CRUISE REPORT

R/V Aranda

Cruise 1/2019

Combine1/2019 Leg 1

22nd – 25th January, 2019

This report is based on preliminary data and is subject to changes.

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Cruise 1/2019, Combine1, Leg 1

22nd – 25th January, 2019

Chief scientist: Harri T. Kankaanpää

INTRODUCTION

The main aim of the cruise was to monitor hydrography, nutrient situation and oil contamination in the Gulf of Finland as part of the national MSFD programme and HELCOM/MONAS Combine programme (Combine1). Additionally samples for monitoring of harmful substances and microplastics were collected.

Altogether 17 stations and one buoy retrieval site were surveyed in the Gulf of Finland and the western entrance to the Gulf of Finland (Figure 1, Table 1).

At every station CTD (salinity, temperature, fluorescence, O_2 concentration profile and pressure), pH, ammonia/ammonium concentration and nutrient concentrations were measured using rosette-bottled samples. In addition to the CTD/rosette profile, these parameters were also measured from near-bottom water samples (1 m aboved the seafloor). Oil contamination was examined using subsurface water from one meter depth at selected stations. Additional samples for quality assurance measurements were taken at station F62.

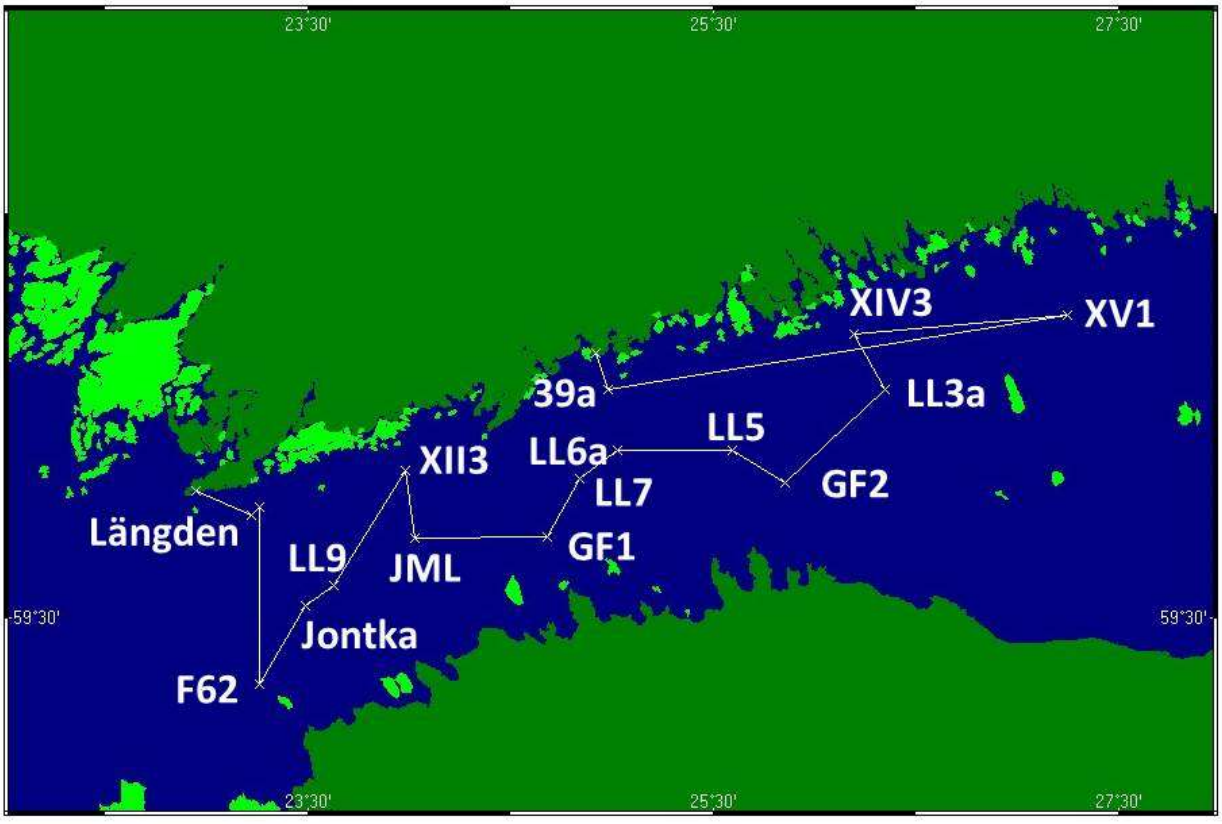


Fig. 1. Research stations and the approximate route of R/V Aranda during the cruise of Combine1 Leg within the Gulf of Finland and its western entrance during January 22 – 25, 2019.

OBSERVATION STATIONS AND MEASUREMENTS

Total number of stations during the cruise was 23. Activities are listed in Table 1.

Index	Station	CTD	Hydrography	Nutrients	Oil	Water	Sediment	Van Veen / benthos	Other
			pH, O_2, H_2S, SAL, NH_3/NH_4^+			/ harmful substances	/ harmful substances	sampling for microplastics	
40	39A	x	x	x					
41	XV1	x	x	x	x		x		
42	XIV3	x	x	x					
43	LL3A	x	x	x	x	x	x	x	
44	GF2	x	x	x					
45	LL5	x	x	x				x	
46	LL6A	x	x	x				x	
47	LL7	x	x	x	x	x			1.
48	GF1	x	x	x					2.
49	LL9	x	x	x					
50	XII3	x	x	x					
51	JML	x	x	x			x		
52	JONTKA	x	x	x					
53	F62	x	x	x					
54	F62		x	x					3.
55	LANGDEN	x	x	x					
56	LANGDEN_PP	x							4.

Table 1. List of stations and monitoring activities. 1. sediment sampling for dinoflagellate research, oil monitoring quality control samples. 2. 1000 litres of surface water collection for phytoplankton research. 3. water chemistry quality control samples. 4. retrieval of FMI's surface temperature buoy.

SUMMARY OF CHEMICAL AND PHYSICAL STATUS

There was a worsened status of the Gulf of Finland compared to the conditions during winter 2016-2017. Due to the renovation of R/V Aranda, There was no comparable Combine 1 winter monitoring cruise organised in 2018. Intensive winds had prevailed during the beginning of 2019. Homogenisation of the uppermost 10-15 section of the water column (CTD profiles in Appendix 1) was apparent, and extended to 20-40 m depth in the western Gulf of Finland.

Phosphate concentrationsin the surface water (Fig. 2) were close to the high levels that were observed in 2017. The most notable change was a substantial change in near-bottom water conditions. Compared to winter 2017 and winter period situation overall, there was an increase in near-bottom phosphate concentrations (Fig. 3) and salinity (Fig. 4), decline in oxygen concentrations (Fig. 5) and increase in hydrogen sulphide concentrations. The edge of the low-oxygen and enriched-phosphate water layer at near-bottom level extended more east that experienced previously.

Highest or second highest near-bottom-water phosphate concentrations for the winter (November – February) season (e.g. 3.49 µM at GF2, record-high 3.68 µM at LL5 and 3.77 µM at LL7)

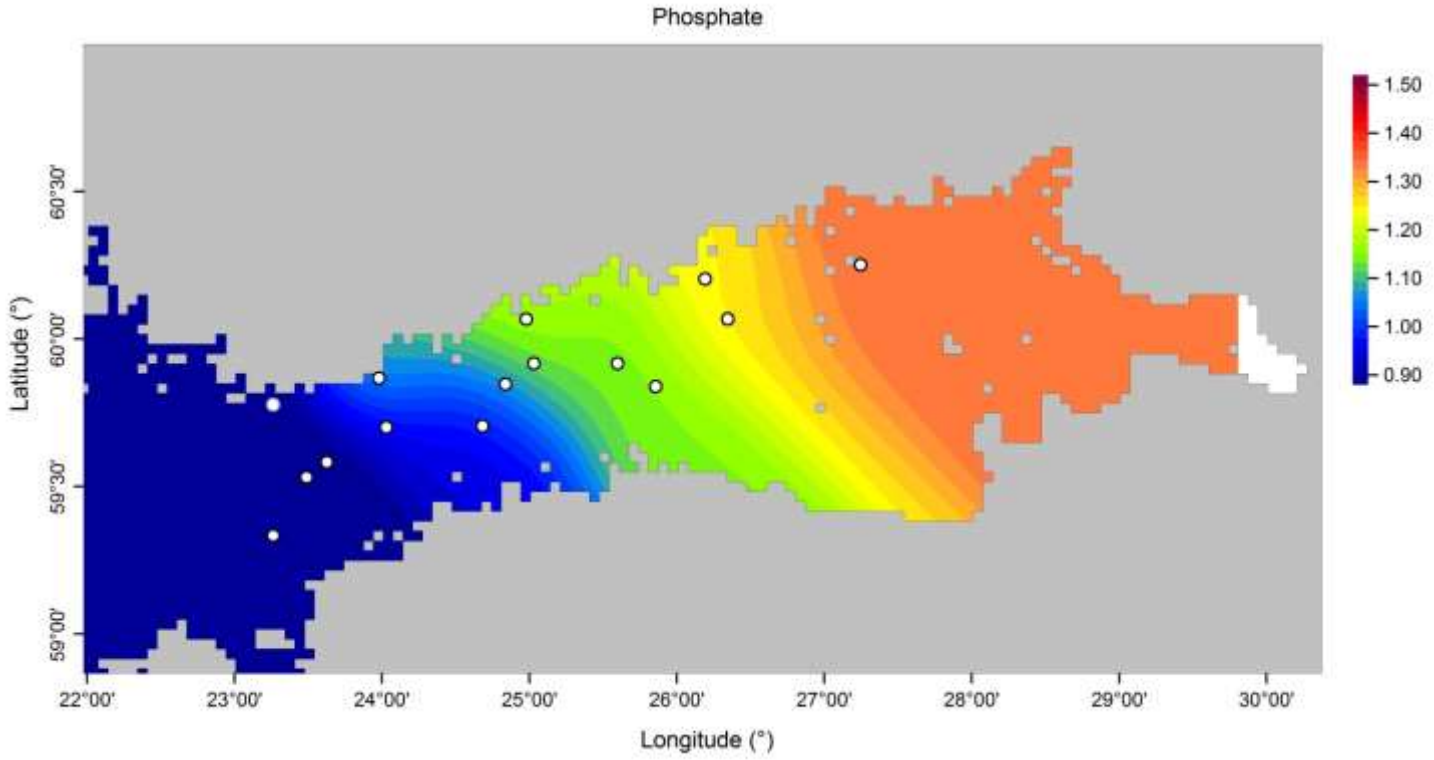


Fig. 2. Interpolated phosphate concentration (µM) values at 1 m depth. Observation stations are marked with white circles.

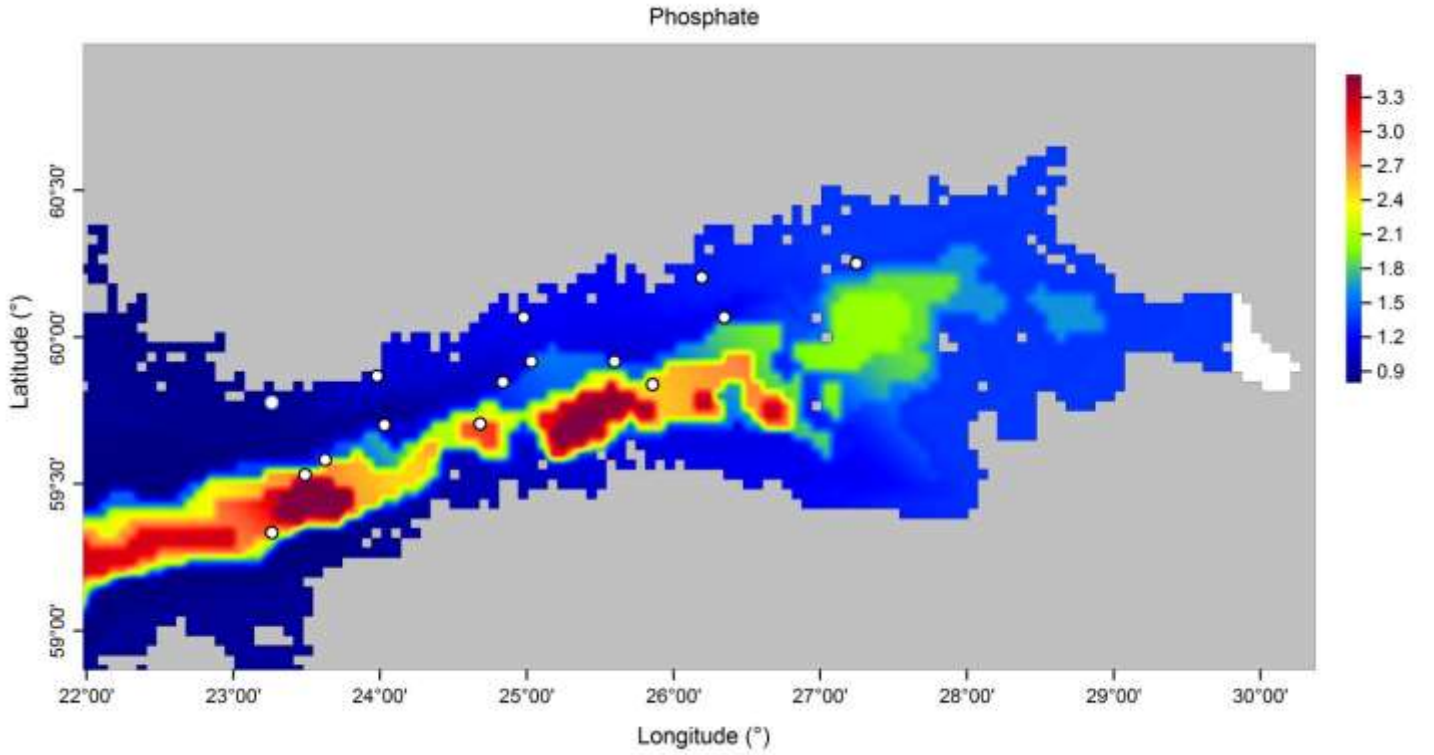


Fig. 3. Interpolated phosphate concentration (µM) values at 1 m above the seafloor. Observation stations are marked with white circles.

Salinity

Overall, the near-bottom salinities were larger compared to winter conditions in 2017.

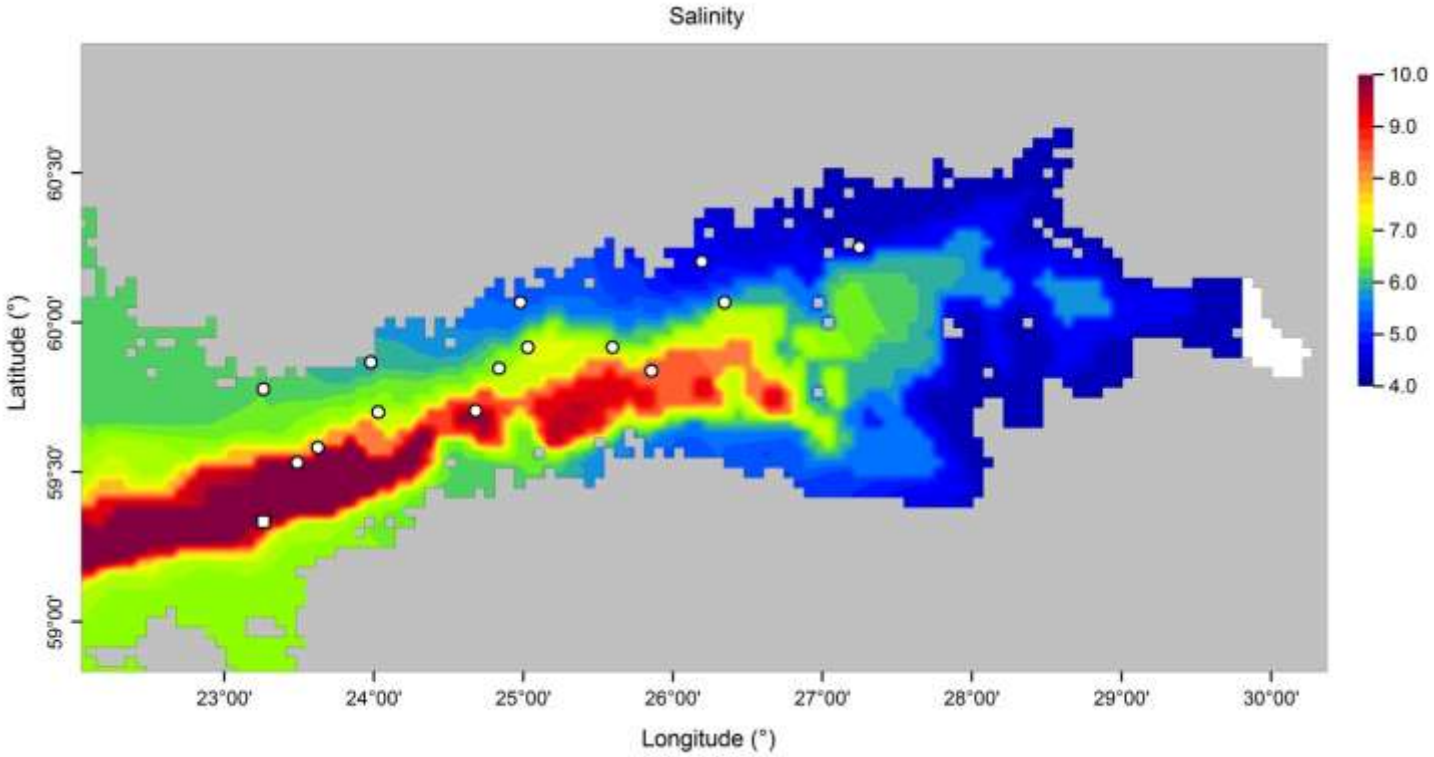


Fig. 4. Interpolated salinity values (PSU) at 1 m above seafloor. Observation stations are marked with white circles

Oxygen and sulfide conditions

The areal coverage of near-bottom environments with less than 2 ml O_2/l had increased from winter 2017, extending more to the central Gulf of Finland. Hypoxia started typically at 55-65 m with worsening oxygen conditions toward the seafloor. There was very little or no oxygen in the deep water layer along the main Gulf of Finland depression, in the west and central areas. Highest or second highest hydrogen sulfide concentrations (total sulfides; e.g. 0.19 µM at LL7, 16.7 µM at GF1 and 30,0 µM at JML) for the winter season and record low oxygen concentrations (0.39 ml l^{-1} at GF2 and 0.64 ml l^{-1} at LL7) in the near-bottom water column were encountered.

