Mooring data from M1 and M2, 2020-2021

Version 1

Øyvind Foss[1,*] (oyvind.foss@npolar.no), Arild Sundfjord[1] (arild.sundfjord@npolar.no)

[1] Norwegian Polar Institute, Tromsø, Norway

Version history of this document:

Version 1 *(07.6.2024): Only RBR (T, CTD) sensors included.*

---

*Previously Lundesgaard

Introduction

This document details the processing of the third deployment (2020-2021) of the Nansen Legacy M1 and M2 moorings in the northwestern Barents Sea. Details of the previous deployments (2018-2019 and 2019-2020) can be found in the document *M1_M2_data_processing_details_2018_2020.pdf*. This document is intended as a supplement to the 2018-2020 document.

Data doi: https://doi.org/10.21334/npolar.2022.1a68b156

Data overview

This document deals with data from the third deployments of two ocean moorings, *M1* and *M2*. The moorings operated in the northern Barents Sea since October 2018 as part of the Nansen Legacy observational program. See Table 1 and Appendix I for the exact instrumentation, locations, and deployment dates of the moorings.

We will occasionally refer to the individual mooring deployments as, e.g., *M1-3* (M1 mooring, third deployment).

Both moorings were equipped with ADCPs measuring ocean currents, and temperature and conductivity-temperature-pressure sensors at various points along the mooring line, as well as other instrumentation not discussed further here.

The M2-3 mooring was deployed on 24.09.2020 during the KPH2020706 cruise led by the Institute of Marine Research. The M1-3 mooring was deployed in 20.02.2021 on the Nansen Legacy Winter Process cruise *KPH2021702* (Nilsen et al., 2021). There is a ~5 month data gap between the recovery of M1-2 and the deployment of M1-3. Both M1-3 and M2-3 were recovered during the KPH2021713 cruise in November 2021 (Renner et al., 2022).

The Norwegian Polar Institute is the owner of all the instrumentation described in this document, and was responsible for data processing and documentation. Data are made globally available under a CC-BY 4.0 license.

The M1 mooring will continue to supply additional data with deployments after M1-3. The M2 mooring was discontinued after M2-3.

Processing

RBR instruments (C, T, p)

Laboratory calibration of the sensors were performed by RBR before and after deployment. Pre-deployment calibration coefficients were programmed into the instruments before deployment.

Data return

RBR returned complete records with the following exceptions:

- Concerto 204985 (M1-3, 25 m nominal depth) did not record any data.

- The record from Concerto 60601 (M2-3, 130 m average depth) exhibited data gaps from 21.07.21, and stopped recording altogether after 15.08.21. Only data up until 21.07.21 are included here.

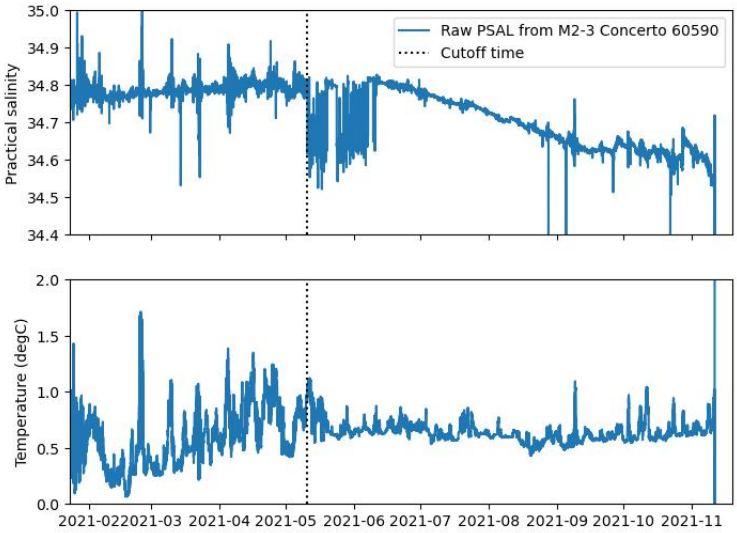


Figure 1: Practical salinity and teperature from Concerto 60590 near 350 m depth at M2-3. Salinity data from after 10.05.2021 (black line) are not included in the processed dataset.

