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Oceanographic Laboratory

2022-08-25
Dnr: S/Gbg-2022-111

Report from SMHI's marine monitoring cruise with R/V Svea

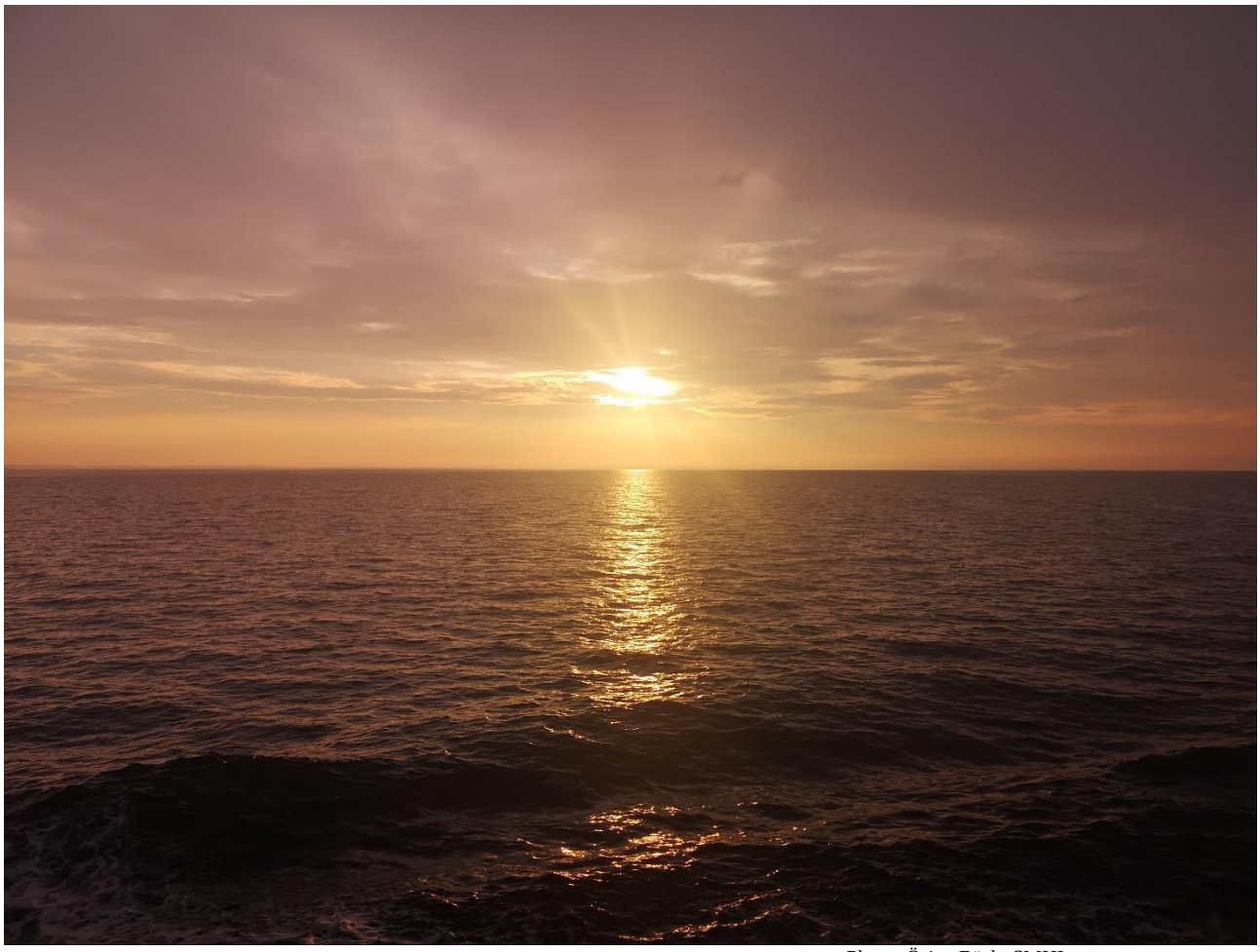

Photo: Örjan Bäck, SMHI

Survey period:	2022-08-12 to 2022-08-18
Principals:	Swedish Meteorological and Hydrological Institute (SMHI), Swedish Agency for Marine and Water Management (SwAM)
Cooperation partners:	Swedish University of Agricultural Sciences (SLU), Swedish Maritime Administration (SMA)

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SUMMARY

The Skagerrak, the Kattegat, The Sound and the Baltic Proper was visited during this cruise, which is part of the national marine monitoring programme of Sweden.

The temperature in the surface water was normal in the Skagerak and Kattegat, where it varied between 17 and 20 degrees. In the Baltic Sea, it was warmer than normal in the Western and Eastern Gotland basins, and the temperature there reached up to 21 degrees. The surface salinity was normal in the Skagerak and Kattegat, but in the Baltic Sea it was above normal at several stations.

Dissolved inorganic nitrogen was depleted in all sea areas down to the pycnocline. There were also low levels of phosphate in the surface water, although it was not completely exhausted. These low levels of nutrients are normal for the season. There were also mostly normal levels of silicate, highest in the Baltic Sea and significantly lower levels in the Skagerak and Kattegat.

There is now acute oxygen deficiency, < 2 ml/l, at all visited stations in the Baltic Proper except at the southern tip of Öland and it is a deterioration from last month. In the Arkona Basin, the oxygen concentration decreased rapidly from 40 m and there was acute oxygen deficiency closest to the bottom. In the Bornholm Basin, acute oxygen deficiency was noted from 70 m and hydrogen sulphide was observed from 80 m. In Hanö Bay, hydrogen sulfide was already noted from 70 m. In the Western and Eastern Gotland basins, there was acute oxygen deficiency from 60 – 70 m and hydrogen sulfide was measured from 70 – 80 m. Below 125 m at the Gotland Deep in the Eastern Gotland Basin, the hydrogen sulfide concentration increased rapidly to very high levels.

Closest to the bottom in the Skagerrak, there was oxygen deficiency at Släggö (3.1 ml/l), in the Kattegatt there was oxygen deficiency at Fladen (3.6 ml/l) and Anholt E (3.1 ml/l) and in Öresund it was also oxygen deficiency (3.7 ml/l).

SMHI's next cruise with R/V Svea is planned for 16th to 22nd of September, starting in Lysekil and ending in Kalmar.

RESULTS

The cruise was performed onboard R/V Svea and began in Lysekil on 12th August and ended in Lysekil on 18th August.

The weather during the cruise was calm with north and north easterly winds and the wind speed was 2 – 9 m/s. The air temperature was around 18 – 23 degrees, most nights were tropical, meaning temperature didn't go below 20 degrees.

In the beginning of the cruise the pump for the ammonia analysis instrument broke, hence no ammonium results and also no evaluation of DIN in the deep water where the concentration of oxygen is below 2 ml/l.

Measurements with Svea's MVP (Moving Vessel Profiler) which is used to measure temperature, salinity and oxygen profiles underway was not used at all due to issues with the equipment, hopefully the problem can be fixed until the next cruise.

Both the Ferrybox (continuous measurements at a depth of 4 meters) and Svea's both ADCPs (current measurement) were running during the expedition.

The wave buoy at Knolls Grund was recovered and a new one was deployed.
In addition to the regular sampling, extra phytoplankton samples were taken for Stockholm University at two stations in the Skagerrak and one in the Kattegat. This is part of an ongoing project ending in February 2023.

This report is based on data that has undergone an initial quality control. When additional quality control has been performed, certain values may change. Data from this cruise is published as soon as possible on the data host's website, this usually takes place within a week after the cruise has ended. Some analyses are made after the cruise and are published later.

Data can be downloaded from SHARKweb here:
https://www.smhi.se/en/services/open-data/national-archive-for-oceanographic-data/download-data-1.153150

The Skagerrak
The temperature in the surface water was almost the same as in July. Along the Å section it was still about 17 degrees and at the coastal station Släggö it was 19 degrees. At P2, however, the temperature had increased by one degree and was now 18 degrees. The salinity was around 32 psu at all stations except at Släggö where it was 24.5 psu. At all stations, both temperature and salinity in the surface water were within the normal range. The surface layer in the Skagerrak was well mixed down to 15 m. Below 15 m along the Å section, the salinity increased and the temperature decreased down to about 50 m, below that the water mass was quite homogeneous with a salinity of 35.2 psu and a temperature of 7.5 degrees. At station P2, the stratification was weaker and only around 80 m did the water become homogeneous.

The concentration of nutrients in the surface water remained low and phosphate and DIN[1] were close to their respective detection limits, which is normal for the time of year. DIN varied between 0.1 – 0.2 µmol/l, phosphate 0.04 – 0.07 µmol/l and silicate 0.2 – 1.1 µmol/l. The highest concentrations were observed closest to the coast at Släggö. All nutrients increased below the stratification.

The oxygen situation at the bottom was good along the Å section and at P2 where the oxygen concentration was 5.2 – 5.9 ml/l. The lowest oxygen concentration was observed at Släggö where it was 3.1 ml/l, this is a decrease since July but still within normal. At P2, an oxygen minimum around 70 m was noted in data from the CTD probe.

Chlorophyll fluorescence is a measure of plankton activity measured with the CTD probe. There were several chlorophyll fluorescence peaks in the stratified layer but lower values closer to the surface. At Släggö the Secchi depth was 9 m and along the Å section 12 m.

The Kattegat and the Sound
The temperature in the Kattegat surface water had increased slightly since July and was now 19 – 20 degrees, in the Sound 18 degrees. The surface salinity varied from 22.9 psu at the Kattegat northernmost station Fladen to 9.6 psu in the Öresund. Both temperature and salinity were normal in the surface water, however the salinity in the Sound was slightly below normal. The top 5 – 10 meters were well mixed and below that the salinity increased down to the halocline at about 20 m. At N14 Falkenberg and in the Sound the thermocline coincided with the halocline, at Fladen and Anholt E the thermocline was deeper, around 50 m.

There were still very low concentrations of nutrients in the surface water which is normal for this time of year. Phosphate varied between 0.05 – 0.08 µmol/l, DIN[1] around 0.1 µmol/l and silicate between 0.7 – 1.0 µmol/l. At Fladen there was a slight increase in phosphate and silicate since last month. In the deep water, below the stratification, the concentration of phosphate and silicate was higher than normal at Anholt E and Fladen. There are no measurements of nutrients in the Sound from this cruise.

The concentration of oxygen near the bottom had decreased since July, which is normal due to the decomposition of organic material coming from the surface layer, and it was now oxygen deficiency in the Kattegat except at the coastal station N14 Falkenberg. The lowest observed values were 3.1 ml/l at Anholt E, 3.7 ml/l in Öresund and att Fladen 3.6 ml/l, which is slightly lower than normal.

[1] DIN – dissolved inorganic nitrogen. DIN is the sum of nitrate, nitrit and ammonium.

Peaks of chlorophyll fluorescence around 20 m were noted at all stations. The Secchi depth in the Kattegat was around 11 m.

The Baltic Proper

In the Baltic Proper, the surface temperature had increased since last month and now varied between 19 - 21 degrees and near the southern tip of Öland it was 14 - 15 degrees. At the majority of stations, it was warmer than normal and mainly in the Western and Eastern Gotland basins. At the station Ref M1V1 it was instead slightly cooler than normal. The salinity of the surface water varied between 6.3 psu in the north-eastern part to 8 psu in the Arkona Basin. It was saltier than normal in the Bornholm Basin, at BCS III-10 and in the northernmost part of the Western Gotland Basin. At the northernmost part of the Eastern Gotland Basin, the salinity was instead lower than normal. The position of the halocline varied from the deepest 65 m at BCS III-10 to the shallowest 20 m in the Arkona Basin. The thermocline varied between 5 and 20 m. In the deep water below the halocline it was 6 degrees and 10.5 psu in the Western Gotland Basin, in the Eastern Gotland Basin it was 7 degrees and 12 – 13 psu. In both Gotland basins, the deep water is warmer and saltier than normal.

The concentration of DIN[1] was at all stations very low from the surface down to the pycnocline, around 0.1 µmol/l. Phosphate in the surface water was not as depleted as DIN, but still low levels that varied between 0.07 µmol/l in the Gotland basins to 0.14 µmol/l in the Arkona Basin. Around the southern tip of Öland, there were higher levels of phosphate, 0.3 – 0.4 µmol/l. The concentration of silicate in the surface water was mostly normal and varied between 8 – 10 µmol/l. At Öland's southern tip and at BCS III-10, however, there were higher silicate concentrations than normal, 12 µmol/l. The low levels of nutrients in the surface water are normal for the time of year.

In the deep water in the Bornholm Basin and the Western- and Eastern Gotland Basin, there were higher levels of phosphate and silicate than normal. There is no analysis of ammonium for August so DIN in the deep water cannot be evaluated.

There is now acute oxygen deficiency, < 2 ml/l, at all visited stations in the Baltic Proper except at the southern tip of Öland and it is a deterioration from last month. In the Arkona Basin, the oxygen concentration decreased rapidly from 40 m and there was oxygen deficiency closest to the bottom. In the Bornholm Basin, oxygen deficiency was noted from 70 m and hydrogen sulfide from 80 m. In Hanö Bay, hydrogen sulfide was already noted from 70 m. In the Western- and Eastern Gotland Basin, there was acute oxygen deficiency from 60 – 70 m and hydrogen sulfide was measured from 70 – 80 m. Below 125 m at the Gotland Deep in the Eastern Gotland Basin, the hydrogen sulfide concentration increased rapidly to very high levels.

Fluorescence measurements from the CTD showed plankton activity in the surface layer down to 20 m at all stations. Higher peaks of chlorophyll fluorescence were observed in the Arkona Basin and at Ref M1V1. The Secchi depth was 6 – 8 m.

More information about the algal situation can be found in the Algaware report for August: https://www.smhi.se/publikationer/publikationer/algrapporter

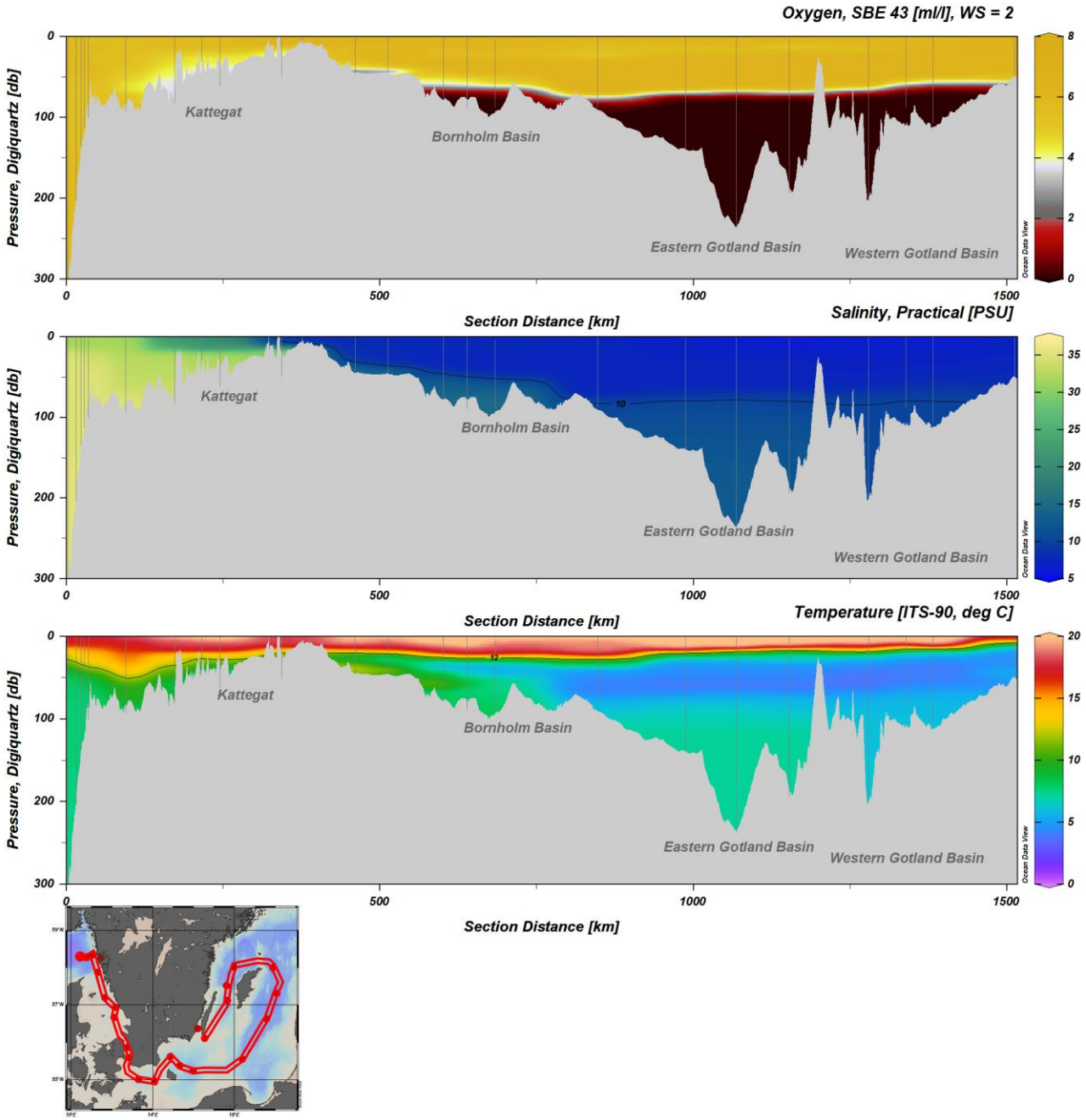


Figure 1. Transect showing CTD measurements of dissolved oxygen, salinity and temperature from Skagerrak, Kattegat, the Sound, further into the Baltic Proper, ending in the Western Gotland Basin. Vertical lines show the positions where data is collected, also shown in the map.

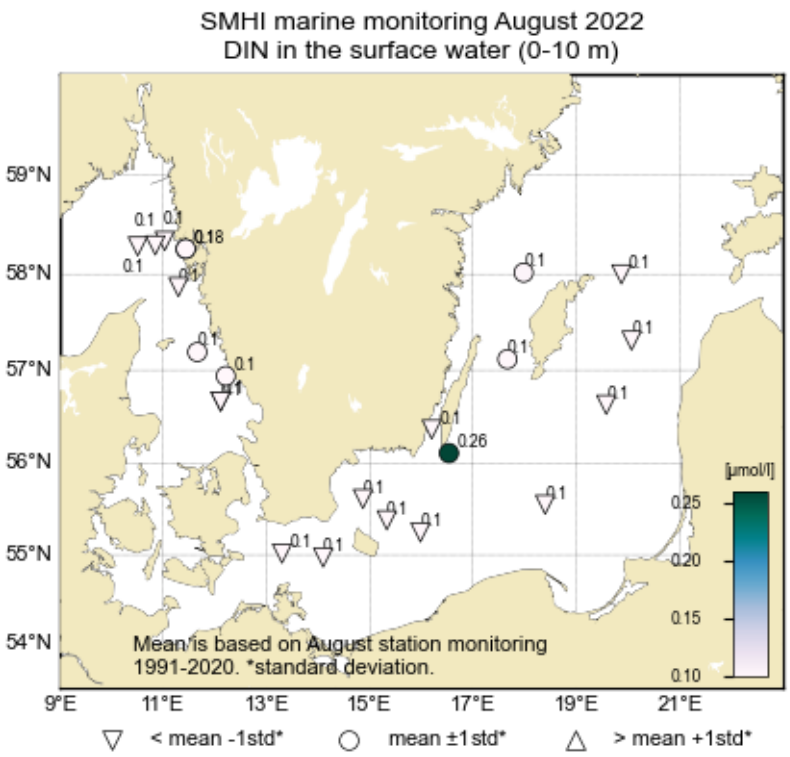


Figure 2. Concentration of dissolved inorganic nitrogen in the surface water (0-10m).

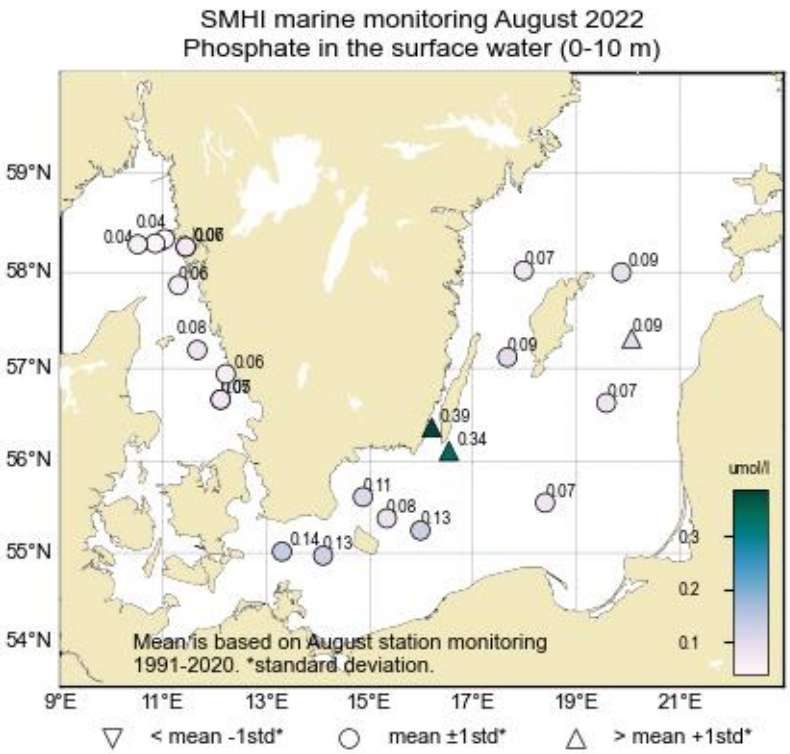


Figure 3. Concentration of phosphate in the surface water (0-10m).

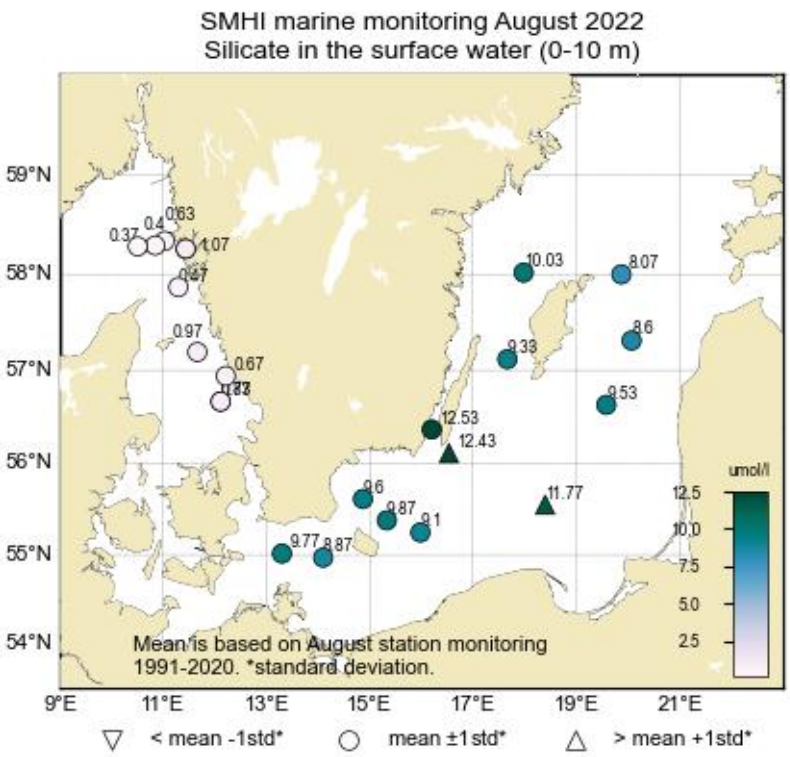


Figure 4. Concentration of silicate in the surface water (0-10m).

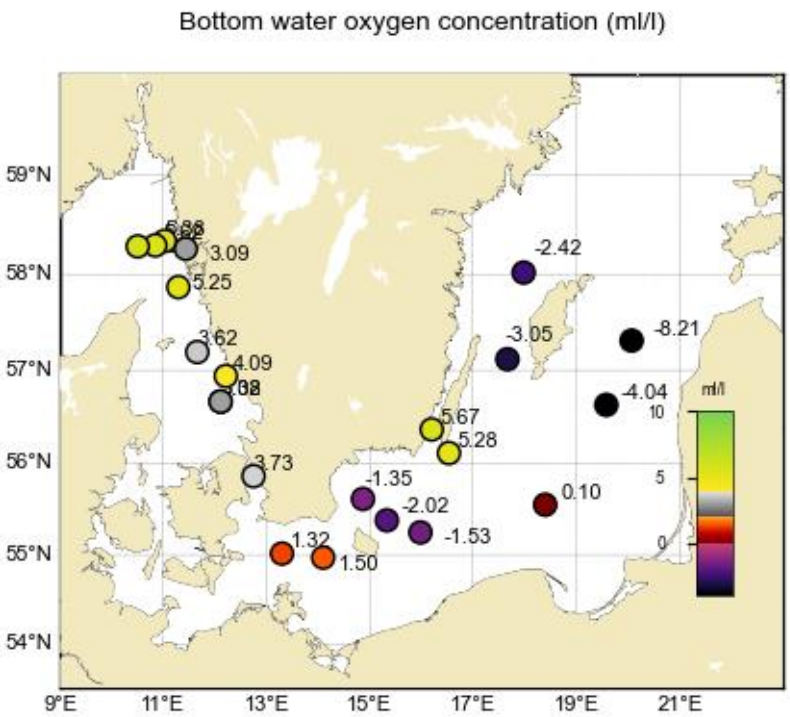


Figure 5. Oxygen concentration in the bottom water.

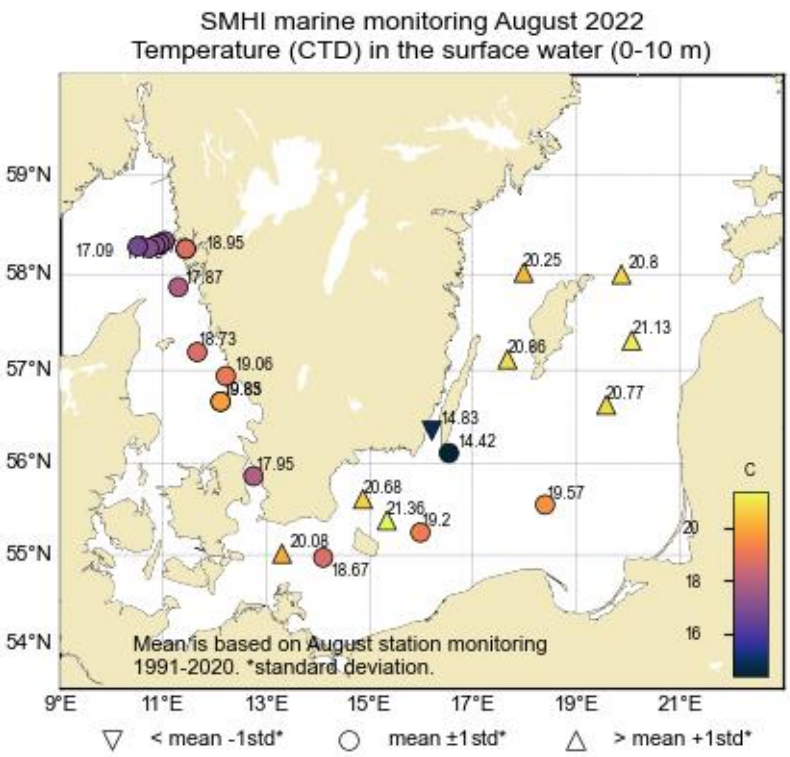


Figure 6. Temperature in the surface water (0-10m).

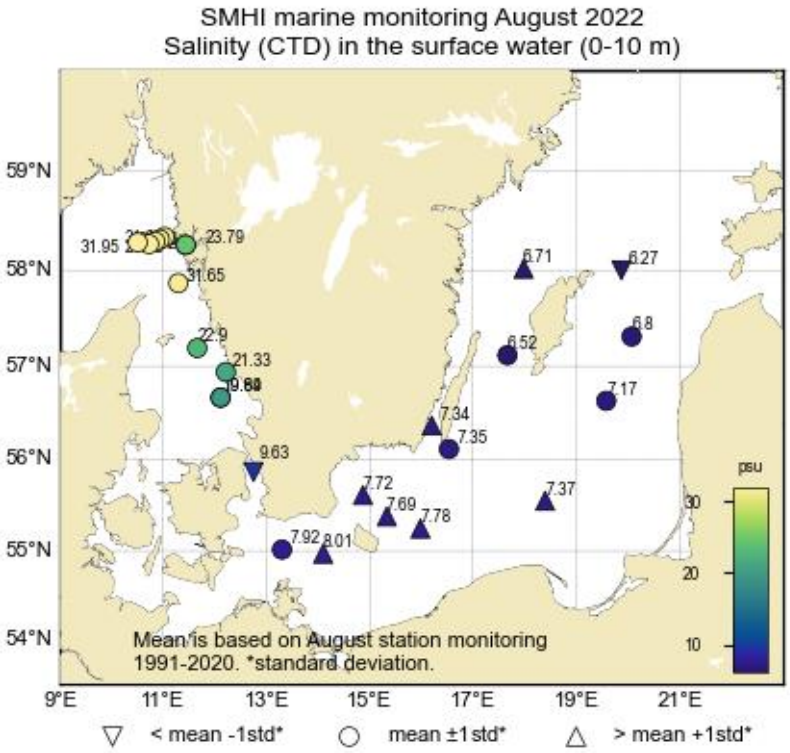


Figure 7. Salinity in the surface water (0-10m).

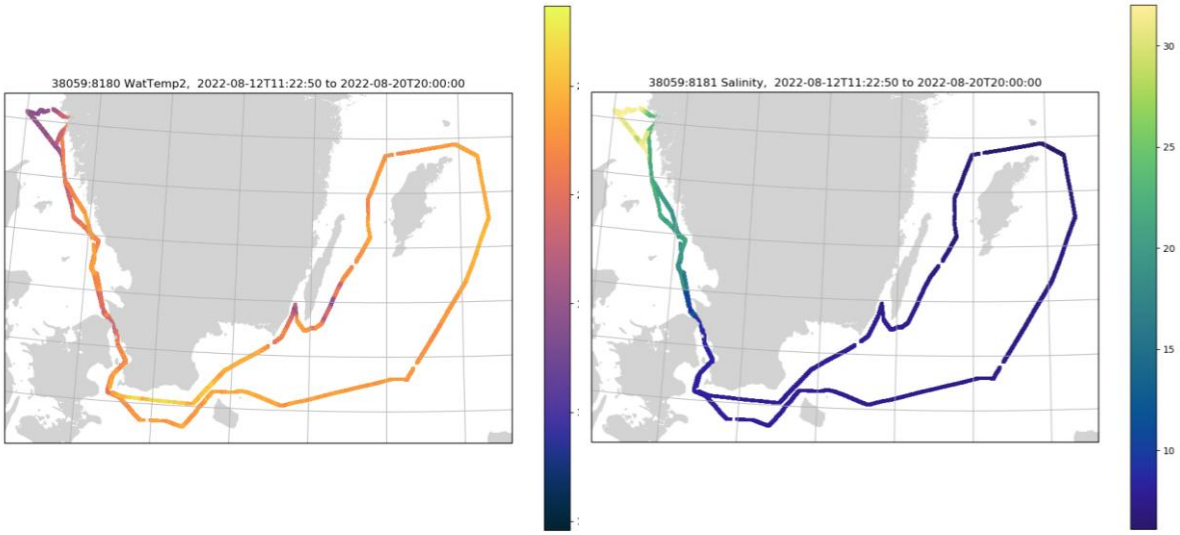


Figure 8. Surface water temperature (left) and salinity (right) from the ferrybox on Svea. Data has only undergone a rough quality control.