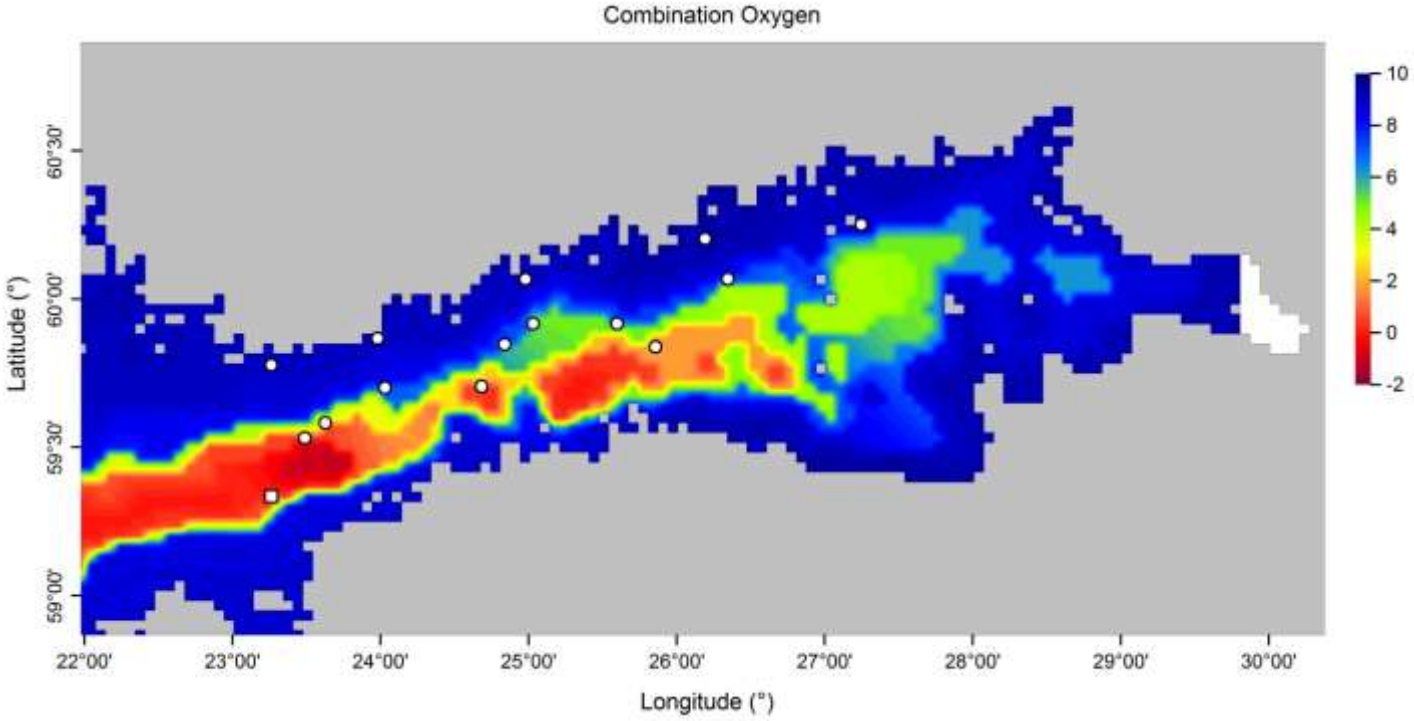


Fig. 5. Interpolated oxygen concentrations (ml O_2 l^{-1} seawater) at 1 m above seafloor. Observation stations are marked with white circles.

Deep water temperature, salinity and oxygen change at F62 over 1.5 hours

In order to obtain understanding of short-term change in hydrographic conditions in the western part of Gulf of Finland main depression, the CTD sond was kept at fixed depth of 88.78 ± 0.02 m (Fig. 6; CTD pressure sensor; average ± standard deviation) for 1 hour 33.5 minutes. Temperature and salinity data over the first one minute is omitted from calculations. The data indicated constant increase in salinity (0.115 unit change; 0.001 units min^{-1}), temperature (0.019 °C change; 0.0002 °C min^{-1}) and calculated density minus 1000 kg m^{-3} (σ_ϑ; 0.089 kg m^{-3} change; 0.001 kg m^{-3} min^{-1}) over the measurement period, suggesting continuing intrusion of denser near-bottom water from the Baltic Sea Proper to the Gulf of Finland. This resembles obserations during H_2S surveys in the western Gulf of Finland in 2014 (Kankaanpää and Virtasalo, 2017).

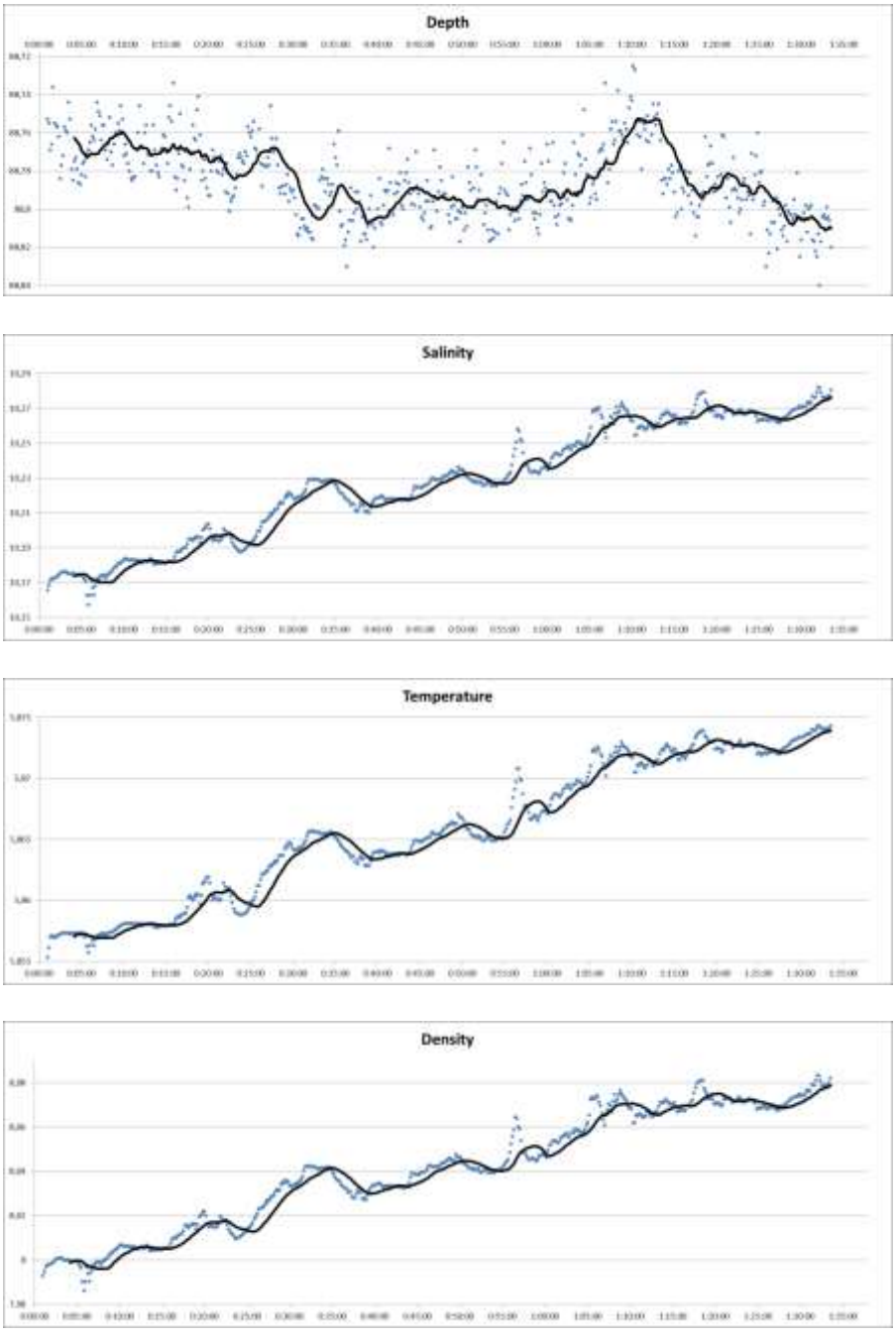


Fig. 6. Changes in CTD measurement depth, salinity, temperature and density over 1 h 33.5 minutes. X axis represents hours:minutes:seconds. Y-axis units, from up to down are decibars, practical salinity units, °C and kg m^{-3}. Moving average over 20 observations is plotted (black line).

Oil In the uppermost water colum

The concentrations of dissolved and dispersed oil at 1 m depth were analysed onboard. The concentrations were 0.36 – 0.85 µg l^{-1}, i.e. all below the 1.0 µg l^{-1} threshold value set by the Intergovernmental Oceaographic Commission and typical for winter season. Additionally 10 replicate samples taken from 30-litre water sampler were analysed for quality control purposes.

Benthic animals for microplastic analyses (Maiju Lehtiniemi and Outi Setälä)

No animals were encountered at stations XV1, LL3a, LL5, LL6a and LL9. *Limecola balthic*a and *Marenzelleria viridis* were obtained at stations XII3 and Längden.

SCIENTIFIC STAFF

Chief scientist: Kankaanpää Harri T.

Participants: Bruun Jan-Erik
Hyvärinen Susanna
Kinnunen Tanja
Lastumäki Ilkka
Varmanen Pia
Riikonen Jere
Hietala Riikka
Kosloff Pekka
Flinkman Juha
Lehtiniemi Maiju
Setälä Outi
Honkanen Martti

Master: Martti Simojoki

Departure from Helsinki on Wednesday January 22, 2019 at 15:26 local time

Arrival to Hanko on Friday January 25, 2017 at 12:45 local time

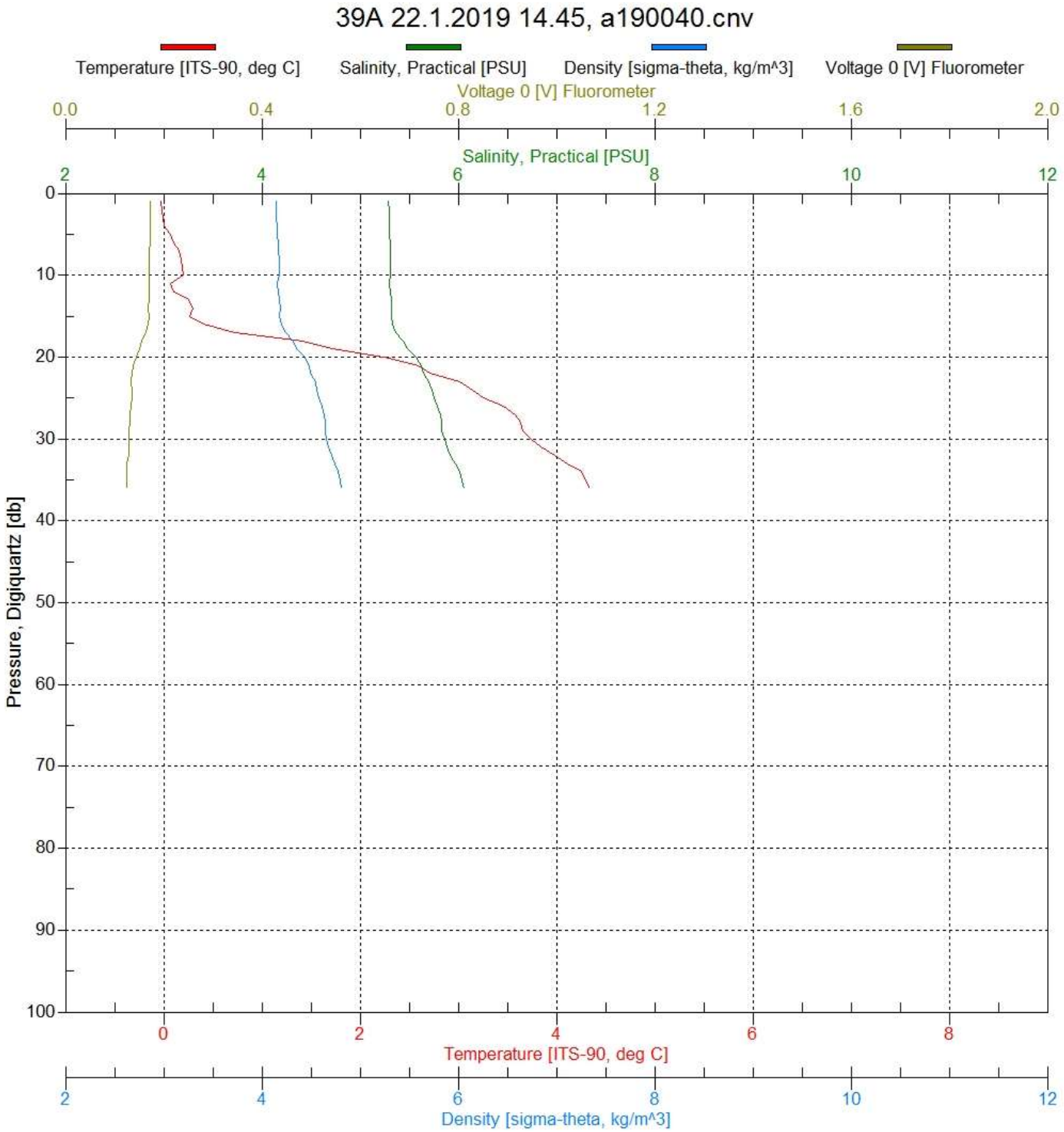
LIST OF STATIONS (all coordinates are given in WGS-84 in degrees.minutes.minute desimals)

index	station	LAT	LON	Depth(m)	date	time (UTC)
40	39A	N60.0400	E024.5880	44.00	20190122	1440
41	XV1	N60.1507	E027.1484	60.00	20190122	2300
42	XIV3	N60.1219	E026.1155	79.00	20190123	0450
43	LL3A	N60.0403	E026.2080	68.00	20190123	0750
44	GF2	N59.5031	E025.5143	84.00	20190123	1507
45	LL5	N59.5500	E025.3584	71.00	20190123	1730
46	LL6A	N59.5501	E025.0181	73.00	20190123	2134
47	LL7	N59.5079	E024.5028	102.00	20190124	0008
48	GF1	N59.4229	E024.4091	84.00	20190124	0415
49	LL9	N59.4201	E024.0181	66.00	20190124	1030
50	XII3	N59.5201	E023.5880	20.00	20190124	1300
51	JML	N59.3491	E023.3760	80.00	20190124	1608
52	JONTKA	N59.3187	E023.2935	120.00	20190124	1950
53	F62	N59.2002	E023.1581	97.00	20190124	2258
54	F62	N59.2001	E023.1581	97.00	20190125	0036
55	LANGDEN	N59.4661	E023.1577	57.00	20190125	0600
56	LANGDEN_PP	N59.4548	E023.1348	34.00	20190125	0842

References

Kankaanpää H. T. and Virtasalo J. J. 2017. Rapid fluctuations in the northern Baltic Sea H_2S layer. Journal of Marine Systems 176:24-37.

