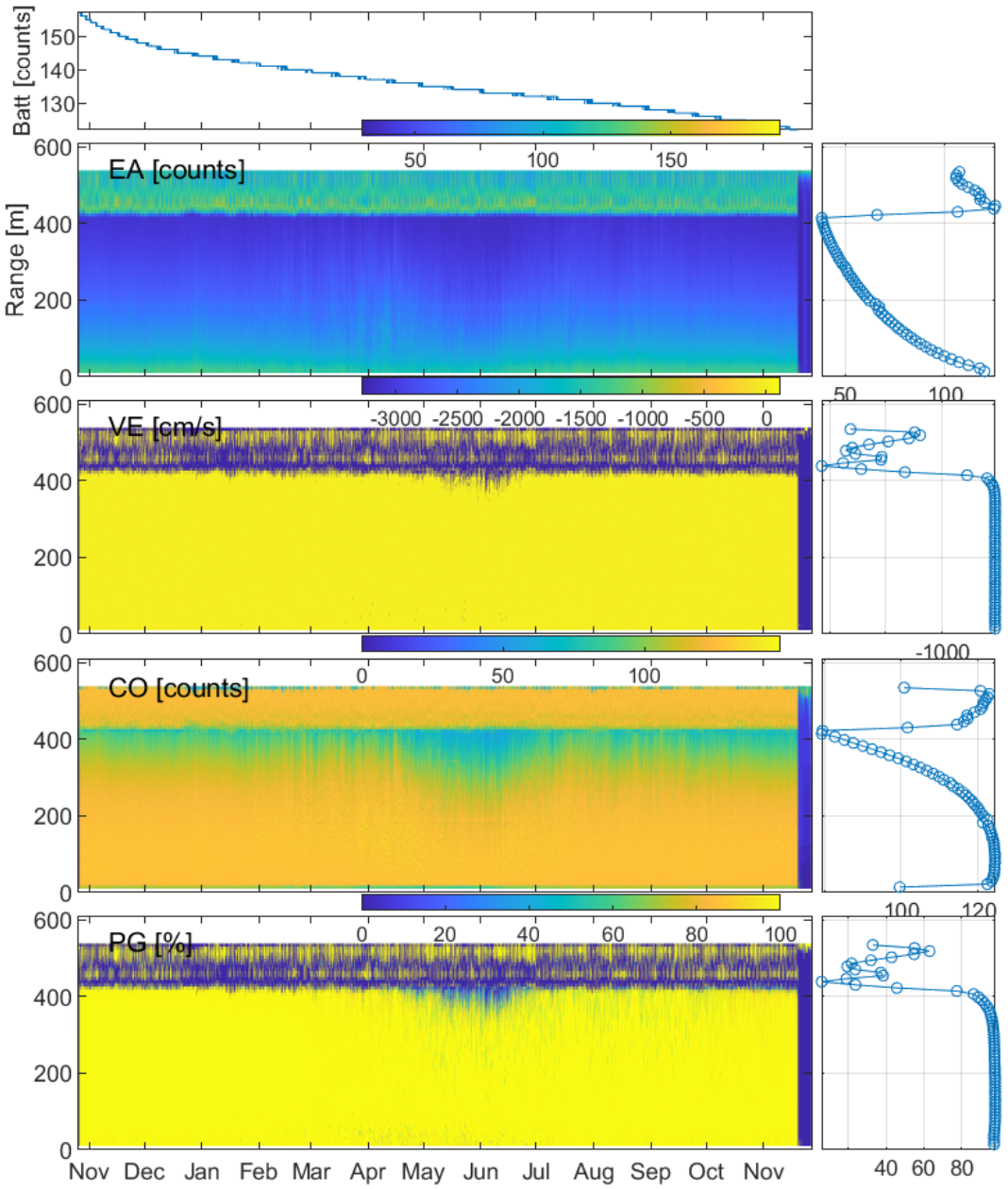

Figure 24. Time series of battery, average echo amplitude (EA), error velocity (VE), average correlation (CO), and percent good (PG) for **RDI 75kHz instrument SN18447**. The panels on the right show the time-averaged distribution.