PARTICIPANTS

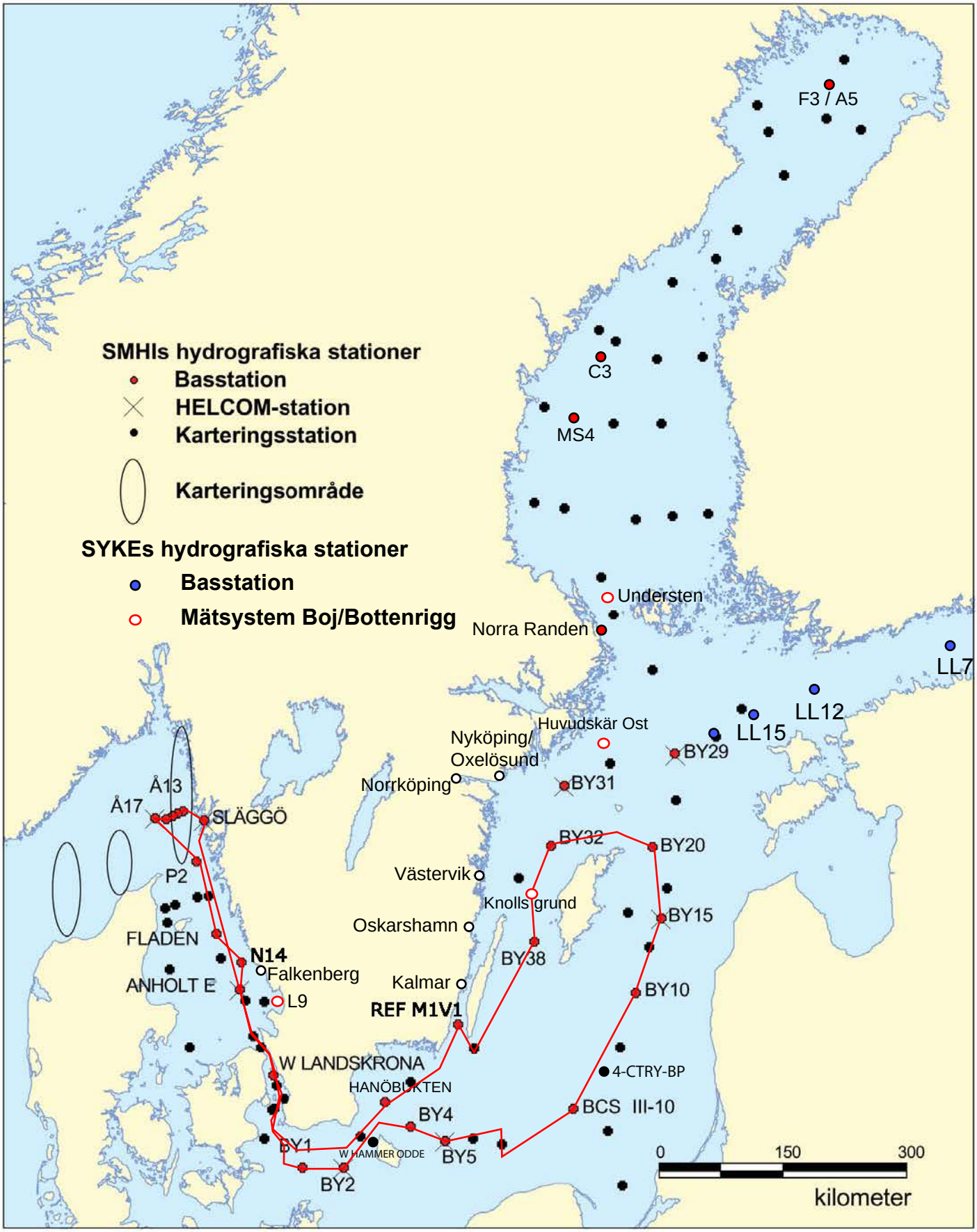
Name	Role	Institute
Örjan Bäck	Chief scientist	SMHI
Kristin Andreasson	Quality manager	SMHI
Ola Kalén		SMHI
Johanna Linders		SMHI
Sari Sipilä		SMHI

APPENDICES

- Track chart
- Table over stations, sampled parameters and number of sampling depths
- Vertical profiles for regular monitoring stations
- Monthly average surface water plots for regular monitoring stations

SMHI
Havs
och Vatten
myndigheten

TRACKCHART
Country: Sweden
Ship: R/V Svea
Date: 20220812-18
Series: 0563-0589



Date: 2022-08-22
Time: 13:05

Ship: SE
Year: 2022

Ser no	Cru no	Stat code	Proj	Stat name	Lat	Lon	Start date yyyymmdd	Start time hhmm	Bottom depth m	Secchi depth m	Wind dir	Wind vel	Air temp C	Air pres hPa	WCWI elac aove tueo hdsb	CZPP hohp loy apt o p	No de	No btl	Temp_bottle	Temp_cast	Salt_bottle	Salt_cast	Phos_bottle	Phos_cast	Doxy_bottle	Doxy_cast	H2S	Phosphate	Nitrite	Nitrate	Nitrite	Ammonia	Alkalinity	Silicate	Shipmom3-sis	Cruise_nr	Cruise_type	Cruise_nr
0563	13	FIBG27	BAS...	SLÄGGÖ	5815.59	01126.14	20220812	1245	75	9	21	4	19.4	1021	0019	xxx-	9	9	x	x	-	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0564	13	SKEX14	BAS...	Å13	5820.36	01101.67	20220812	1520	101	12	19	6	18.0	1020	1120	x---	10	10	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0565	13	SKEX15	BAS...	Å14	5818.93	01056.01	20220812	1700	113		19	5.6	18.0	1020	0020	----	11		x	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0566	13	SKEX16	BAS...	Å15	5817.67	01050.65	20220812	1820	136		18	4.5	18.0	1019	0020	x---	12	12	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0567	13	SKEX17	BAS...	Å16	5816.02	01043.46	20220812	2005	203		18	3.9	17.9	1019	0020	----	13		x	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0568	13	SKEX18	BAS...	Å17	5817.06	01030.26	20220812	2130	350		18	4	18.1	1019	9999	xxx-	15	15	x	x	-	x	x	x	x	-	x	x	x	x	x	-	x	x	x	-	x	-
0569	13	SKEX23	BAS...	P2	5752.02	01117.53	20220813	0300	94		15	5	18.6	1019	9999	x---	10	10	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0570	13	KANX25	BAS...	FLADEN	5711.53	01139.53	20220813	0800	83	11	15	3.5	20.1	1019	1120	x---	13	13	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0571	13	KANX50	BAS...	N14 FALKENBERG	5656.39	01212.71	20220813	1115	32	11	20	1.8	20.7	1019	1120	xxx-	7	7	x	x	x	x	-	x	x	-	x	-	x	x	x	-	x	-	x	-	x	-
0572	13	KAEX29	BAS...	ANHOLT E	5640.12	01206.67	20220813	1350	63	12	27	2	22.4	1018	1219	xxx-	10	10	x	x	x	x	x	x	x	-	x	x	x	x	x	-	x	x	x	x	x	-
0573	13	SOCX39	BAS...	W LANDSKRONA	5552.01	01244.93	20220813	2015	50		18	4	22.0	1017	9999	x---	9	9	x	x	x	x	-	x	x	-	-	-	-	-	-	-	-	-	-	-	x	-
0574	13	SOSX00	EXT...	FLINTEN-7	5535.31	01250.69	20220813	2300	9		08	2	21.2	1017	9999	----	3		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0575	13	BPSA02	BAS...	BY1	5500.95	01318.03	20220814	0415	46		07	7	21.0	1014	0020	x---	8	8	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0576	13	BPSA03	BAS...	BY2 ARKONA	5458.28	01405.9	20220814	0755	45	8	05	7	22.1	1014	1230	xxx-	8	8	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	x	x	x
0577	13	BPSB06	BAS...	BY4 CHRISTIANSÖ	5523.00	01519.93	20220814	1400	89	8	06	8	21.4	1011	0030	x---	12	12	x	x	x	x	-	x	x	x	x	x	x	x	x	-	x	-	x	-	x	-
0578	13	BPSB07	BAS...	BY5 BORNHOLMSDJ	5515.00	01558.99	20220814	1730	90		07	10	21.8	1010	0030	xxx-	12	12	x	x	x	x	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
0579	13	BPSE11	BAS...	BCS III-10	5533.3	01824.02	20220815	0330	91		11	7	21.8	1008	2430	x---	12	12	x	x	x	x	-	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
0580	13	BPEX13	BAS...	BY10	5638.01	01935.11	20220815	1120	143	6	10	4.9	23	1010	1330	x---	15	15	x	x	x	x	-	x	x	x	x	x	x	x	x	-	x	-	x	-	x	x
0581	13	BPEX21	BAS...	BY15 GOTLANDSDJ	5718.74	02004.55	20220815	1645	241		08	6	23.4	1008	0020	xxx-	24	24	x	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x	x	x
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0583	13	BPWX38	BAS...	BY32 NORRKÖPINGSDJ	5801	01759.05	20220816	0630	202	6	12	5	21.6	1009	2830	x---	17	17	x	x	-	x	-	x	x	x	x	x	x	x	-	x	-	x	-	x	x
0584	13	BPWX00	EXT...	KNOLLS GRUND	5731.08	01737	20220816	1130	90		17	8	21.8	1008	2430	----	12		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-
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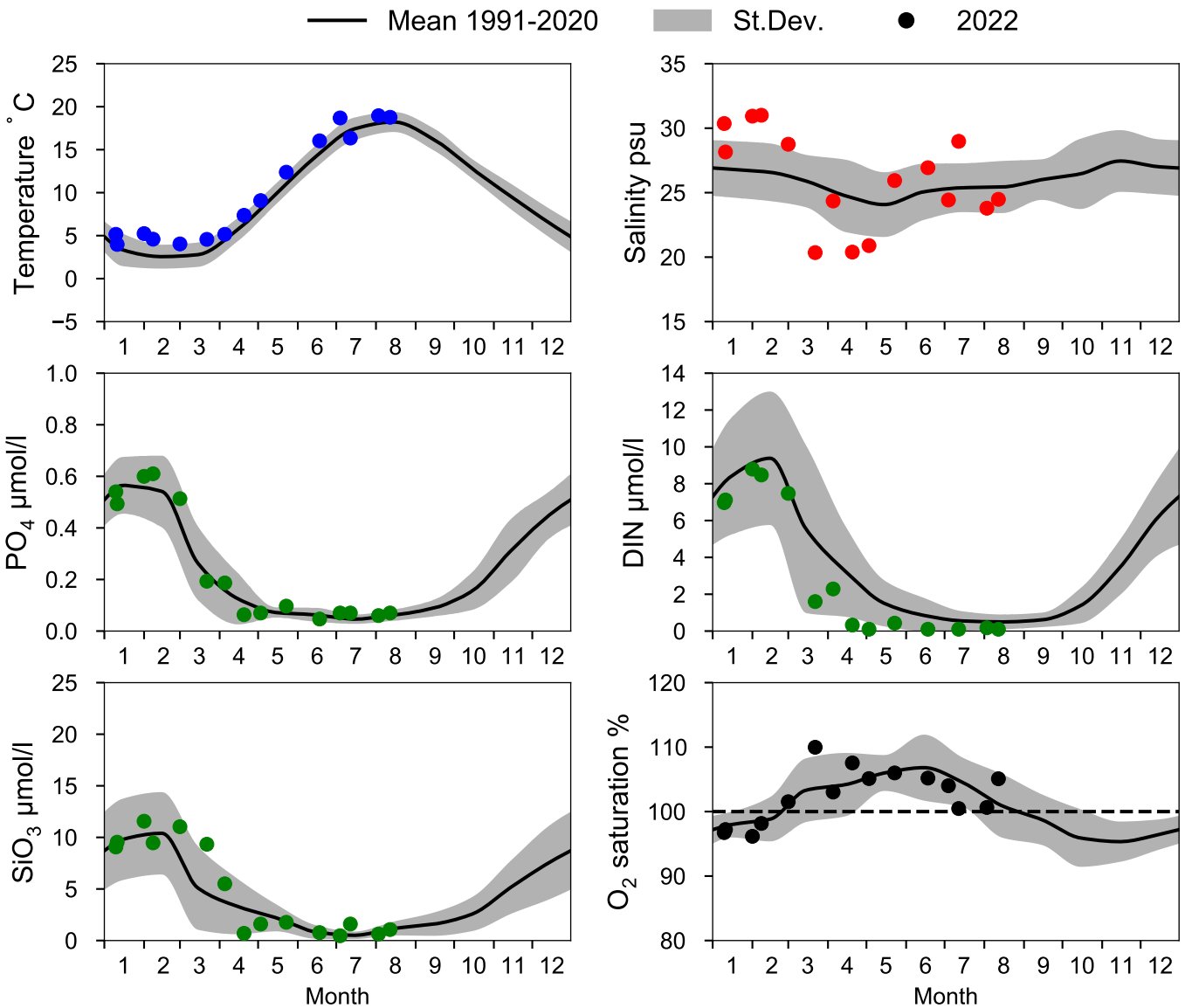
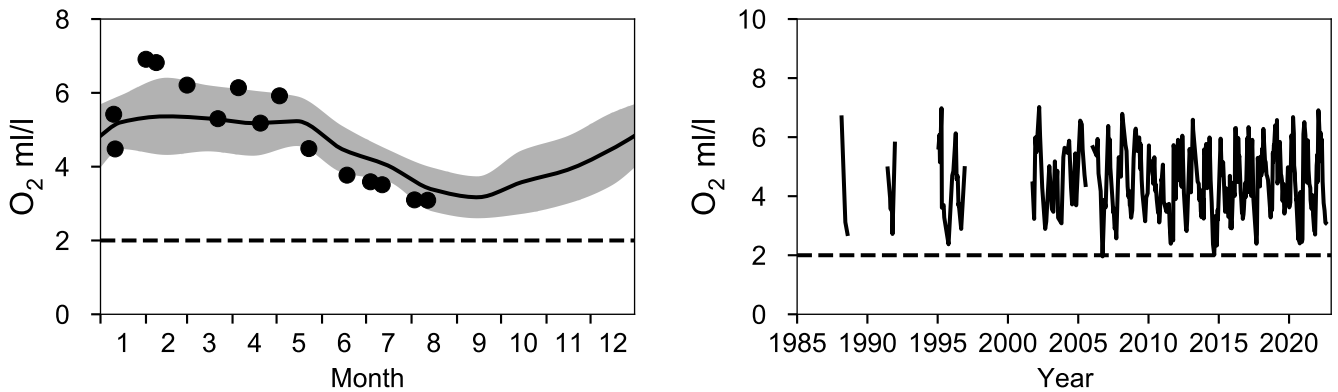
0586	13	BPSE49	BAS...	BY39 ÖLANDS S UDDE	5606.98	01632.15	20220816	2225	52		18	4	20.7	1009	9990	x---	8	8	x	x	x	x	-	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0587	13	BPWK01	BAS...	REF M1V1	5622.25	01612.11	20220817	0140	21		20	3	19.2	1009	9999	xxx-	5	5	x	x	x	x	x	x	x	-	x	x	x	x	x	-	x	-	x	-	x	-
0588	13	BPSH05	BAS...	HANÖBUKTEN	5537.06	01452.15	20220817	0840	80	7	21	2.3	21.6	1011	1120	x---	11	11	x	x	x	x	-	x	x	x	x	x	x	x	-	x	-	x	-	x	-
0589	13	KAEX29	BAS...	ANHOLT E	5640.12	01206.64	20220818	0240	63		10	2.9	20.1	1011	9999	xxx-	10	10	x	x	x	x	x	x	x	-	x	x	x	x	x	-	x	x	x	x	x	-

STATION SLÄGGÖ SURFACE WATER (0-10 m)

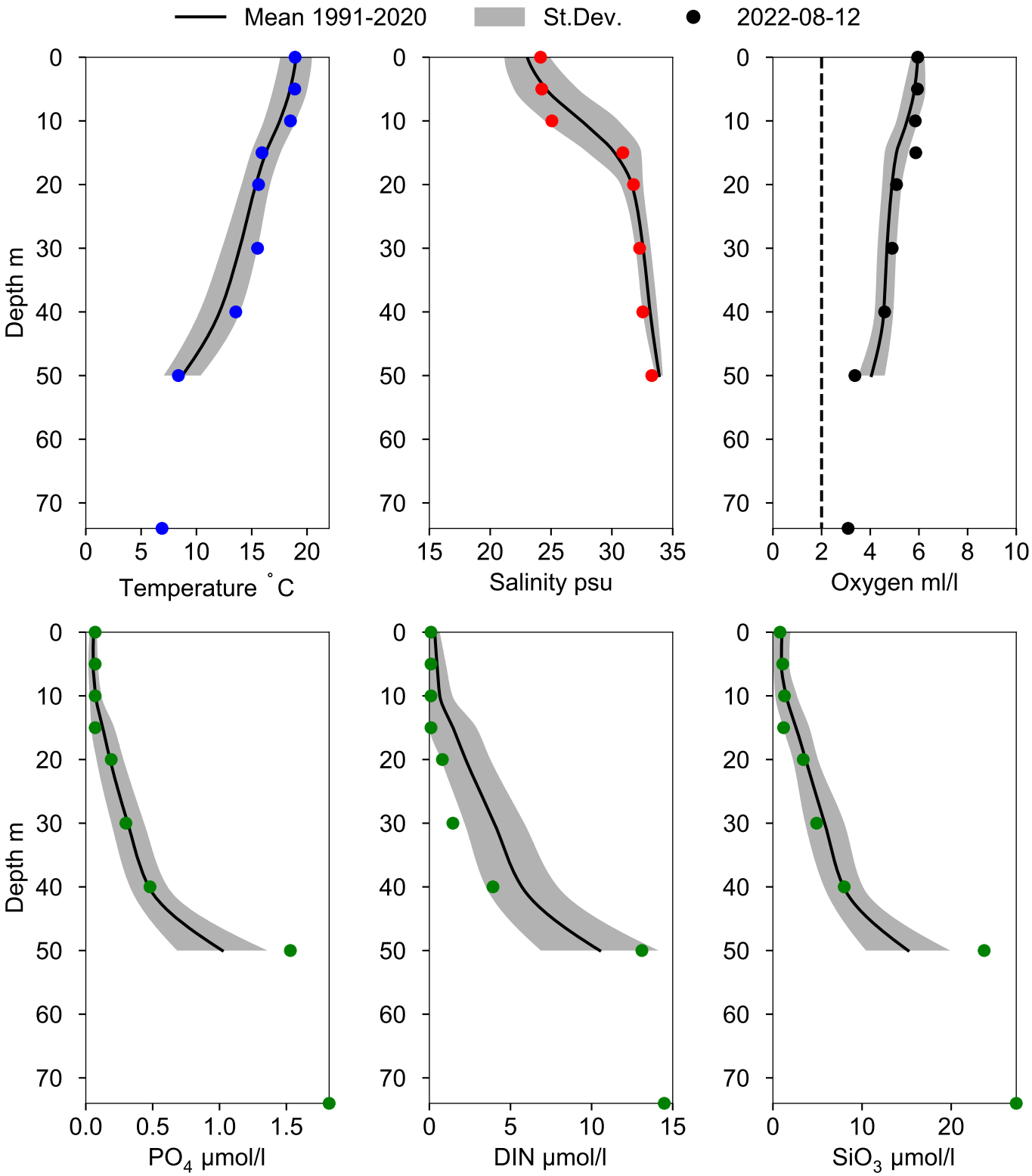
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)

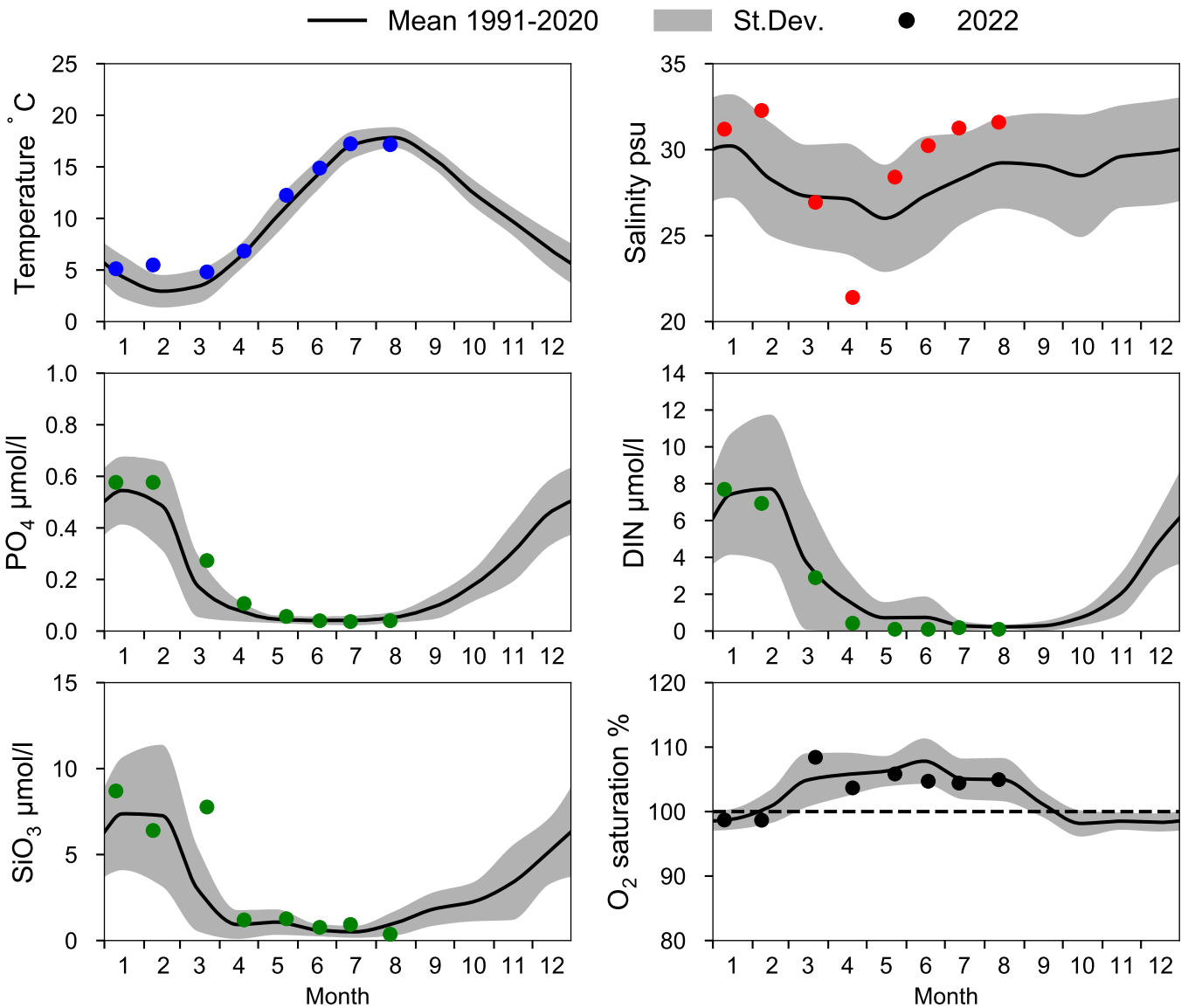


Vertical profiles SLÄGGÖ
August

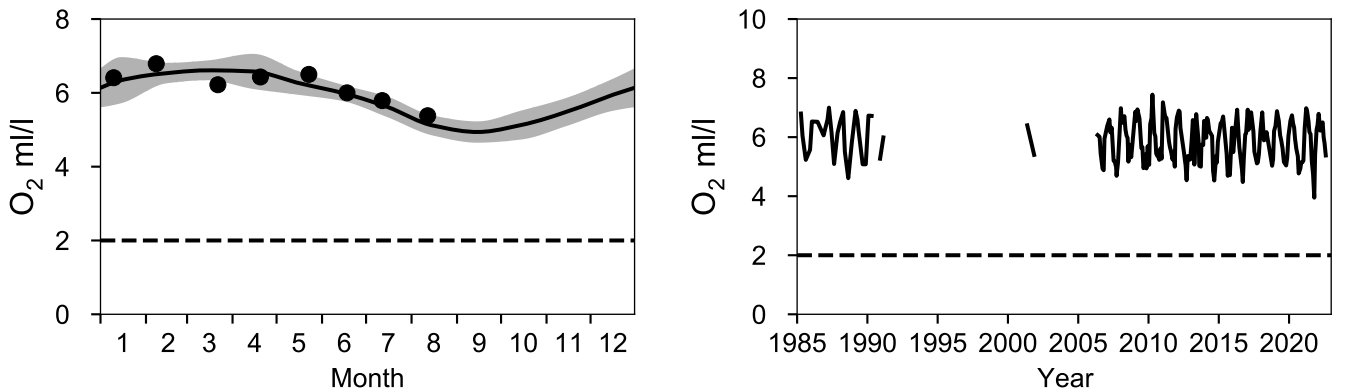


STATION Å13 SURFACE WATER (0-10 m)

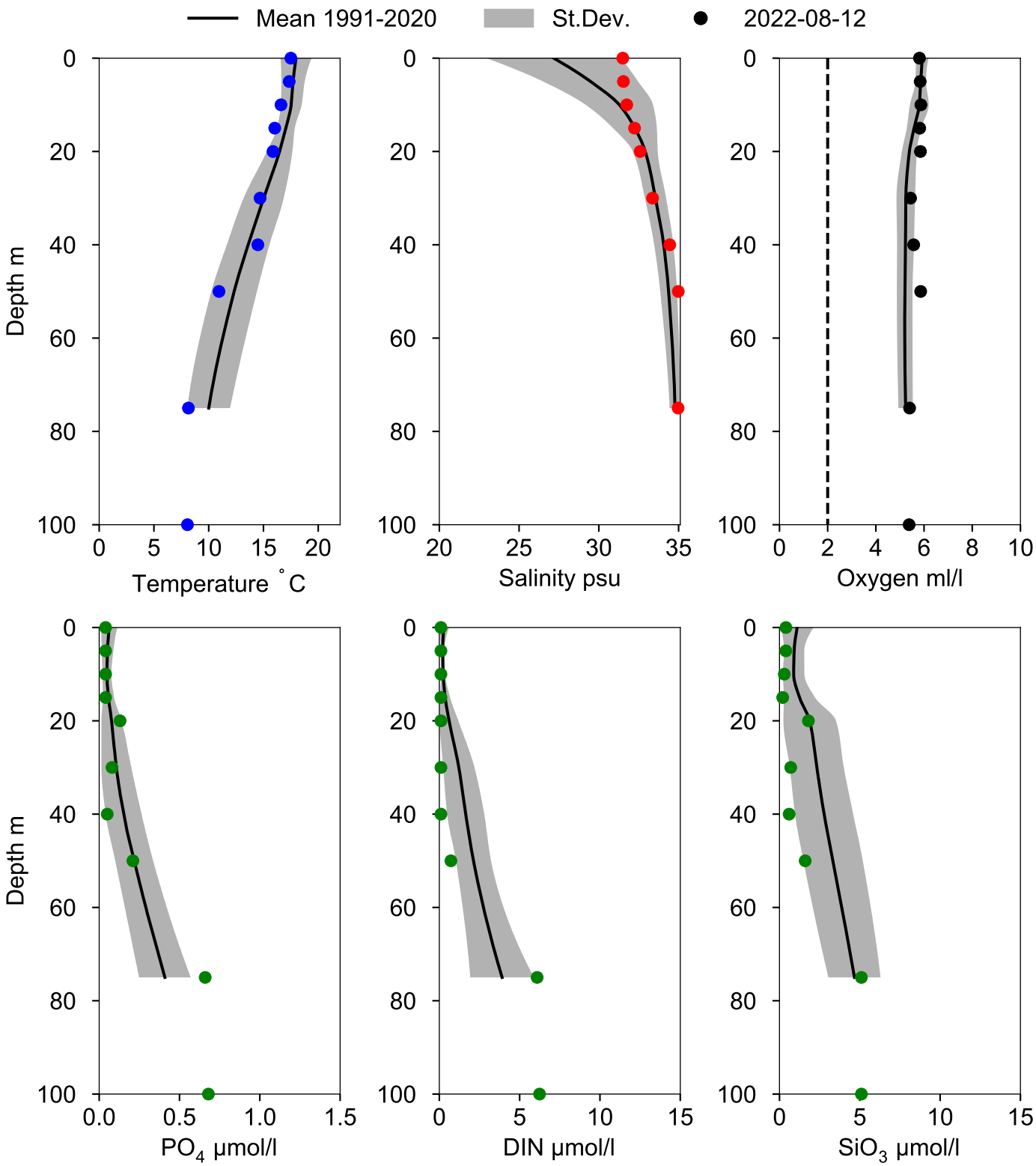
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 82 m)

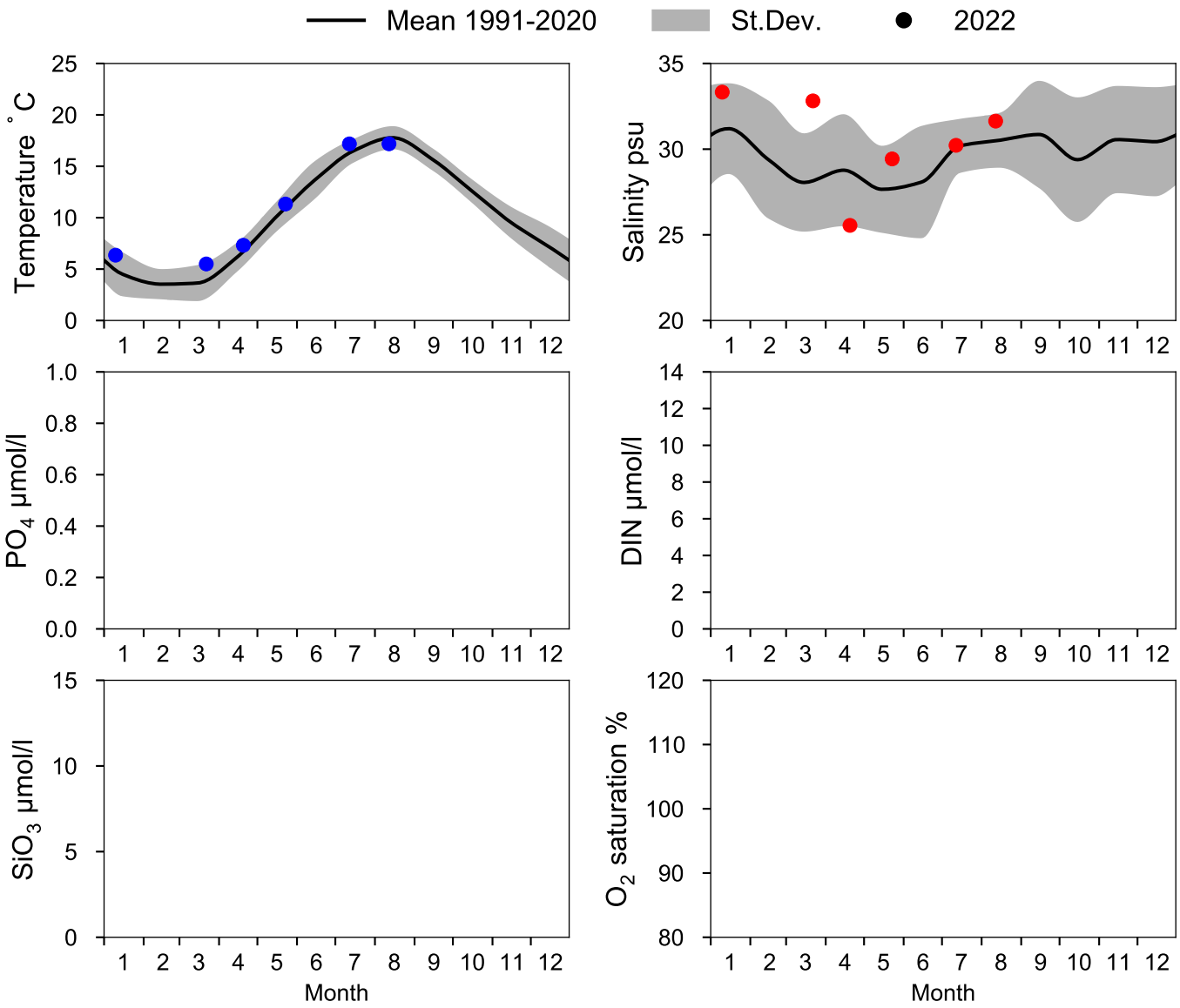


Vertical profiles Å13
August

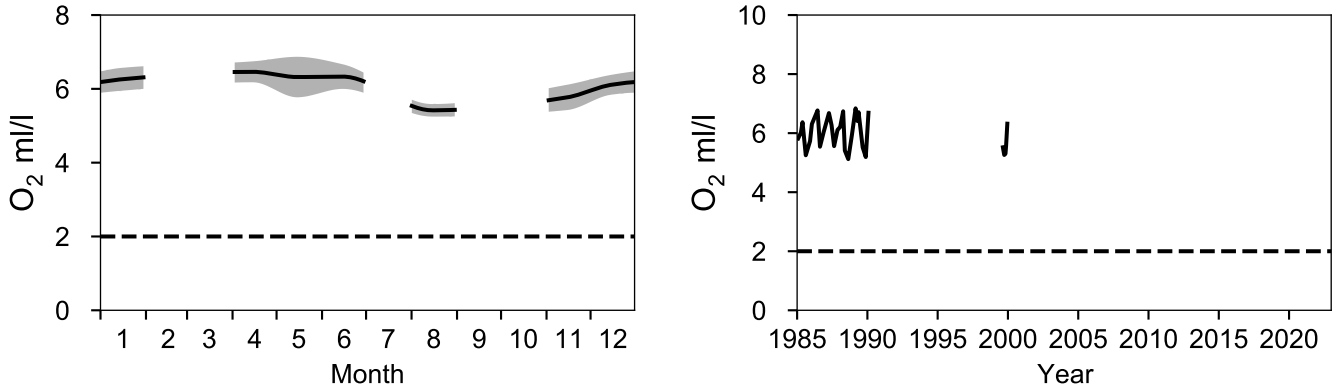


STATION Å14 SURFACE WATER (0-10 m)

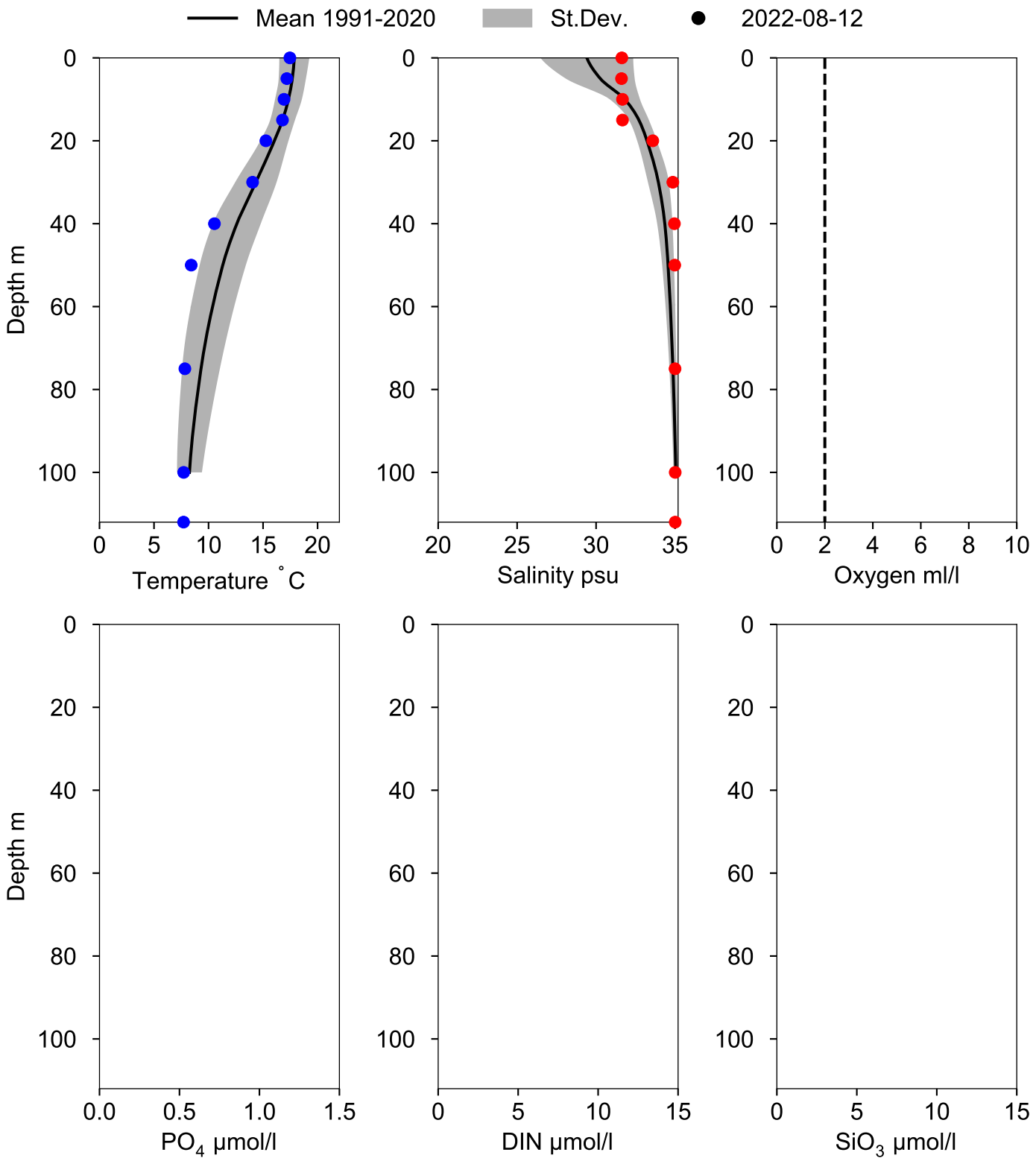
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