Appendix 1. CTD profiles obtained during the cruise.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Voltage 0 [V] Fluorometer
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Salinity, Practical [PSU]
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Pressure, Digiquartz [db]
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Temperature [ITS-90, deg C]
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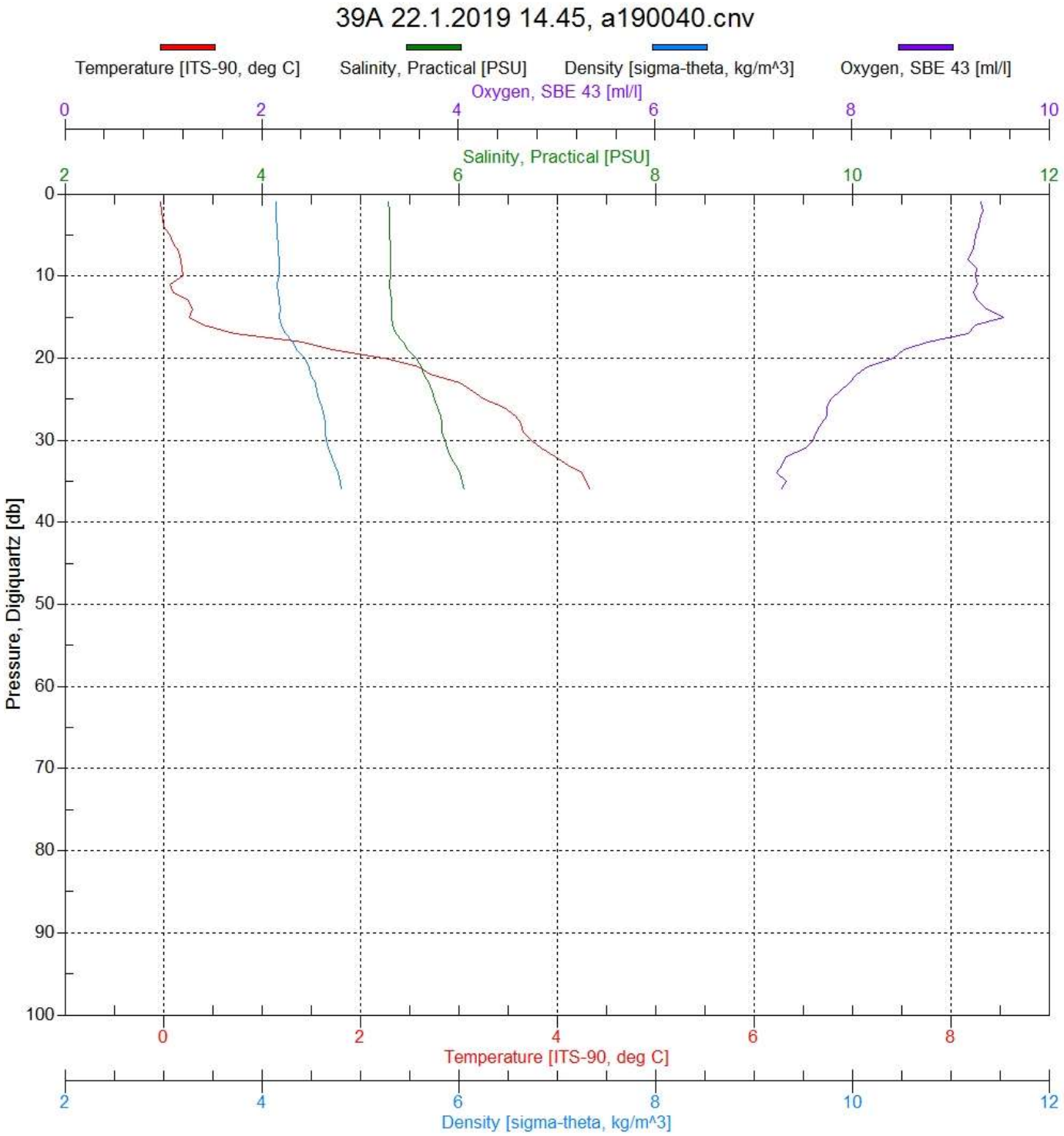
Density [sigma-theta, kg/m^3]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Oxygen, SBE 43 [ml/l]
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Salinity, Practical [PSU]
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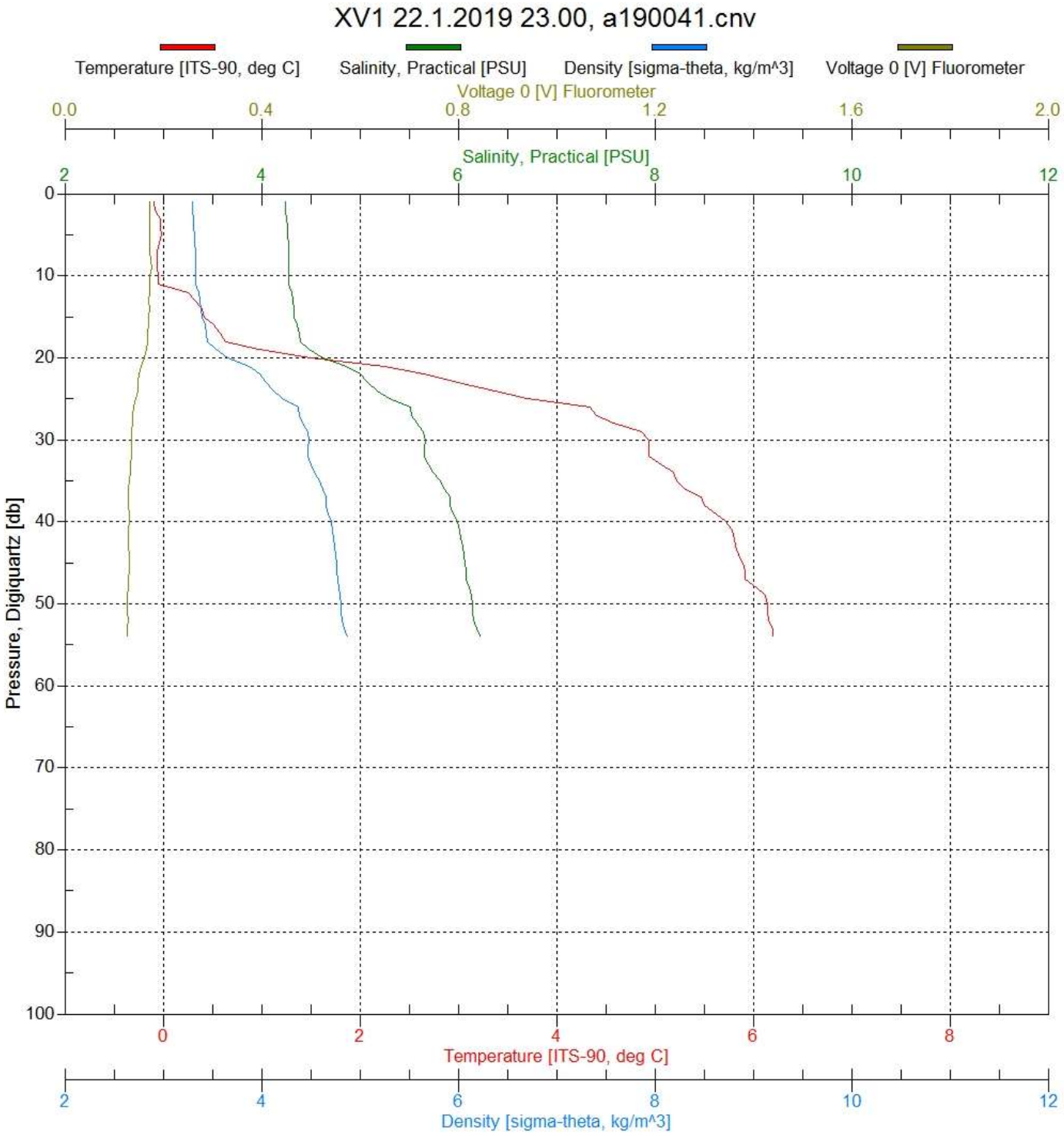
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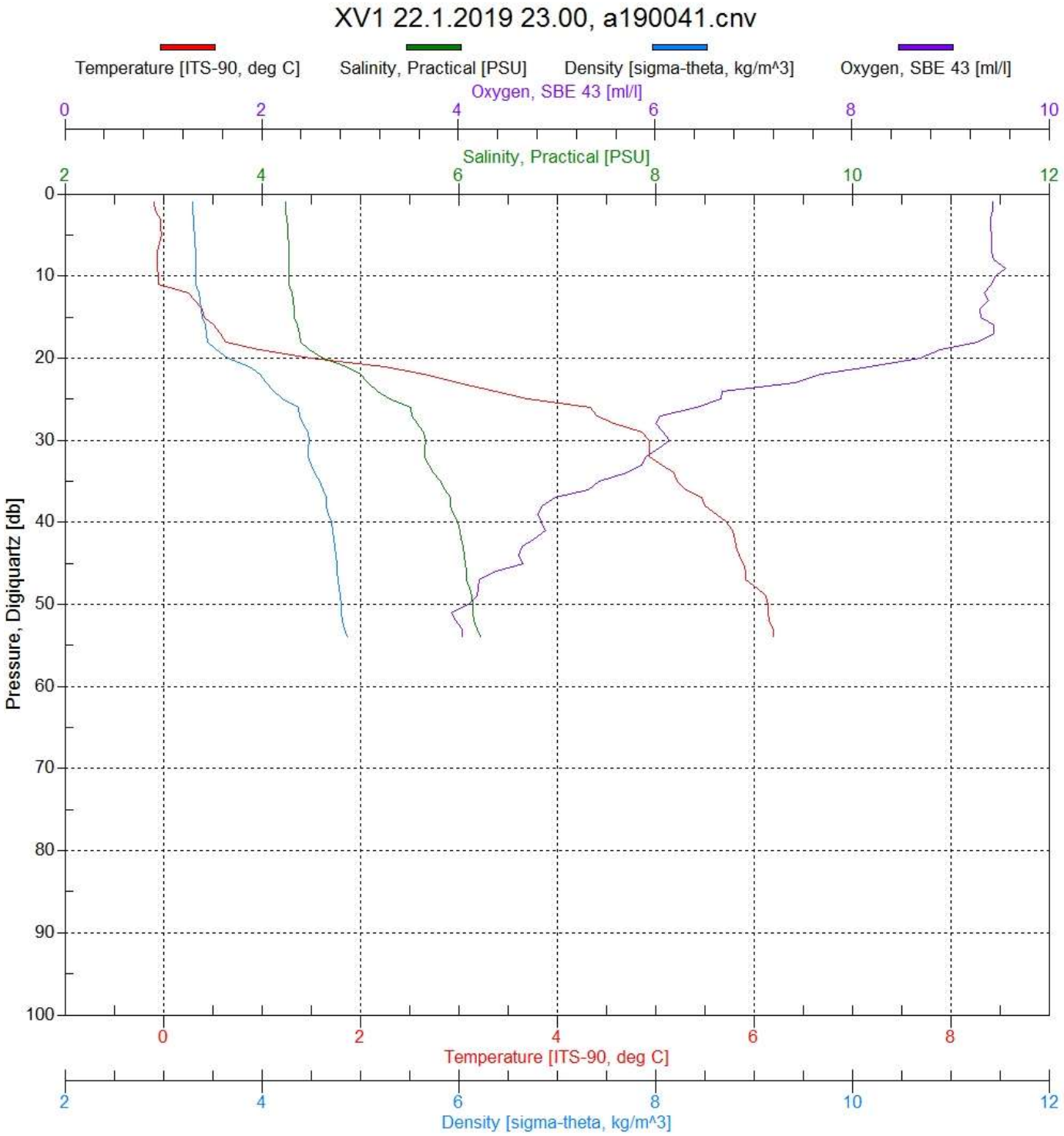