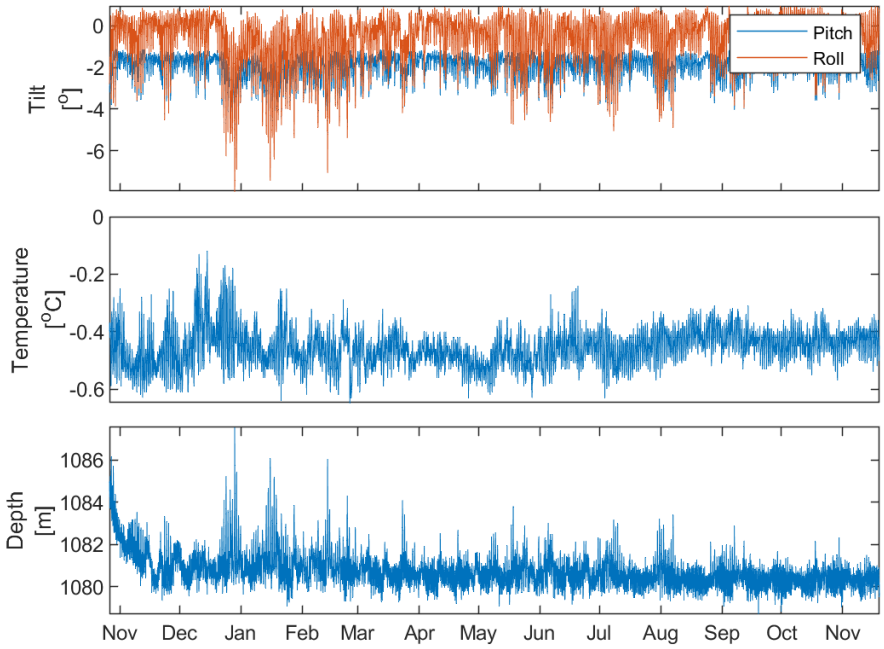

Figure 25. Time series of tilt (pitch and roll), temperature, and depth for **RDI 75kHz instrument SN18447**.

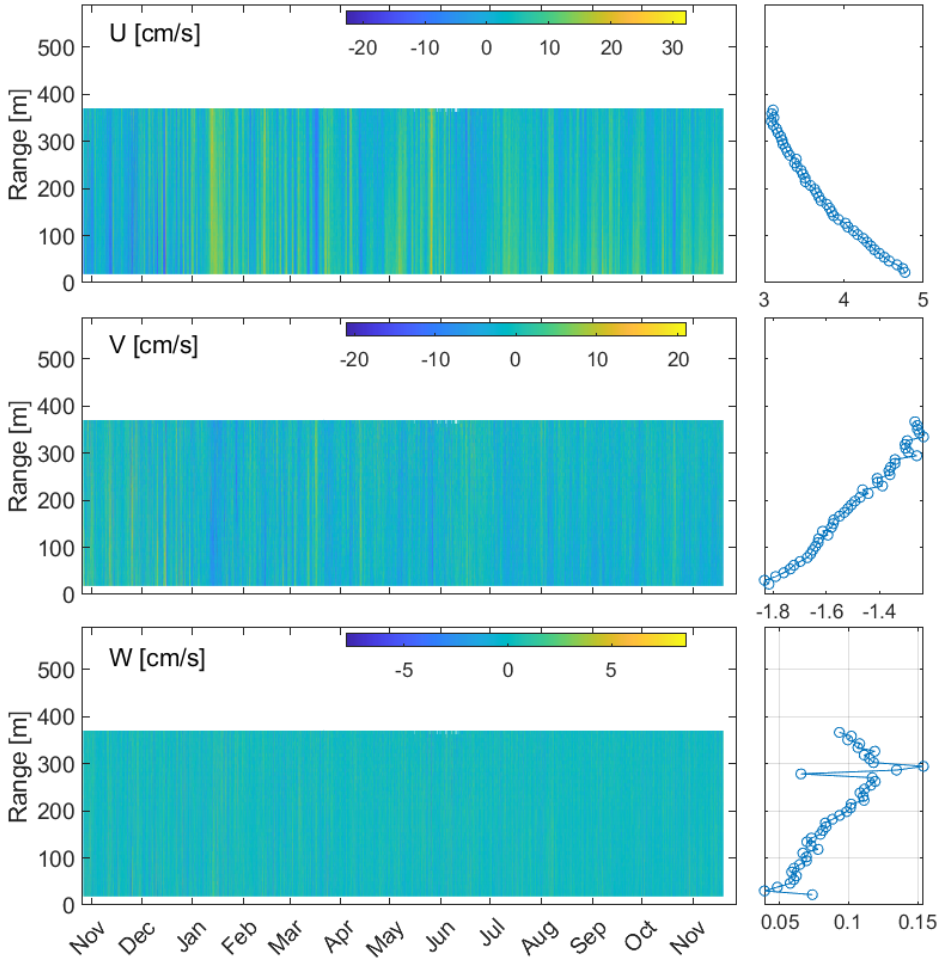

Figure 26. Time series of the eastward (U), northward (V), and vertical (W) velocity components after quality control and interpolation were performed for **RDI 75kHz instrument SN18447**. The panels on the right show time-averaged profiles.