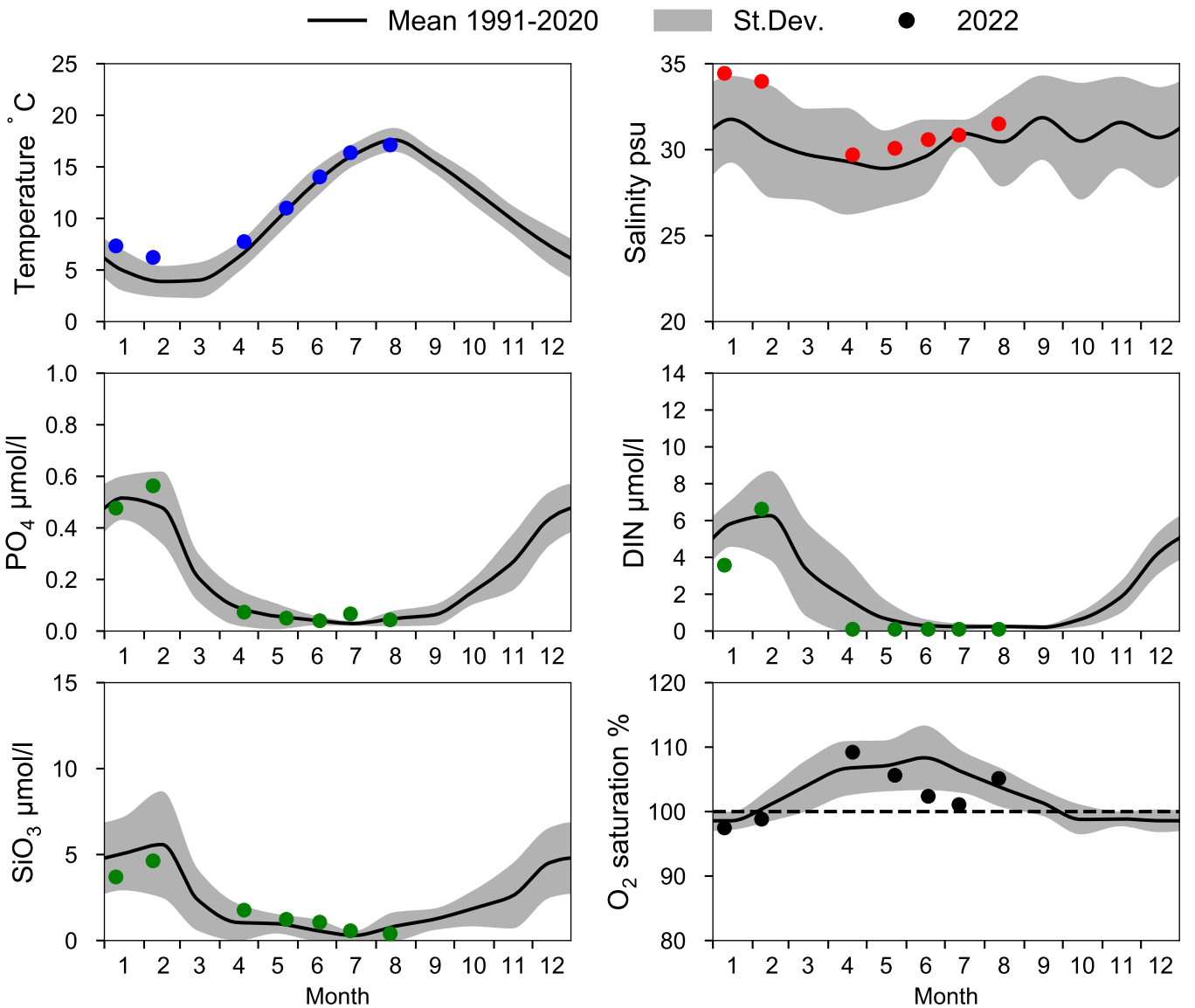


Vertical profiles Å14
August

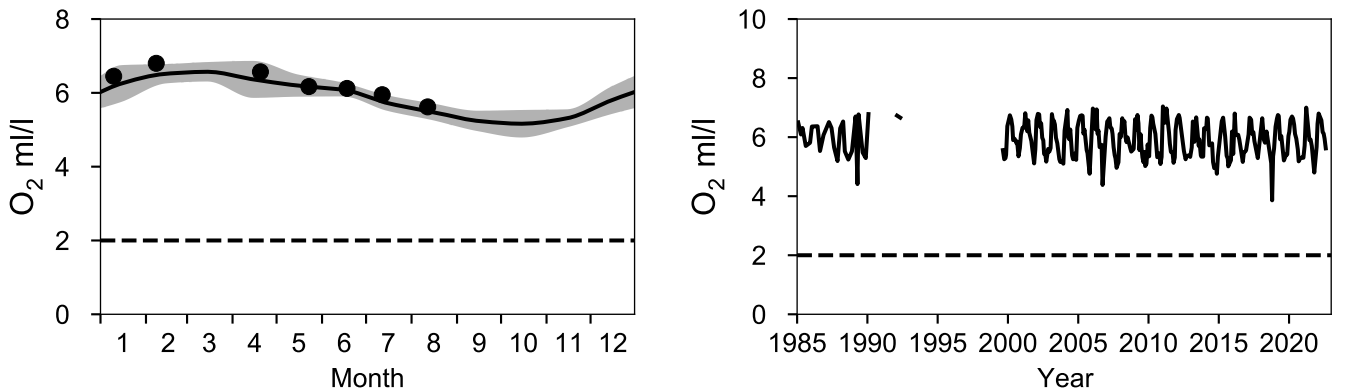


STATION Å15 SURFACE WATER (0-10 m)

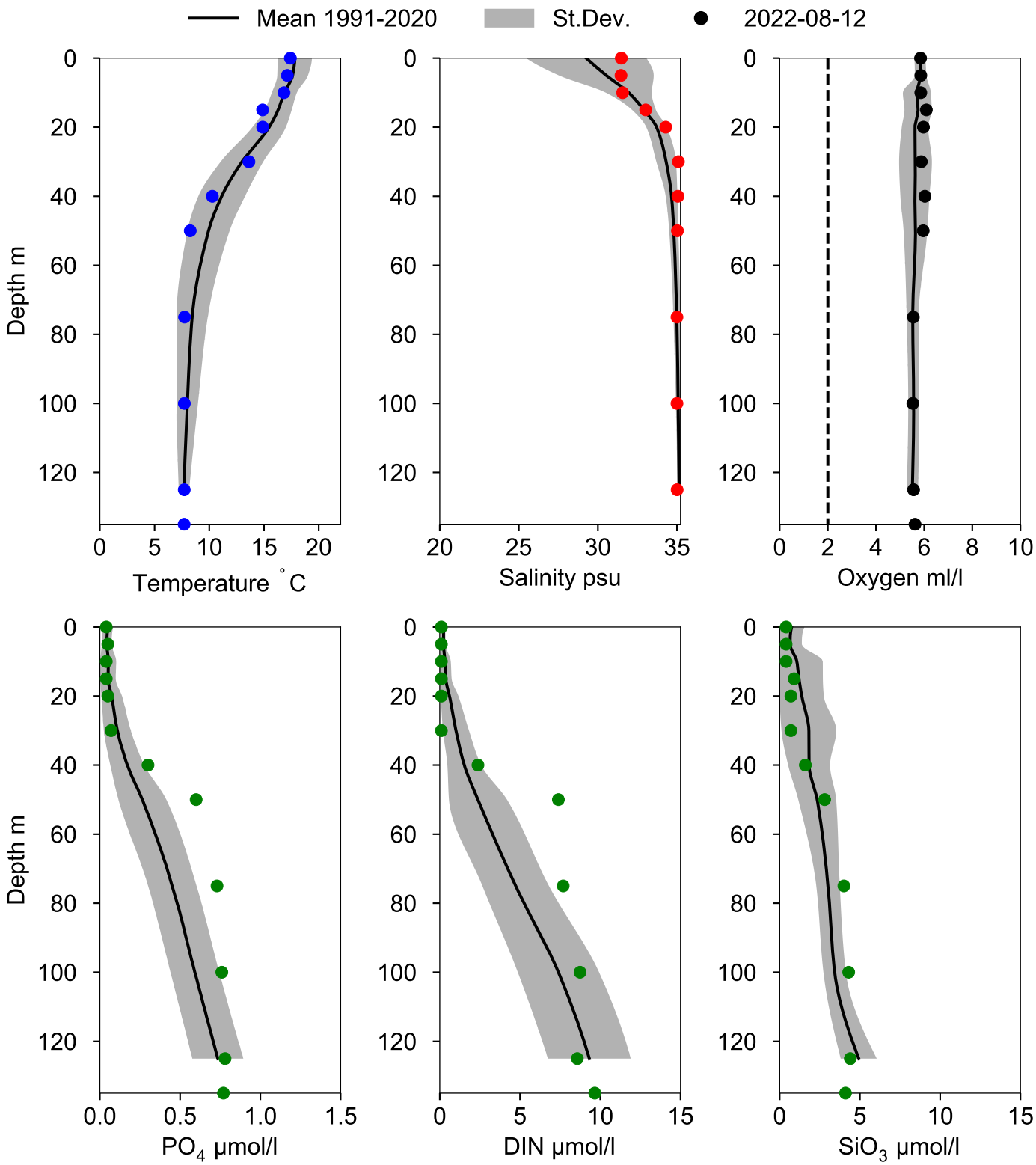
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

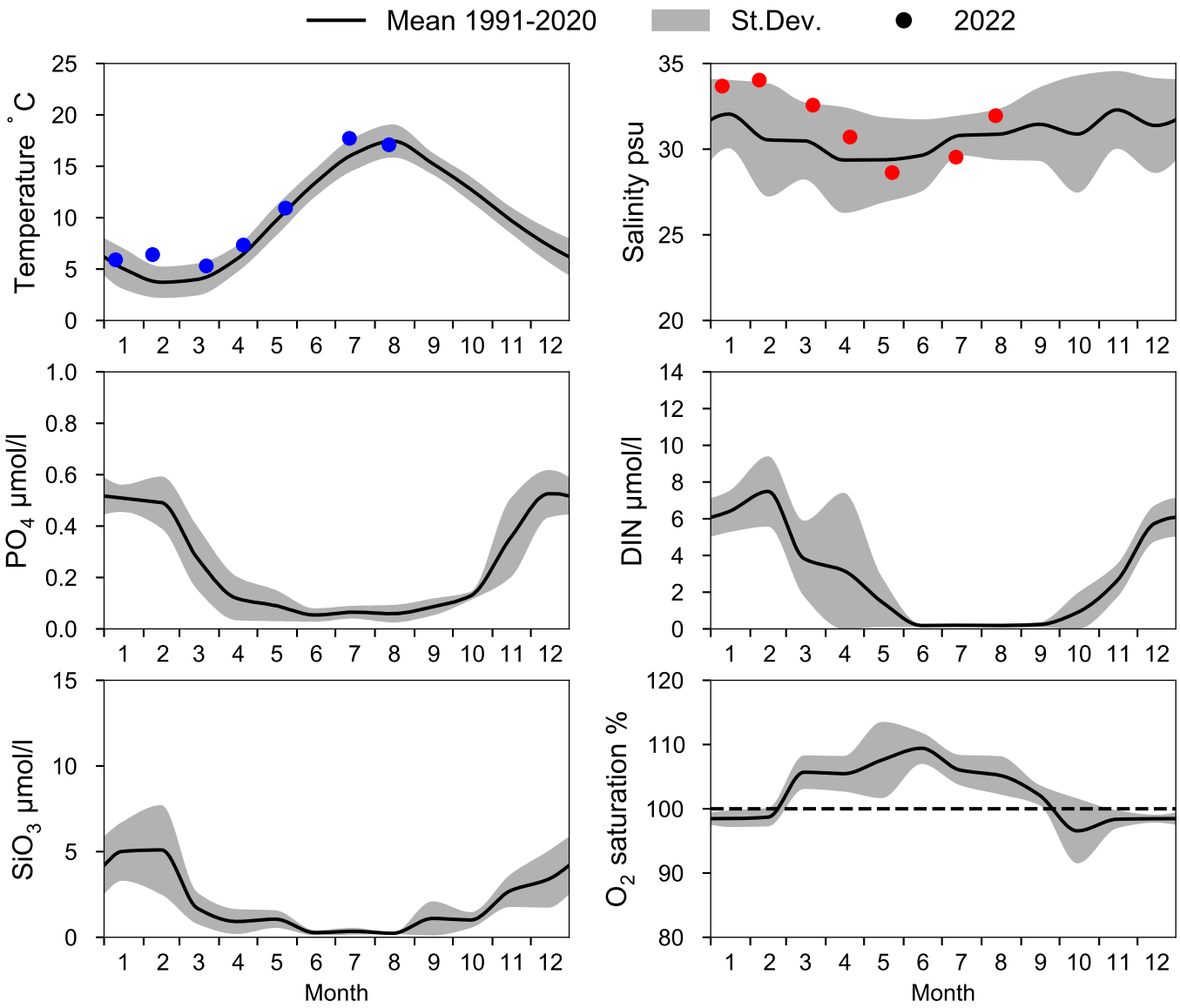


Vertical profiles Å15
August

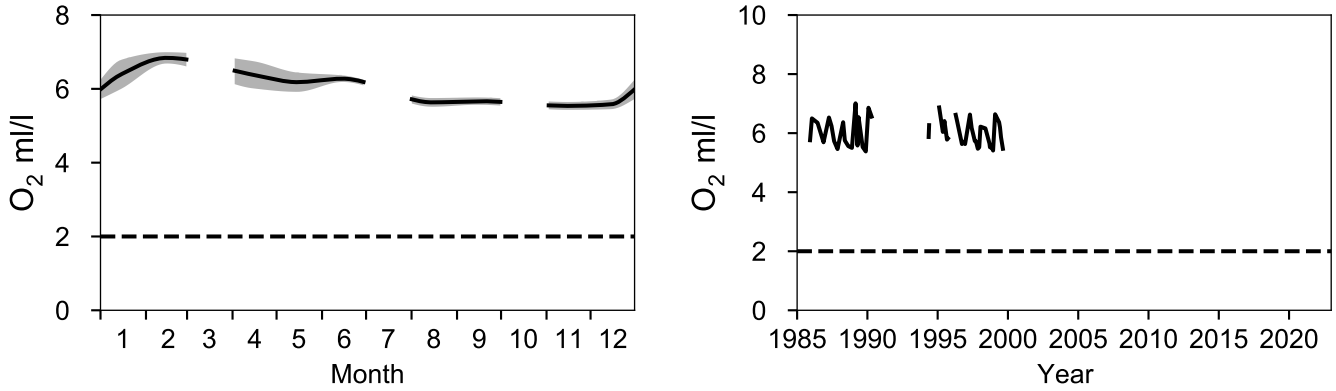


STATION Å16 SURFACE WATER (0-10 m)

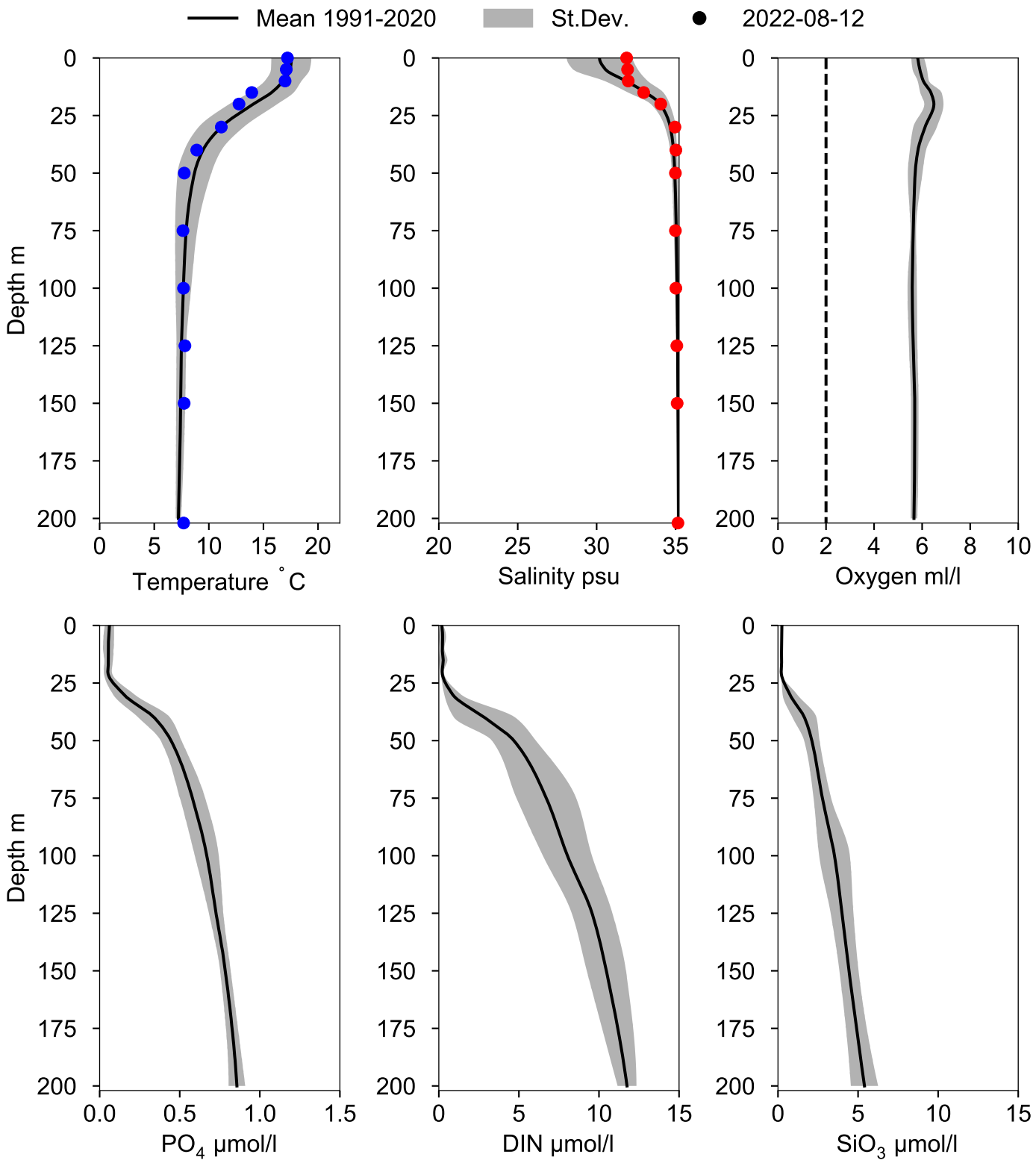
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 193 m)

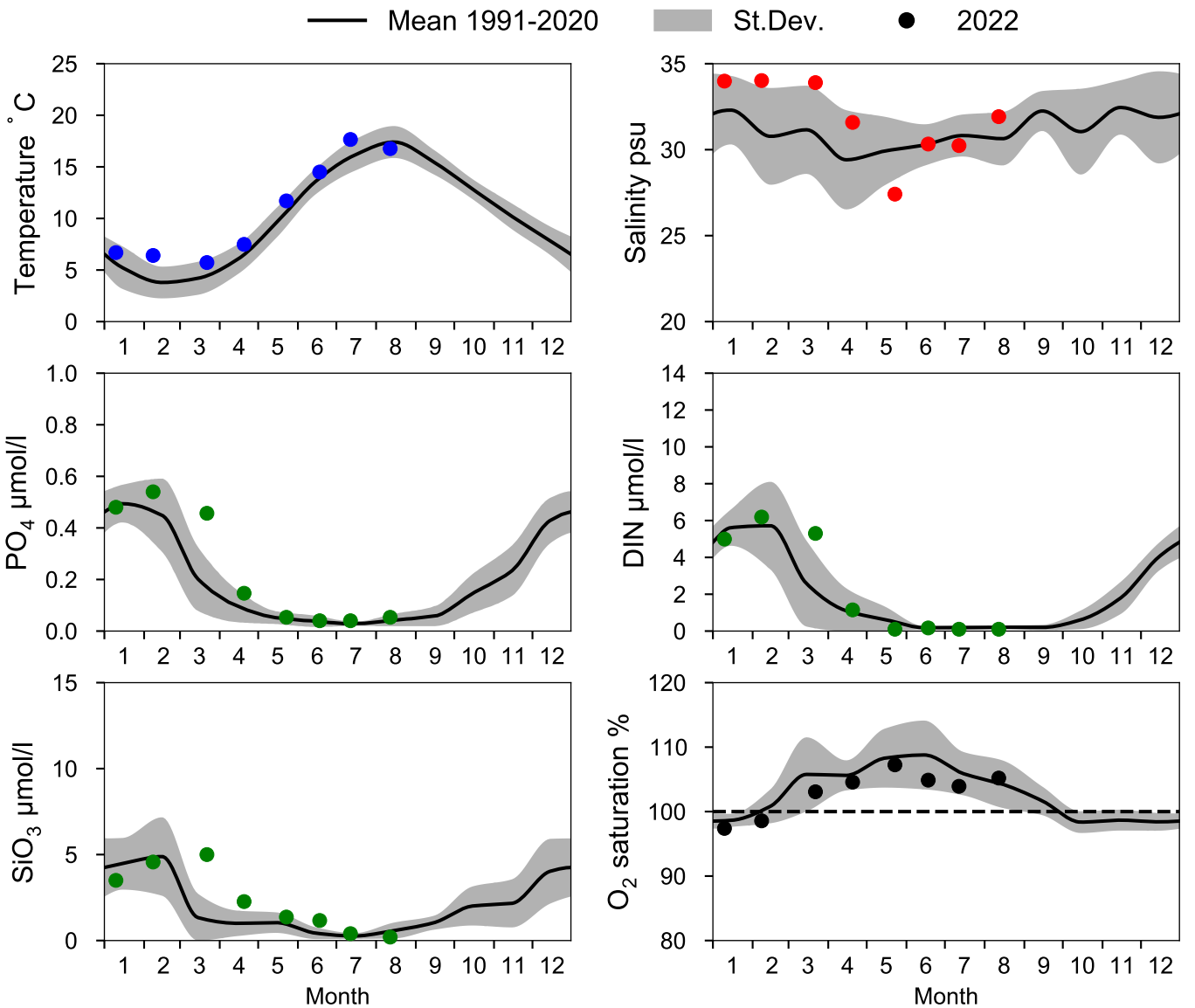


Vertical profiles Å16
August

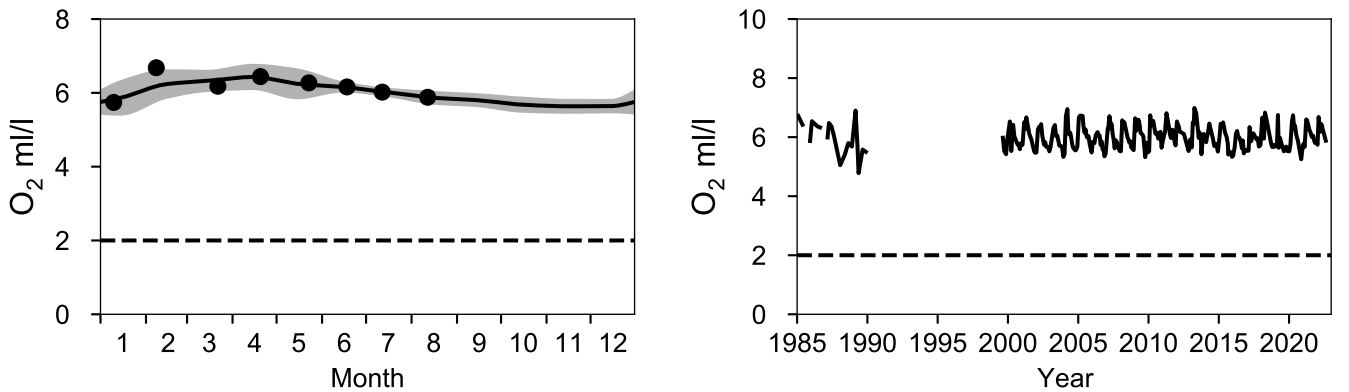


STATION Å17 SURFACE WATER (0-10 m)

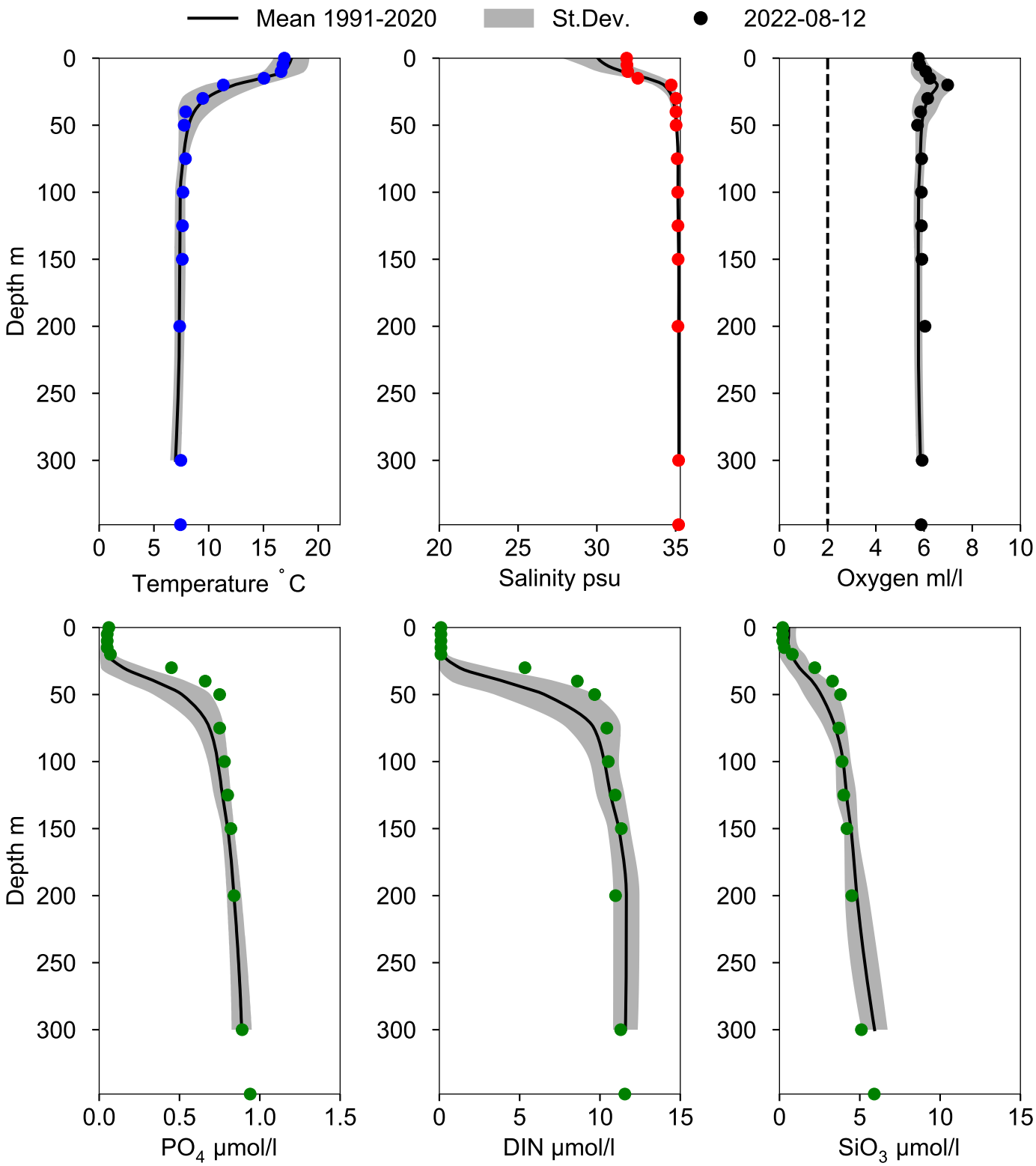
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 300 m)

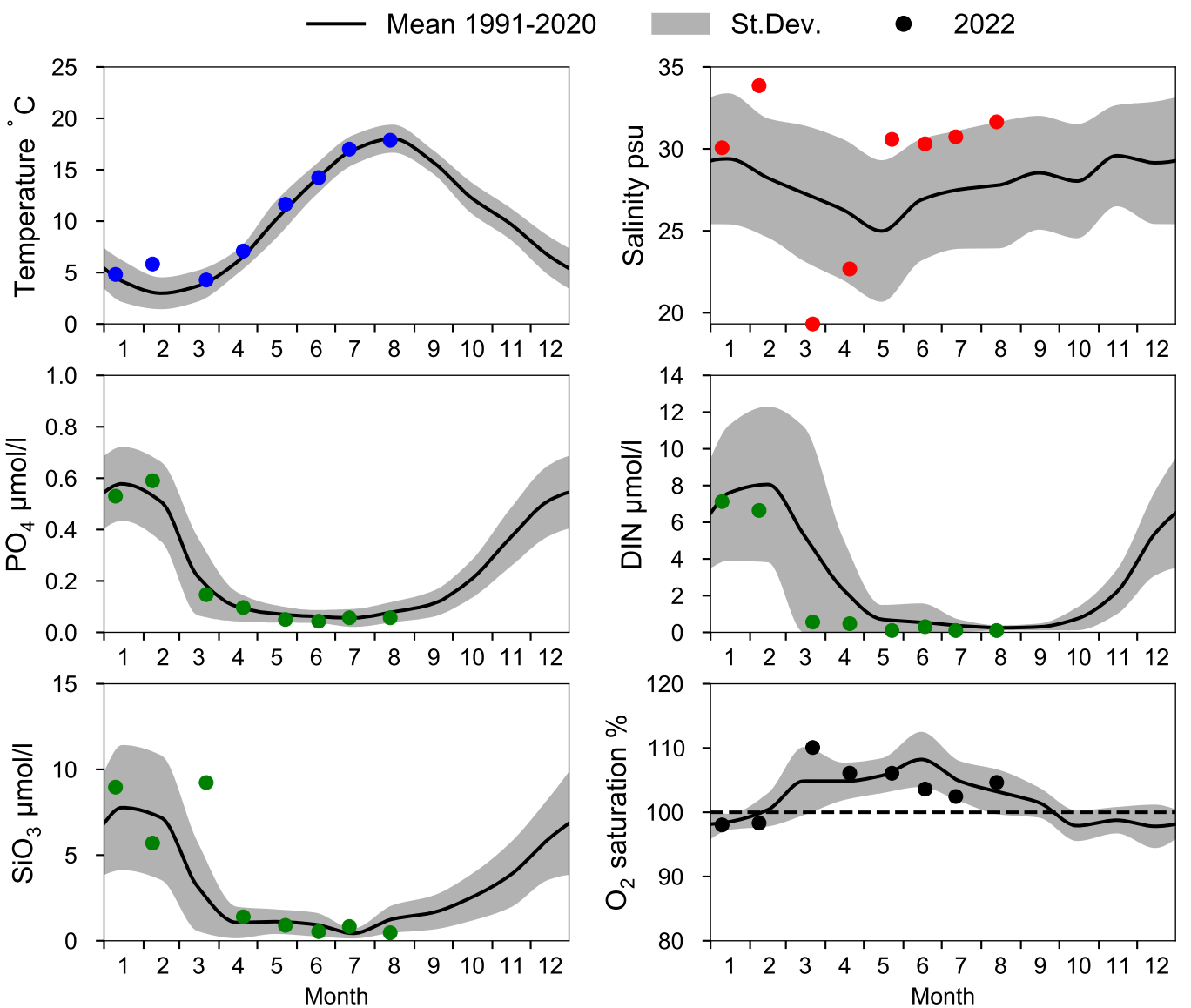


Vertical profiles Å17
August

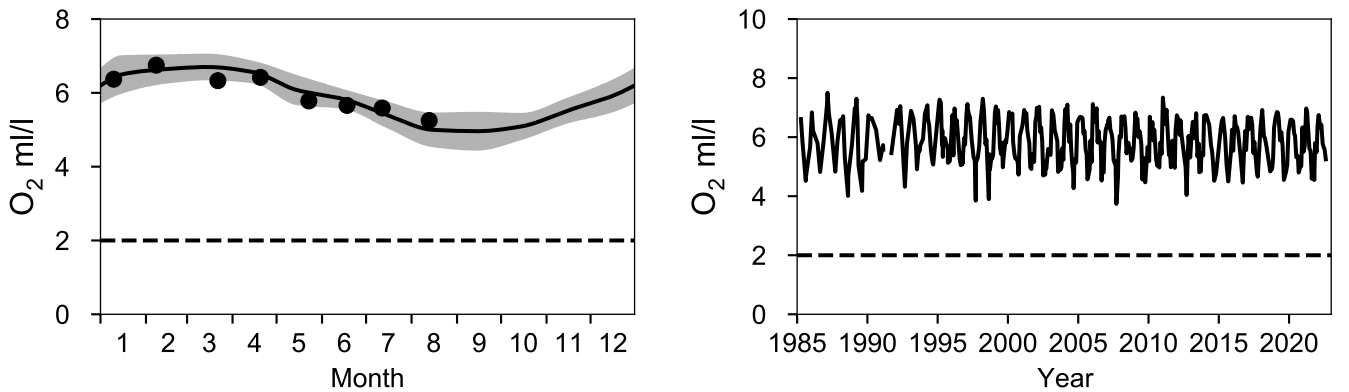


STATION P2 SURFACE WATER (0-10 m)