Density [sigma-theta, kg/m^3]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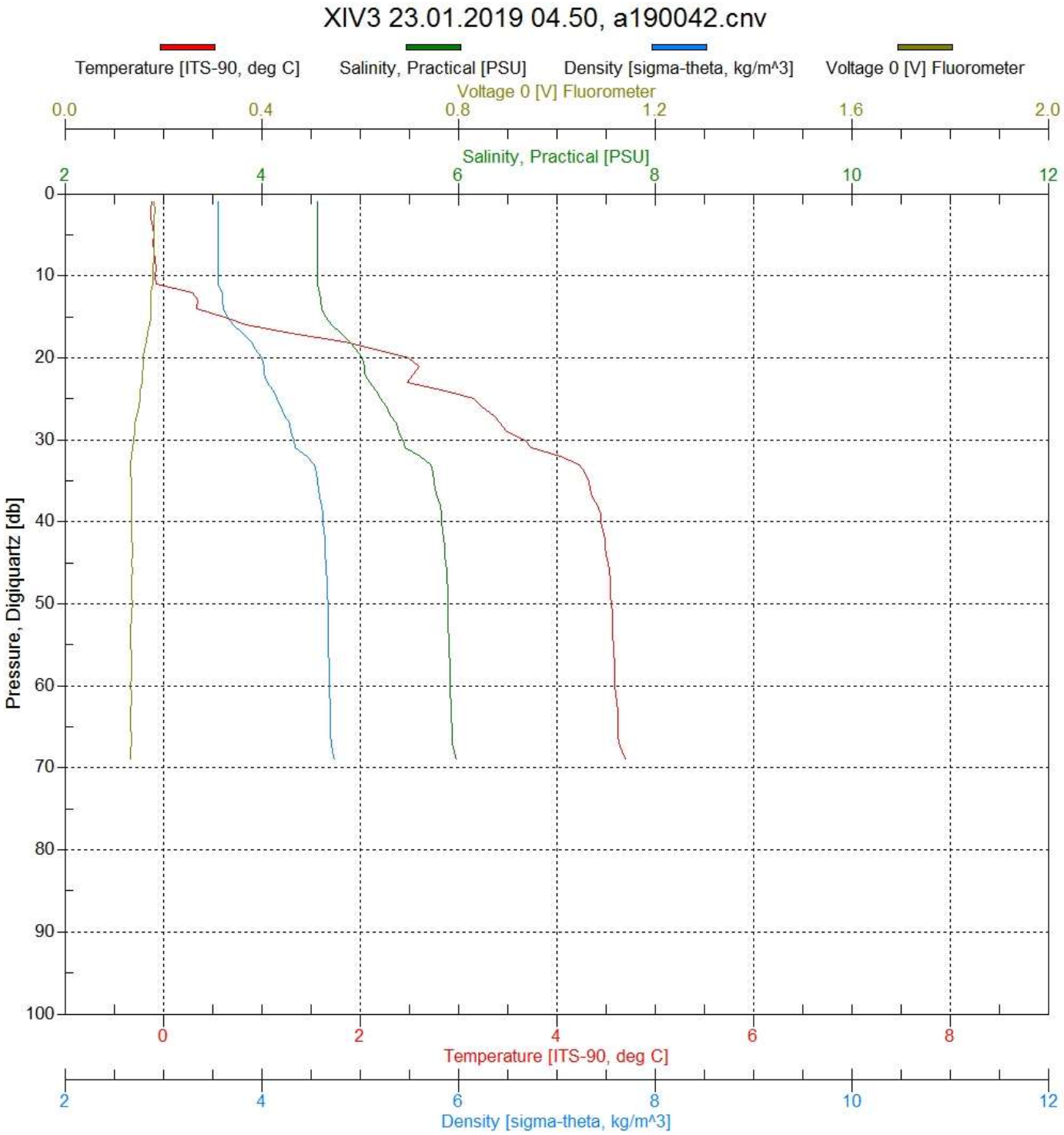
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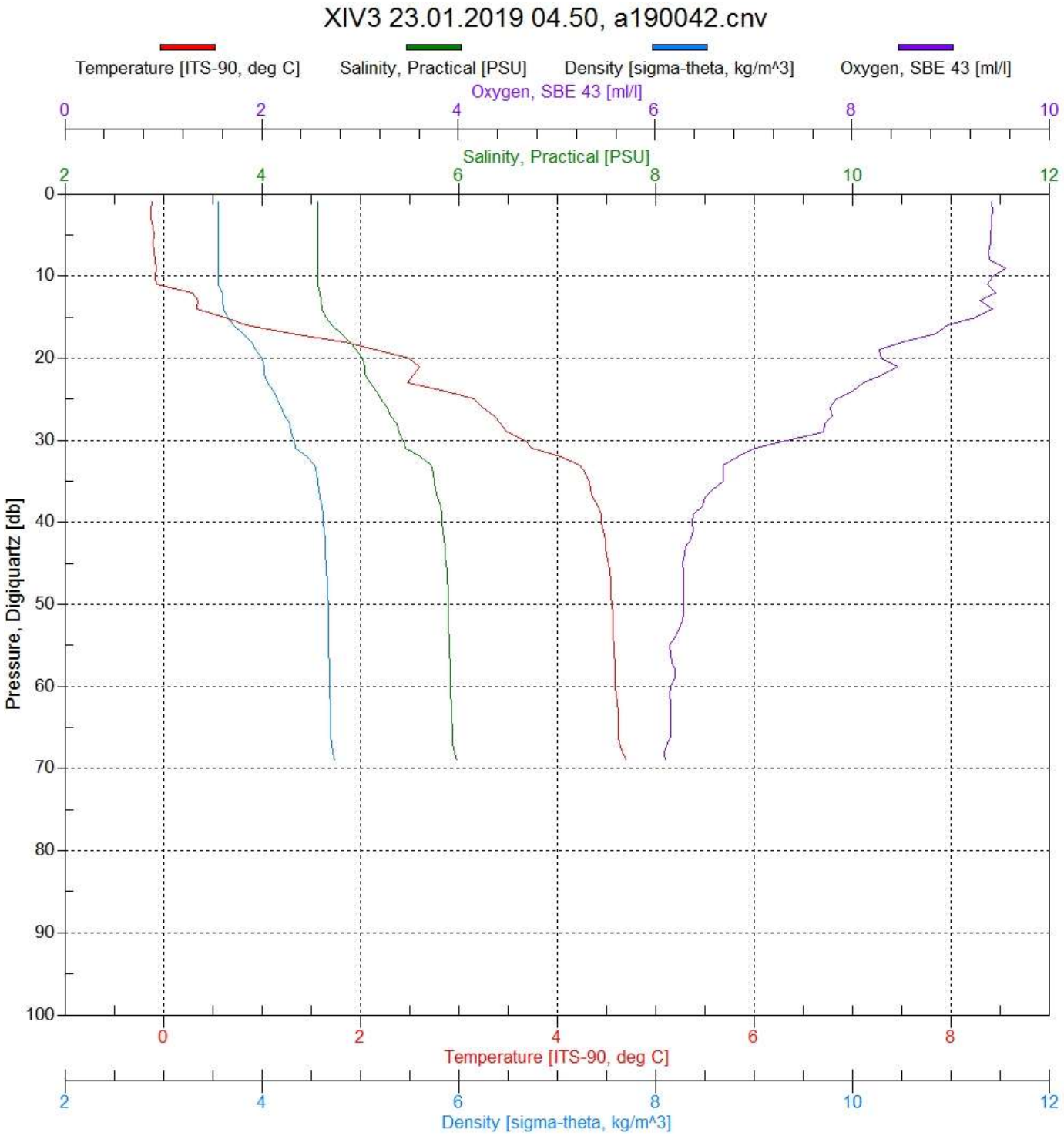
Density [sigma-theta, kg/m^3]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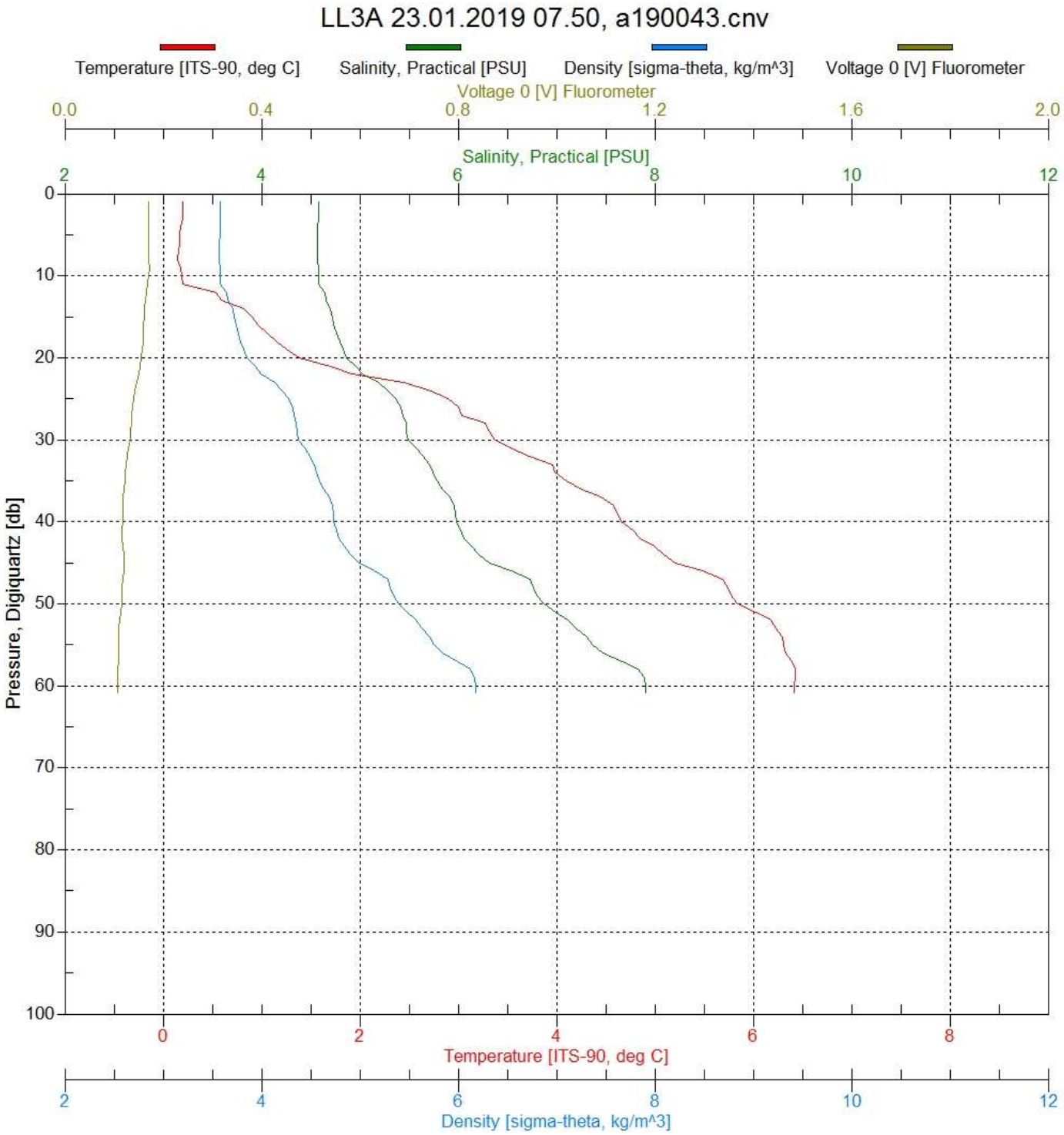
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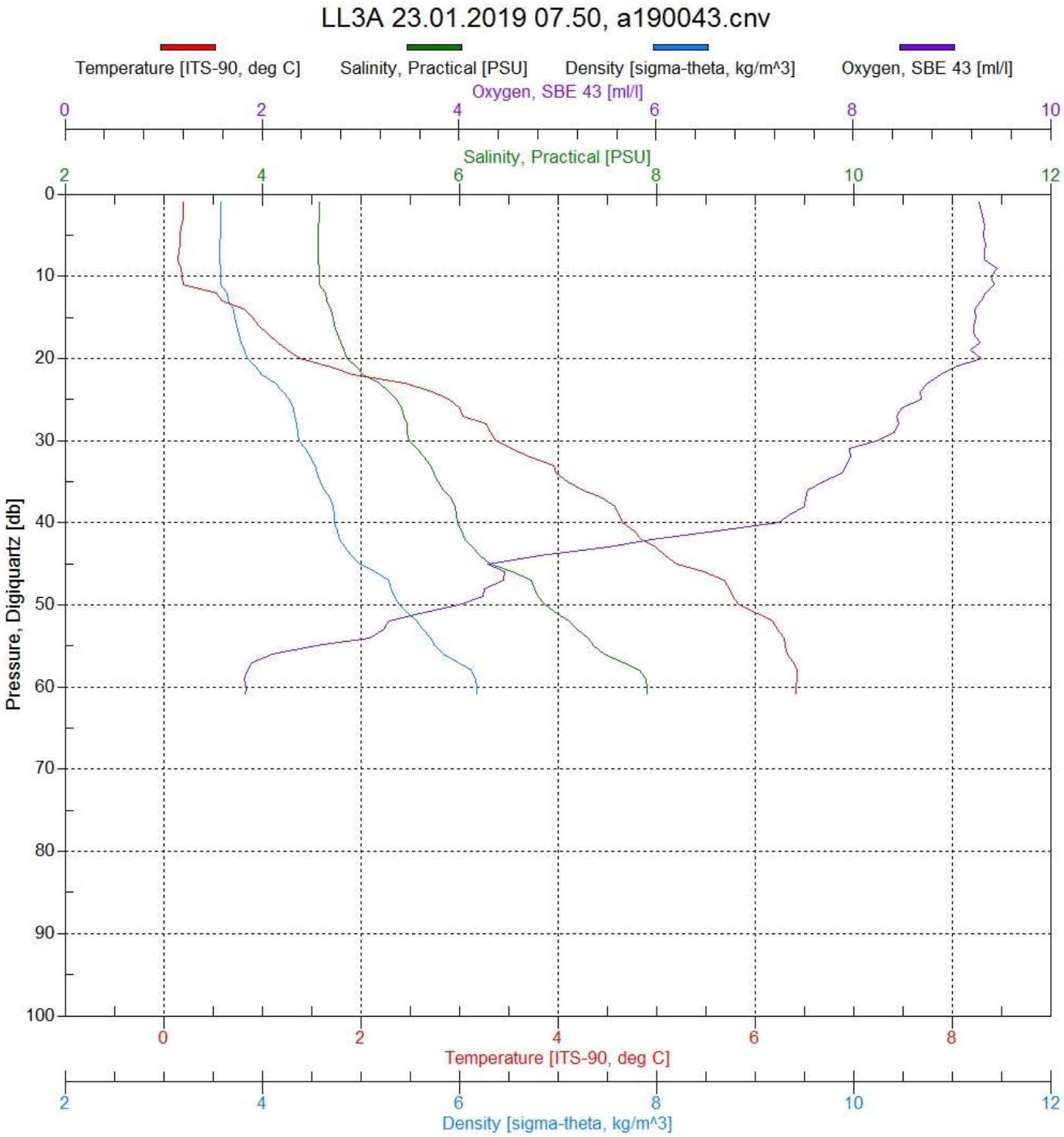
Density [sigma-theta, kg/m^3]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Oxygen, SBE 43 [ml/l]
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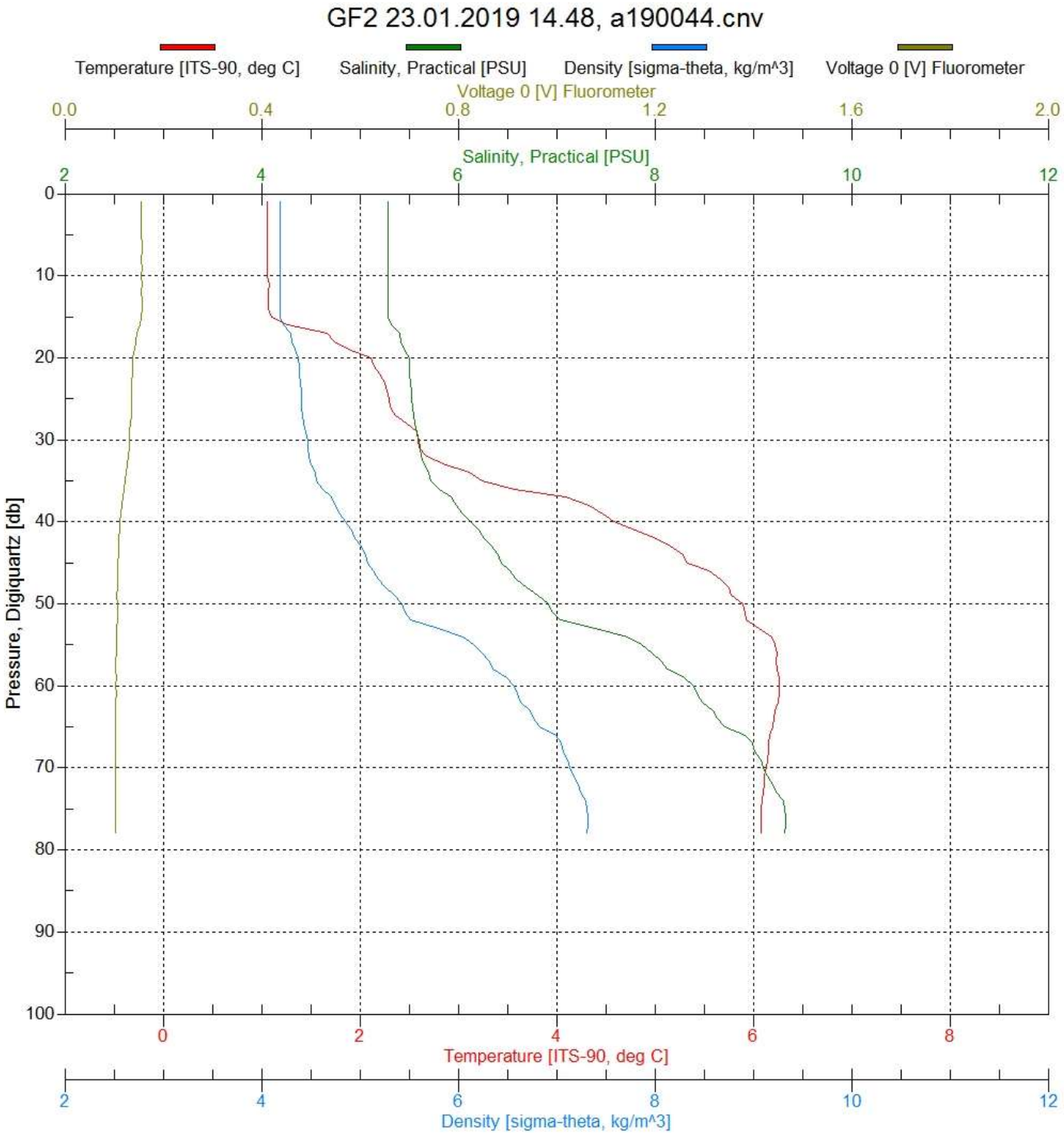
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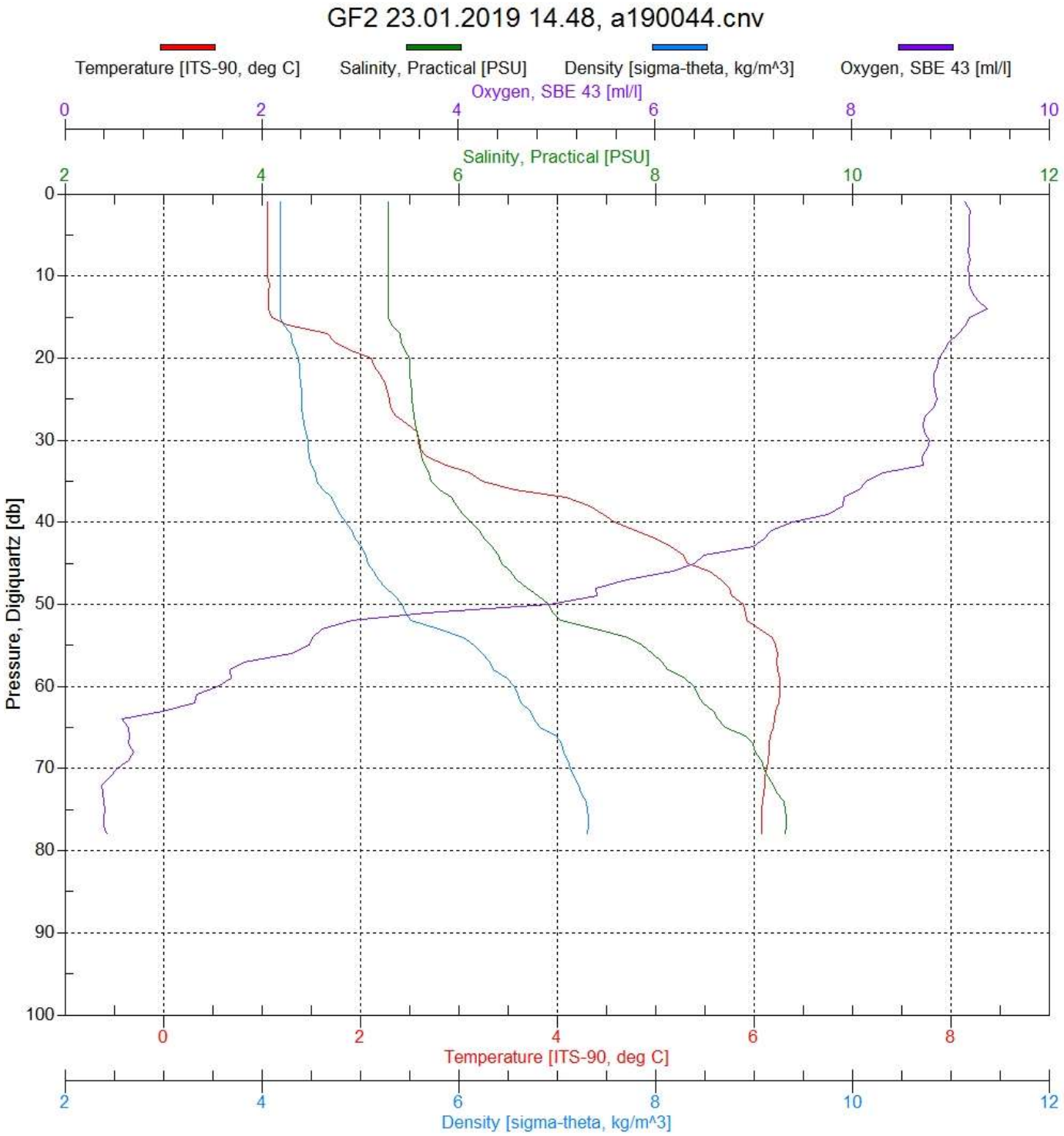
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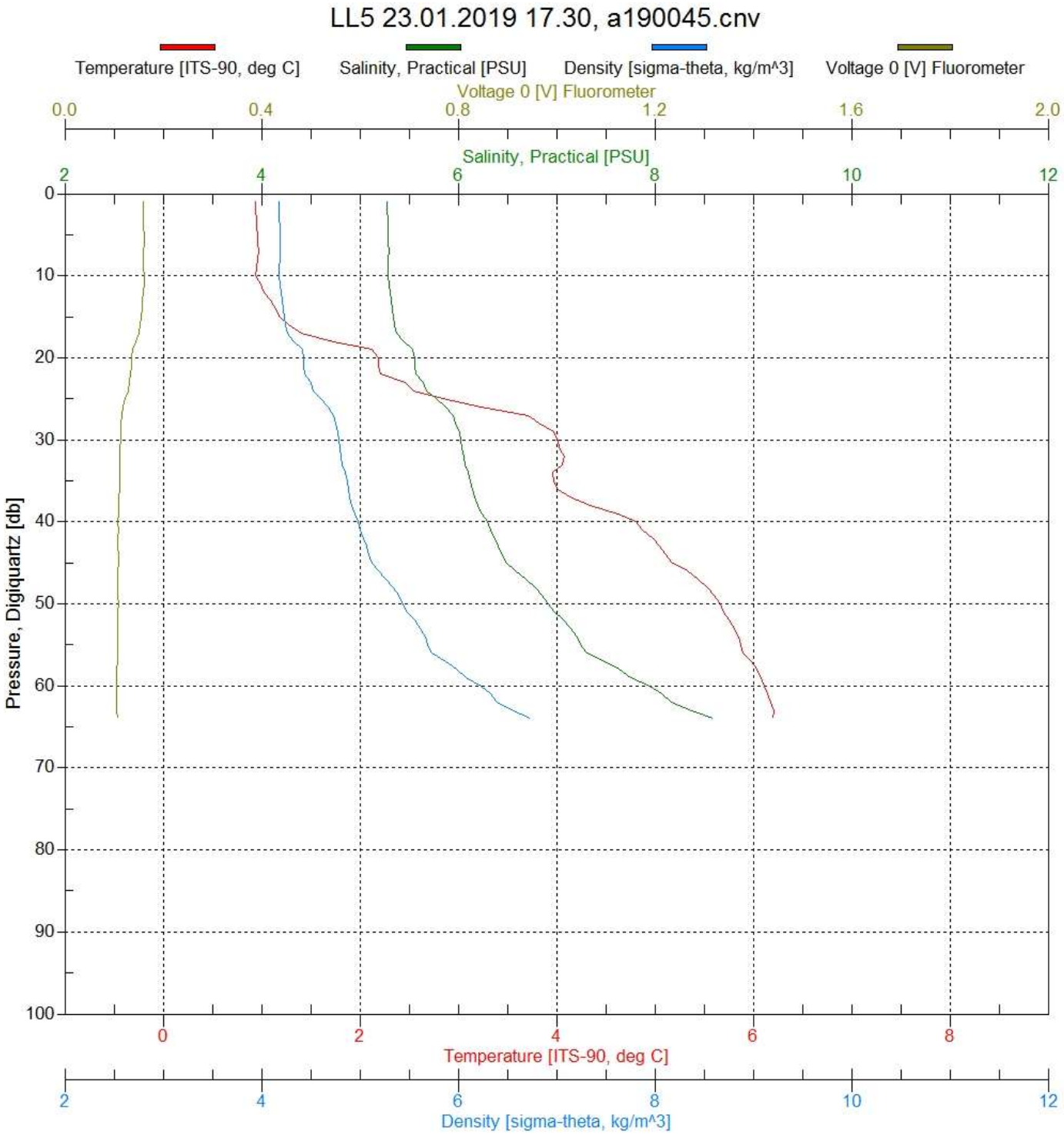