- The salinity record from Concerto 60590 (M2-3, 350 m nominal depth) exhibits a long period of negative salinity outliers starting around 10.05.21 (Figure 1). The outlier period ended in early June; however, after this period, the salinity record shows a steady negative drift that was deemed indicative of a potential issue with the salinity sensor. Salinity data after 10.05.21 are not included in the processed dataset.

Assigning depth to RBR Solo sensors

As with previous deployments, RBR Solo depths were estimated by interpolation between adjacent RBR Concerto sensors. For M2-3, observed RBR Concerto depths deviated greatly from nominal depths (by as much as 35 m in no consistent direction; Table 1). Since this indicates that the mooring was different from the setup indicated in the mooring diagram, we cannot estimate the depth of RBR Solos, and have therefore not included M2-3 Solos in the final dataset. RBR Concertos, which have an onboard pressure sensor, are not affected. At M1-3, RBR Solo depths were assigned, giving median depths between 4 to 12 m of nominal depth.

Processing

RBR data were processed similarly to the two previous deployments (see 3.1.2-3.1.4 of M1_M2_data_processing_details_2018_2020.pdf). Instead of using the *Ruskin* software, the Python package pyRSKtools (v1.1.1) was used to read the data from the original .rsk files.

Outlier removal and running median filter were applied to salinity records. Condictivity was left unedited - users can produce unedited salinity from the conductivity, temperature and pressure records.

Processed data was calculated based on linear drift from pre-to post-deployment calibration coefficients. In general, we found small differences between values calculated using post-and pre-deployment calibration coefficients.

Table 1: Overview of M1 and M2 with depths of moored CTP instruments. Conc: RBR Concerto (CTP), Solo: RBR Solo (T), Nominal depths (D_{NOM}) in meters read from mooring diagrams. True depth, D_{OBS} is median depth (m) calculated from pressure after removing deployment/recovery. For the Solos, D_{OBS} is assigned based on interpolation between adjacent Concertos with pressure sensors. The Range column shows the estimated range (m) of the median depth of RBR Solos.

M1-3: 20.02.2021 - 10.11.2021, *79°35.325'N 28°5.303'E,* 265 m depth			
Instrument	**D_{NOM}**	**D_{OBS}**	**Comment**
Conc #201415	20	19.1	
Conc #204985*	25	-	NO DATA
Solo #102494	55	58.7	
Conc #204982	89	97.2	
Solo #102490	149	158.3	
Conc #204979	170	179.7	
Solo #102484	209	220.7	
Conc #204986	242	255.4	

M2-3: 24.09.2020 - 11.11.2021, *79°40.536'N, 32°18.884'E,* 360 m depth			
Instrument	**D_{NOM}**	**D_{OBS}**	**Comment**
Conc #60599◎	30	21.8	
Conc #66090*◎	33	29.6	With optical sensors
Solo #102485	63		Unknown depth□
Conc #60601△	95	129.9	
Solo #102483	165		Unknown depth□
Conc #60593◎	215	180.4	
Solo #102479	277		Unknown depth□
Conc #60590•	350	346.2	

** Concerto with Chl and PAR sensors (no post-deployment calibration available). Optical sensor data not included here.*

△ Record ends on 15.08.2021.

□Unable to assign instrument depth - record not included.

◎Ad-hoc correction applied to salinity near the end of the record.

•Salinity record after 10.05.21 not included (potential instrument issues).

Post-recovery CTD comparison of M1 sensors

For M1, a calibration shipboard CTD cast was performed after recovery of the moorings to account for possible data drift. All RBR Concertos were attached to the ship CTD rosette and lowered down to around 300 m depth. The ship CTD readings were then compared with the RBR Concerto readings as a quick quality check (Figure 2). Since the sensors were clamped to the rosette, metal components of the rosette frame may have influenced the reading of the inductive conductivity sensors of the RBRs - we therefore do not consider this a rigourous validation, but rather a sanity check that sensors had not drifted very far away from true values.

Salinity agreed to within approximately 0.02 of the SBE911+ sensors, with a spread of up to 0.03 between RBR sensors. We deem this aceptable given the above.

Pressure readings generally agreed well with the SBE911+. We consider the spread of up to 0.5 db to be acceptably small. It may also have been affected with between the various instruments were positioned at different locations on the rosette.

Temperature readings aligned well with the ship CTD and the spread was <0.01 C.