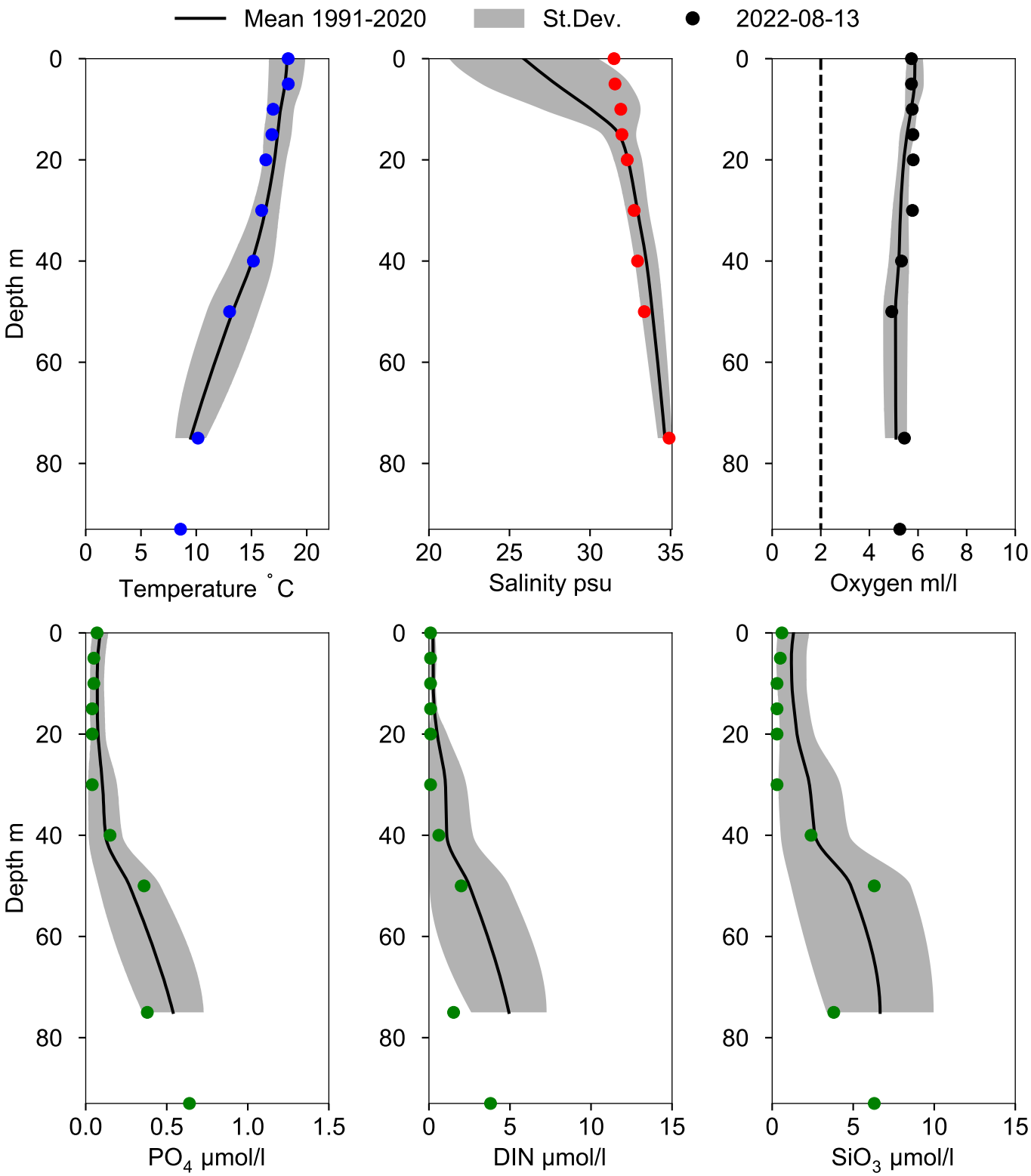
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 75 m)

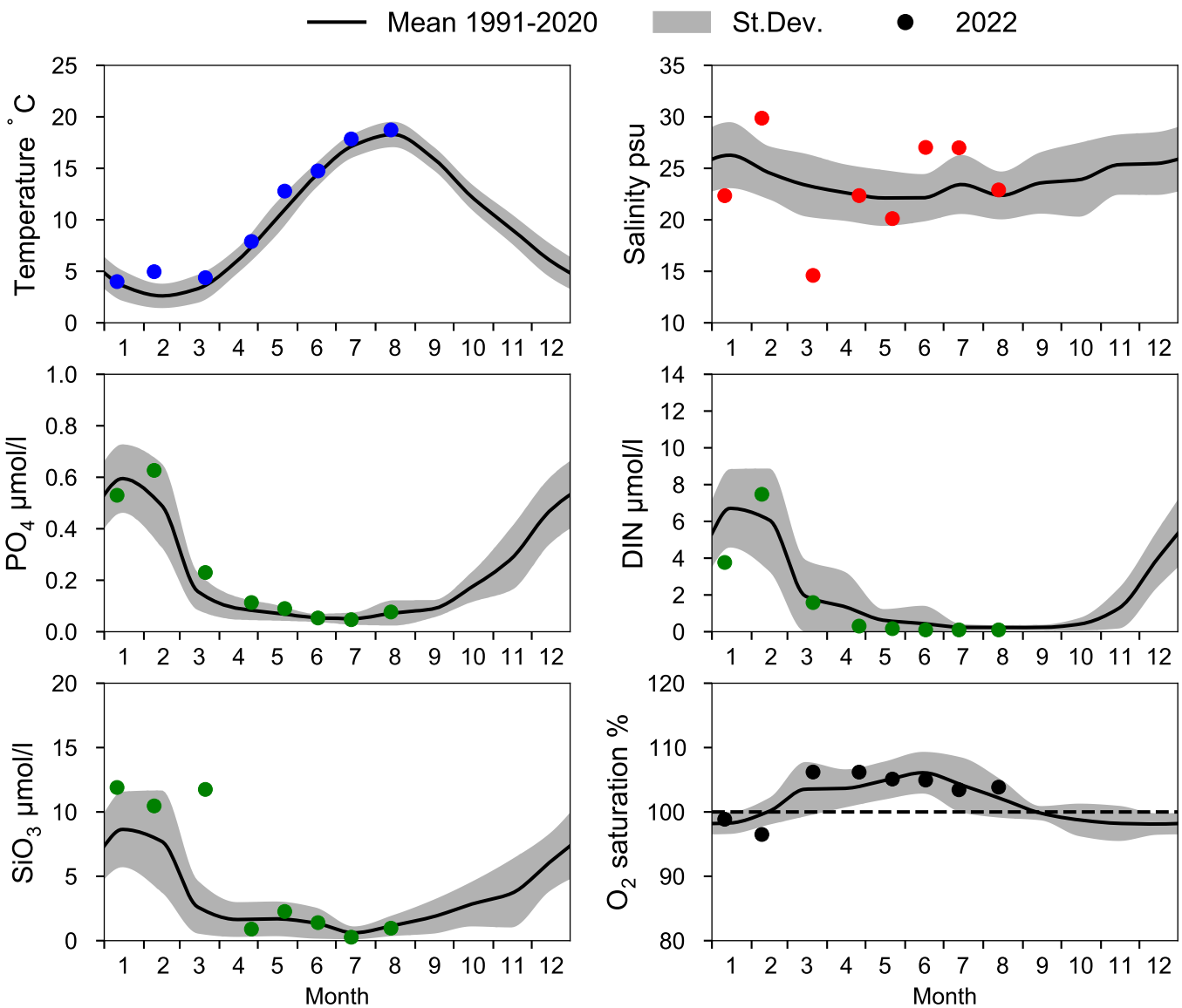


Vertical profiles P2
August

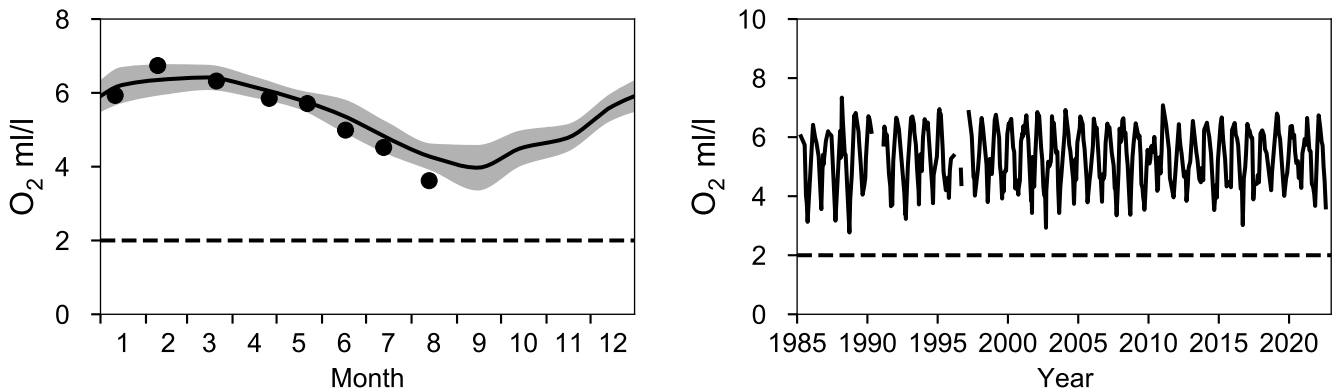


STATION FLADEN SURFACE WATER (0-10 m)

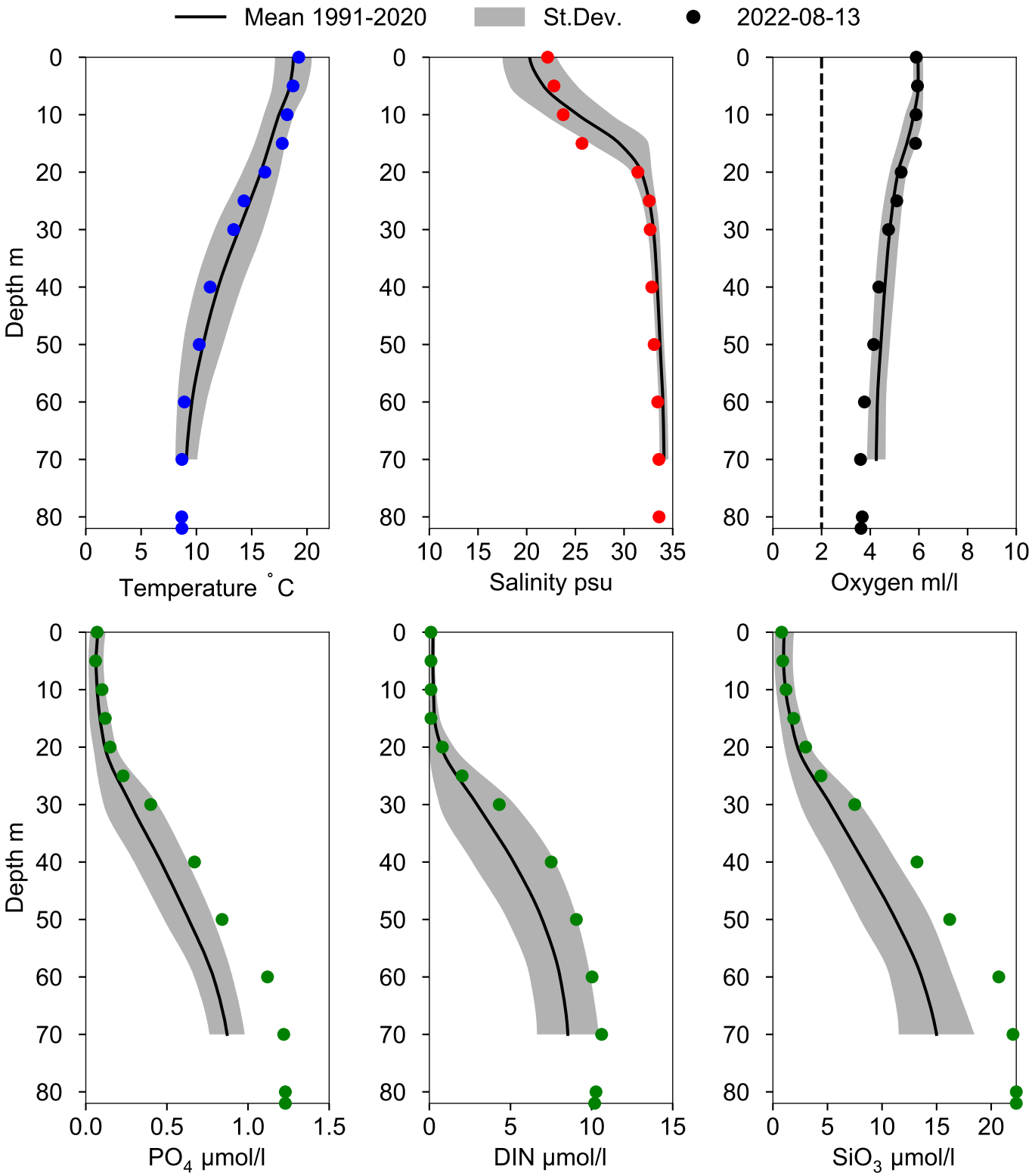
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 74 m)

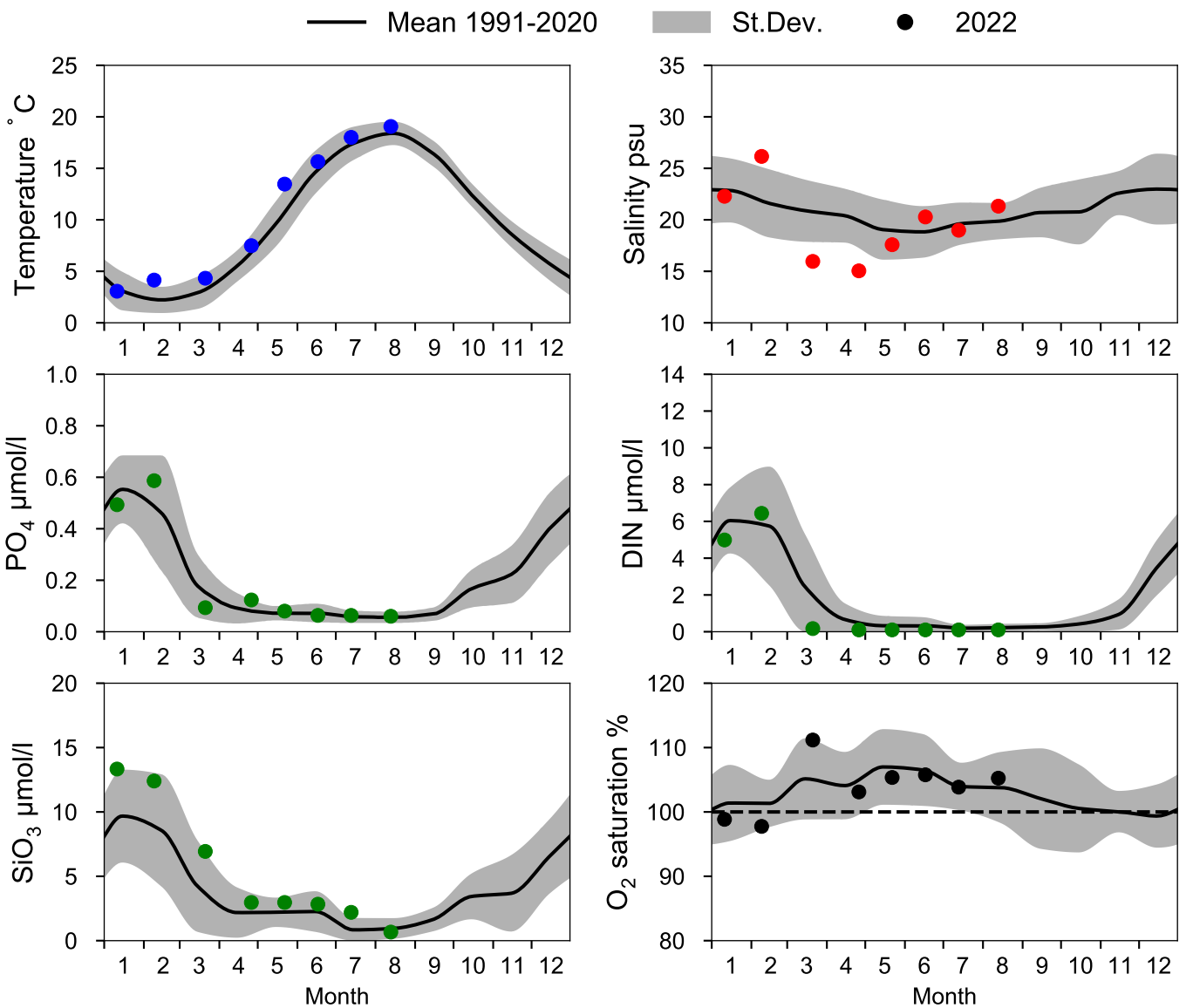


Vertical profiles FLADEN
August

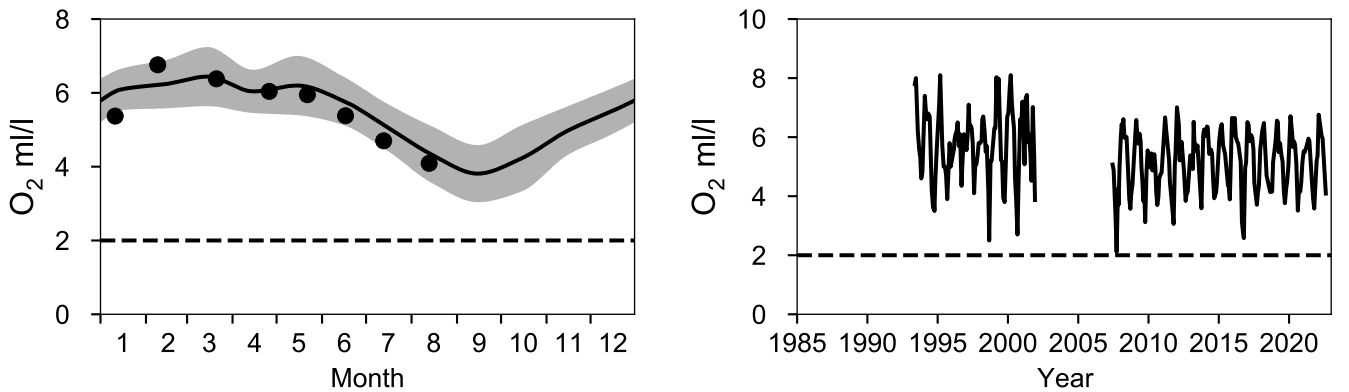


STATION N14 FALKENBERG SURFACE WATER (0-10 m)

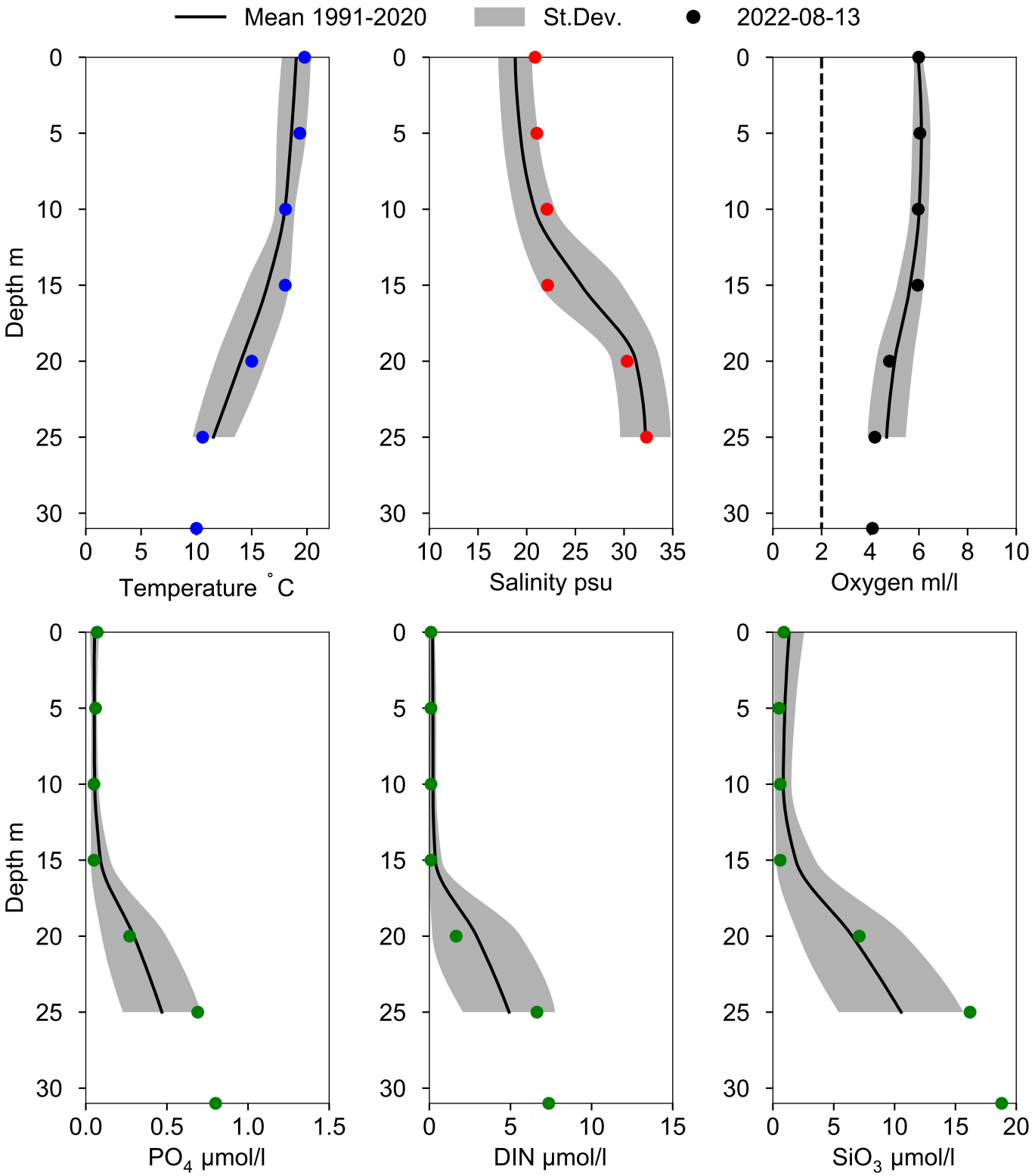
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 25 m)

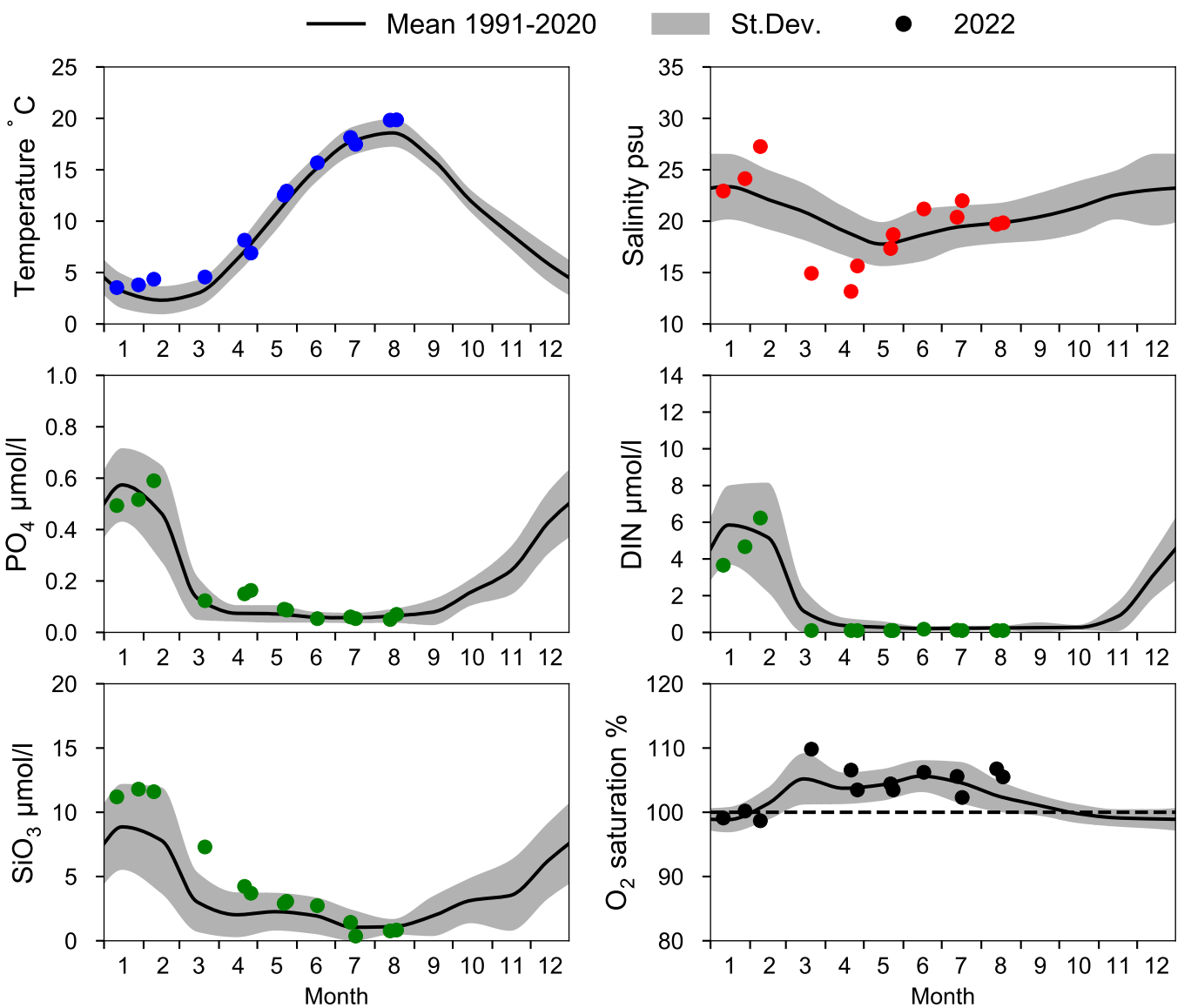


Vertical profiles N14 FALKENBERG
August

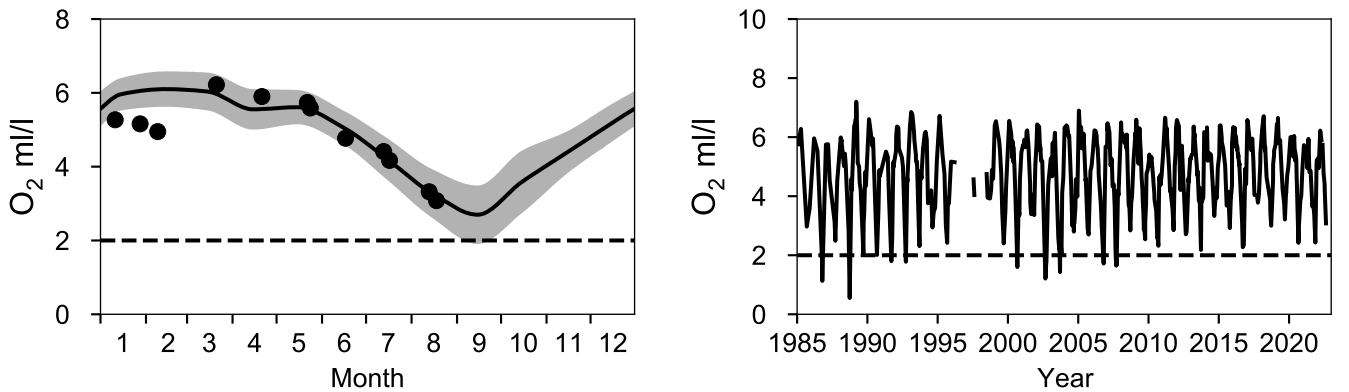


STATION ANHOLT E SURFACE WATER (0-10 m)

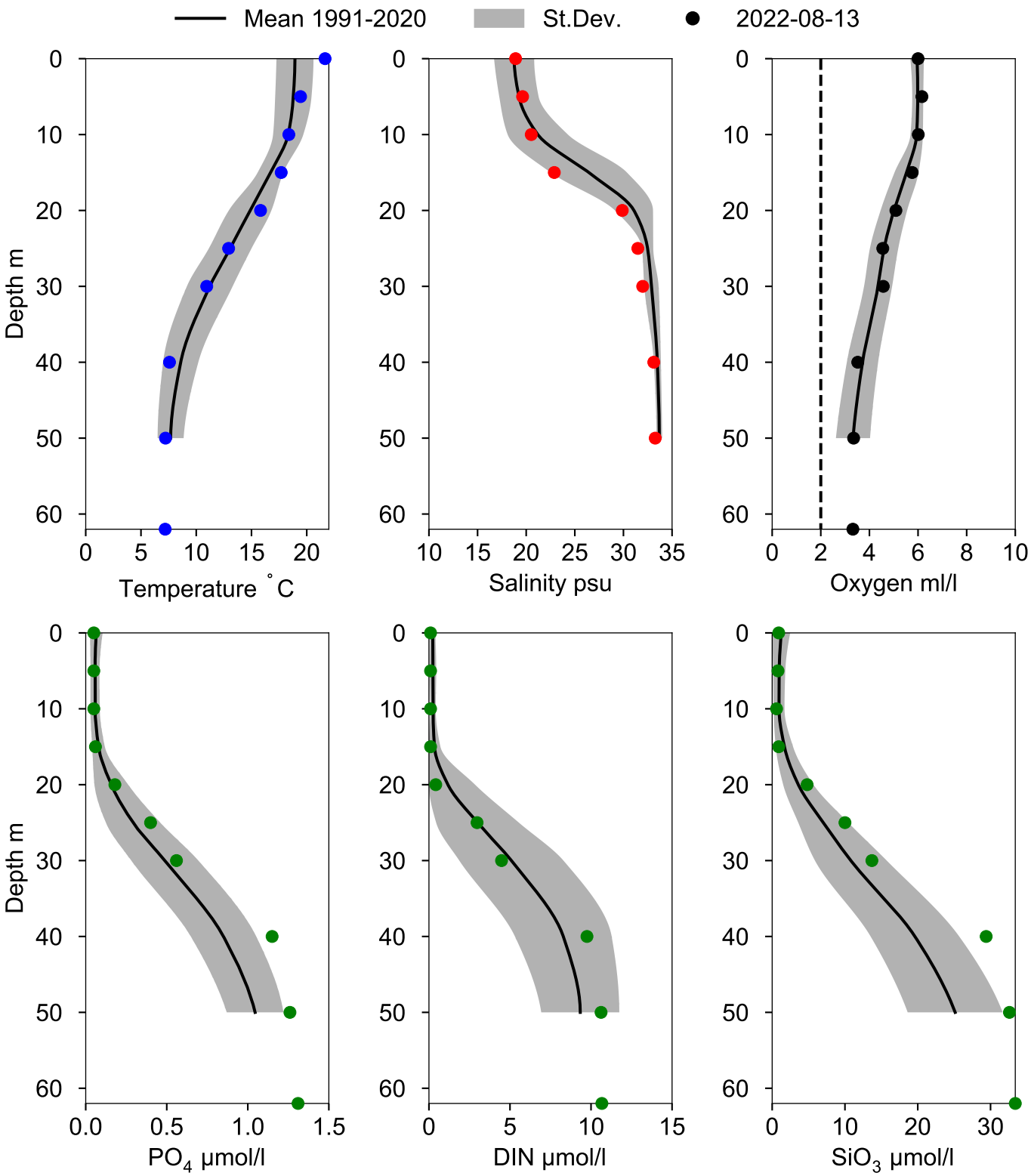
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

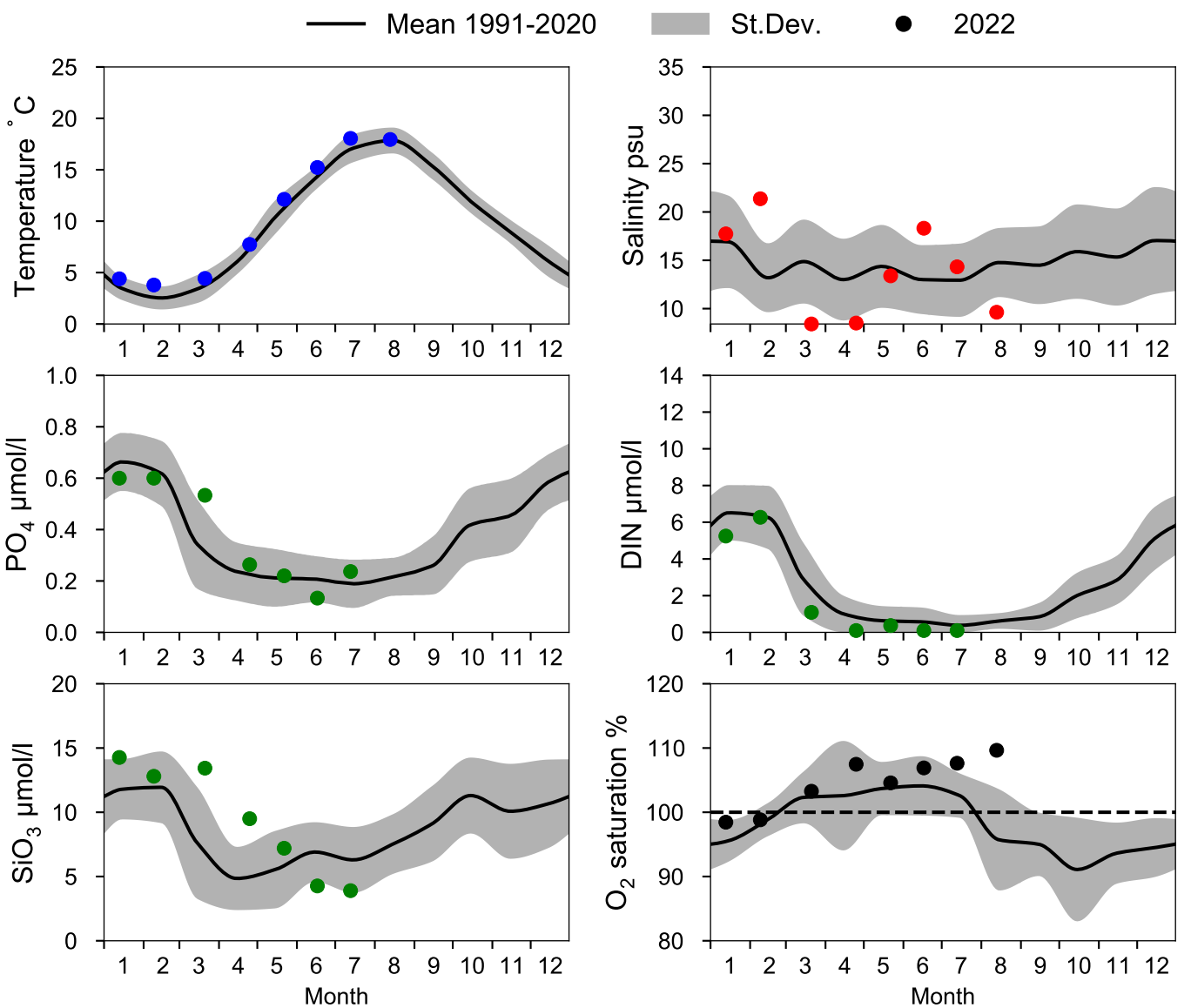


Vertical profiles ANHOLT E
August

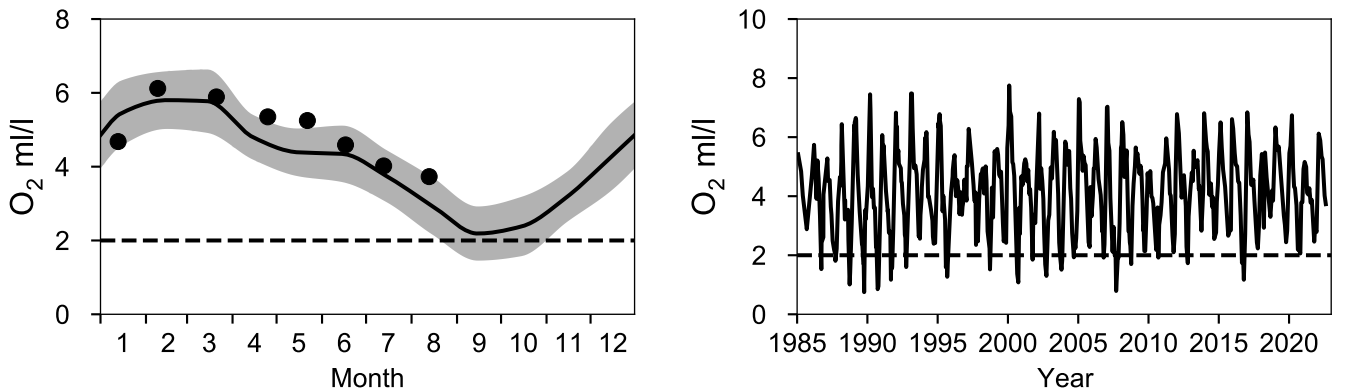


STATION W LANDSKRONA SURFACE WATER (0-10 m)