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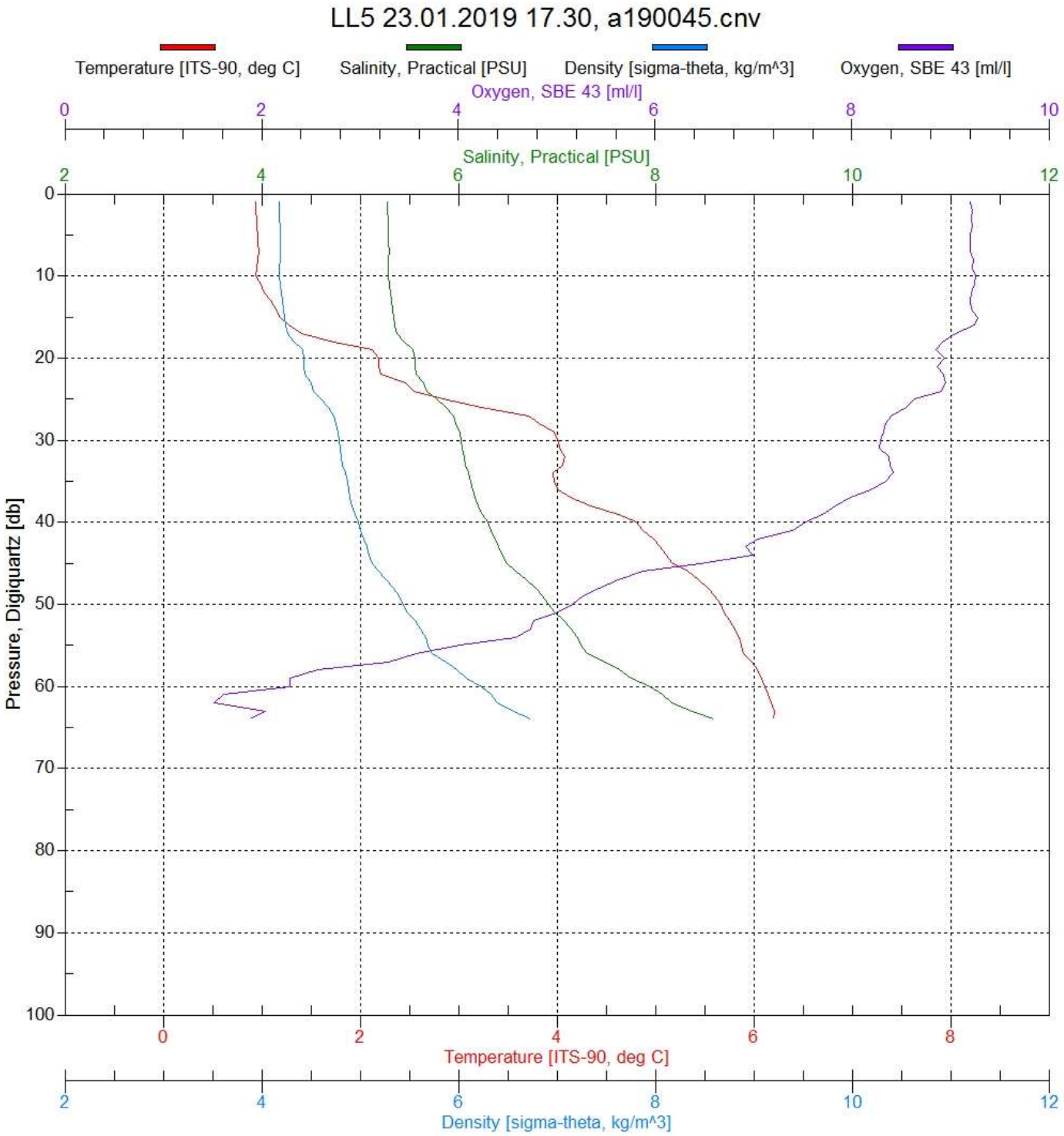
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Oxygen, SBE 43 [ml/l]
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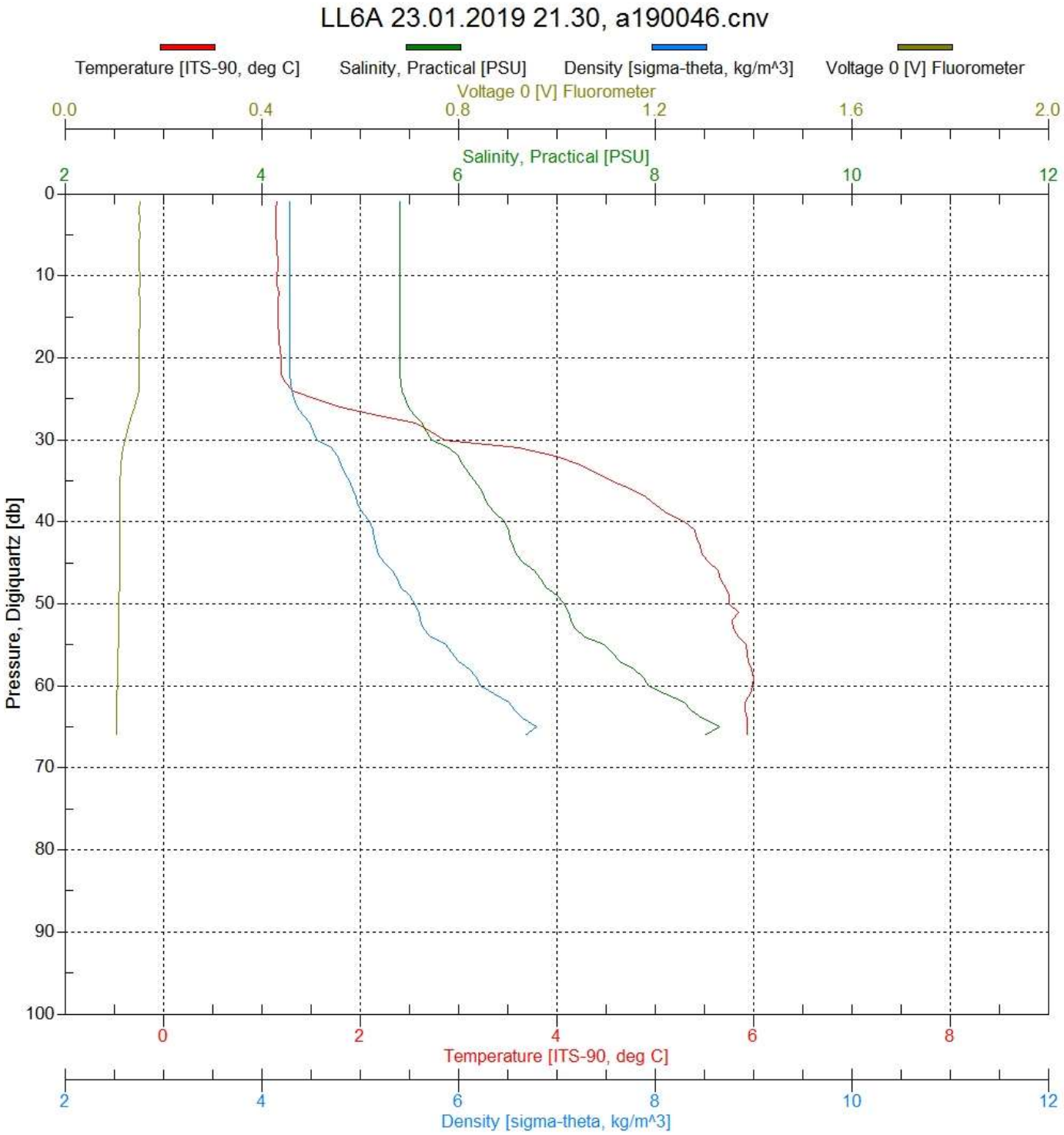
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Voltage 0 [V] Fluorometer
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Pressure, Digiquartz [db]
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Temperature [ITS-90, deg C]
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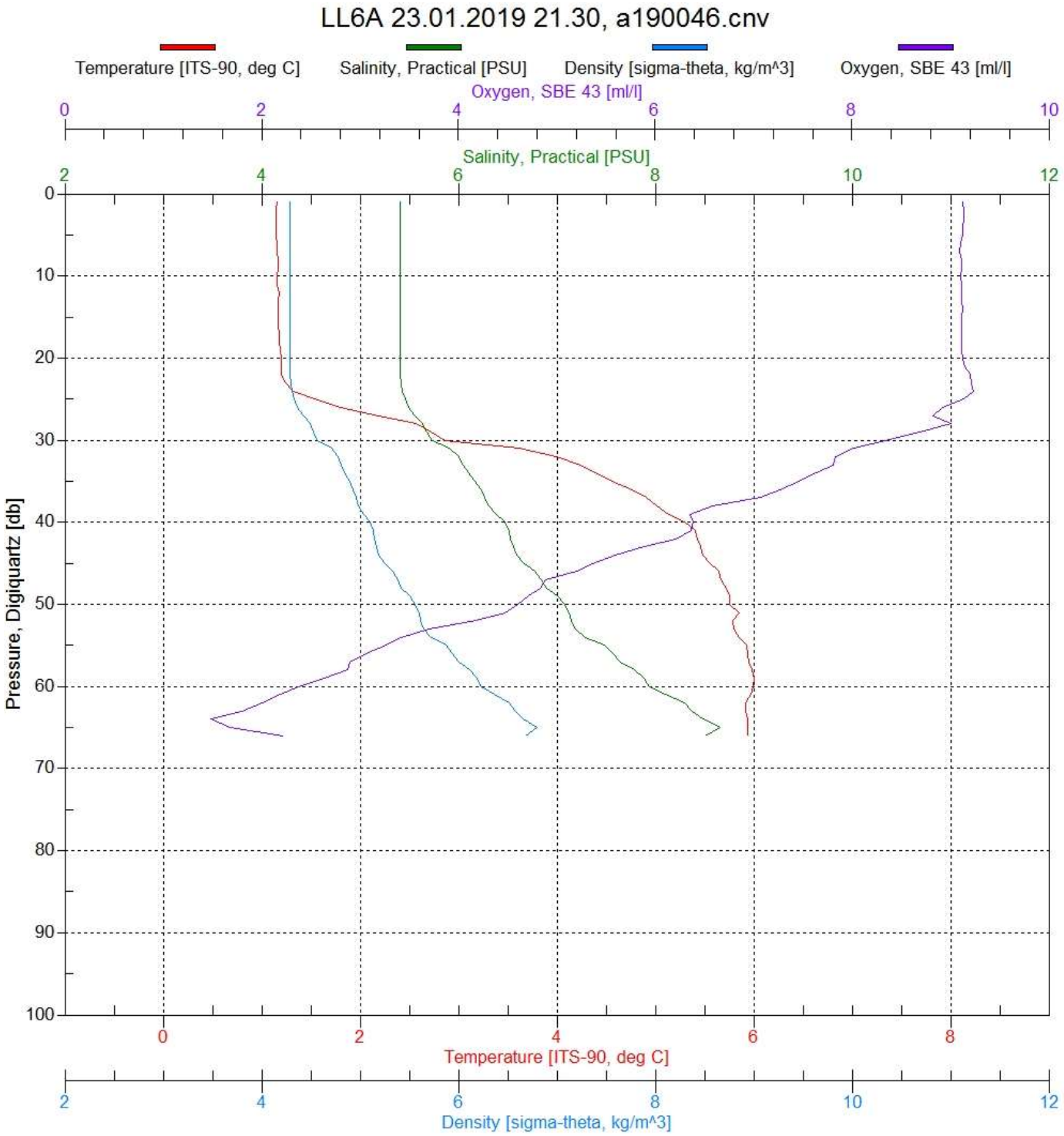
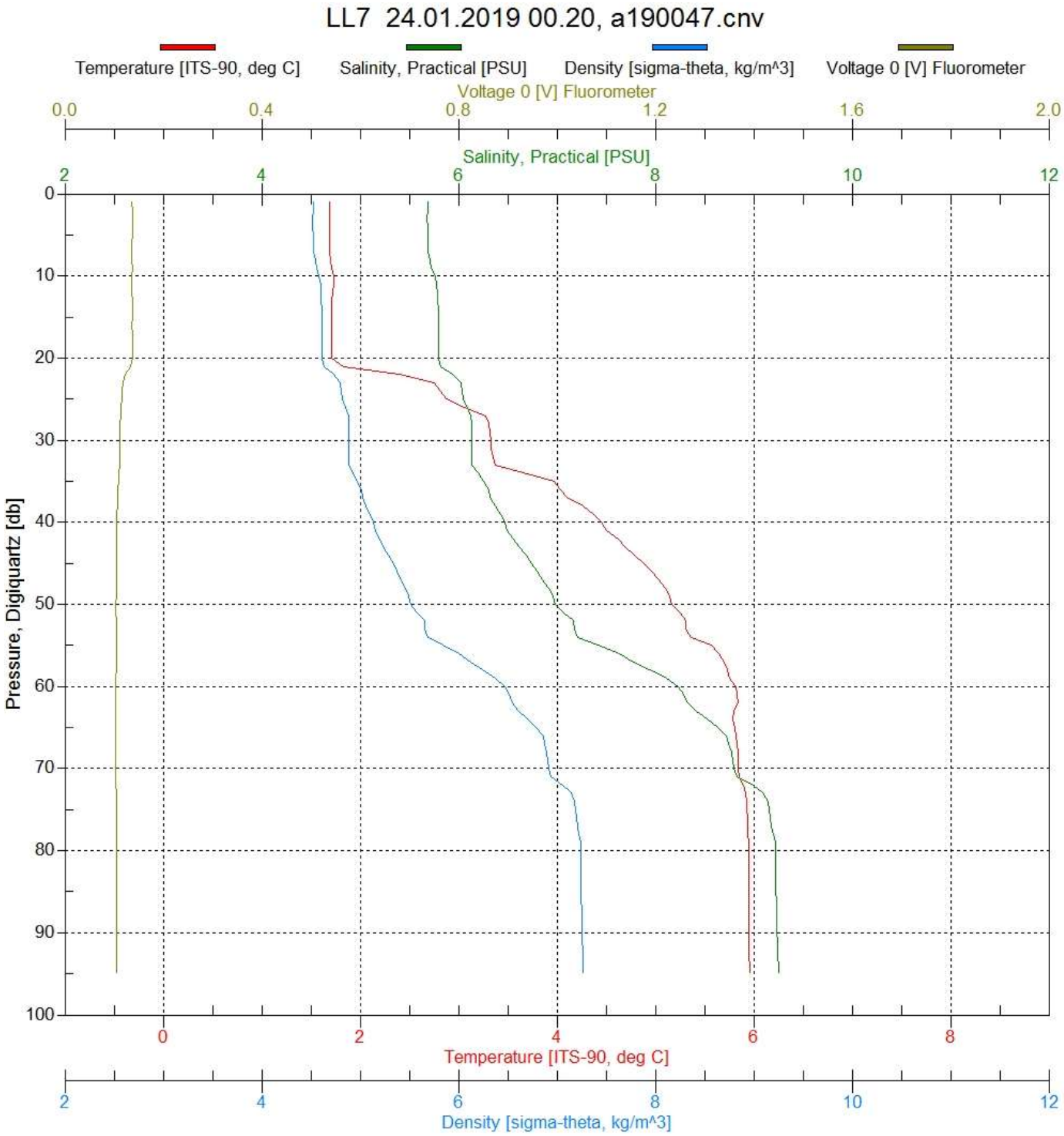
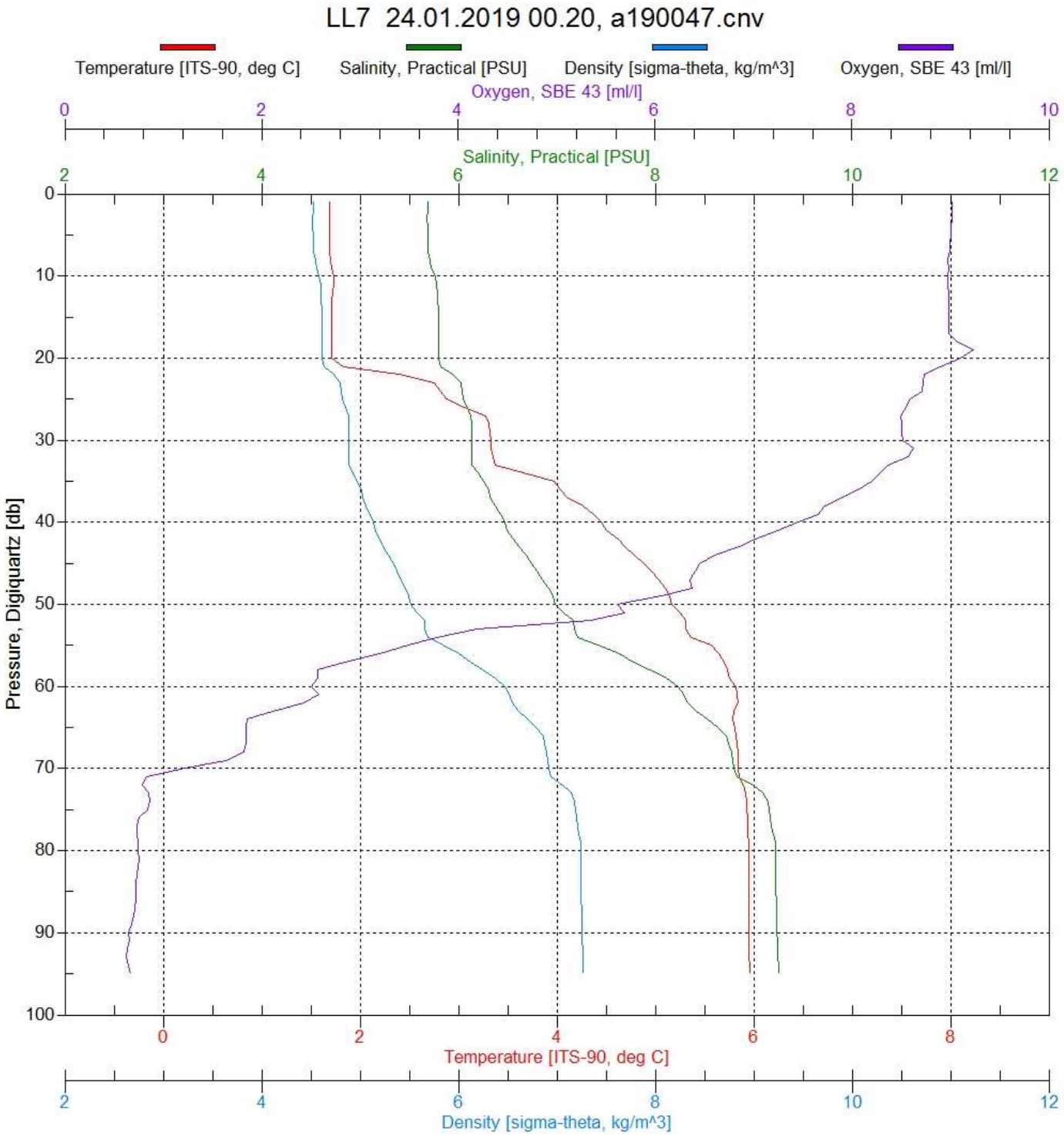
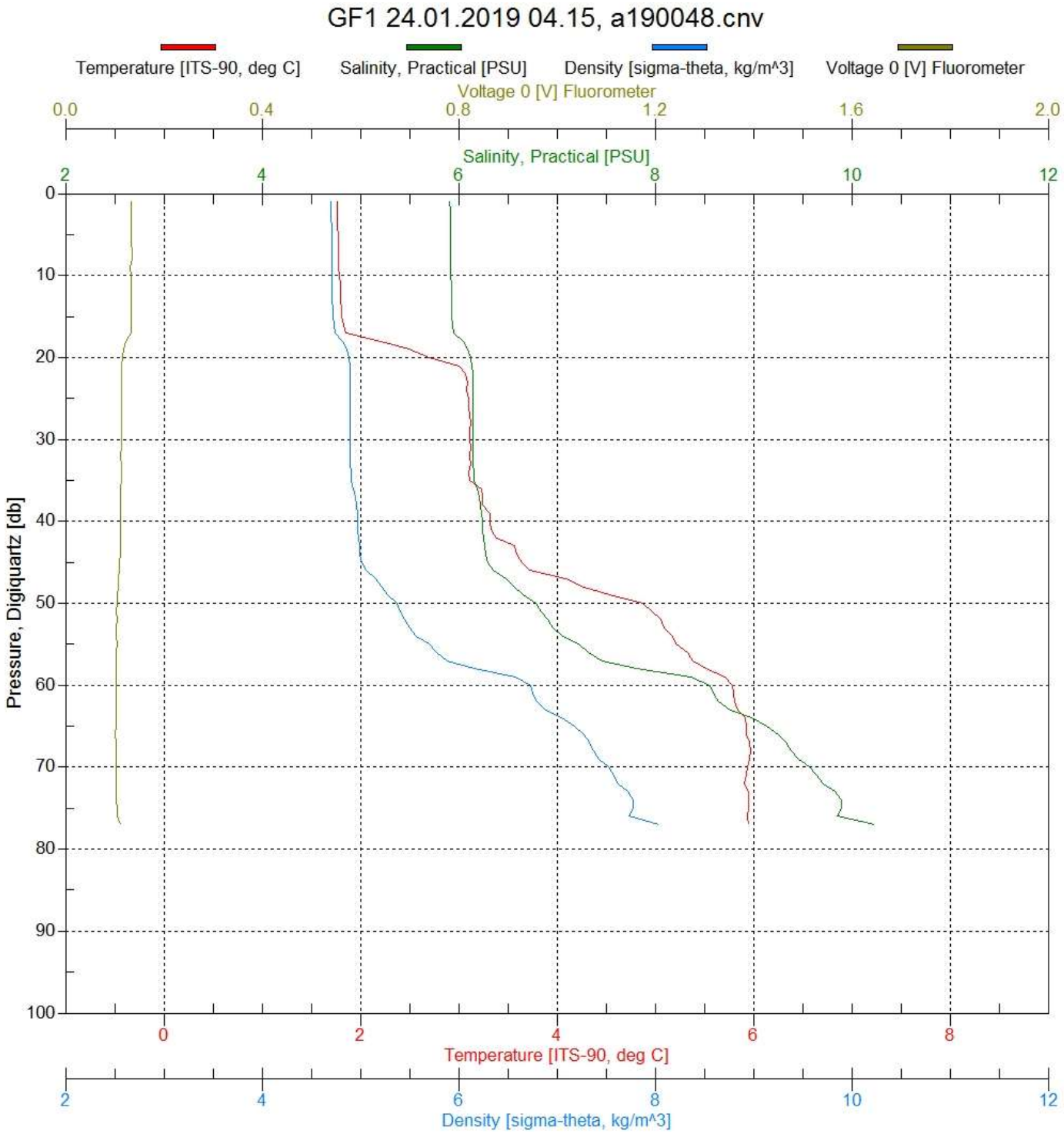
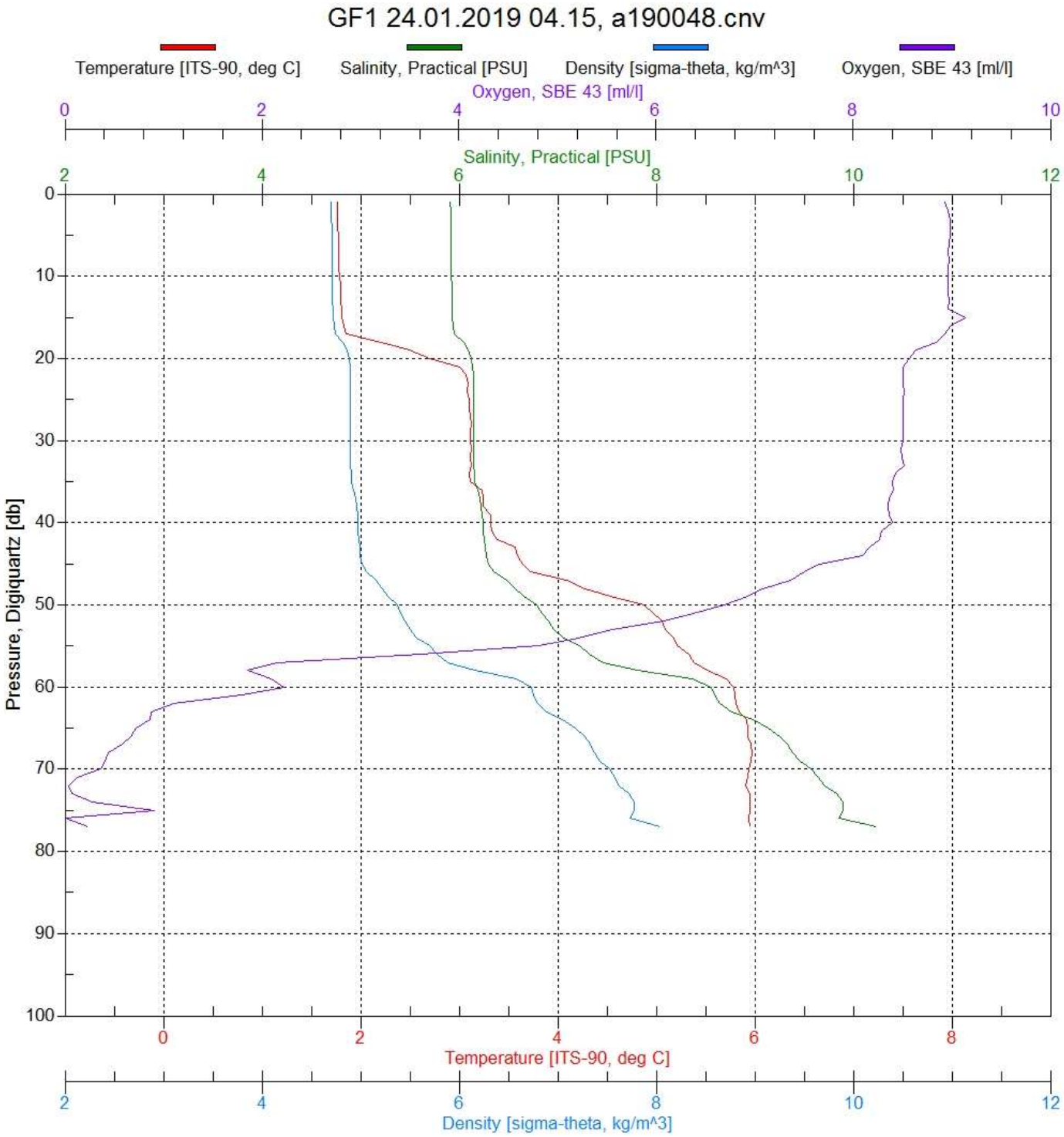
12
Density [sigma-theta, kg/m^3]