No corrections were made to the M1-3 RBR data based on this comparison.

Comparison between mooring measurements and CTD profiles collected around recovery of the mooring are shown in Figure 2. We find good agreement in light of the large degree of temporal variability (as evidenced by large differences between CTD profiles collected on the same day).

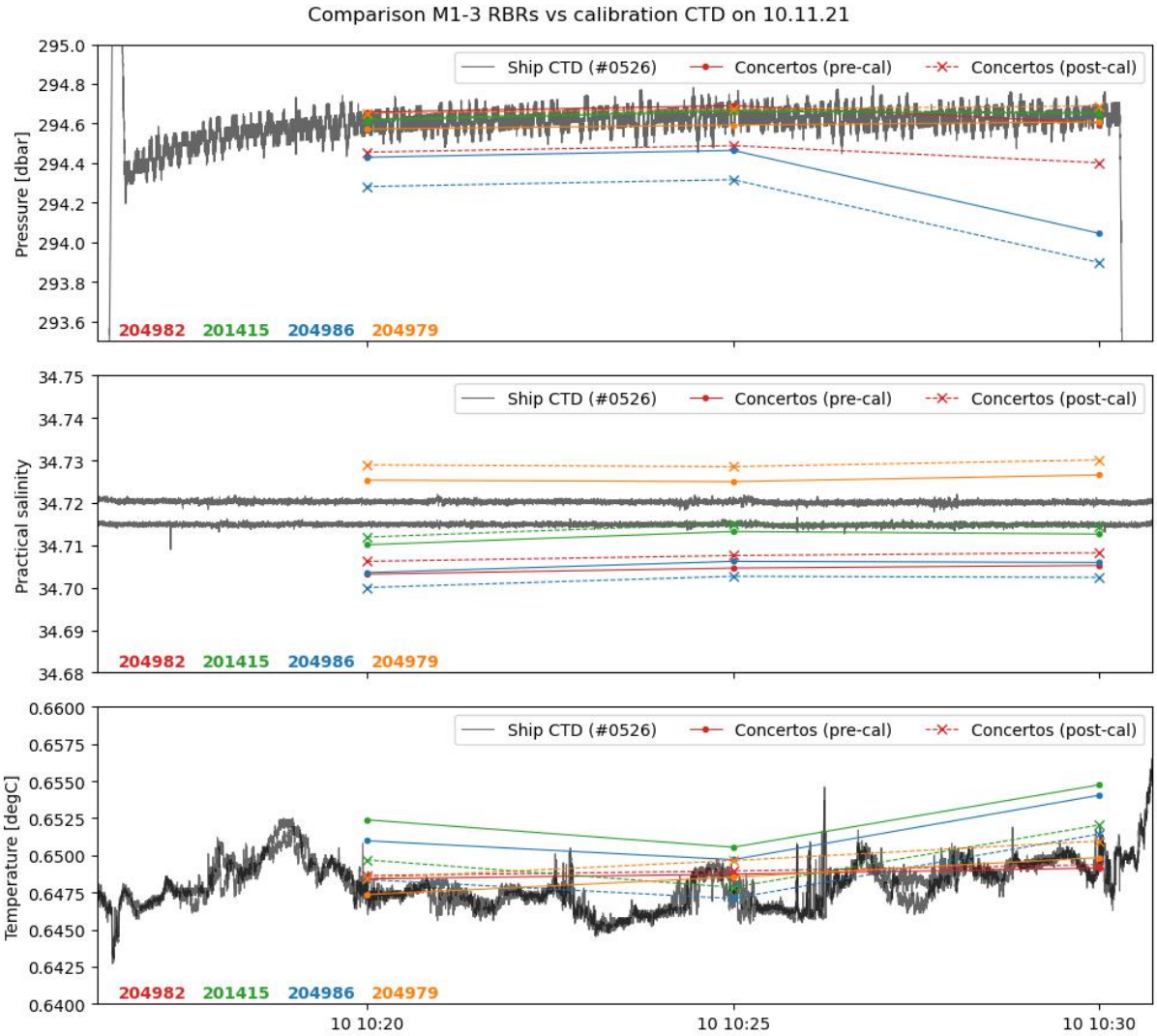


Figure 2: Comparison of RBR Concerto and Ship SBE911+ CTD readings from a CTD cast where RBR sensors were mounted on the ship rosette. RBR Concerto values are shown calculated with pre- (circles, full lines) and post-deployment (x, dashed lines) coefficients. The SBE911+ had dual sensors for salinity and temperature, both are shown here.