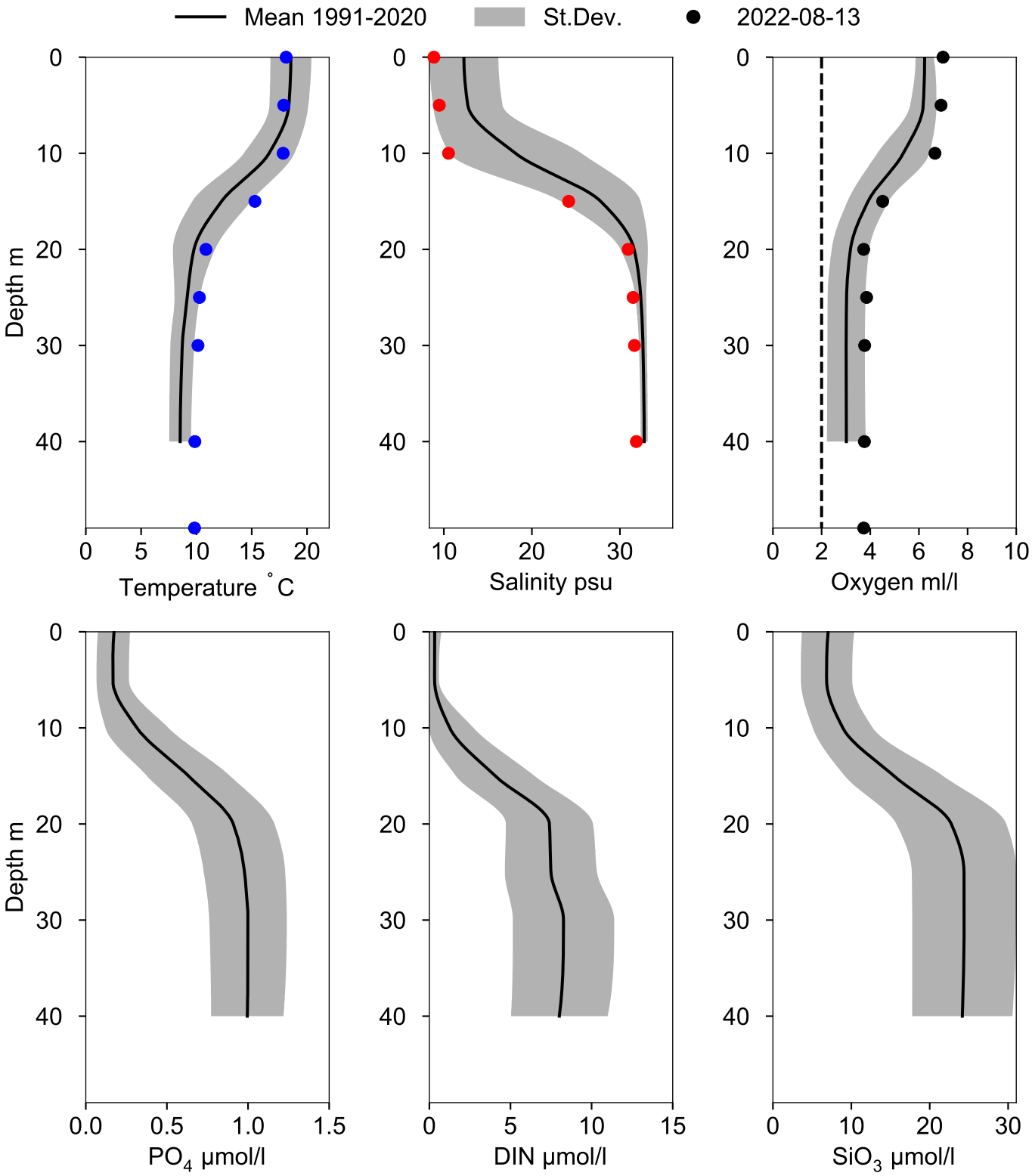
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

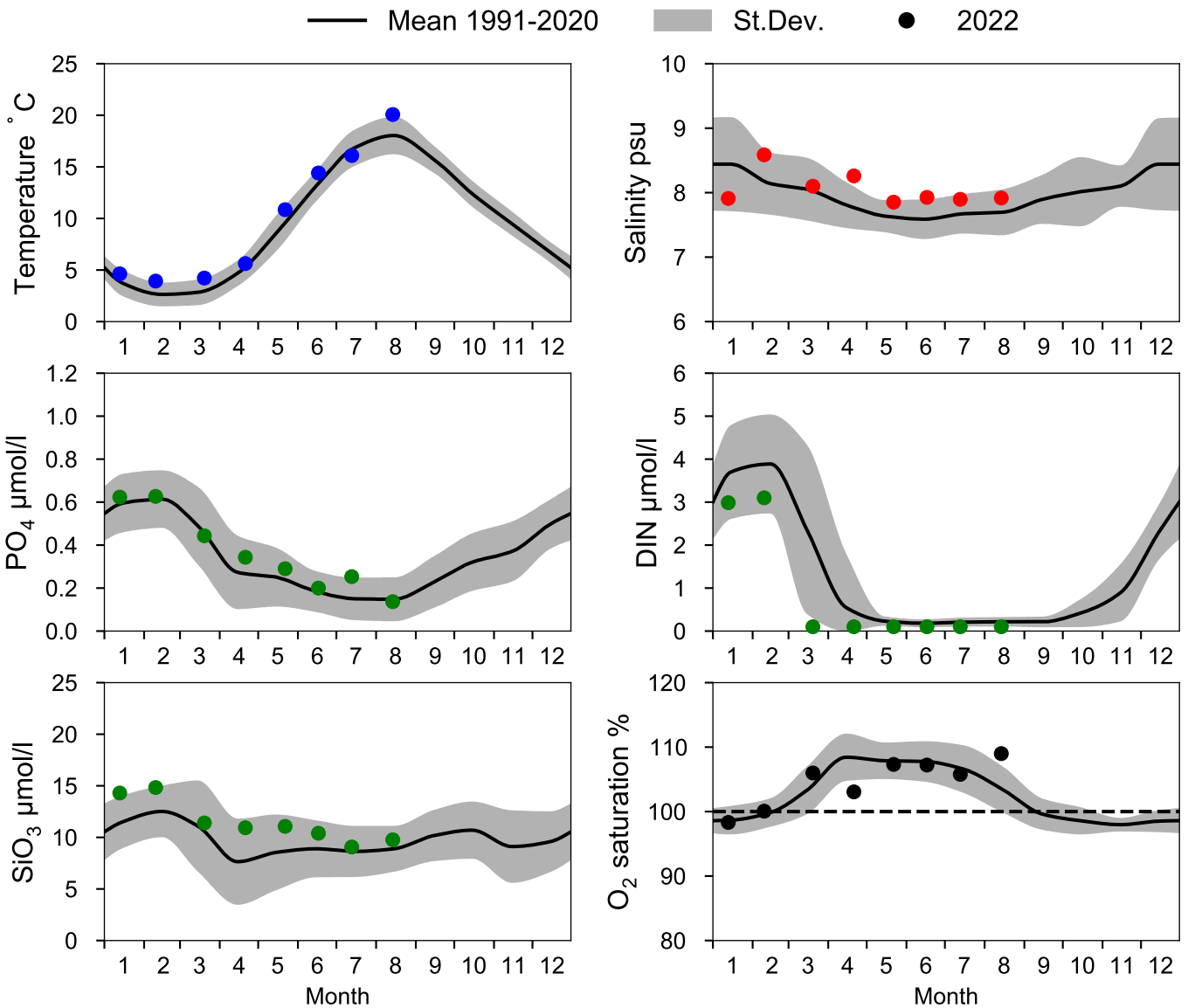


Vertical profiles W LANDSKRONA
August

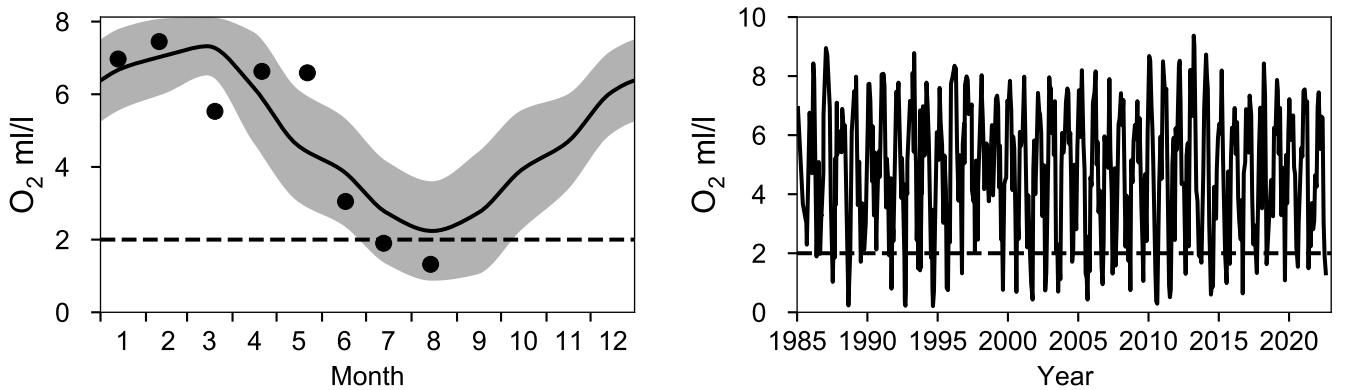


STATION BY1 SURFACE WATER (0-10 m)

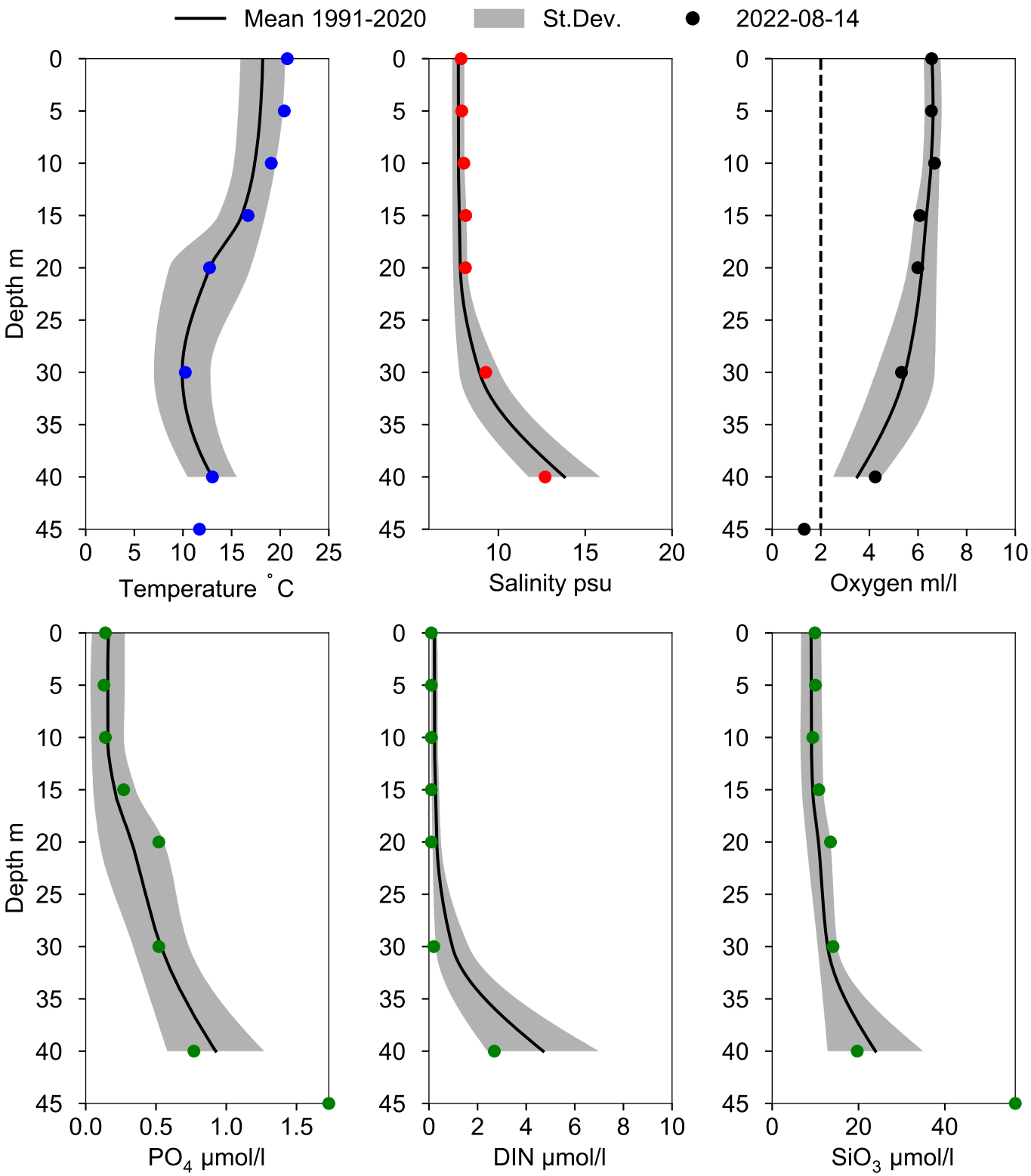
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 39 m)

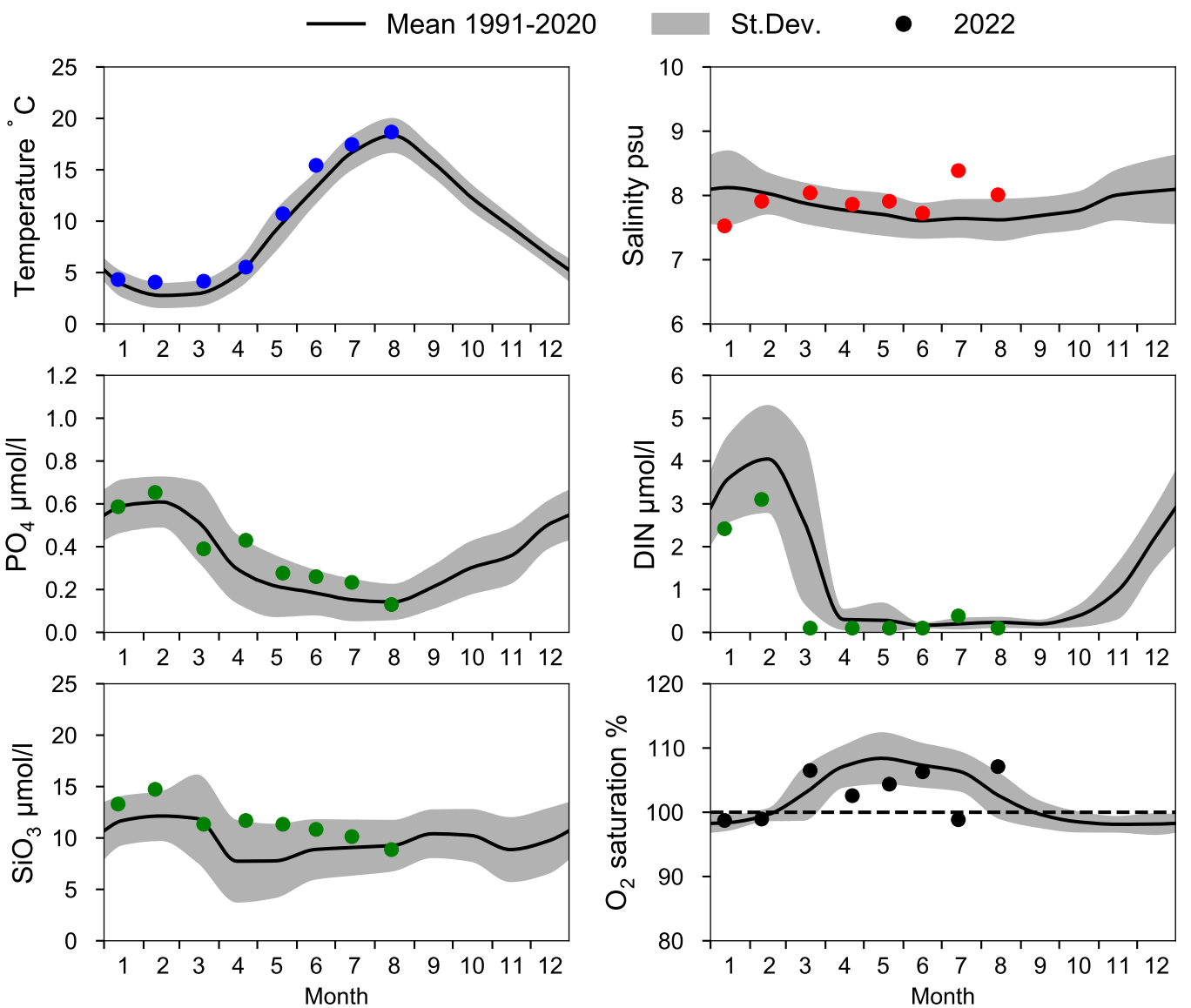


Vertical profiles BY1
August

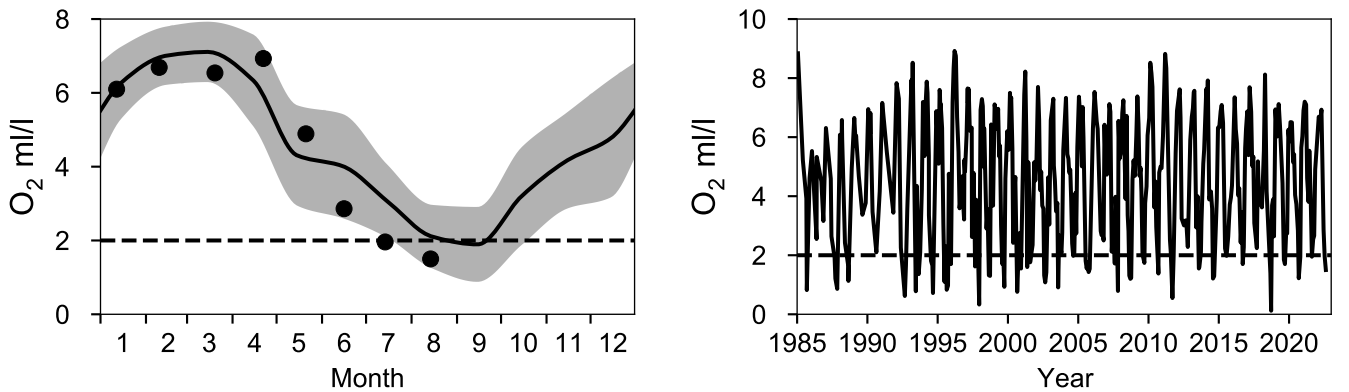


STATION BY2 ARKONA SURFACE WATER (0-10 m)

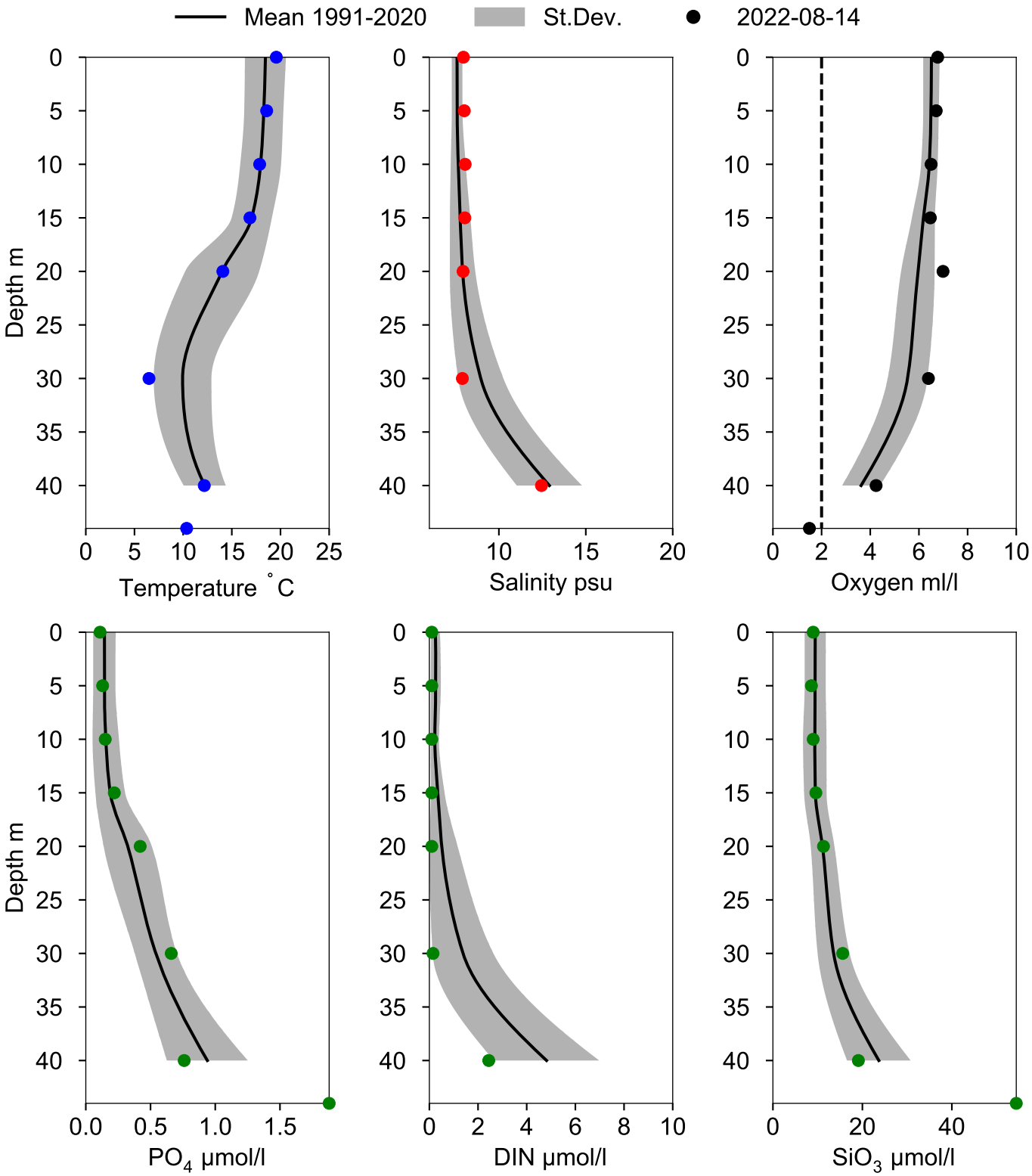
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

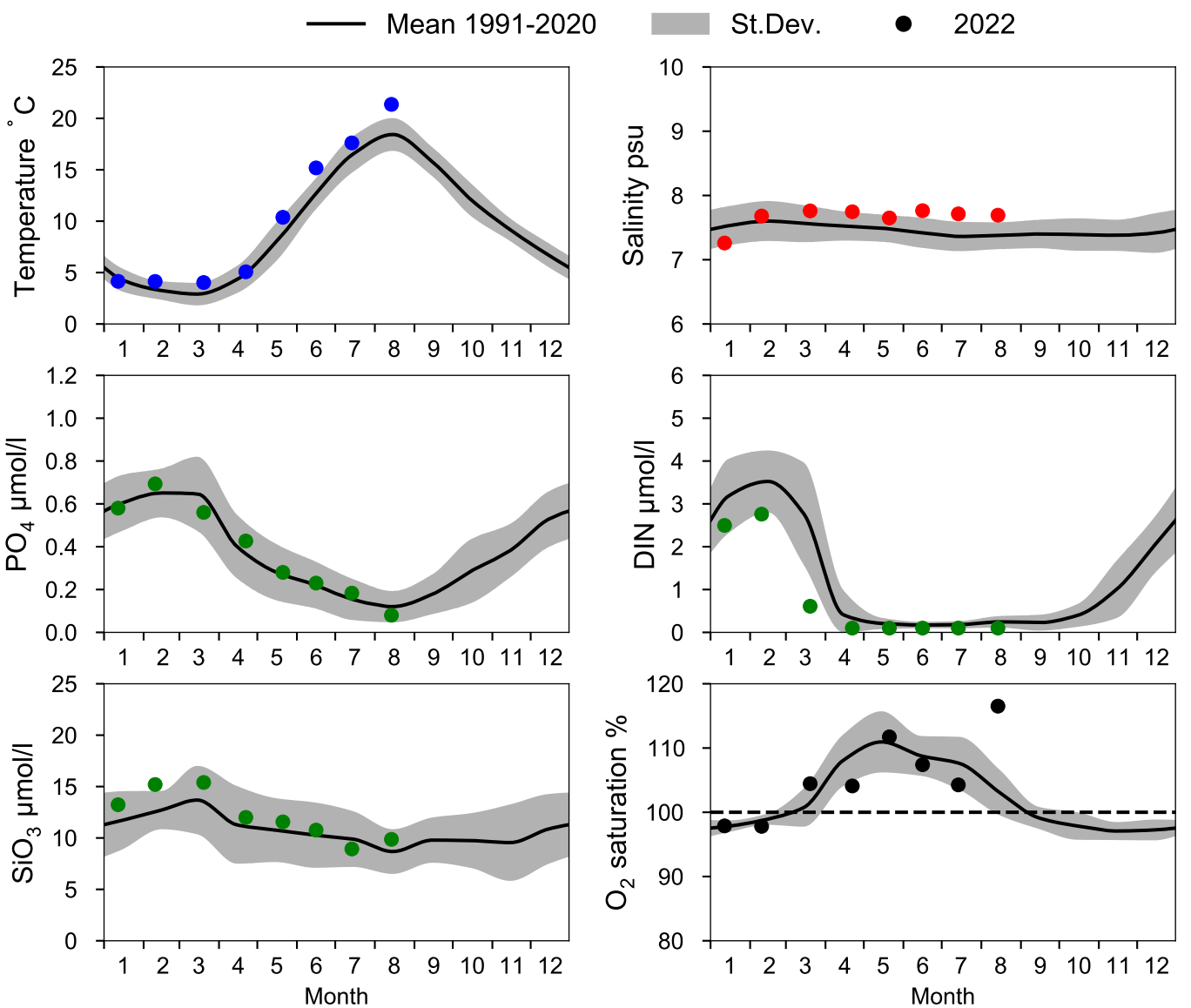


Vertical profiles BY2 ARKONA
August

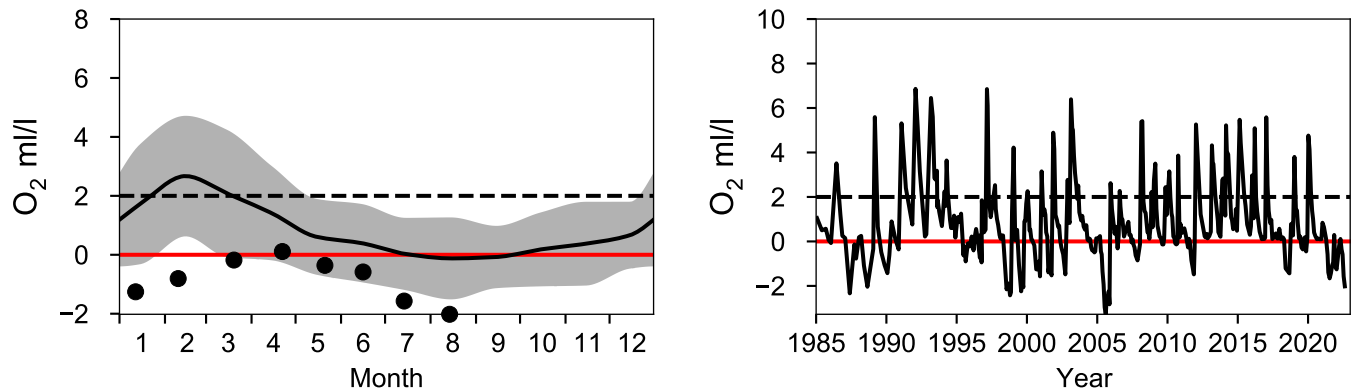


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

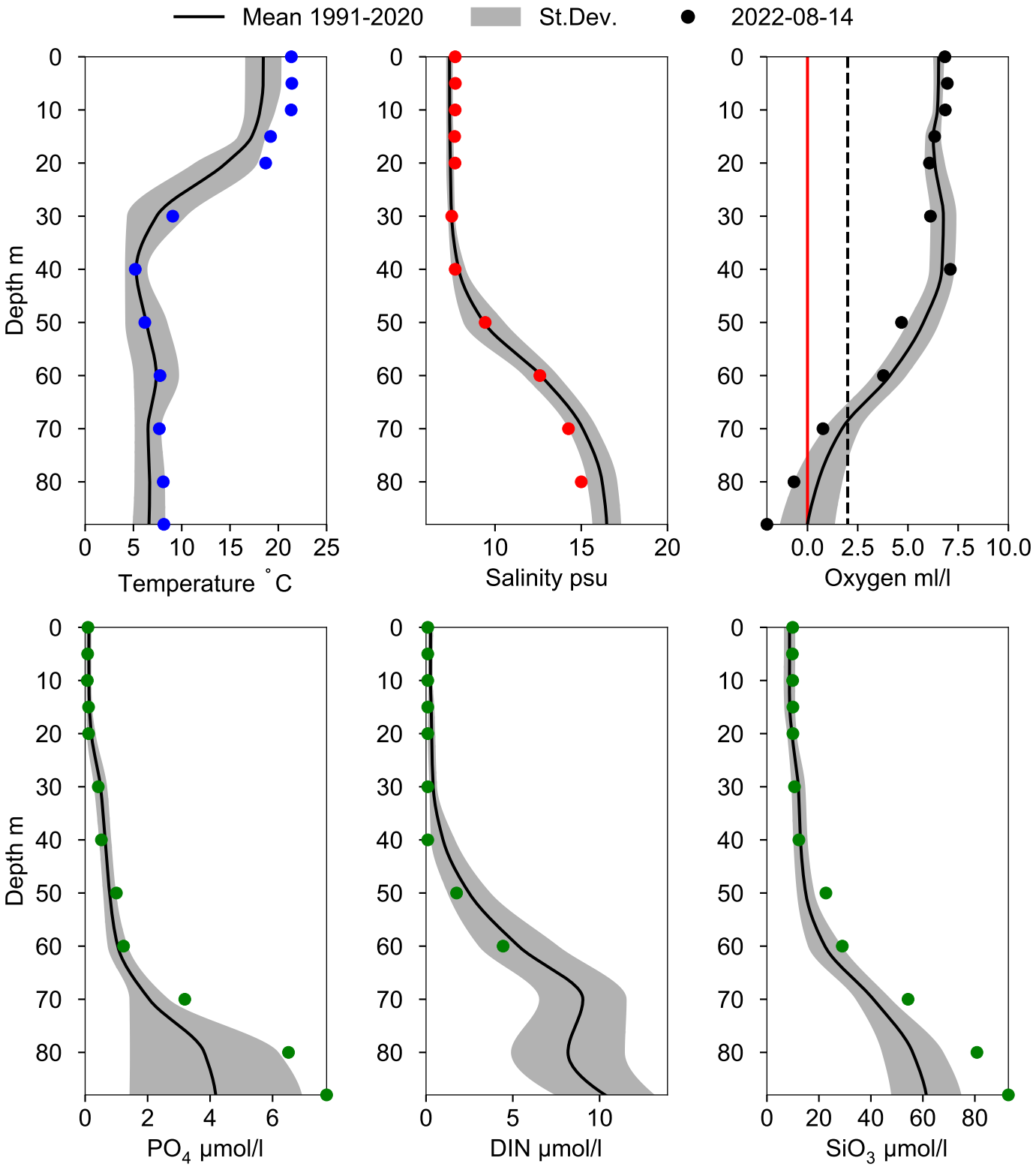
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