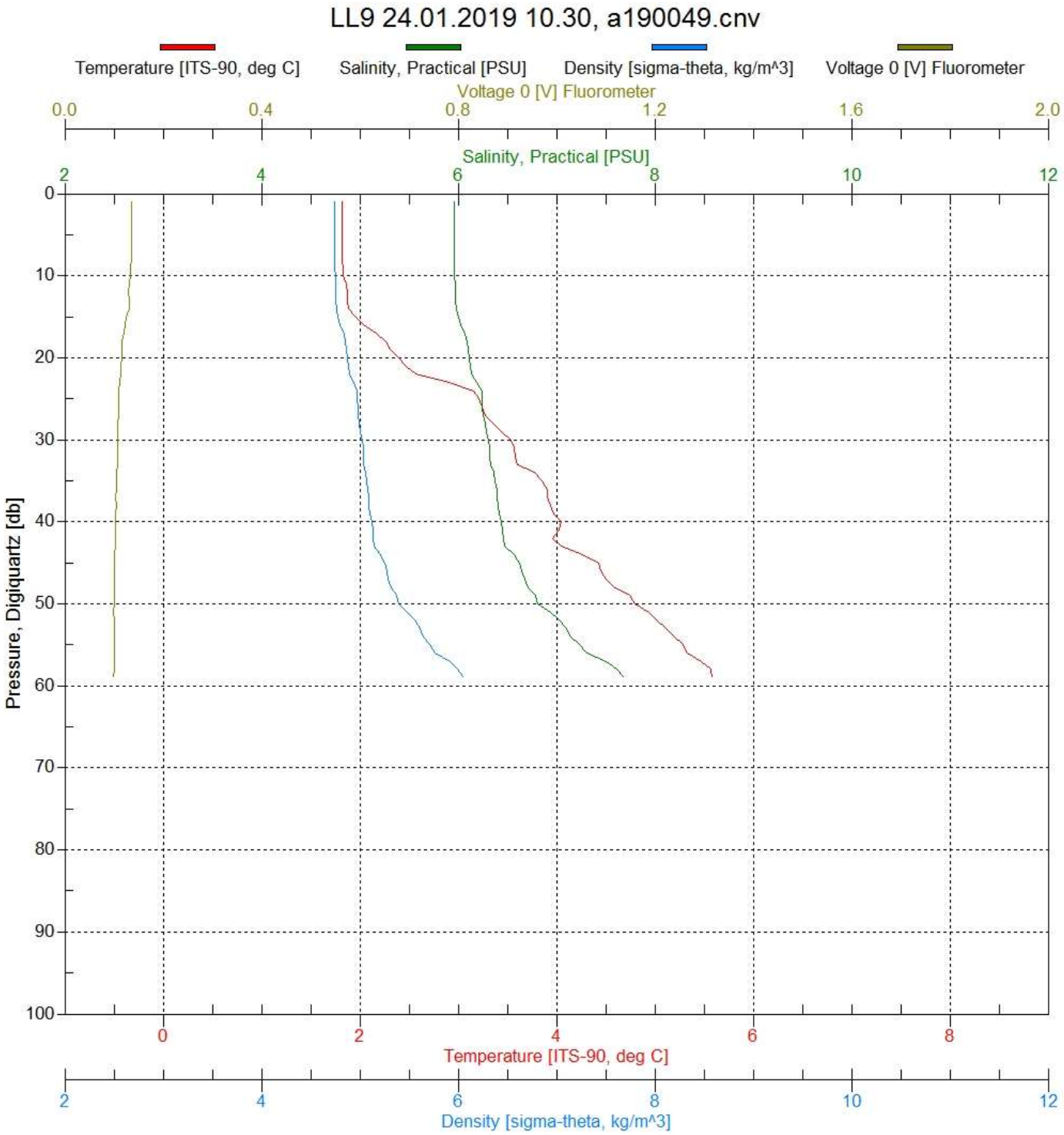

LL6A 23.01.2019 21.30, a190046.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

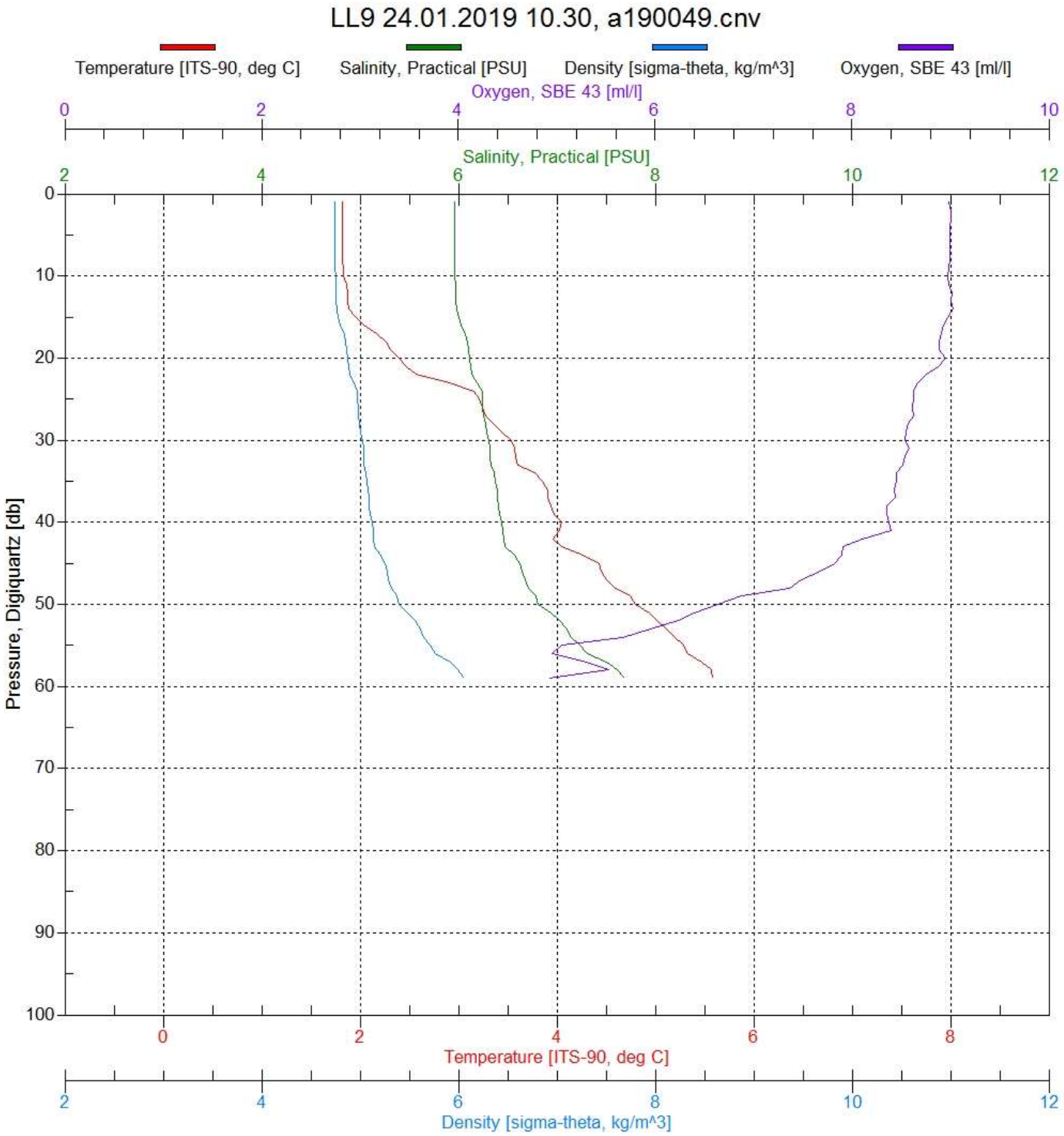

LL7 24.01.2019 00.20, a190047.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

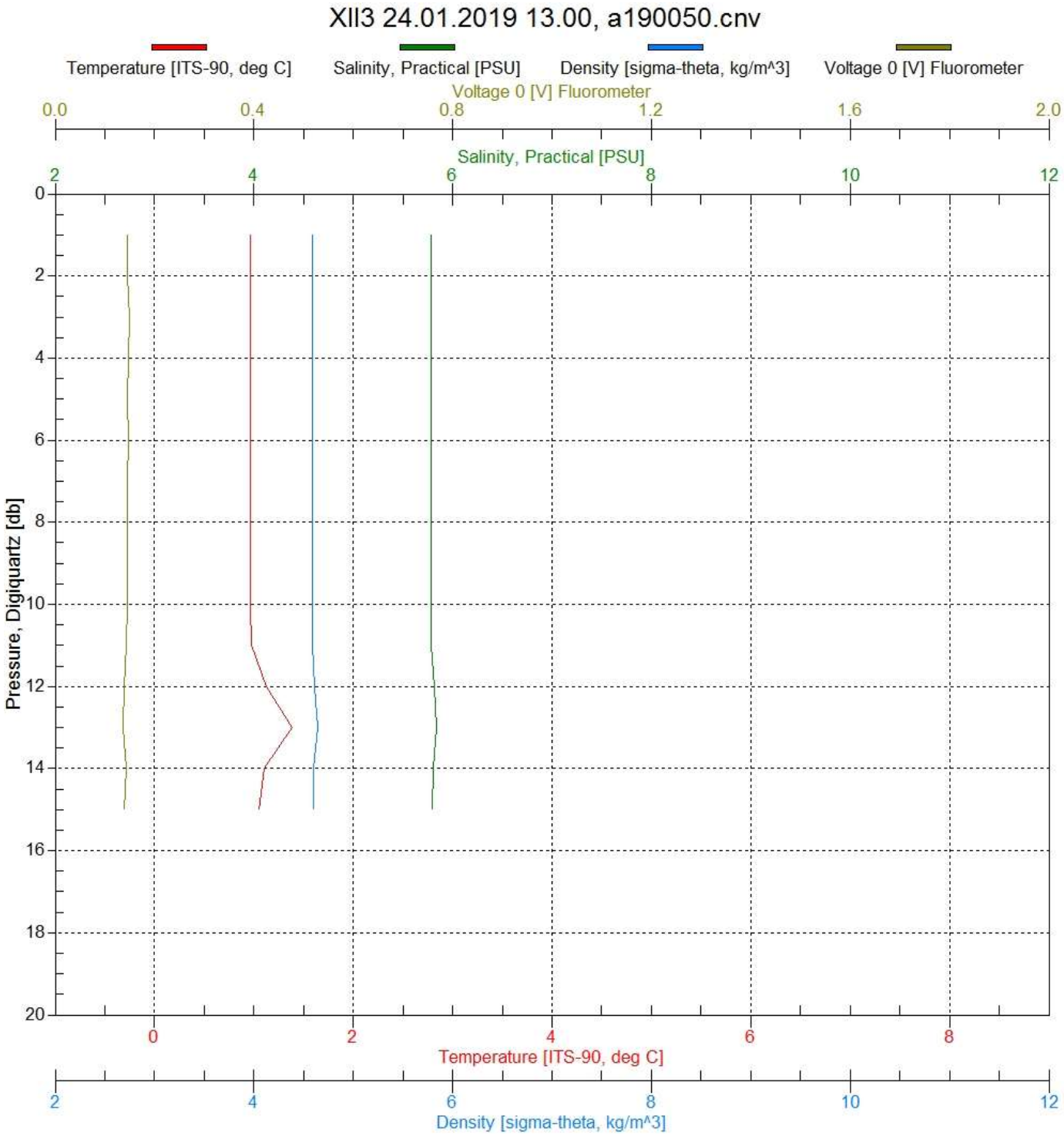

LL7 24.01.2019 00.20, a190047.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

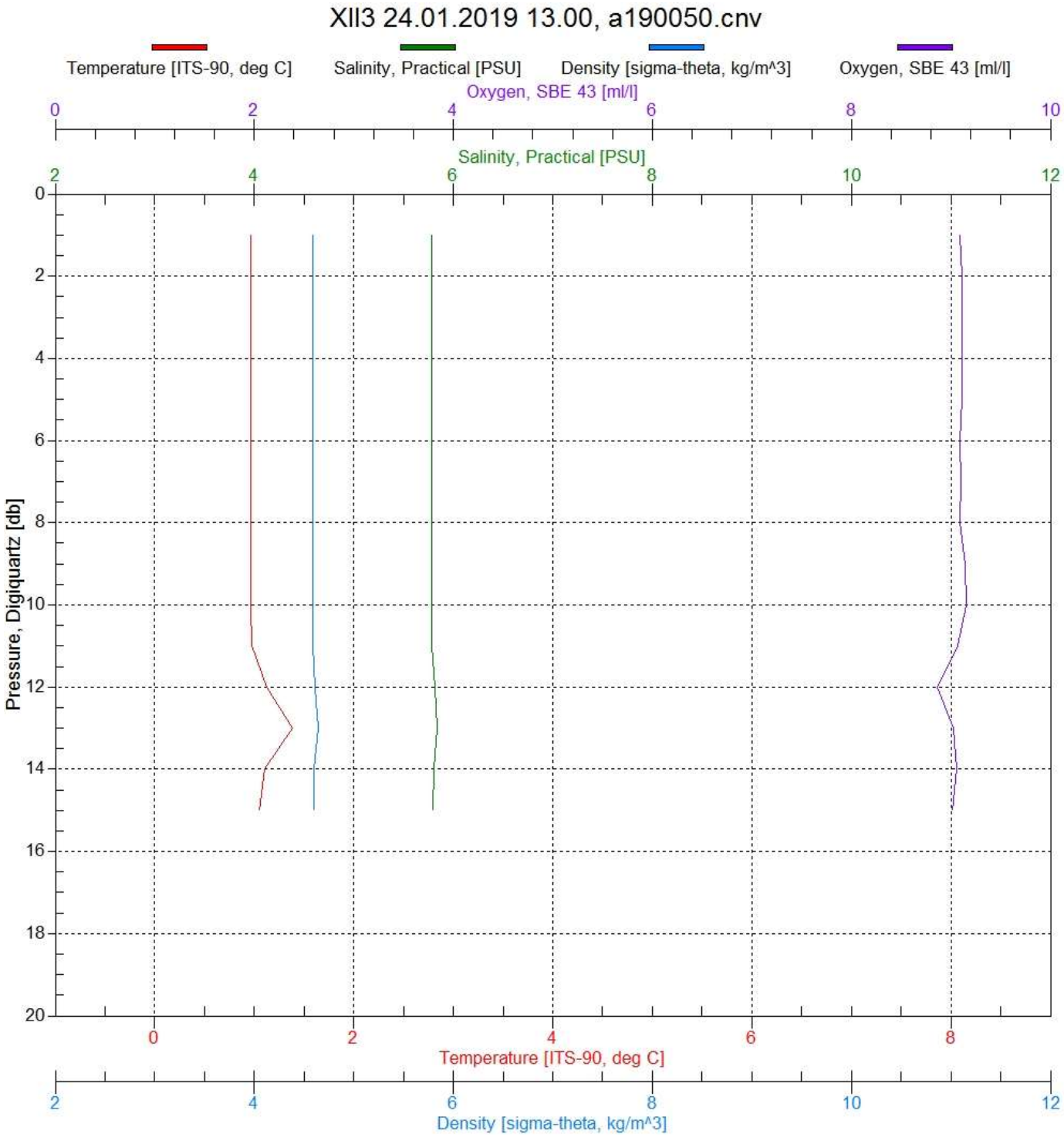

GF1 24.01.2019 04.15, a190048.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