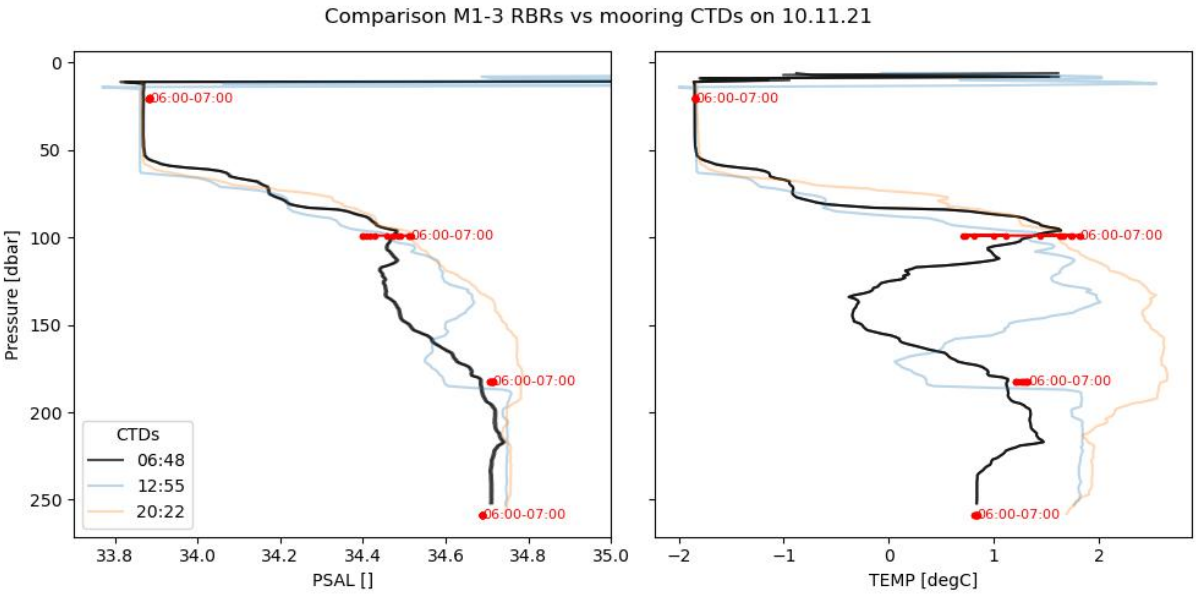


Figure 3: Comparison of salinity (left) and temperature (right) profiles collected using the shipboard SBE911+ CTD and RBR Concerto CTDs on the M1-3 mooring. Red dots show RBR Concerto measurements collcted between 0600 and 0700. Black profiles shows SBE911+ profiles collected before recovery. Blue and orange profiles were collected near the same location on the same day after recovery of M1-3.

Post-recovery CTD comparison and correction of M2 sensors

Comparison of M2-3 RBR Concerto values and recovery SBE911+ CTD profiles revealed offsets between the profile and salinity measured by the RBR Concerto upon recovery (Figure 3). Ad-hoc corrections were applied to salinity records from the three[1] sensors whose records extended through recovery, with a positive salinity offset increasing linearly from zero between a specified date to a value aligning it with the ship CTD profile upon recovery (Table 3).