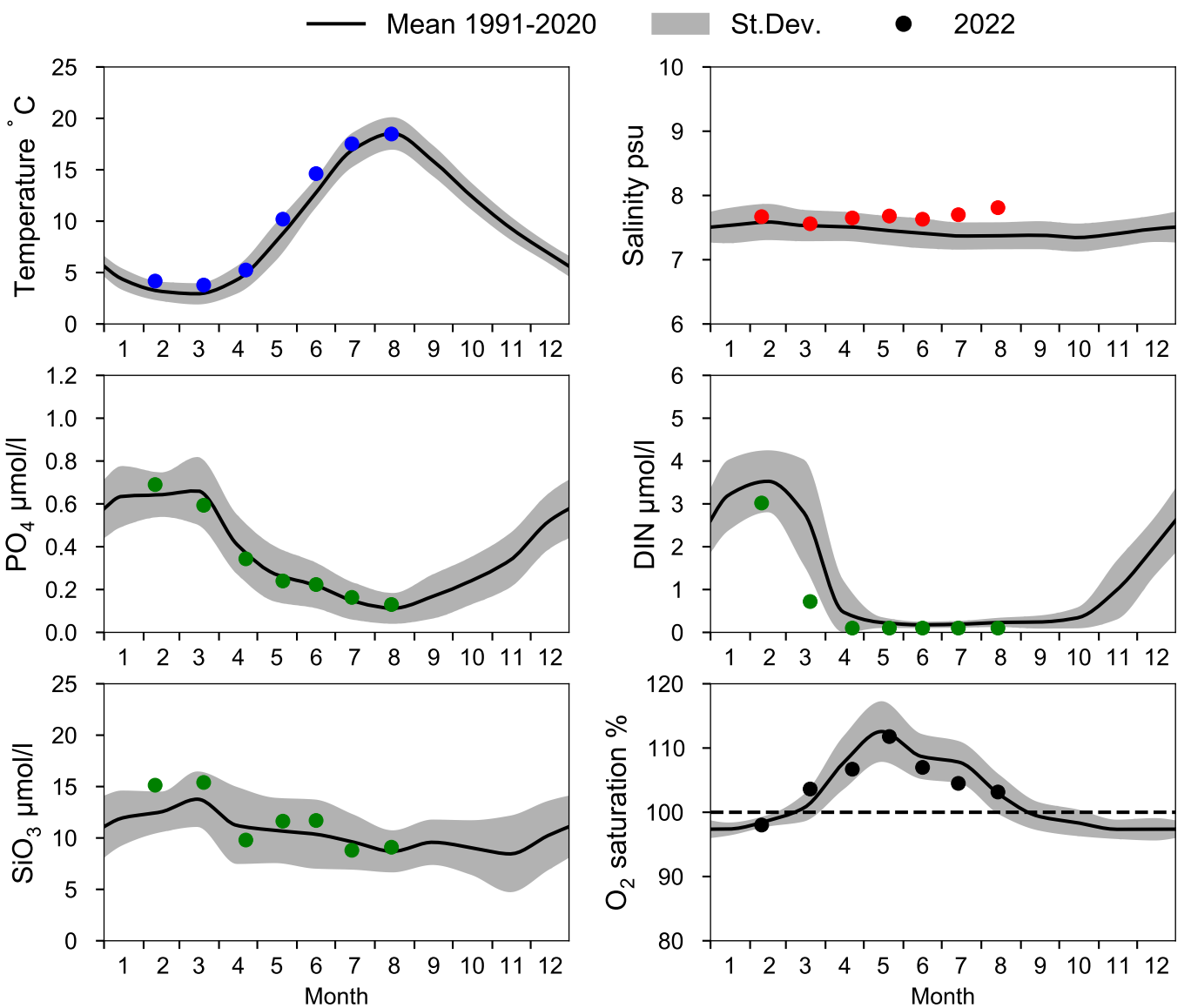


Vertical profiles BY4 CHRISTIANSÖ
August

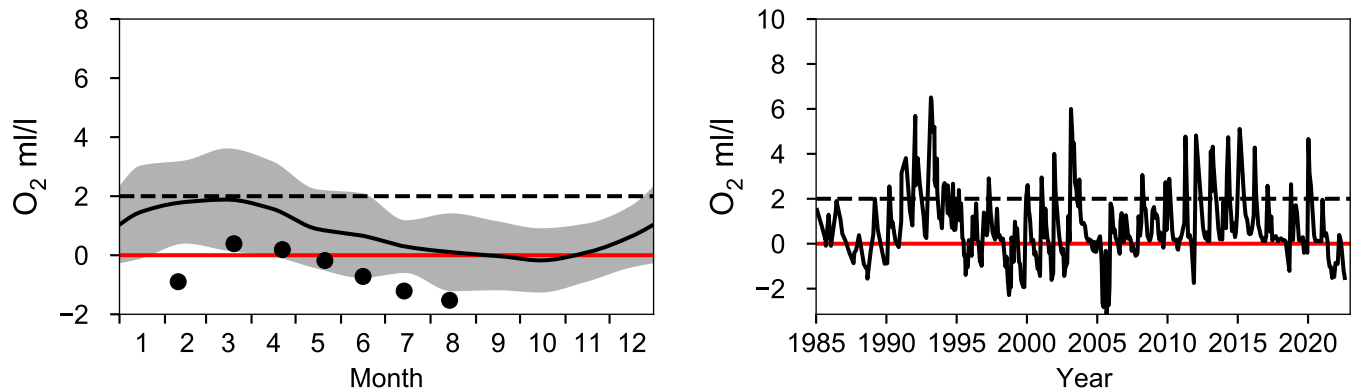


STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

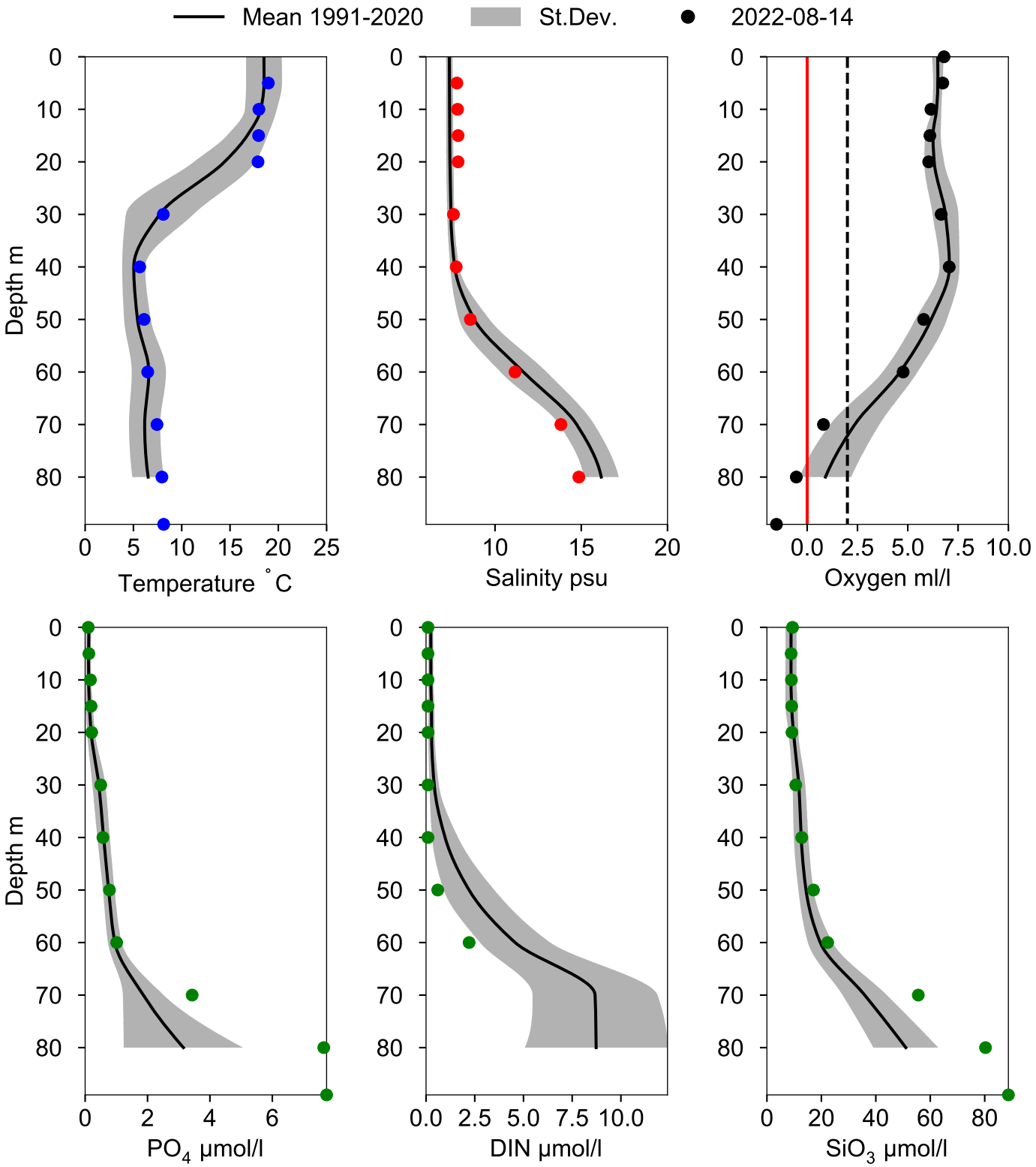
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

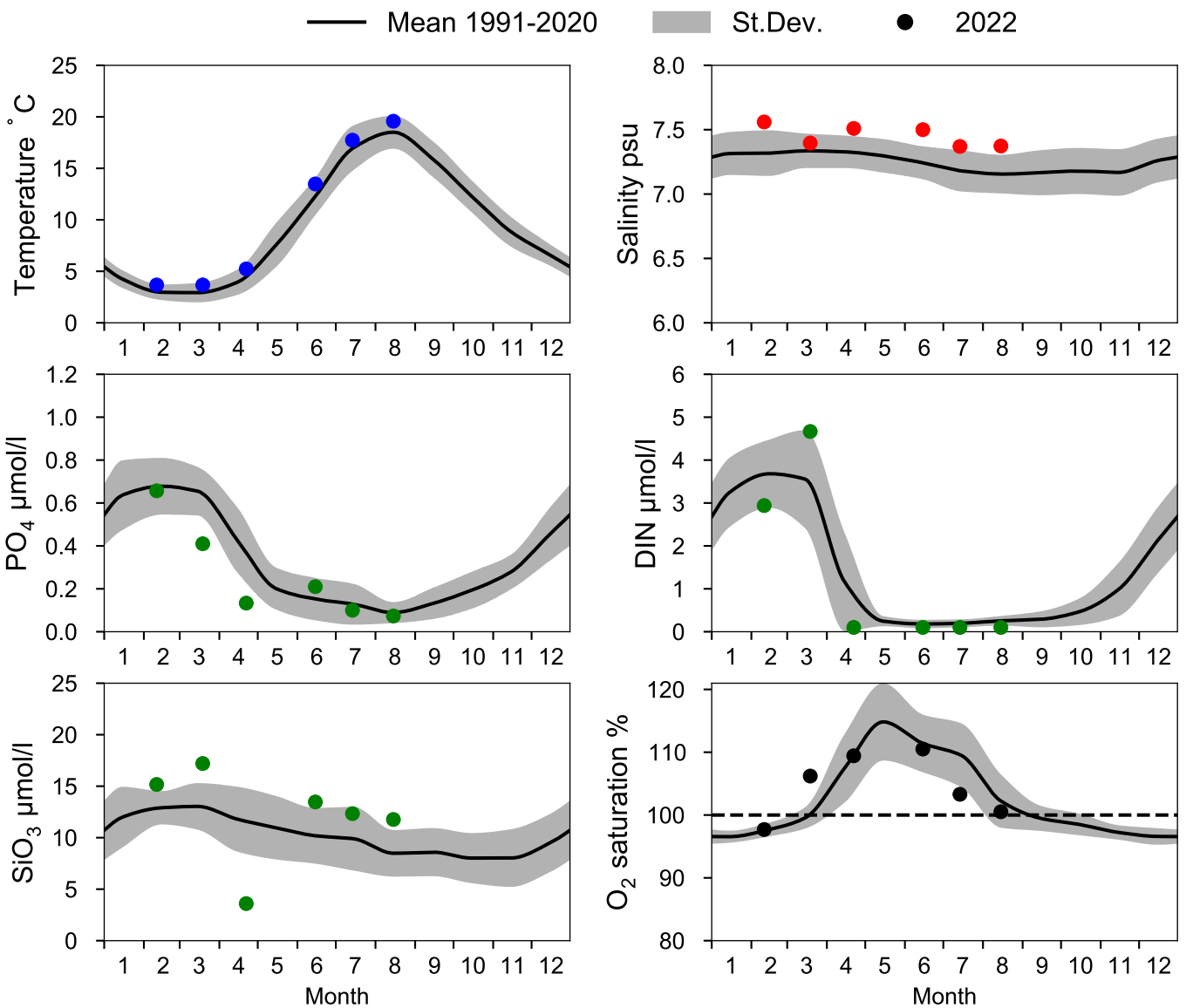


Vertical profiles BY5 BORNHOLMSDJ
August

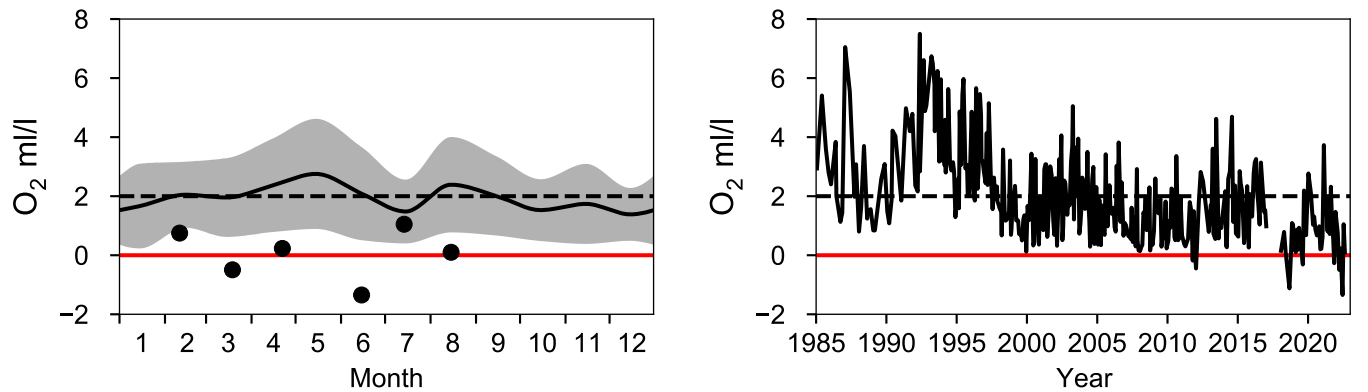


STATION BCS III-10 SURFACE WATER (0-10 m)

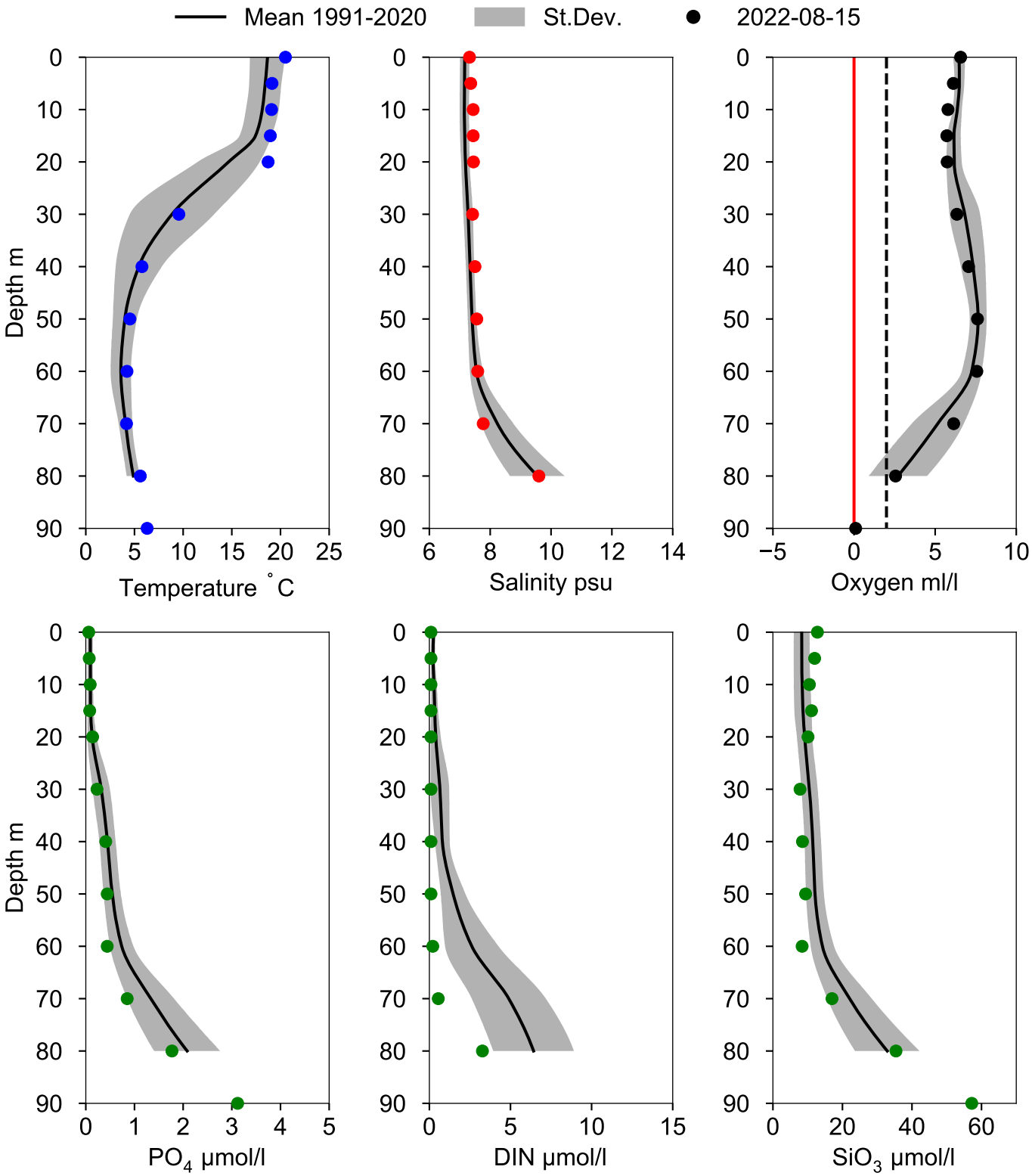
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

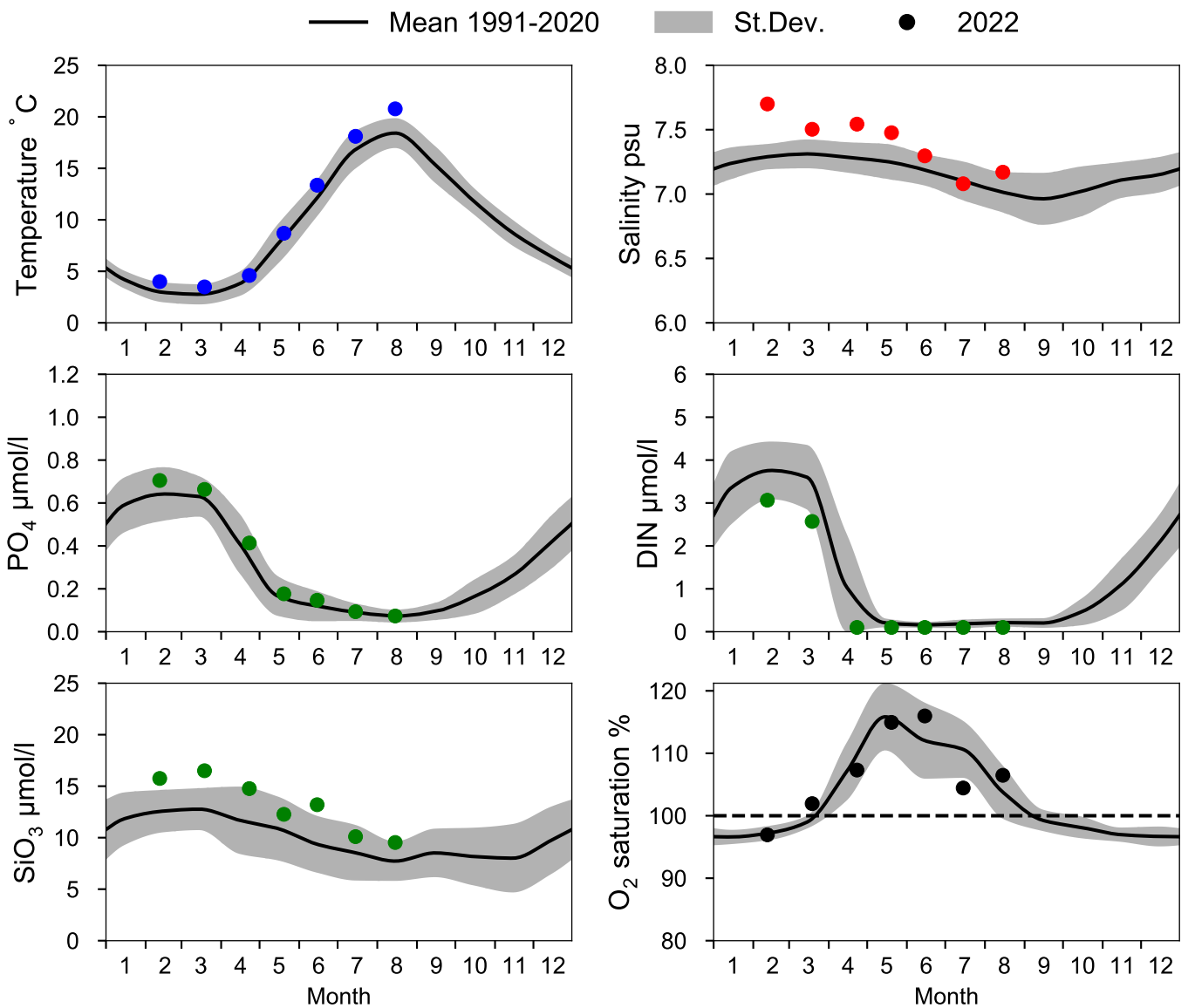


Vertical profiles BCS III-10
August

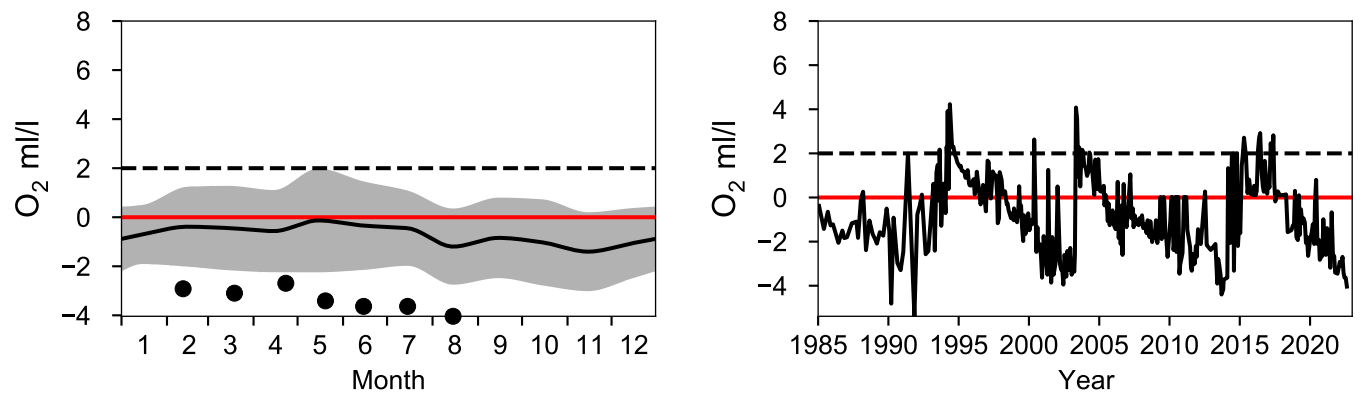


STATION BY10 SURFACE WATER (0-10 m)

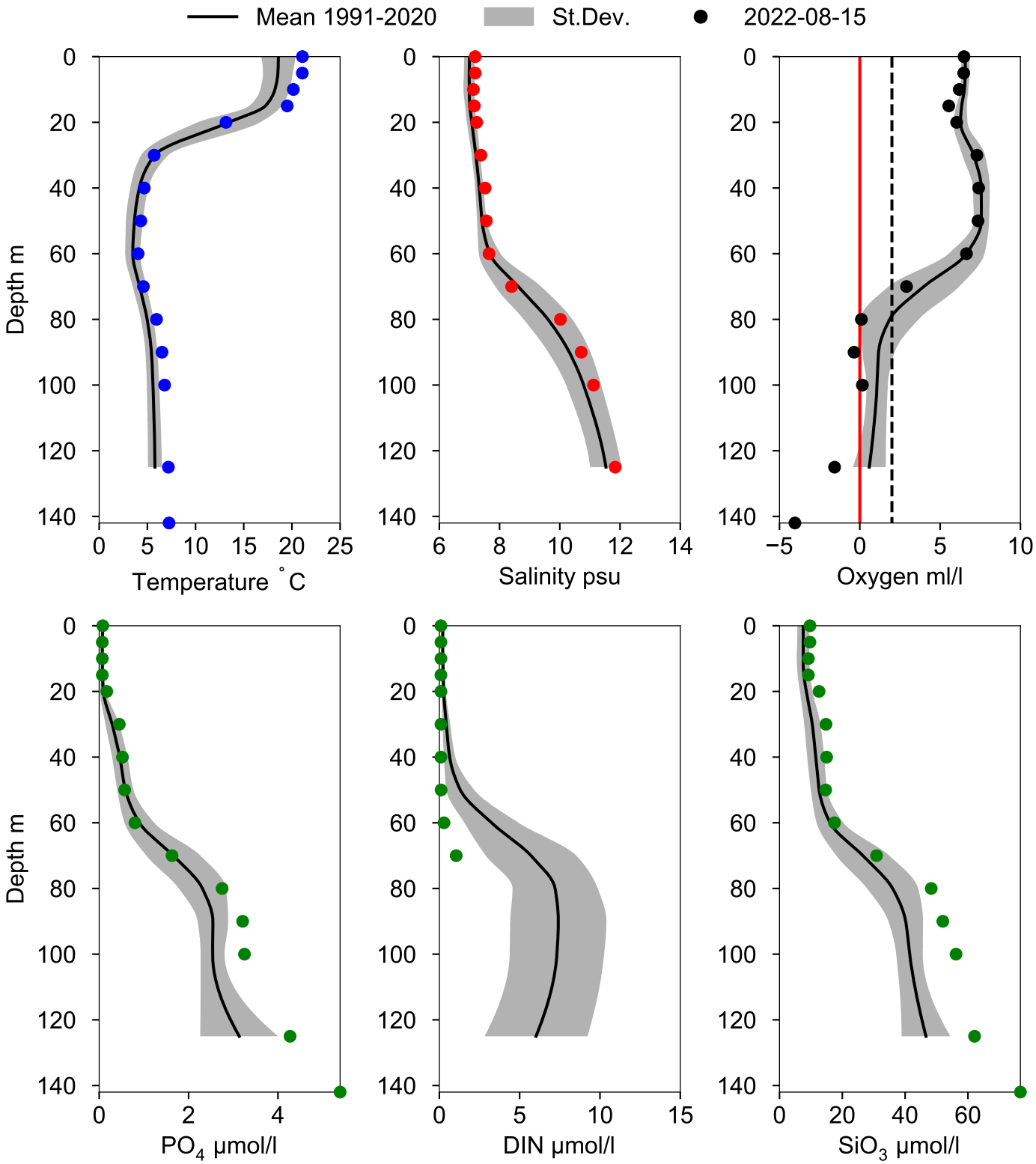
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

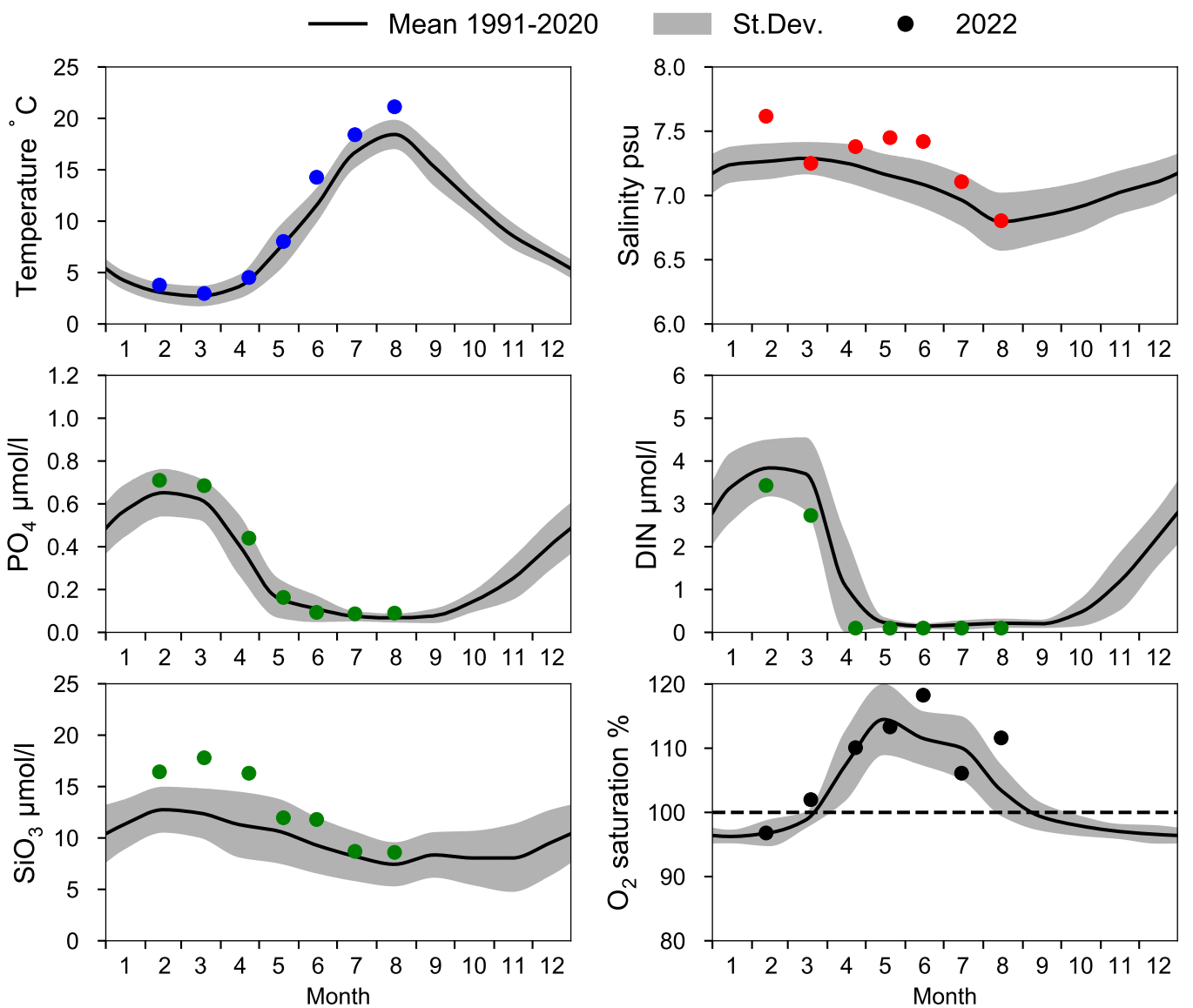


Vertical profiles BY10
August

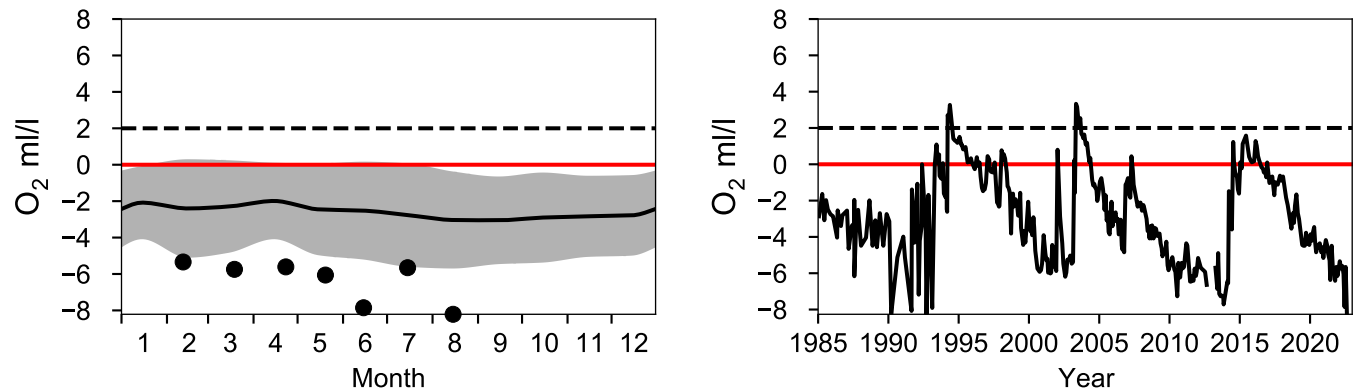


STATION BY15 GOTLANDSDJ SURFACE WATER (0-10 m)

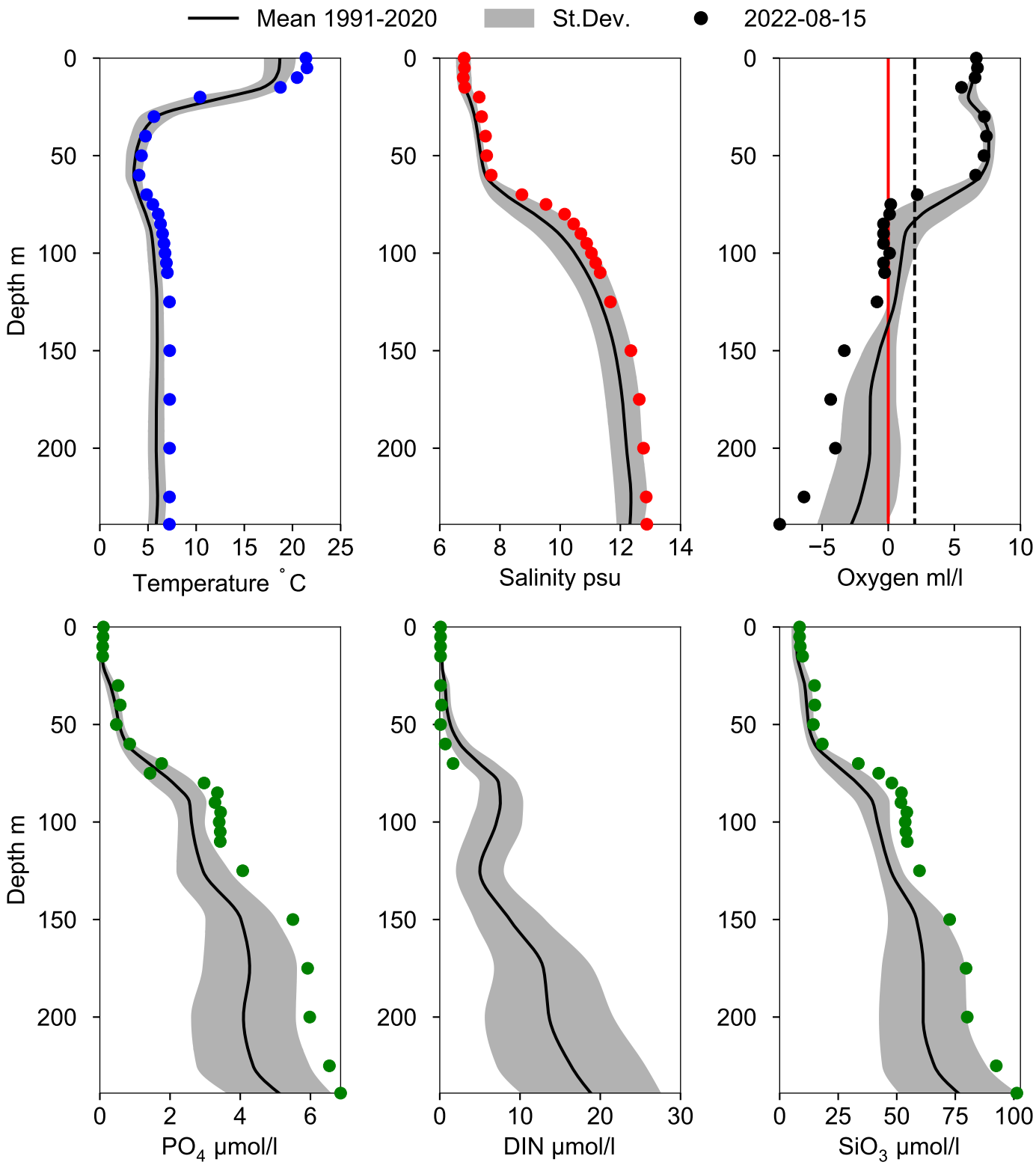
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 225 m)