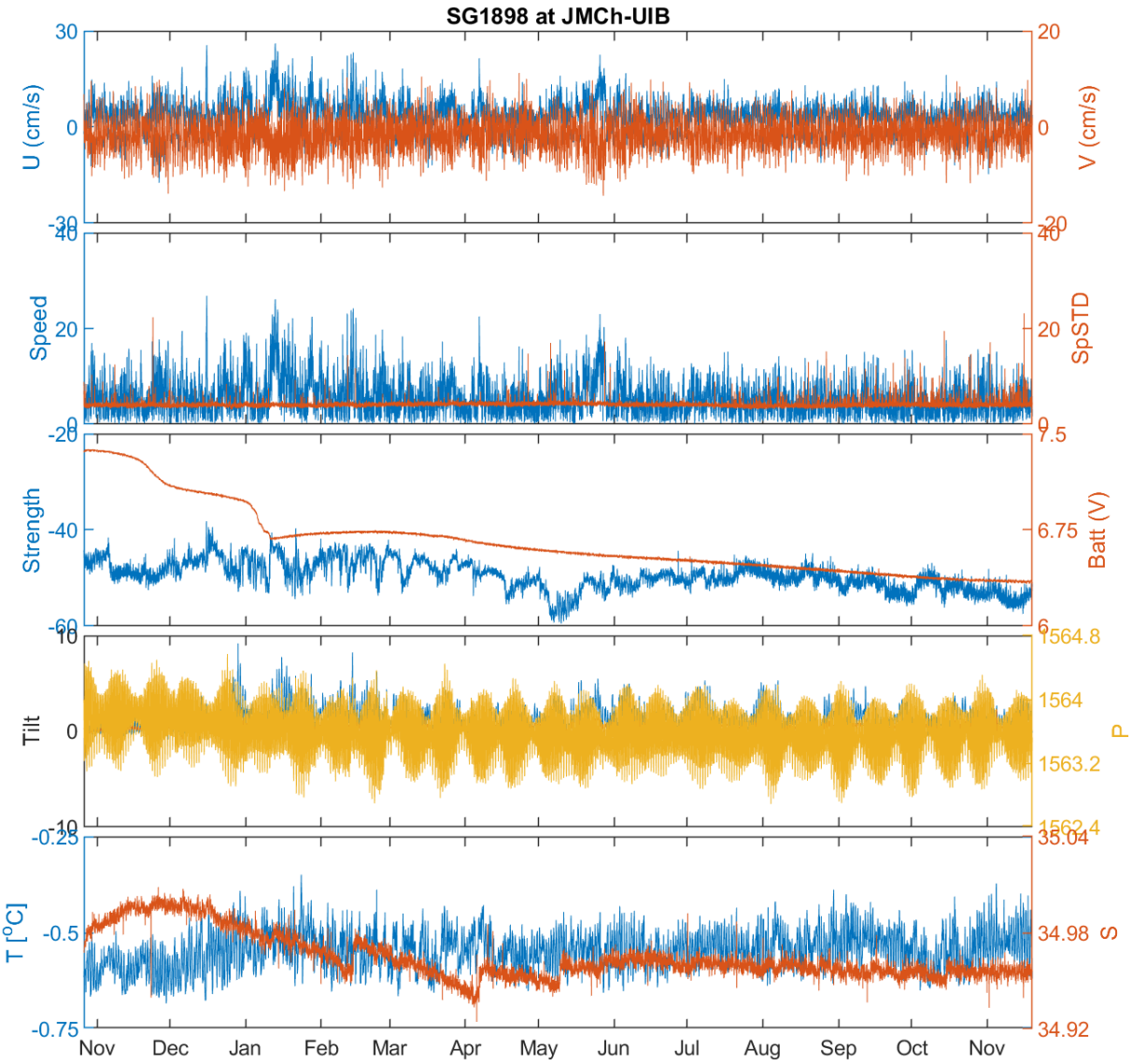

Figure 27. Time series of eastward (U) and northward (V) velocity, speed and its standard deviation (SpSTD), strength in dB and battery voltage, tilt and pressure (P), temperature (T) and salinity (S) for **Seaguard instrument SN 1898**.