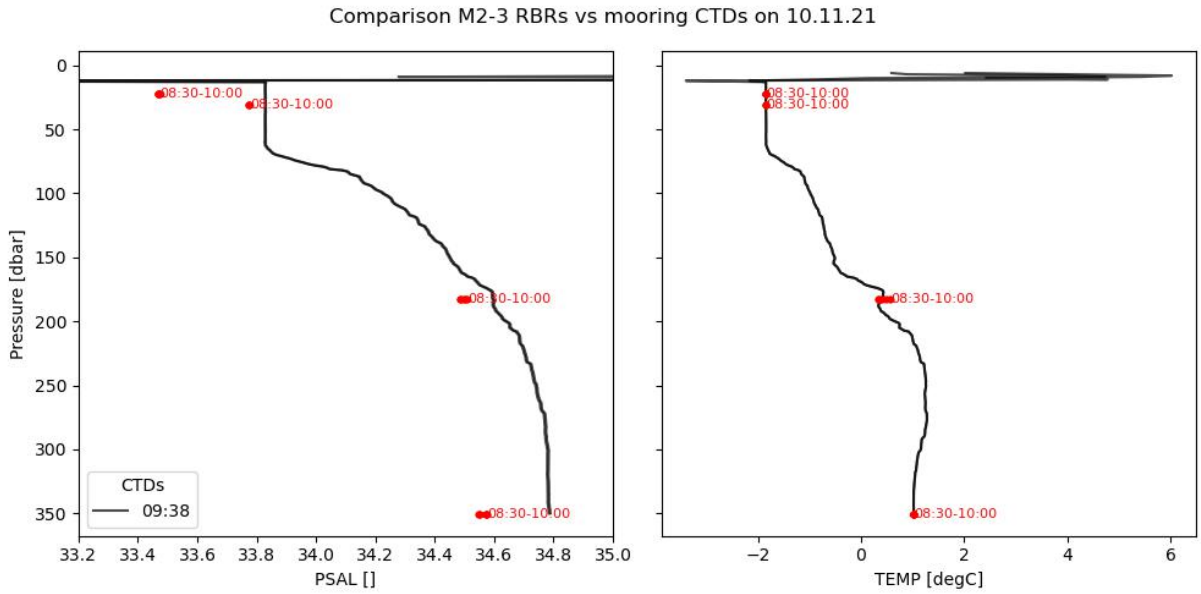


Figure 4: Comparison of salinity (left) and temperature (right) profiles collected using the shipboard SBE911+ CTD and RBR Concerto CTDs on the M1-3 mooring. Red dots show RBR Concerto measurements collcted between 0830 and 0700. Black profiles shows SBE911+ profile collected before recovery. Blue and orange profiles were collected near the same location on the same day after recovery of M1-3.

RBR Concerto sensor	Offset on recovery	Offset start date (00:00)
60599 (22 m)	0.360	19.08.2021
66090 (30 m)	0.057	19.08.2021
60593 (180 m)	0.115	15.07.2021

Table 2: Offsets applied to RBR Concerto salinity data from M2-3. Applied offsets linearly increased from zero on the the "offset start date" to the "offset on recovery" value on 11.11.21.

[1] *Salinity data from Concerto #60590 near 350 m depth was not included after 10.05.2021 (Figure 1), and no corrective salinity offset was therefore applied to this sensor.*