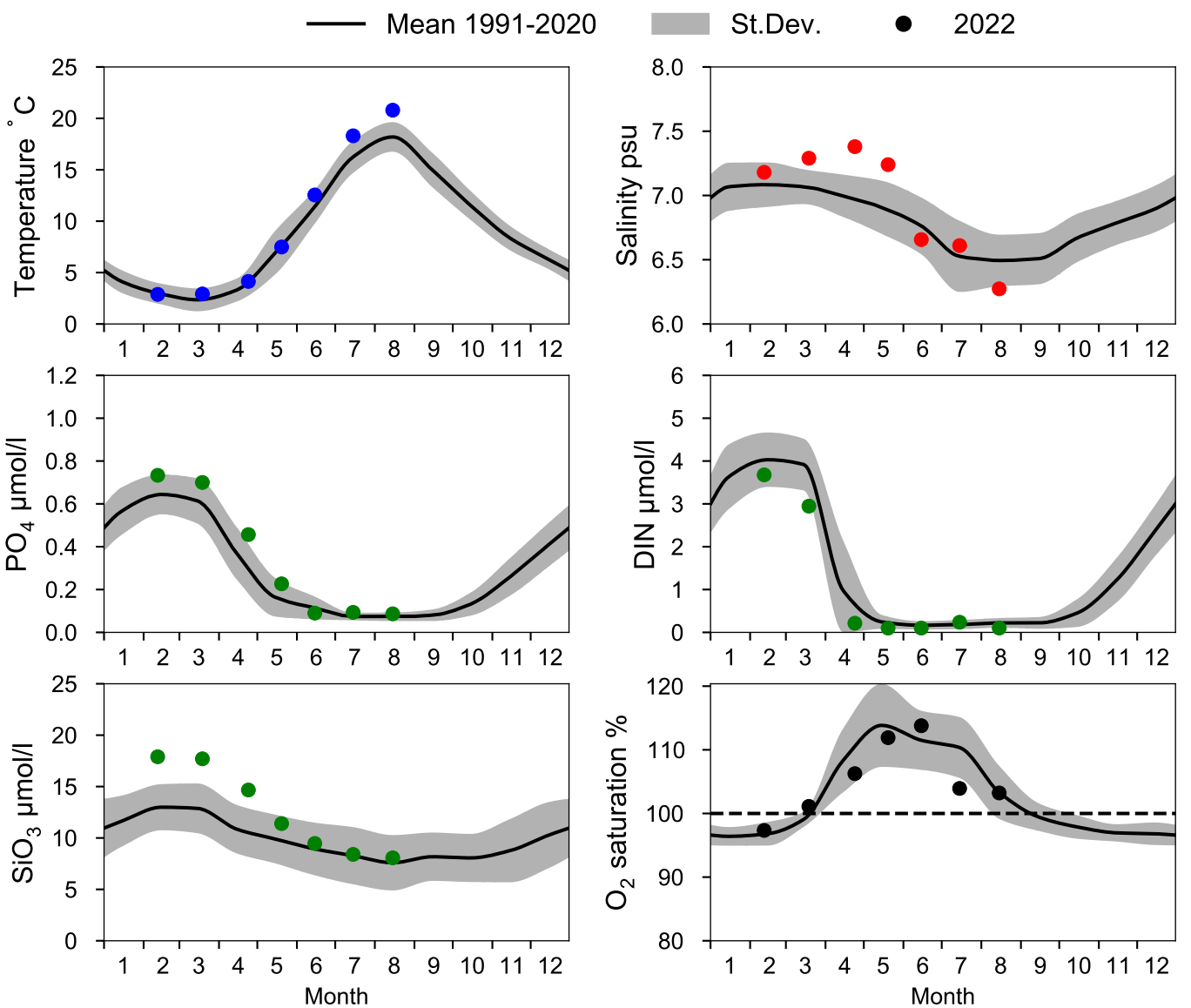


Vertical profiles BY15 GOTLANDSDJ
August

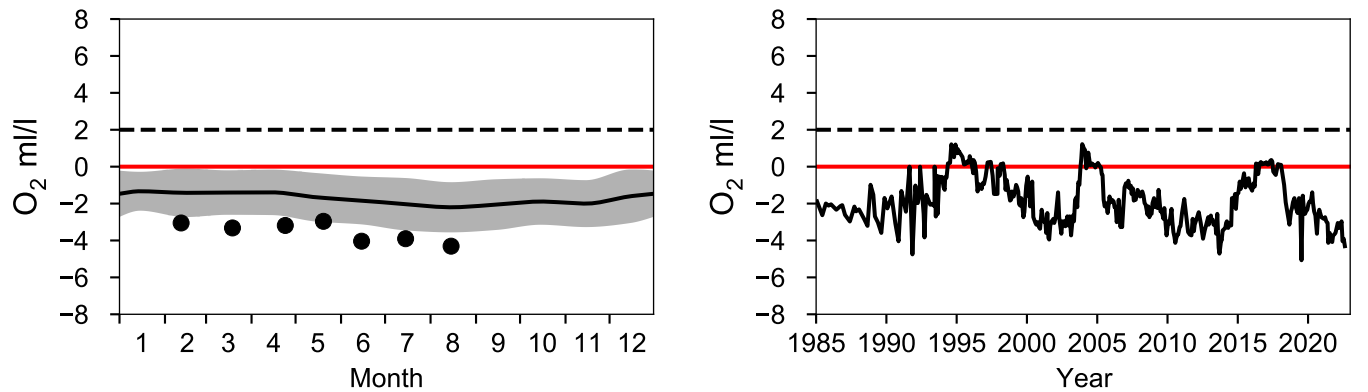


STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

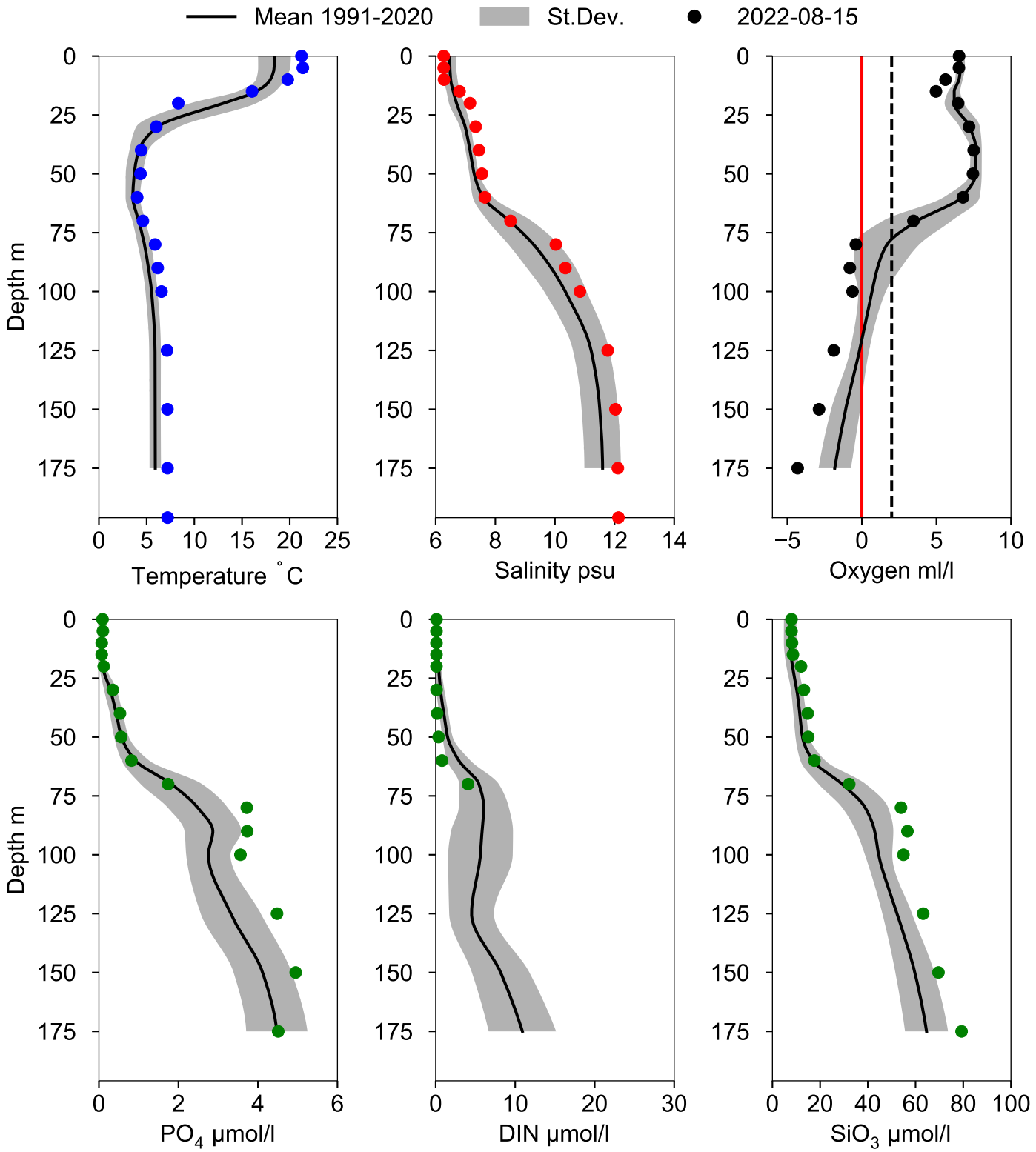
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

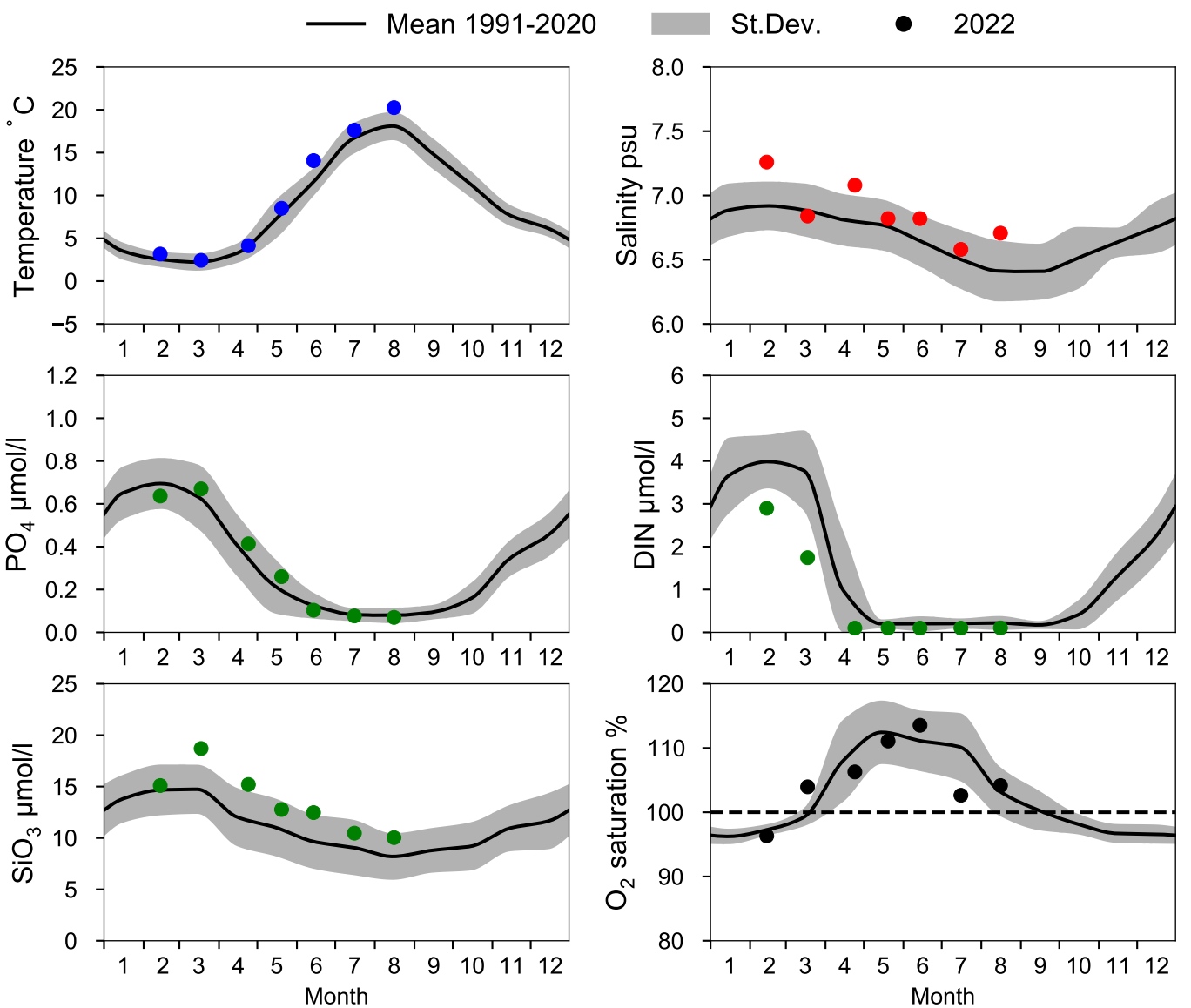


Vertical profiles BY20 FÅRÖDJ
August

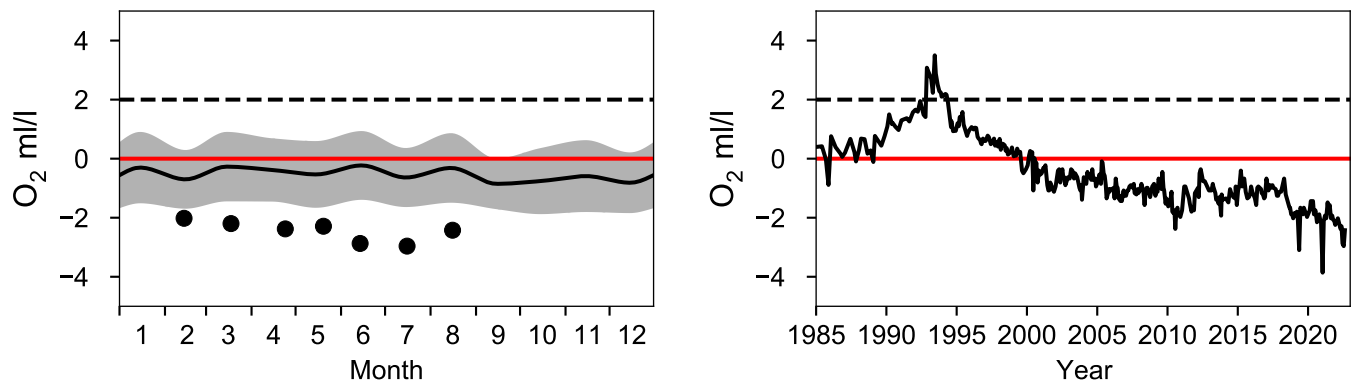


STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

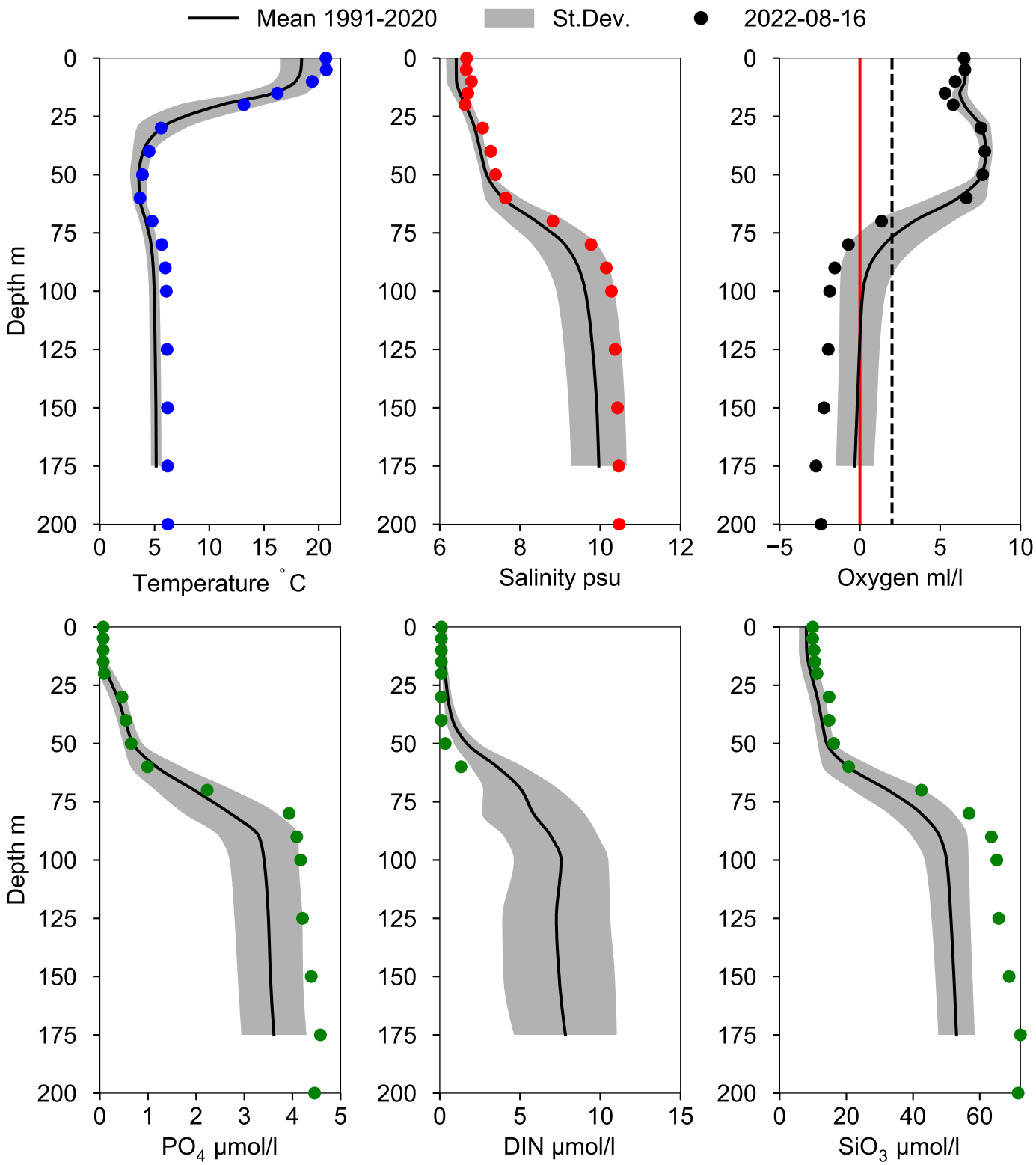
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

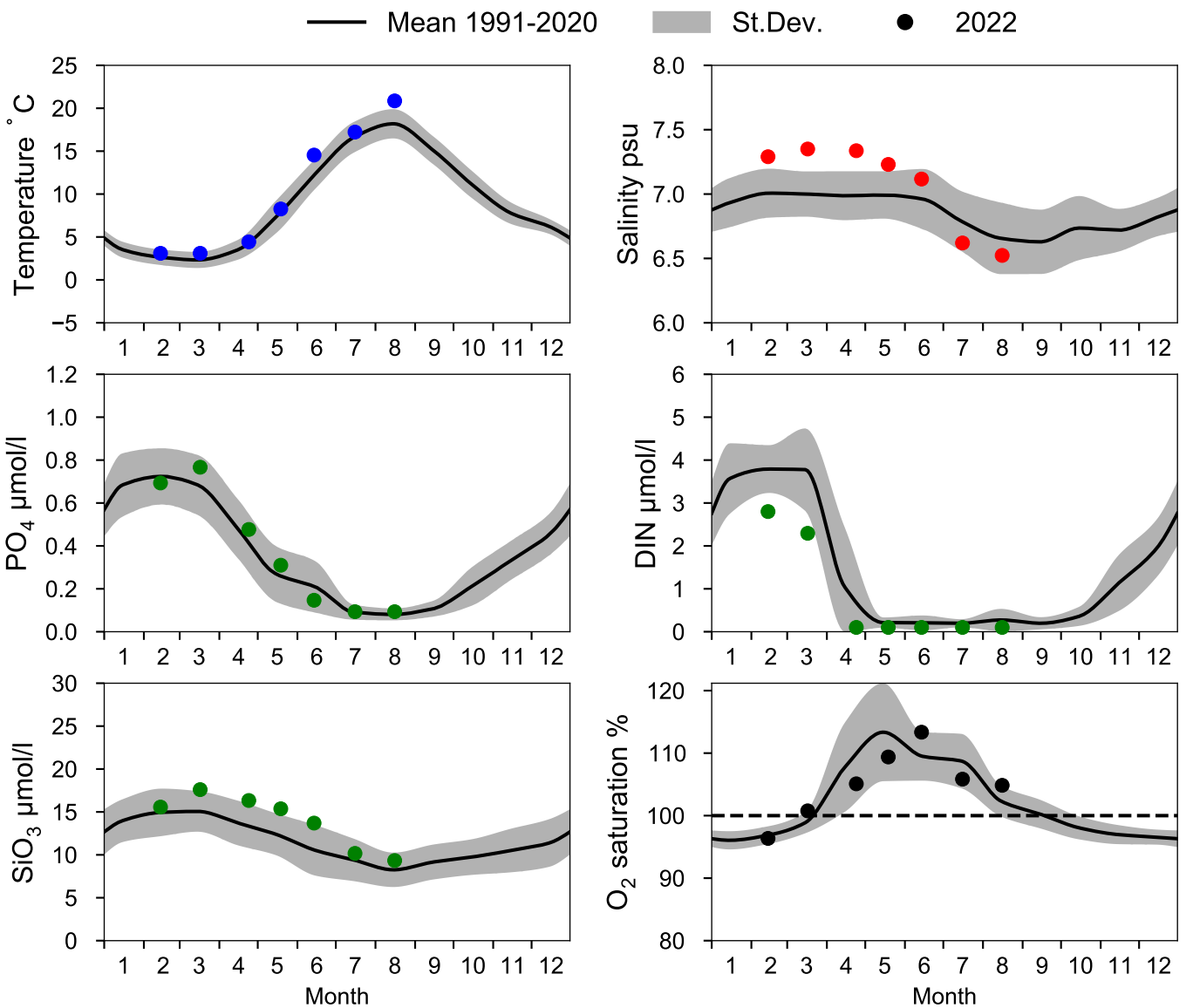


Vertical profiles BY32 NORRKÖPINGSDJ
August

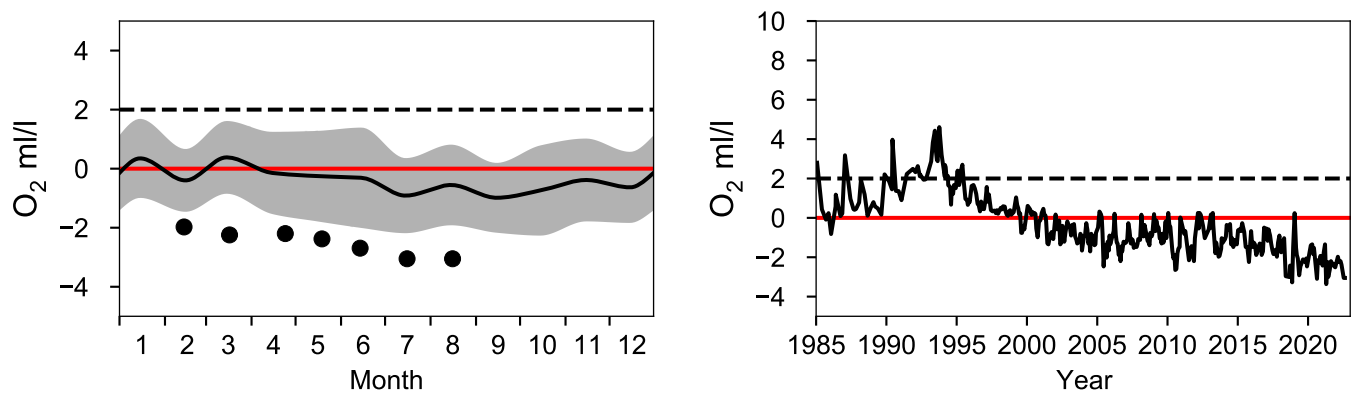


STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

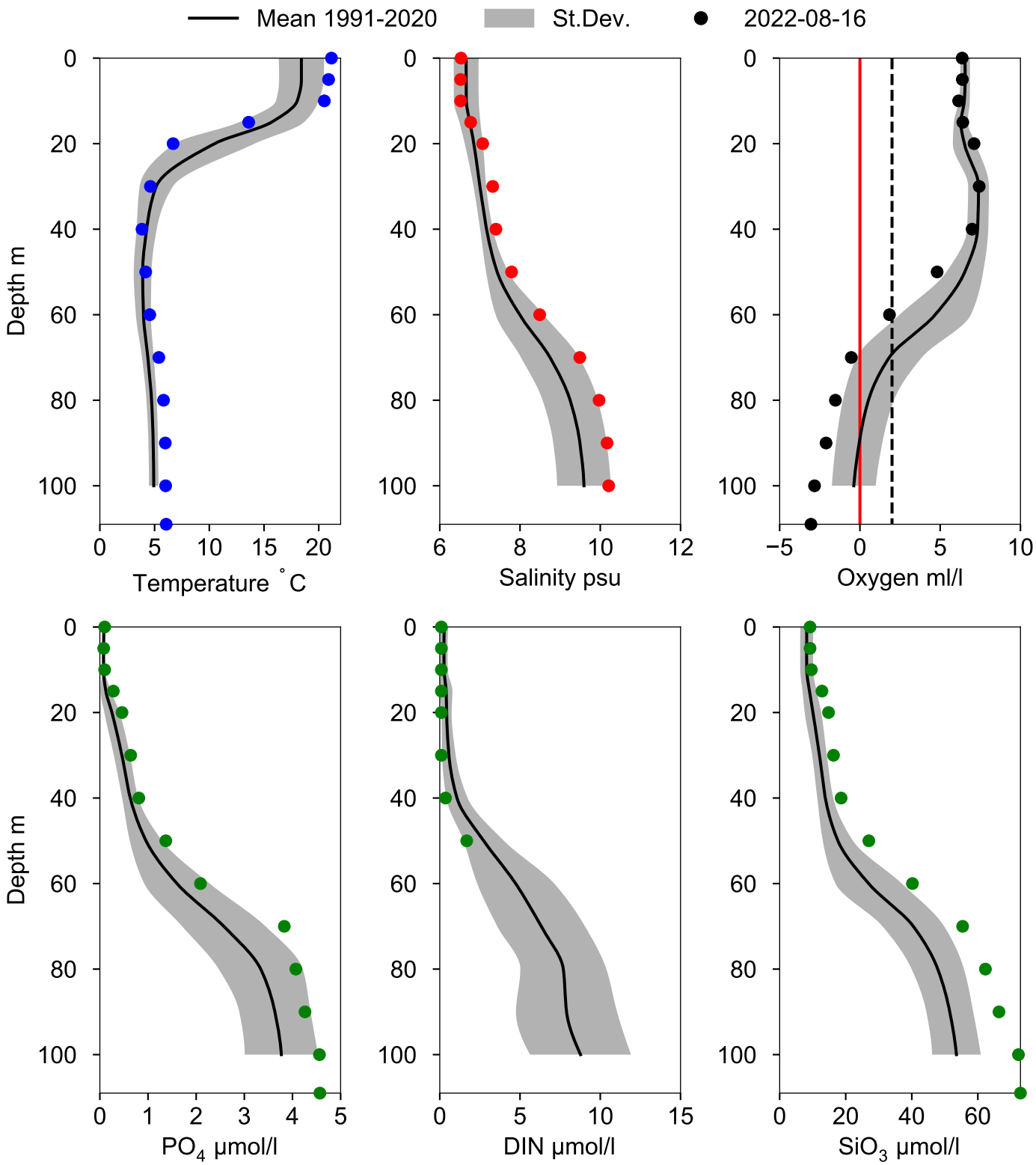
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

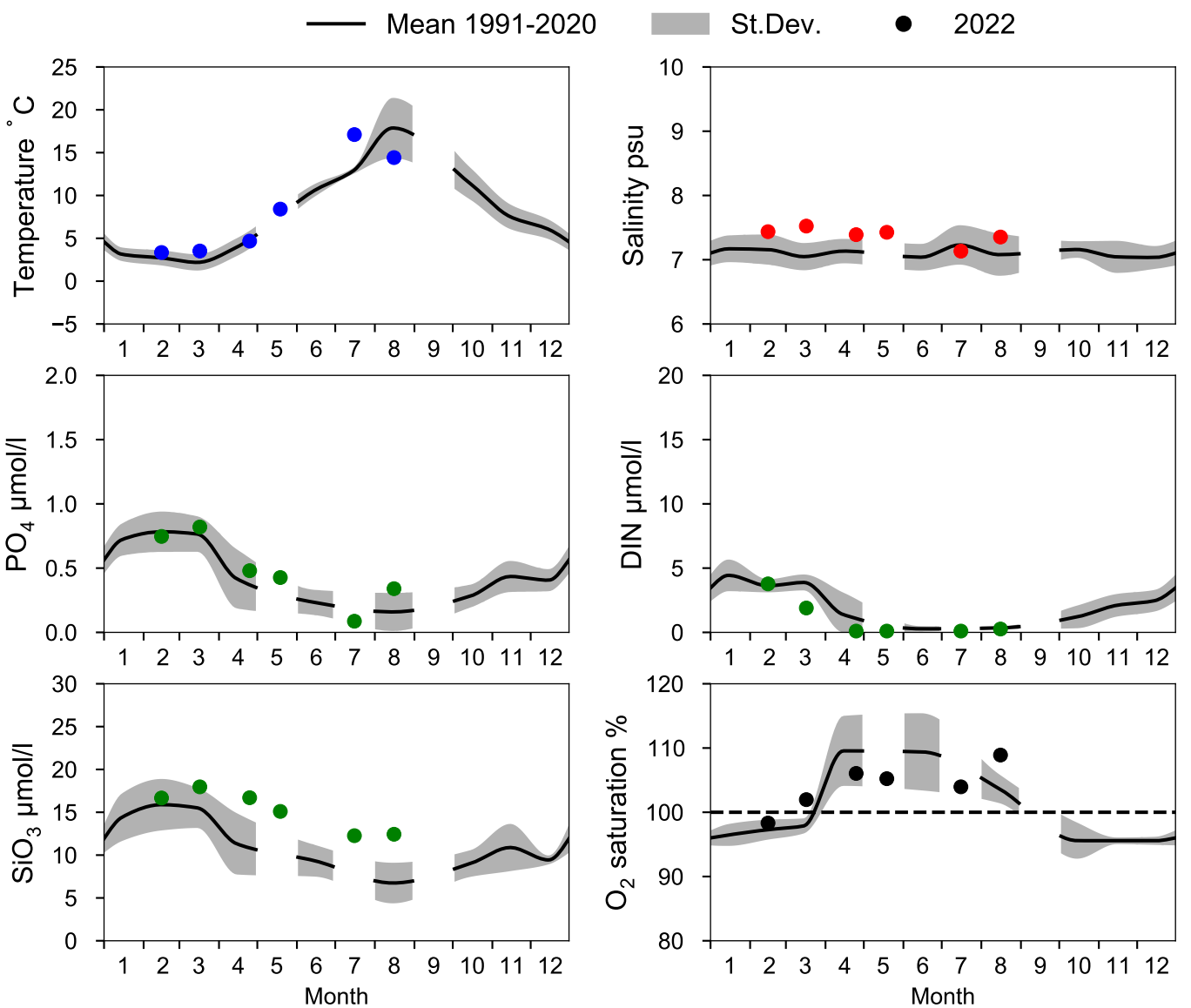


Vertical profiles BY38 KARLSÖDJ
August

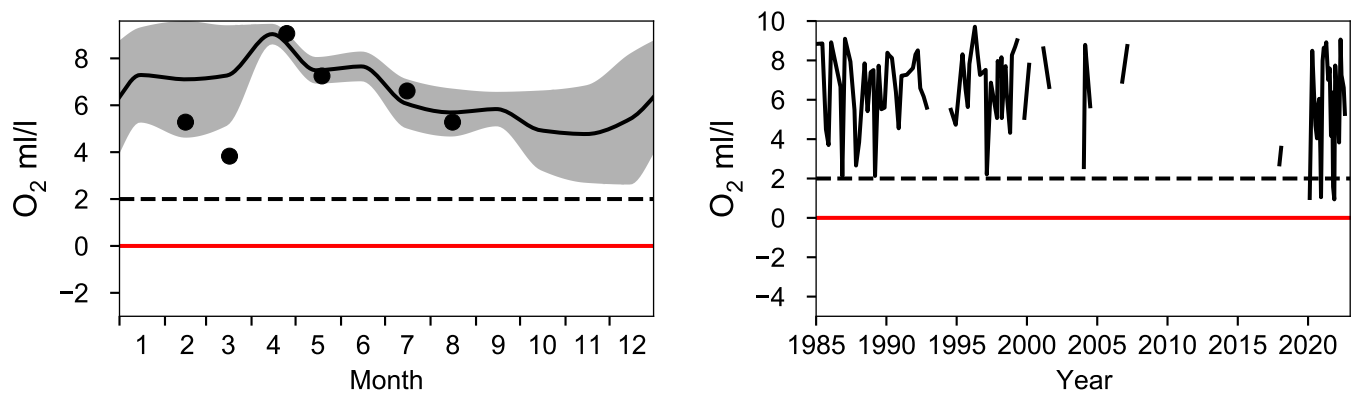


STATION BY39 ÖLANDS S UDDE SURFACE WATER (0-10 m)