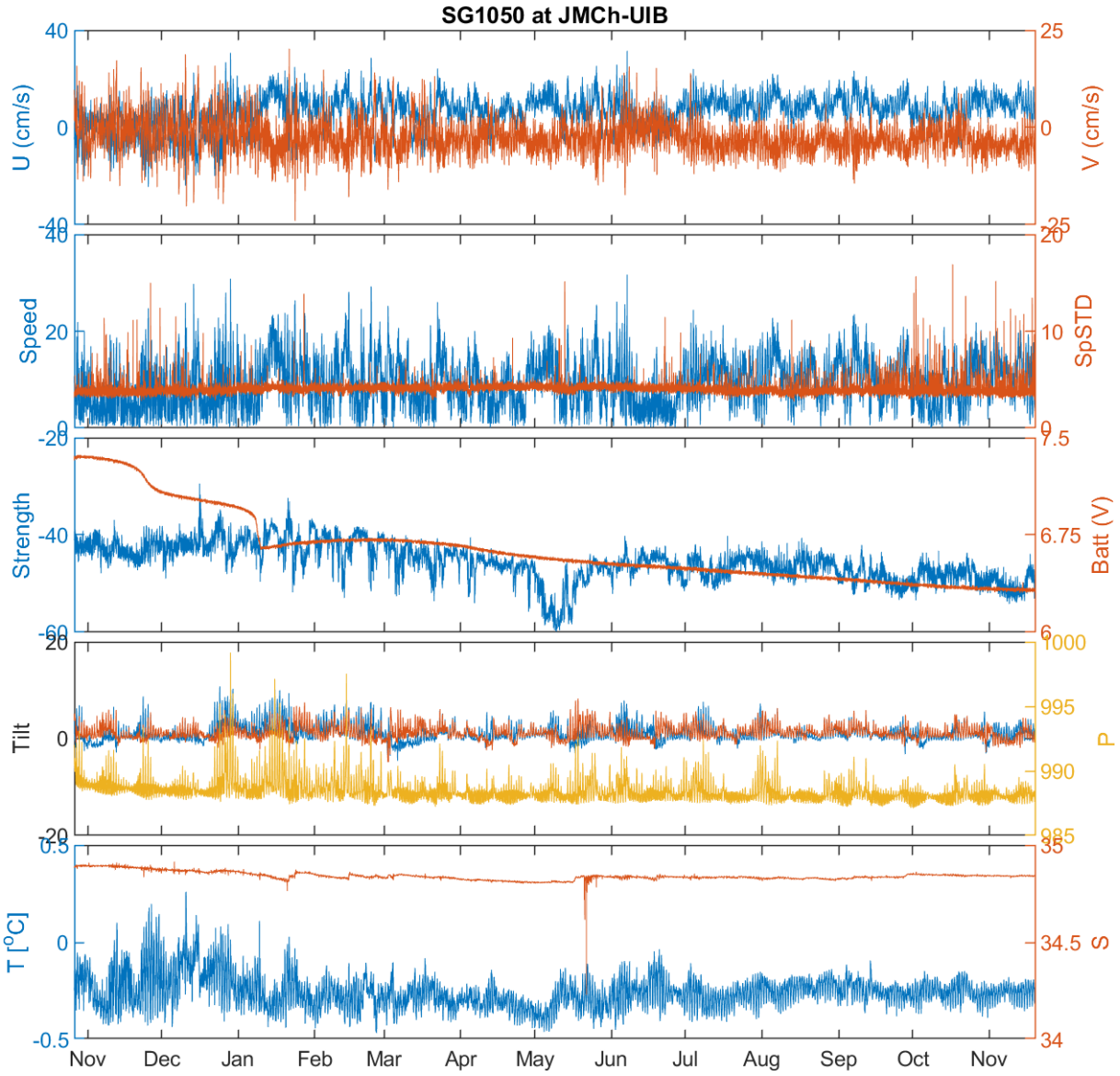

Figure 28. Time series of eastward (U) and northward (V) velocity, speed (cm/s) and its standard deviation (SpSTD), strength in dB and battery voltage, tilt and pressure (P), temperature (T) and salinity (S) for **Seaguard instrument SN 1050**.