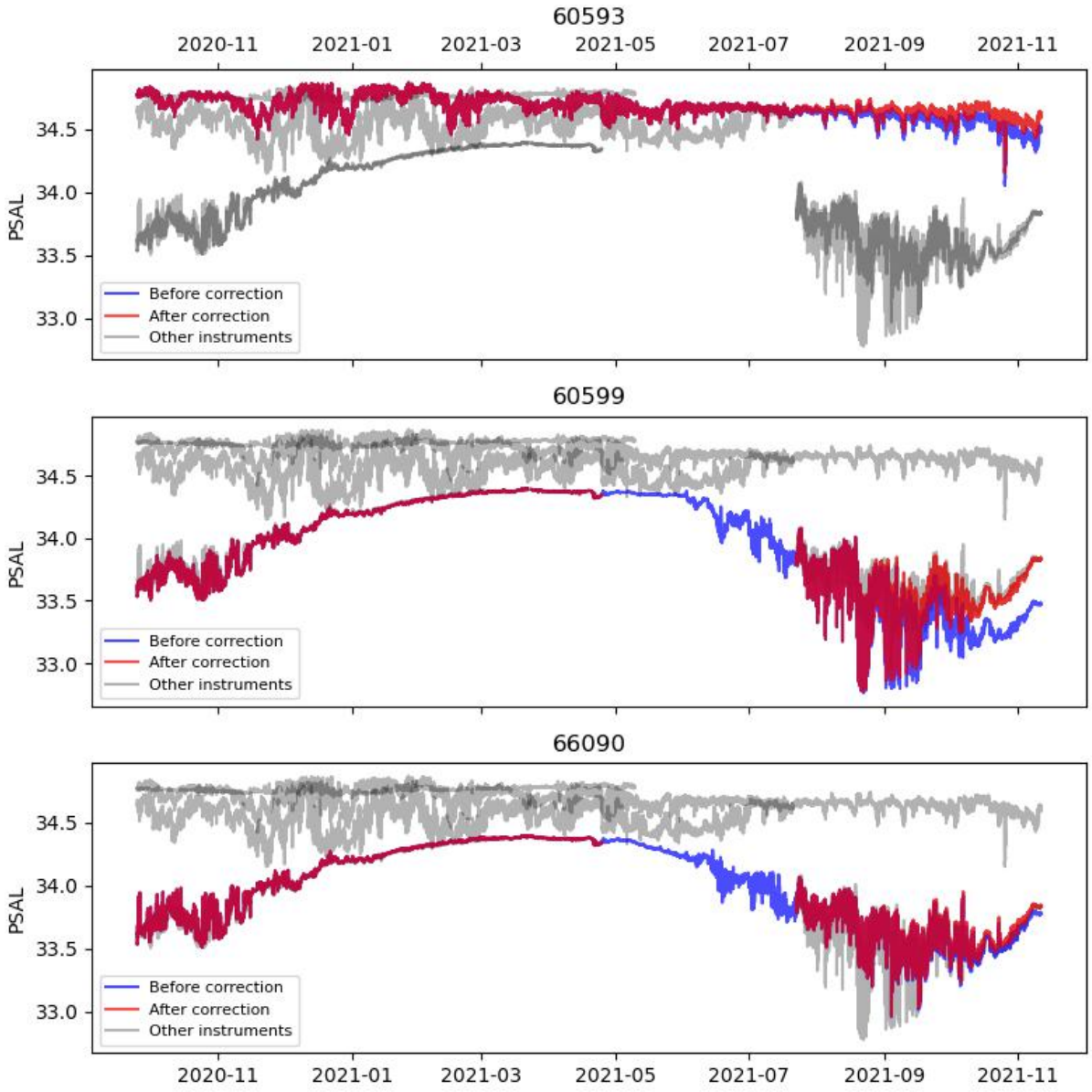


Figure 5: Salinity records from M2-3 concertos before (blue) and after (red) applying drift correction (Table 2). (Adjusted) salinity from the other sensors shown in gray.

Removal of salinity data from part of the records from the two uppermost sensors

When comparing the uppermost two Concerto sensors from M2-3 (#60599 near 22 m and #66090 near 30 m), we observe what seems to be a persistent static instability from late April to late June 2021 (Figure 5). The apparent instability is present both before and after correcting salinity.

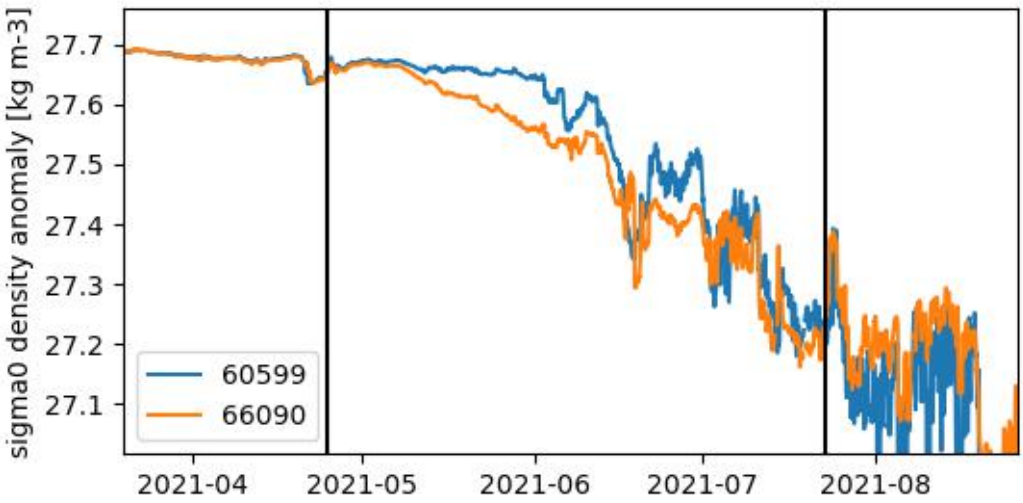
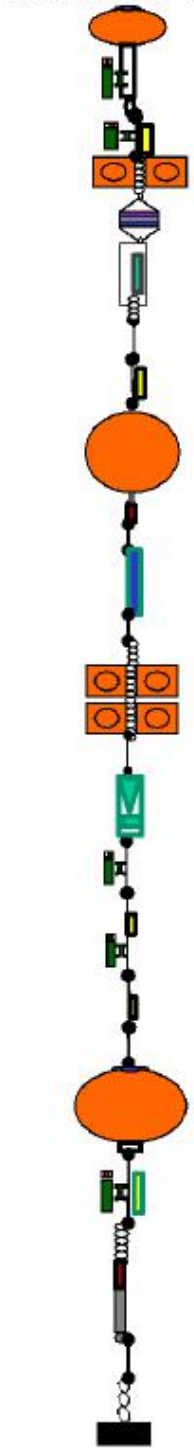