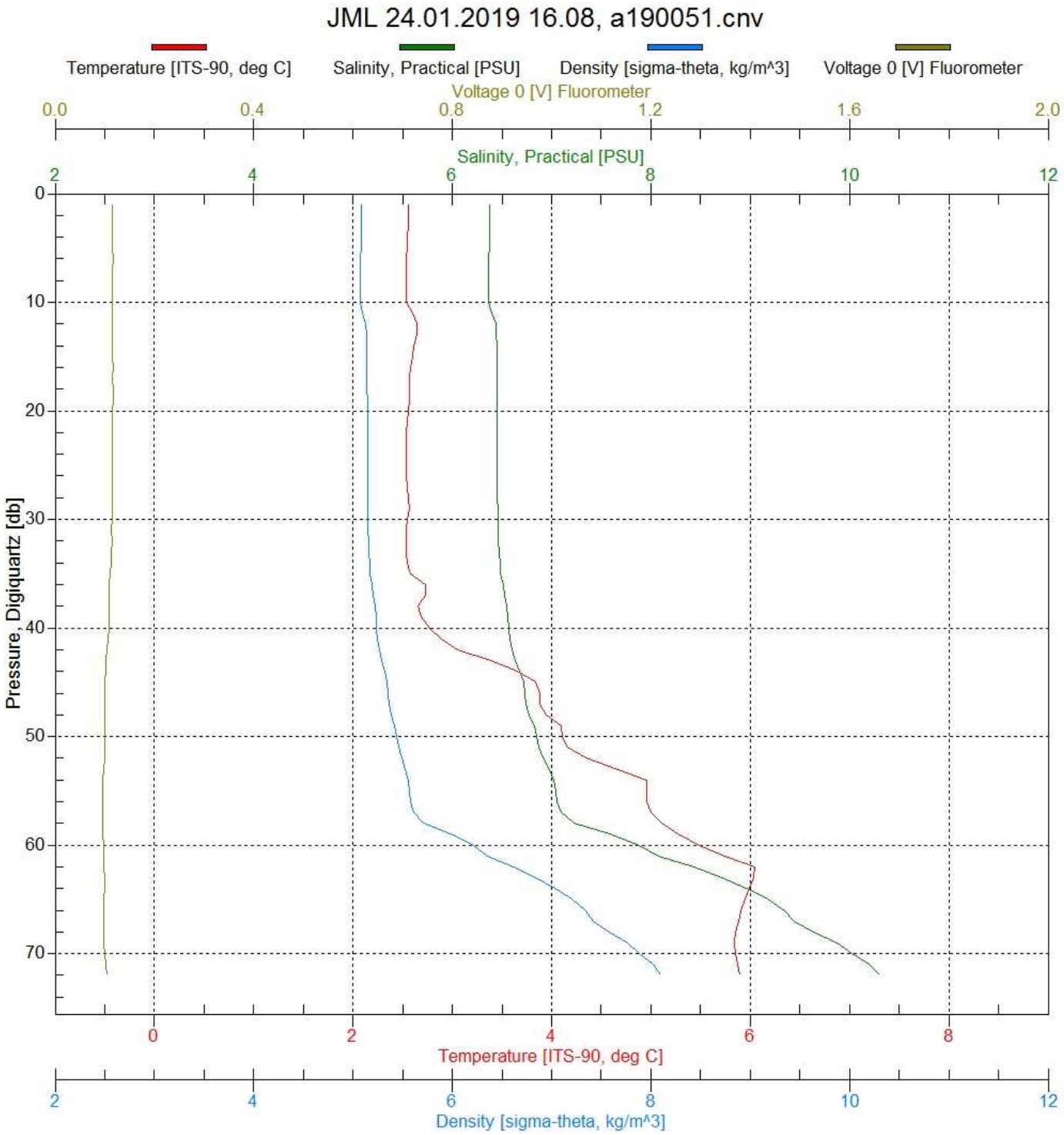

GF1 24.01.2019 04.15, a190048.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Temperature [ITS-90, deg C]
Density [sigma-theta, kg/m^3]

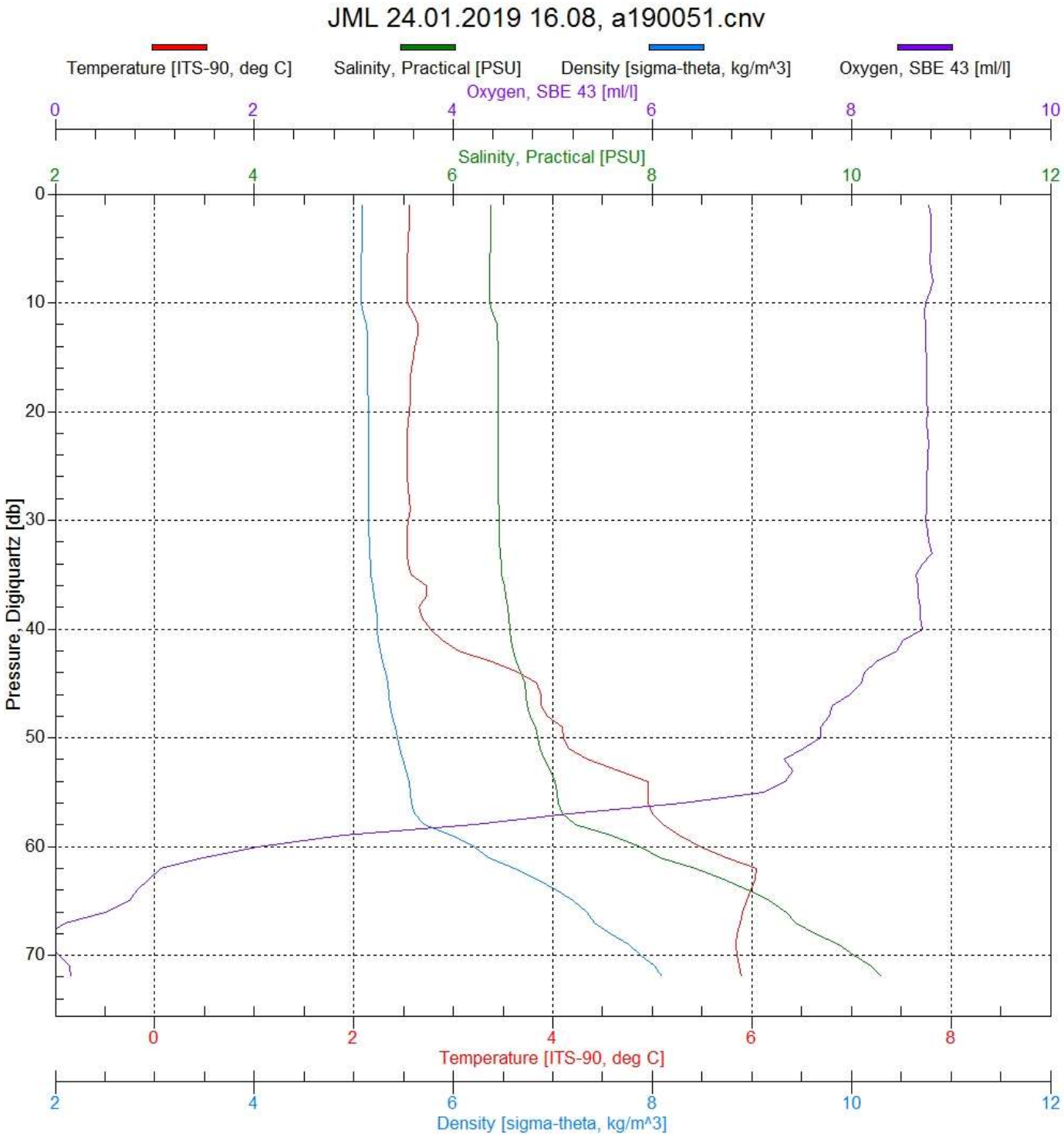

LL9 24.01.2019 10.30, a190049.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

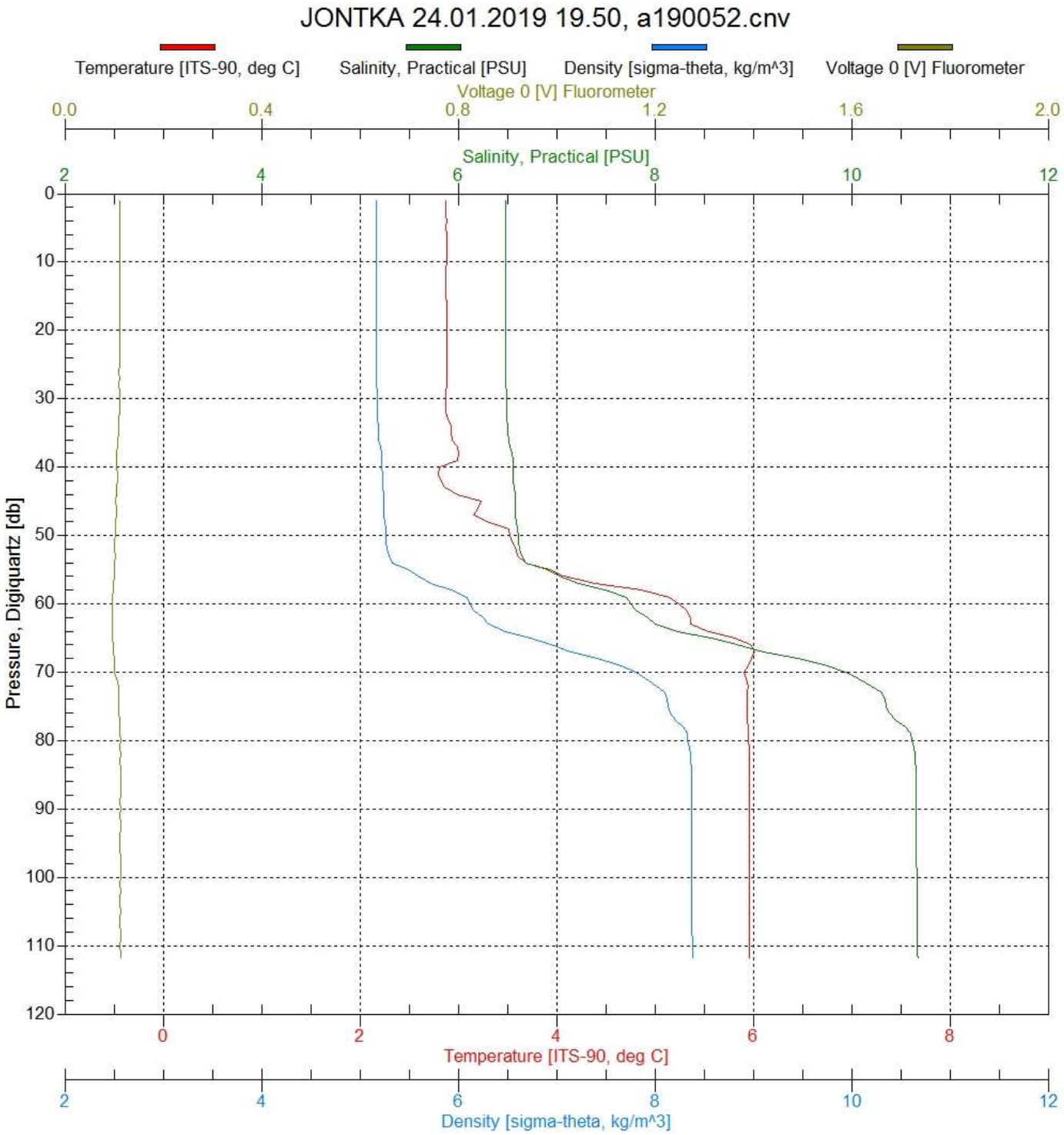

LL9 24.01.2019 10.30, a190049.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

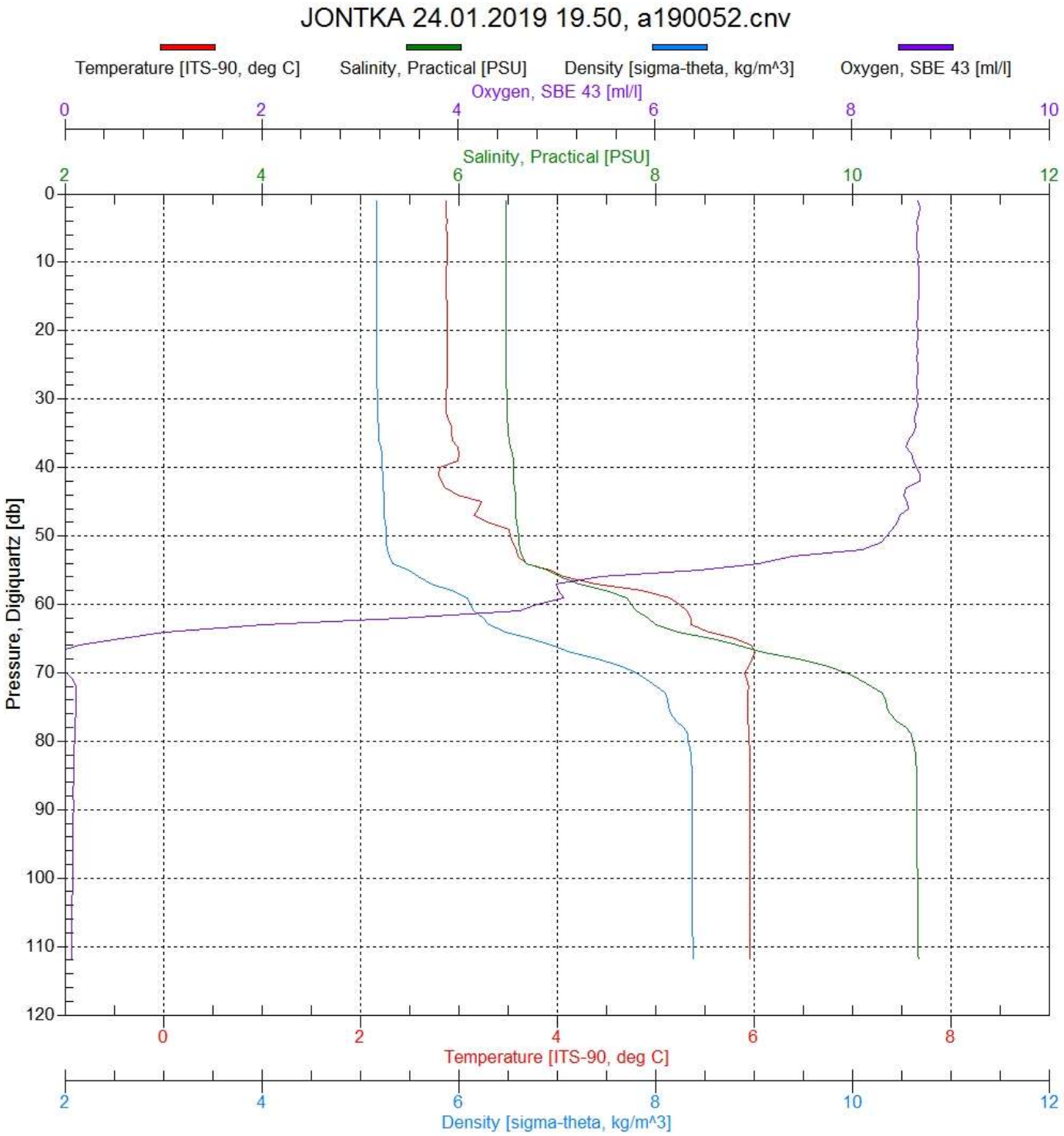

XII3 24.01.2019 13.00, a190050.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
2
4
6
8
10
12
14
16
18
20
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

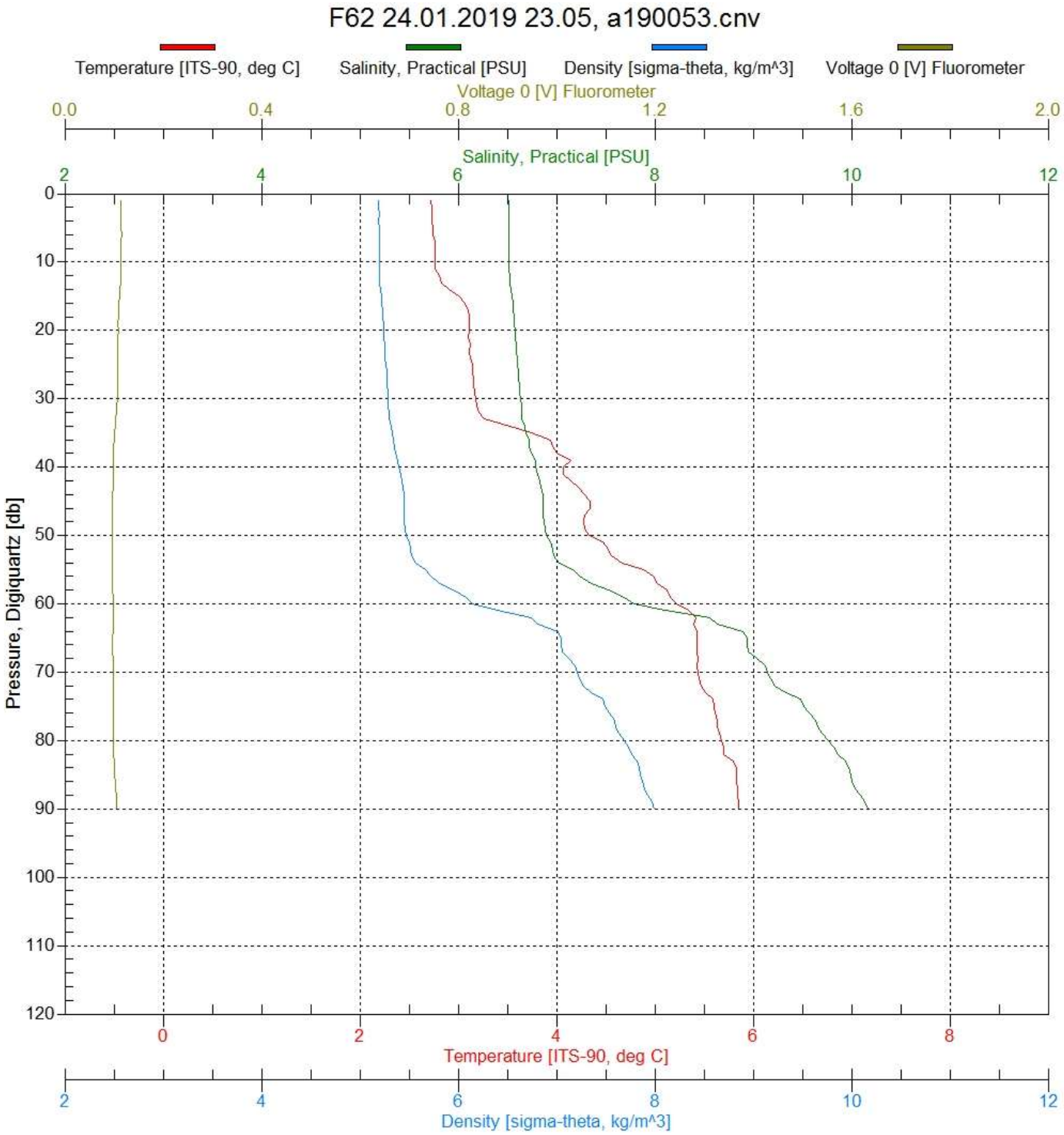

XII3 24.01.2019 13.00, a190050.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Temperature [ITS-90, deg C]
Density [sigma-theta, kg/m^3]