Figure 6: Density anomalies from the two to M2-3 sensors. #60599 is the upper sensor (near 22 m) and #66090 the lower (30 m). Black vertical lines indicate the period where salinity data were removed from both instrument records due to an apparent static instability.

While the large offset of sensor #60599 from shipboard profiles collected on recovery (Figure 4) might suggests that the issue was related to the upper sensor (60599), we cannot know which sensor was the source of this apparent instability. Moreover, typical conductivity issues due to biofouling etc typically result in *lower* salinity - which would point to the lower sensor (66090) as the culprit.

In sum, we cannot know which sensor may have experienced issues, and as a result, we have removed al salinity measurements during the period 25.04 through 23.07 from the processed data records from both these instruments. Other variables, including conductivity, have not been removed and observed salinity during this period can be recovered by calculating it from the C/T/P records (users doing this should be aware that there are potential issues with the data.

Appendix I: mooring diagrams



Rigg M1-3

Satt ut 20 .FEB .2021 , kl 19:00: 79 35.034 N 028 03.937 E

			Dyp:	Fra bunn:	Ut:
Nortek S500	SNR. 812		19	233	20:00
RBR Concerto	NR.201415		20	232	
SeaFET 2033, uCAT 22418			22	230	
2 Glasskuler i 1 m Kjetting galv.					
Sedimenteksperiment Nadjejda Espinel			24	228	
Concerto 204985 + ECO 5804			25	227	
0,5 m Kjetting galv.					
20 m Kevlar					
10 m Kevlar					
RBR SoloT	SNR. 102949		55	197	
HF36			56	196	
Svivel					
2 m Kevlar					
Aural Hvallyd	SNR. 288		60	192	
2 m Kjetting galv					
1 m Kjetting galv.					
4 Glasskuler i 2 m Kjetting galv.					
0,5 m Kjetting galv.					
20 m Kevlar					
McLane Sedim.	SNR. 14449-02		88	164	
RBR Concerto	SNR. 204982		89	163	
50 (51) m Kevlar					
RBR SOLO	SNR. 102490		149	113	
20 (21) + 10 m Kevlar					
RBR Concerto	SNR. 204979				
40 (41) m Kevlar			170	82	
RBR SOLO	SNR. 102476		209	43	
20 + 10 (11) m Kevlar					
ADCP150	SNR. 16493		240	12	
2 m Kevlar					
SeaPhox	SNR. 20172/2004		241	11	19:00
RBR Concerto	SNR. 204986				
		242	10	19:05	
AR861B2S	SNR. 2632	Ping on:	2B47		
		Release:	2B55		
2 m Kjetting.		Arm:	2BEB		
2 m Kjetting galv.					
ANKER	700/(600)kg		252	0	

Figure 5: Mooring diagram, M1-3. Note: RBR Solo #102476 was replaced by RBR Solo #102484. RBR Concerto #204985 did not record.