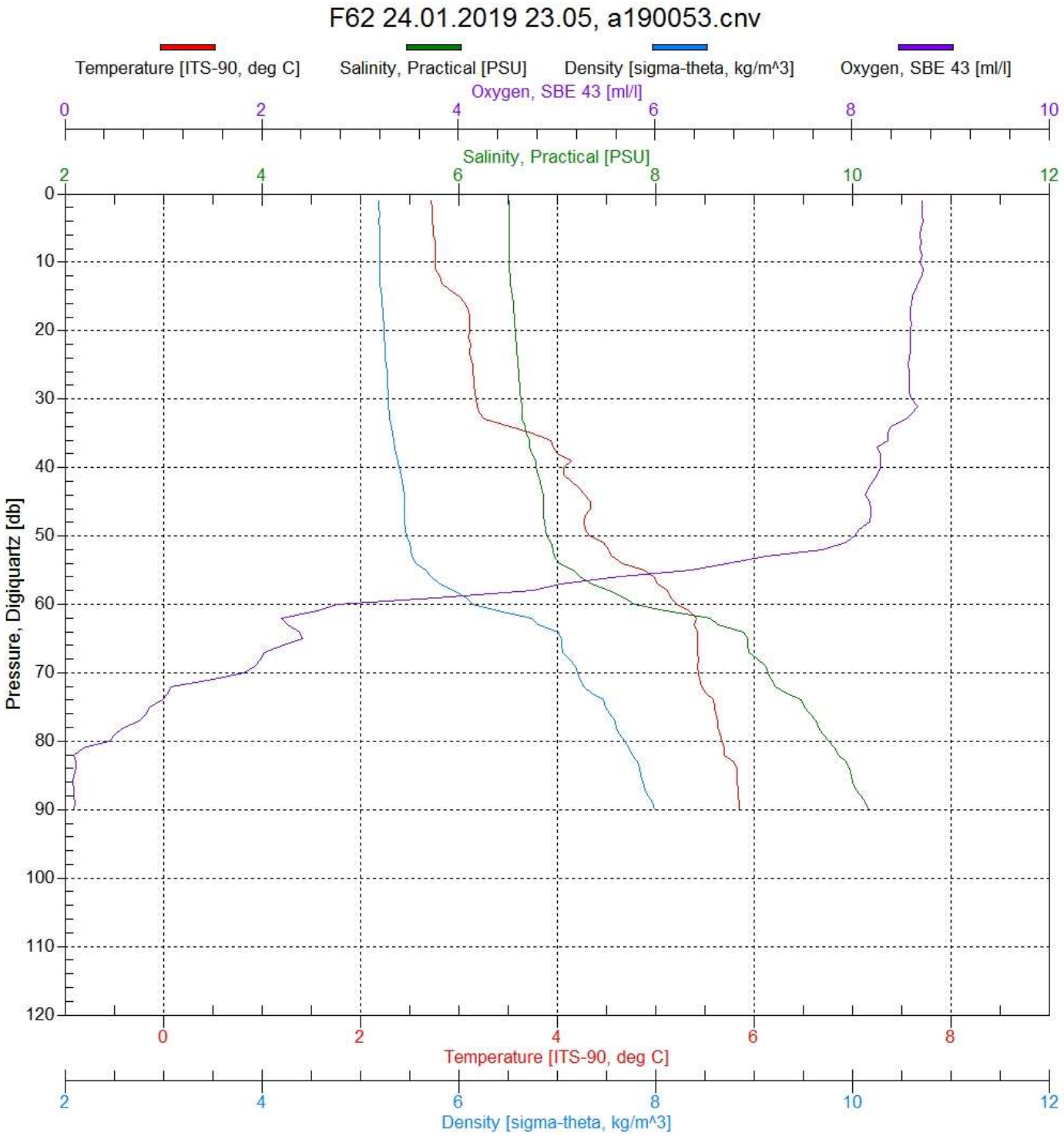

JML 24.01.2019 16.08, a190051.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
0
10
20
30
40
50
60
70
Pressure, Digiquartz [db]
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

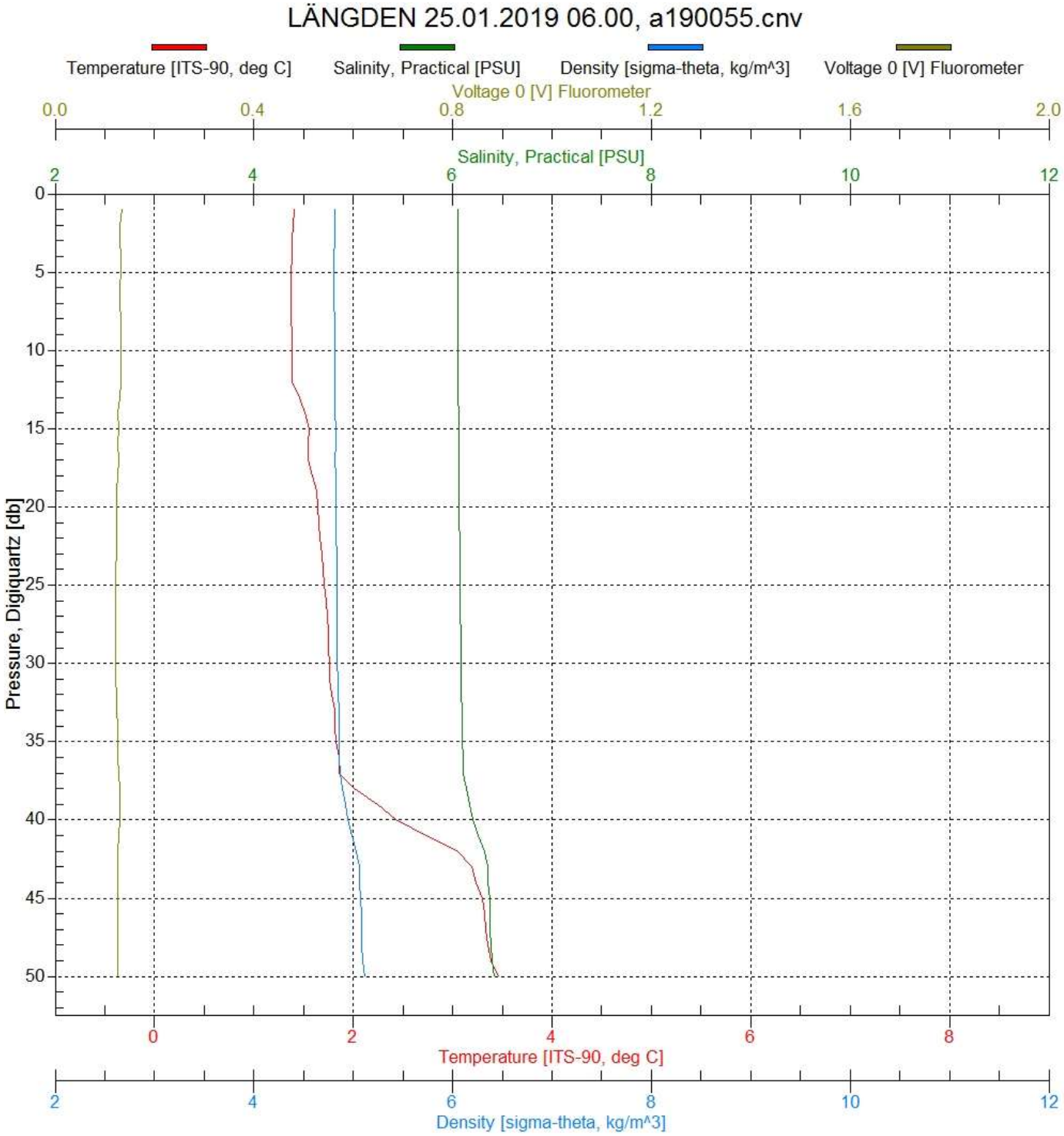

JML 24.01.2019 16.08, a190051.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

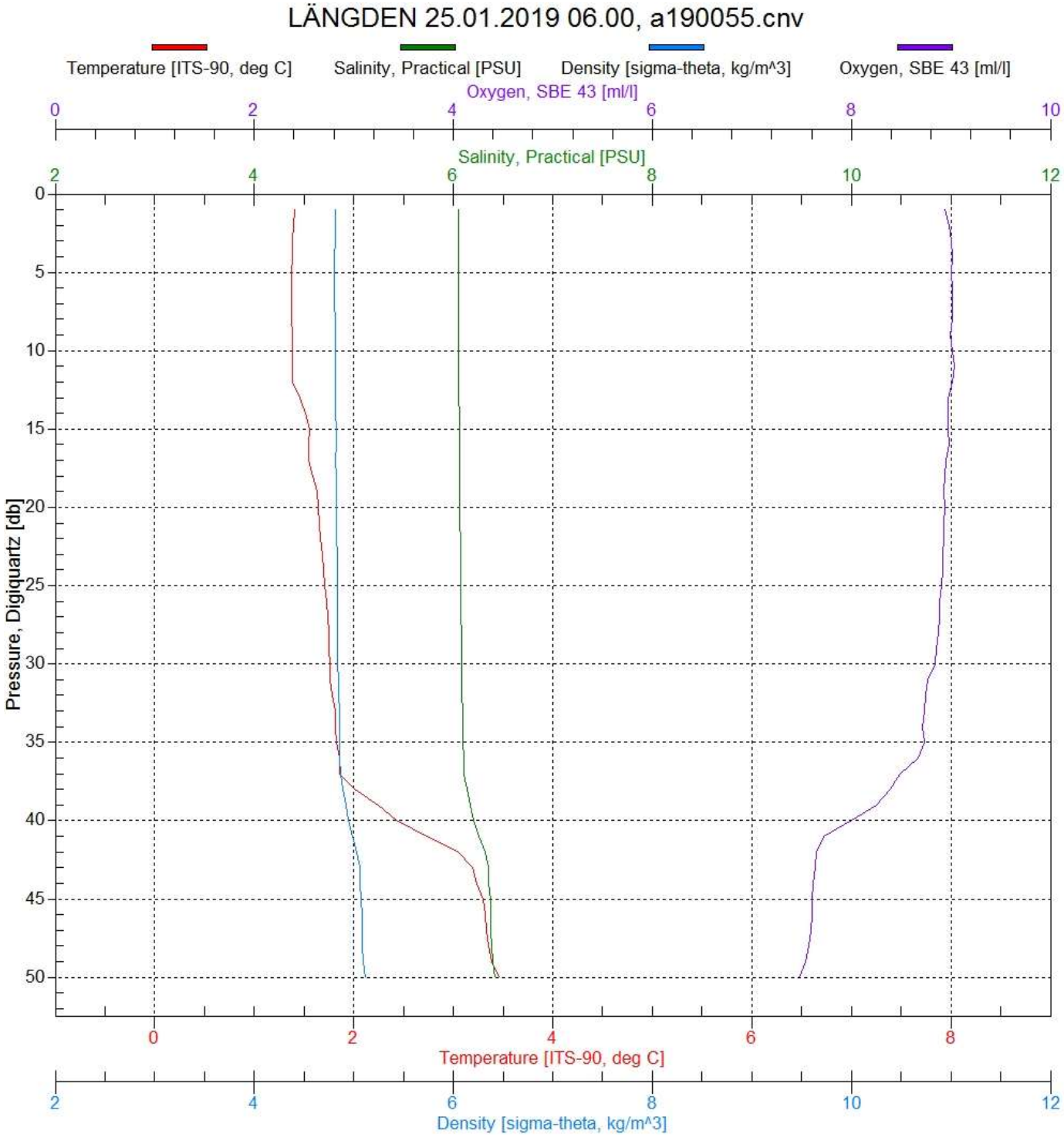

JONTKA 24.01.2019 19.50, a190052.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
110
120
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

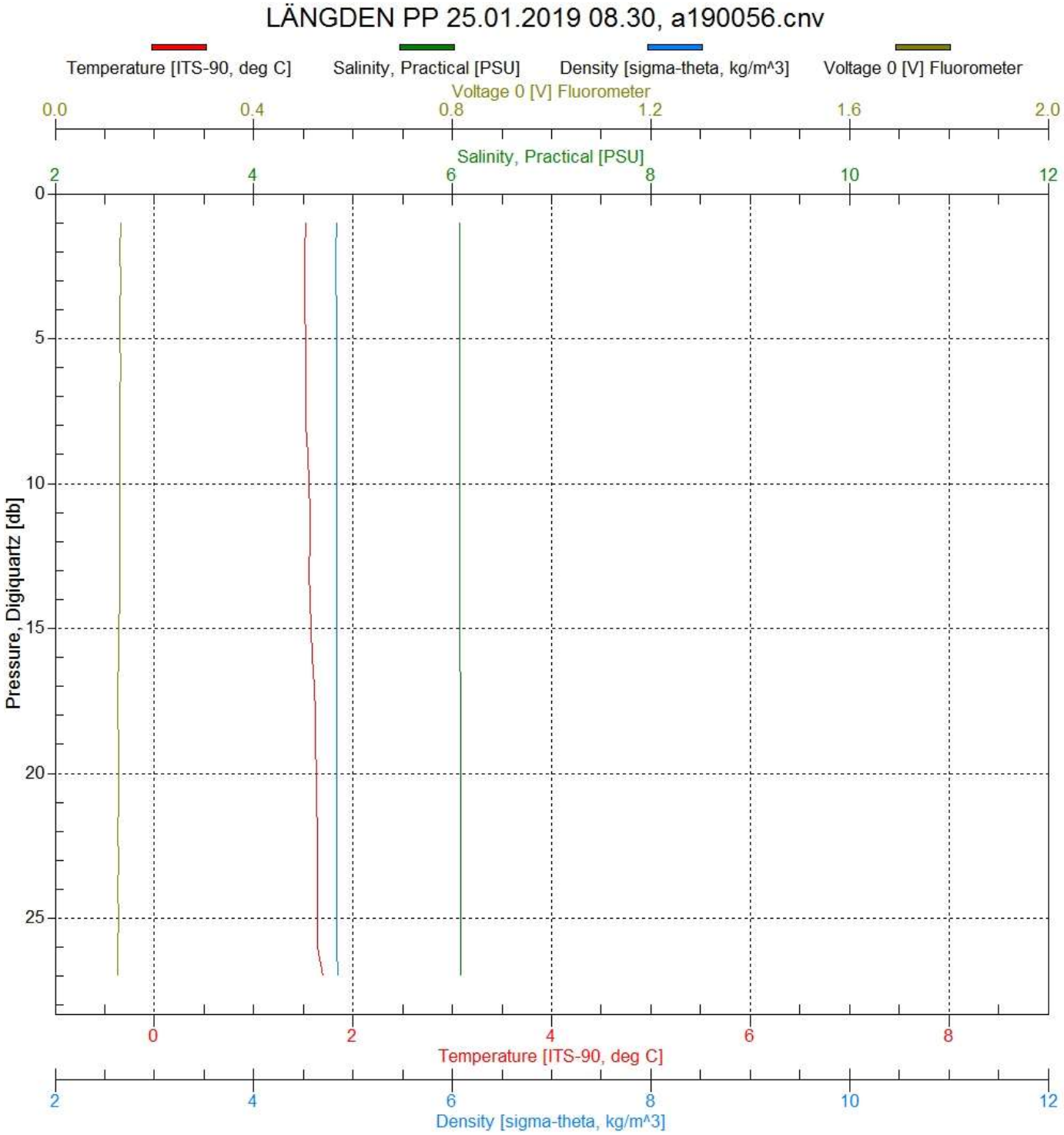

JONTKA 24.01.2019 19.50, a190052.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
110
120
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]

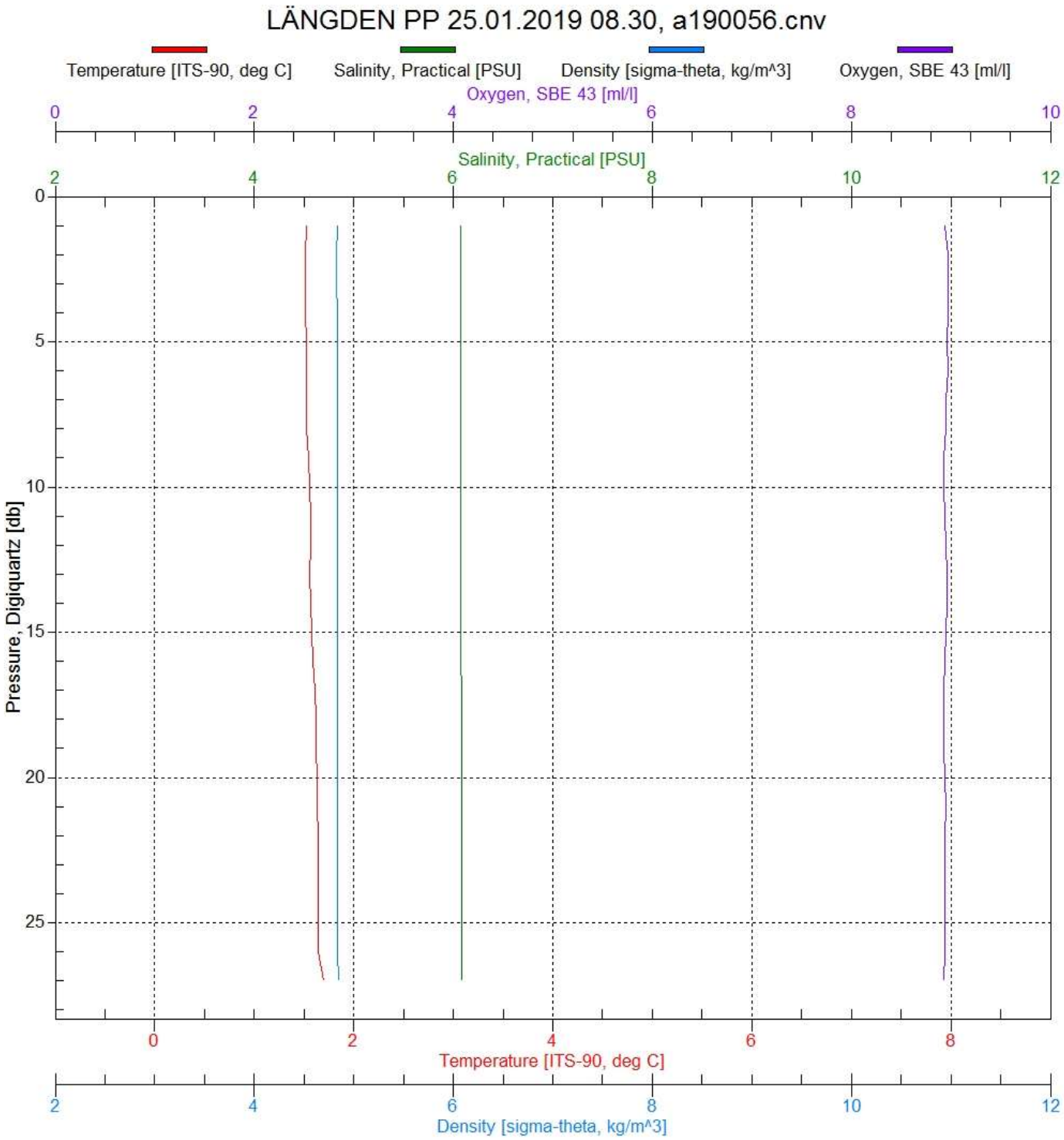

F62 24.01.2019 23.05, a190053.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
10
20
30
40
50
60
70
80
90
100
110
120
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]


F62 24.01.2019 23.05, a190053.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
Salinity, Practical [PSU]
Pressure, Digiquartz [db]
Temperature [ITS-90, deg C]
Density [sigma-theta, kg/m^3]


LÄNGDEN 25.01.2019 06.00, a190055.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
5
10
15
20
25
30
35
40
45
50
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]


LÄNGDEN 25.01.2019 06.00, a190055.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
Pressure, Digiquartz [db]
0
5
10
15
20
25
30
35
40
45
50
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]


LÄNGDEN PP 25.01.2019 08.30, a190056.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Voltage 0 [V] Fluorometer
Voltage 0 [V] Fluorometer
0.0
0.4
0.8
1.2
1.6
2.0
Salinity, Practical [PSU]
2
4
6
8
10
12
0
5
10
15
20
25
Pressure, Digiquartz [db]
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]


LÄNGDEN PP 25.01.2019 08.30, a190056.cnv
Temperature [ITS-90, deg C]
Salinity, Practical [PSU]
Density [sigma-theta, kg/m^3]
Oxygen, SBE 43 [ml/l]
Oxygen, SBE 43 [ml/l]
0
2
4
6
8
10
Salinity, Practical [PSU]
2
4
6
8
10
12
0
5
10
15
20
25
Pressure, Digiquartz [db]
0
2
4
6
8
Temperature [ITS-90, deg C]
2
4
6
8
10
12
Density [sigma-theta, kg/m^3]