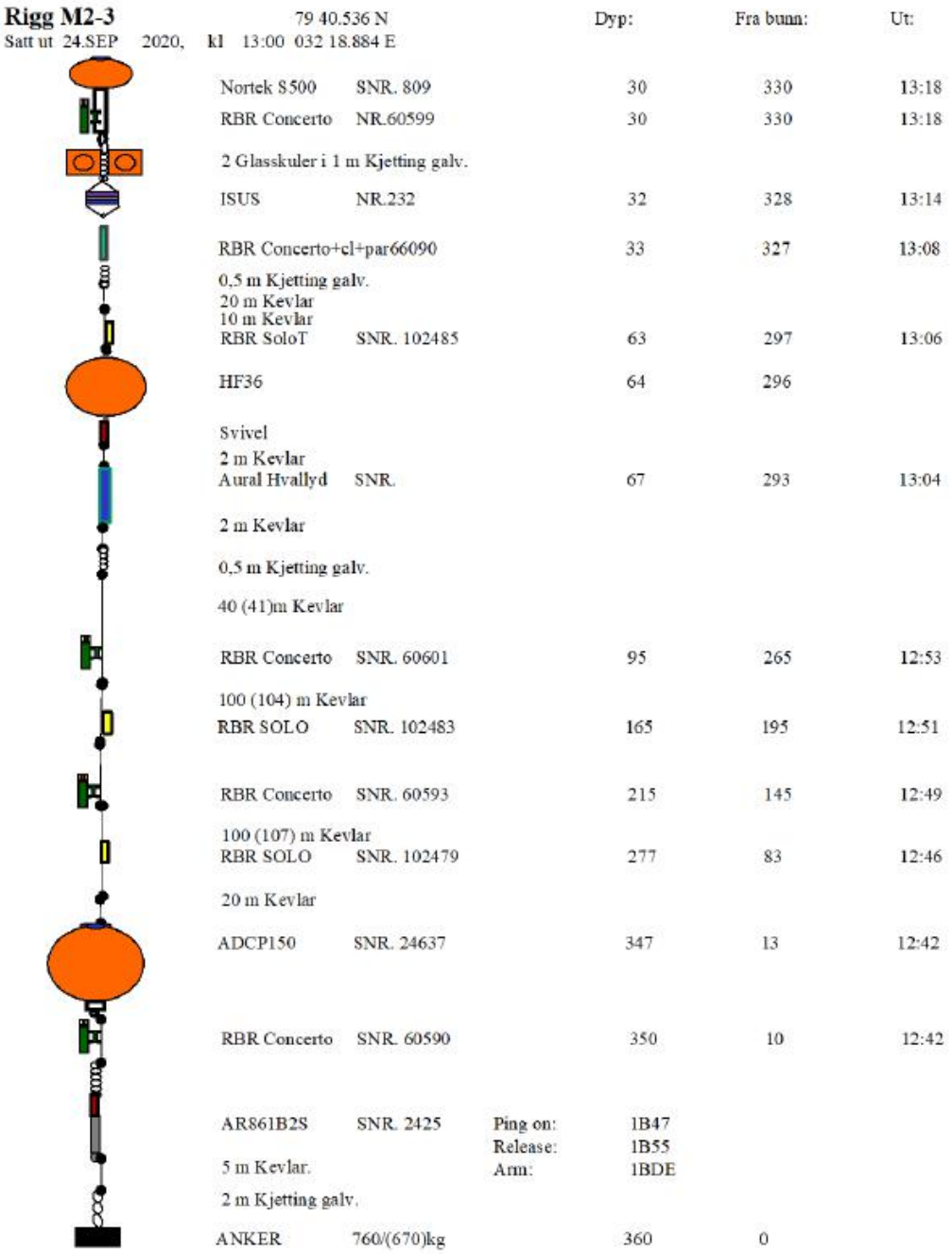


Figure 2: Mooring diagram, M2-3. ADCP serial number #24637 should be #24636

Appendix II: References

Frank Nilsen, Ilker Fer, Till M. Baumann, Øyvind Breivik, Ceslav Czyz, Lukas Frank, Kjersti Kalhagen, Zoe Koenig, Eivind H. Kolås, Stephan T. Kral, Bayoumy, Mohamed A. Mabrouk, Tore Mo-Bjørkelund, Malte Muller, and Jean Rabault (2021). *PC-2 Winter Process Cruise (WPC): Cruise Report*. Nansen Legacy Report Series 26/2021. DOI: https://doi.org/10.7557/nlrs.6324.

Angelika Renner and Arild Sundfjord (2022). *Mooring service cruise 2021: Cruise Report.* The Nansen Legacy Report Series, 28/2022. DOI: https://doi.org/10.7557/nlrs.6461