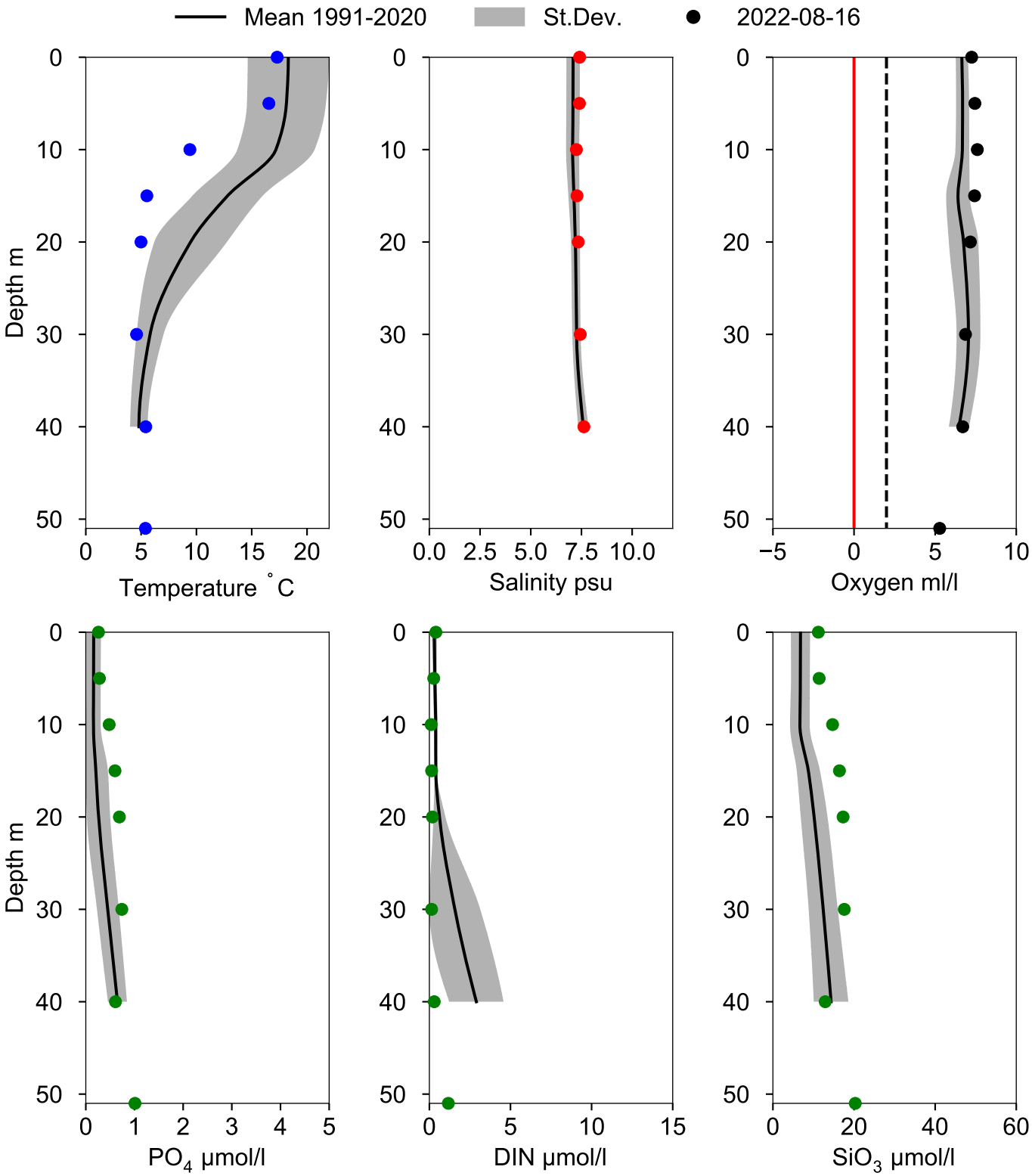
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

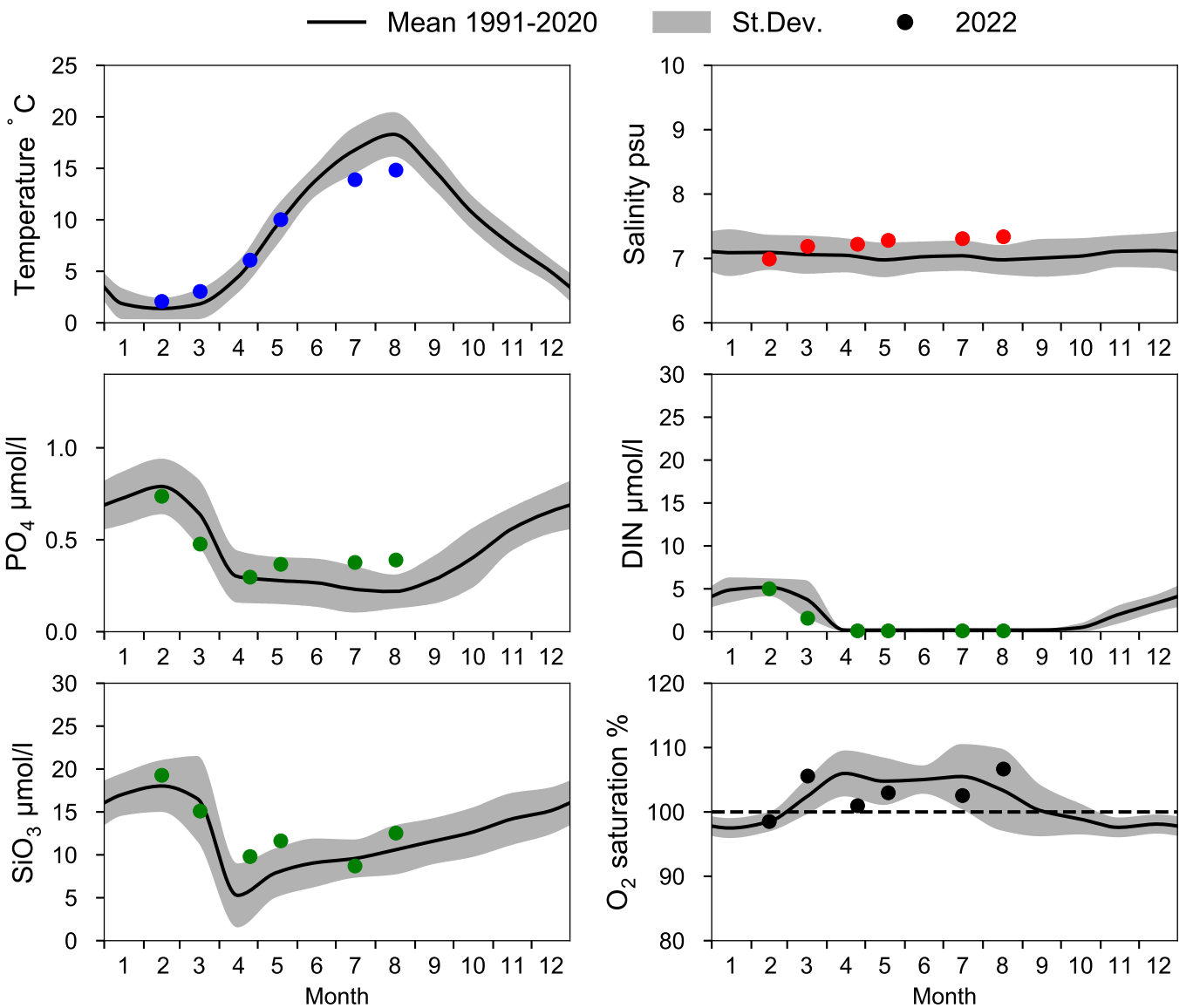


Vertical profiles BY39 ÖLANDS S UDDE
August

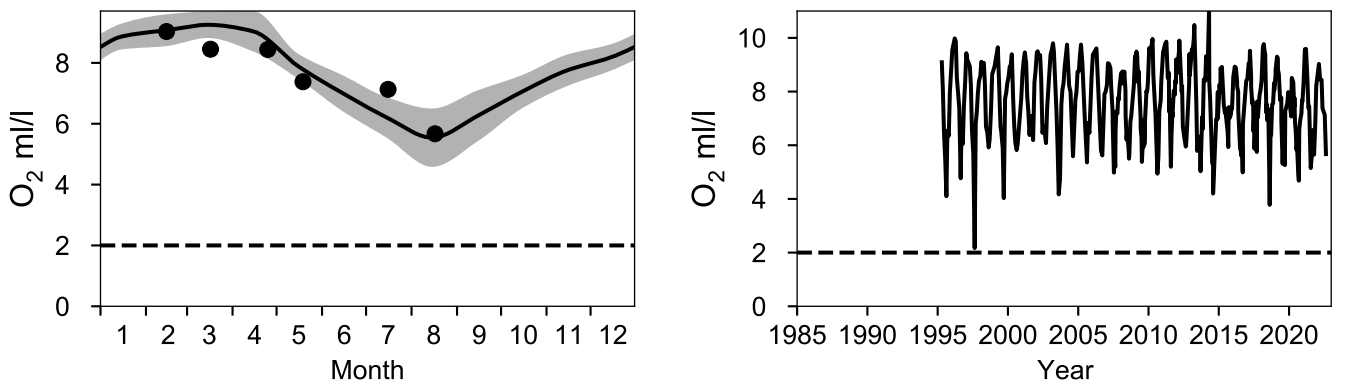


STATION REF M1V1 SURFACE WATER (0-10 m)

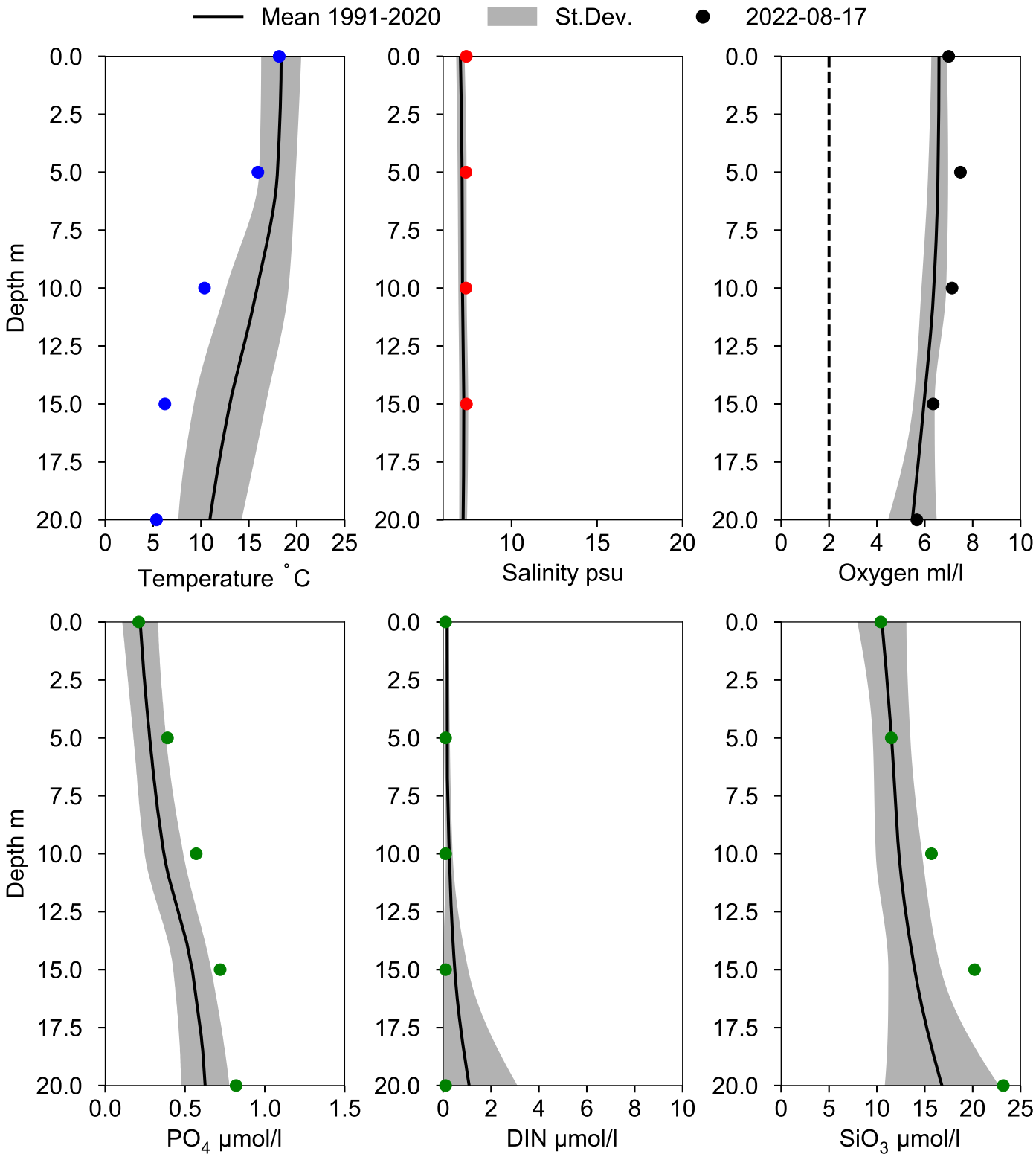
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 15 m)

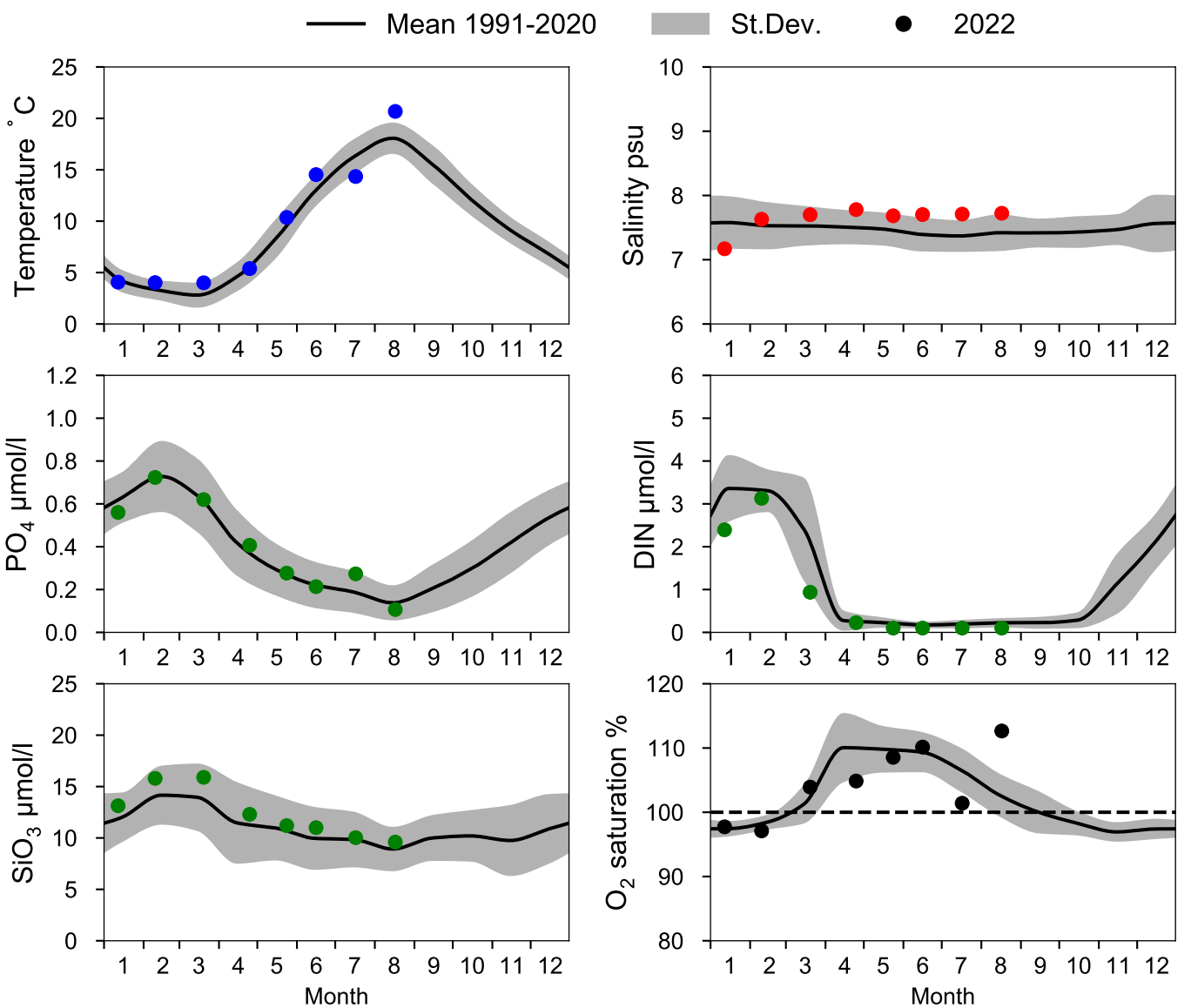


Vertical profiles REF M1V1
August

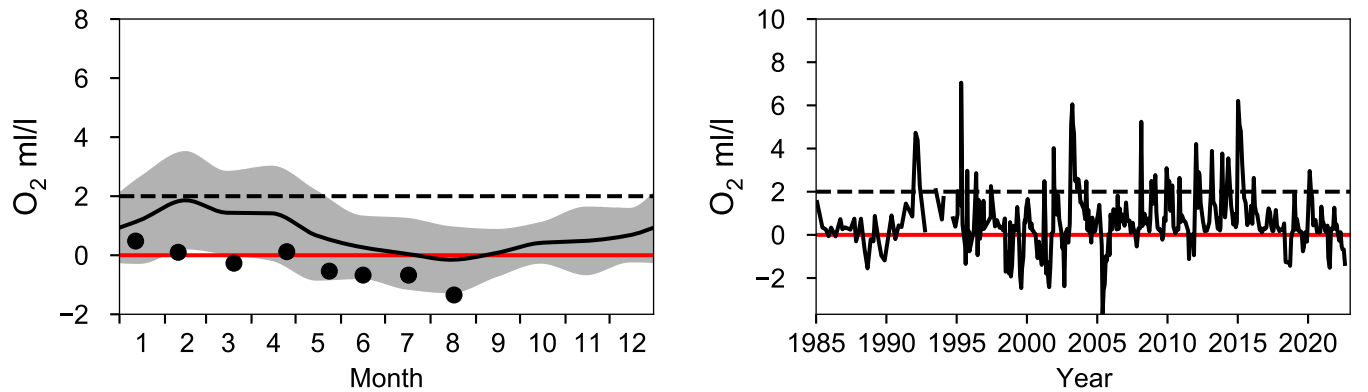


STATION HANÖBUKTEN SURFACE WATER (0-10 m)

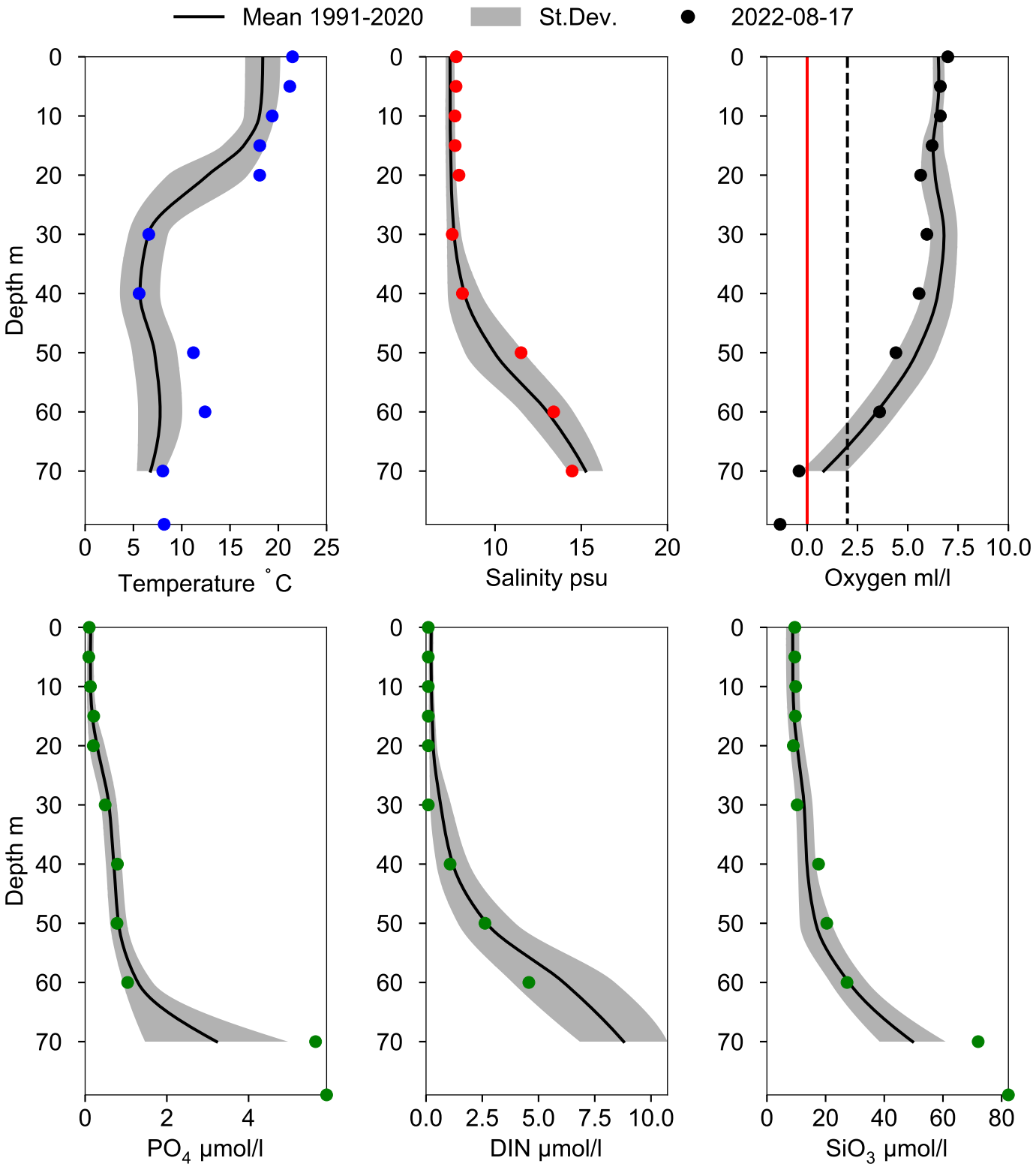
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)

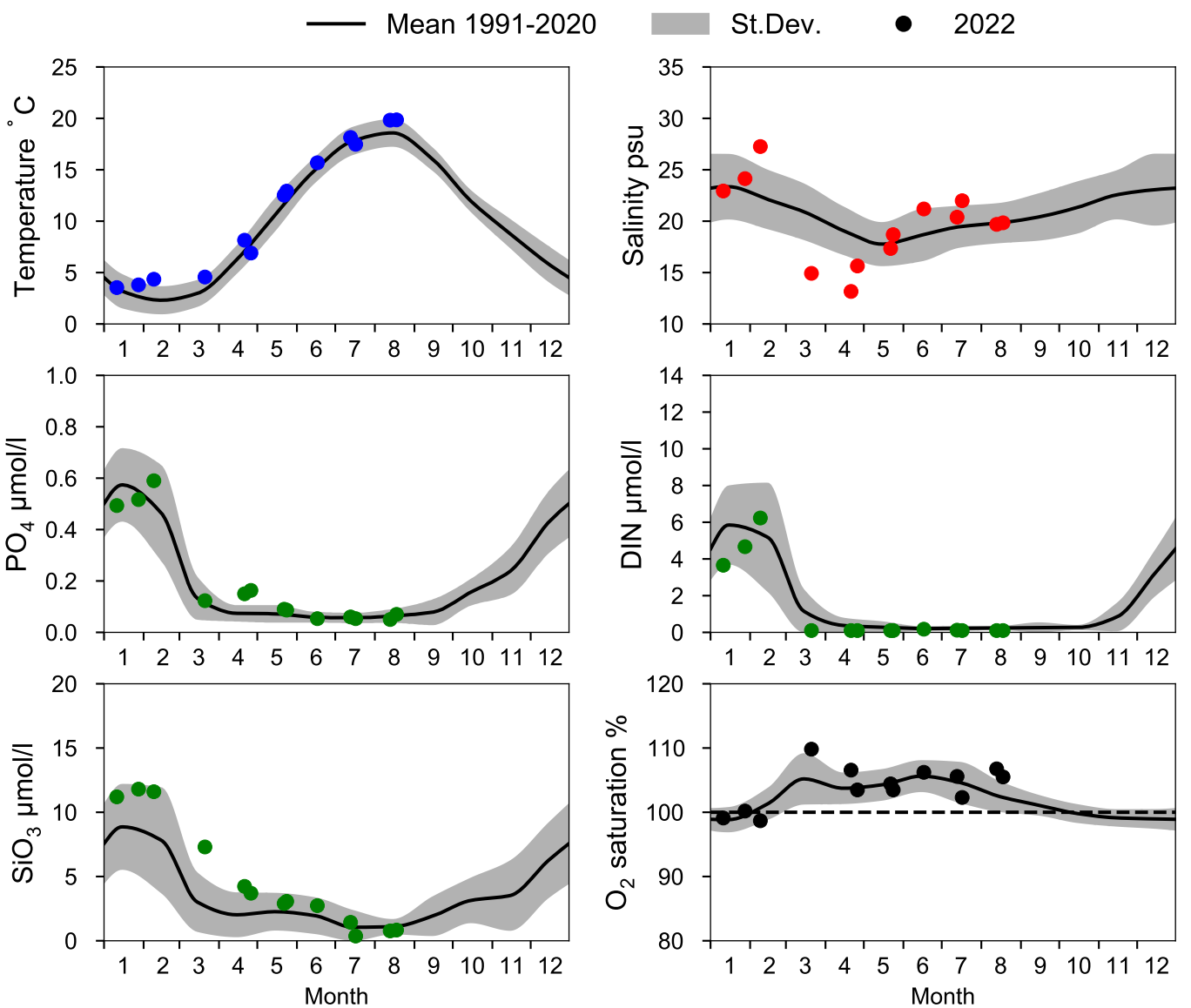


Vertical profiles HANÖBUKTEN
August

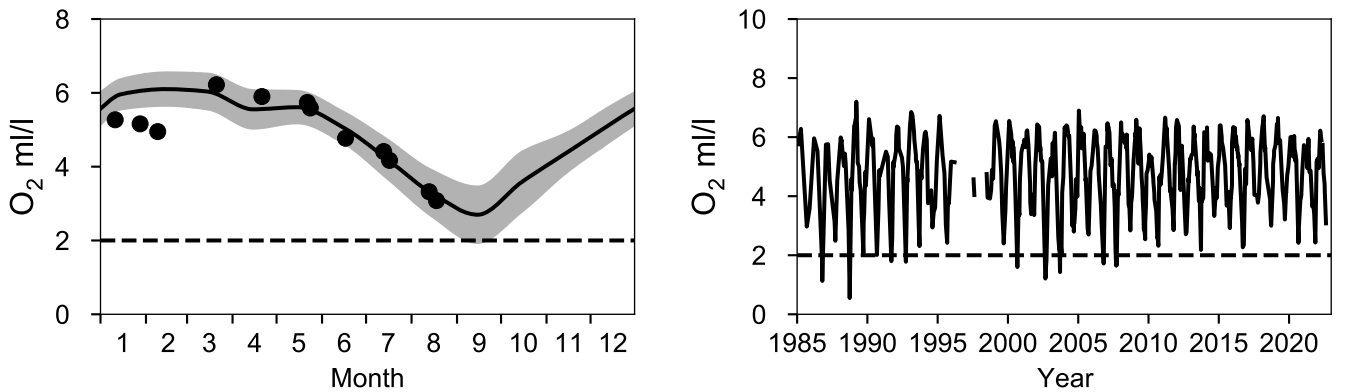


STATION ANHOLT E SURFACE WATER (0-10 m)

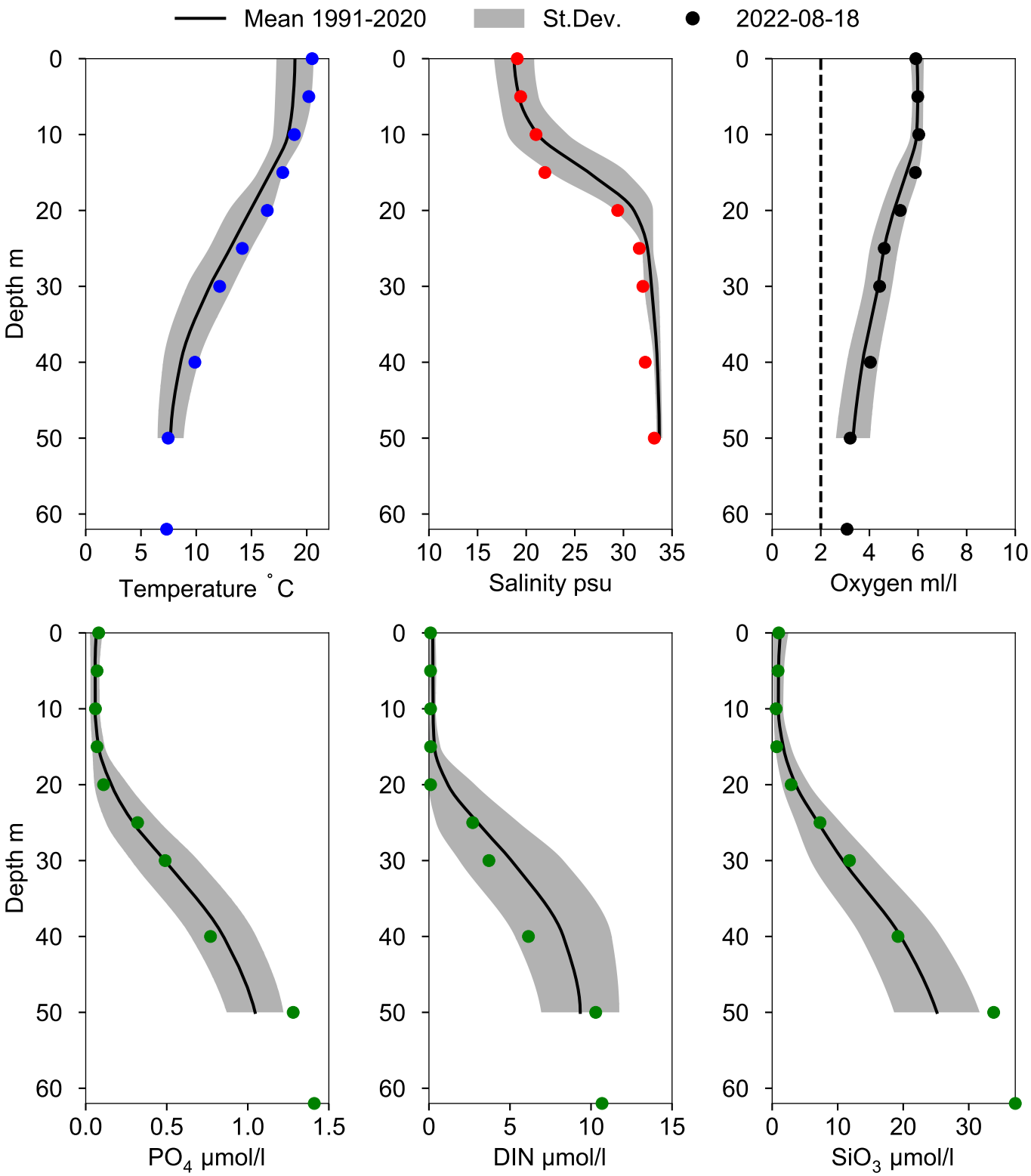
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

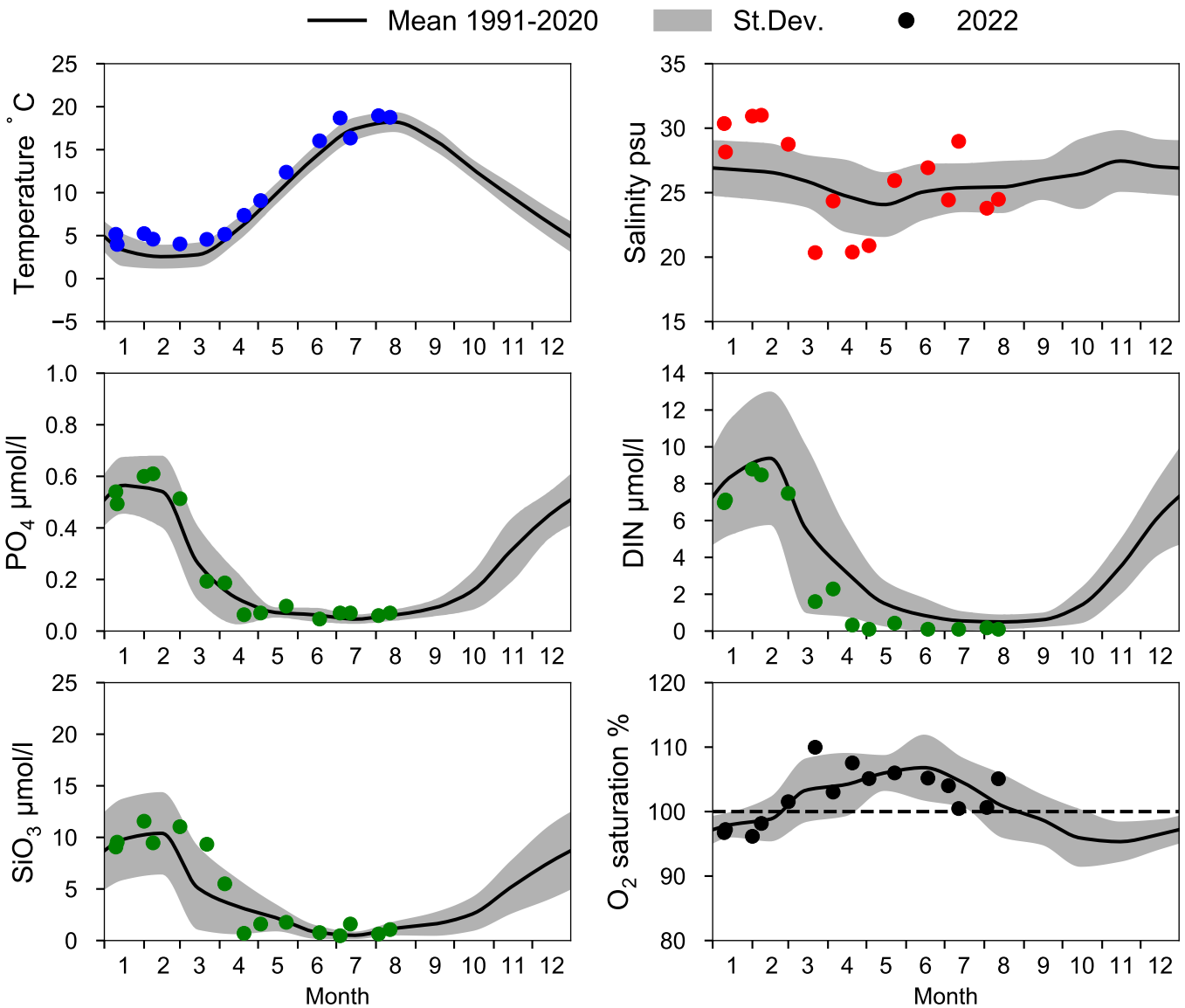


Vertical profiles ANHOLT E
August

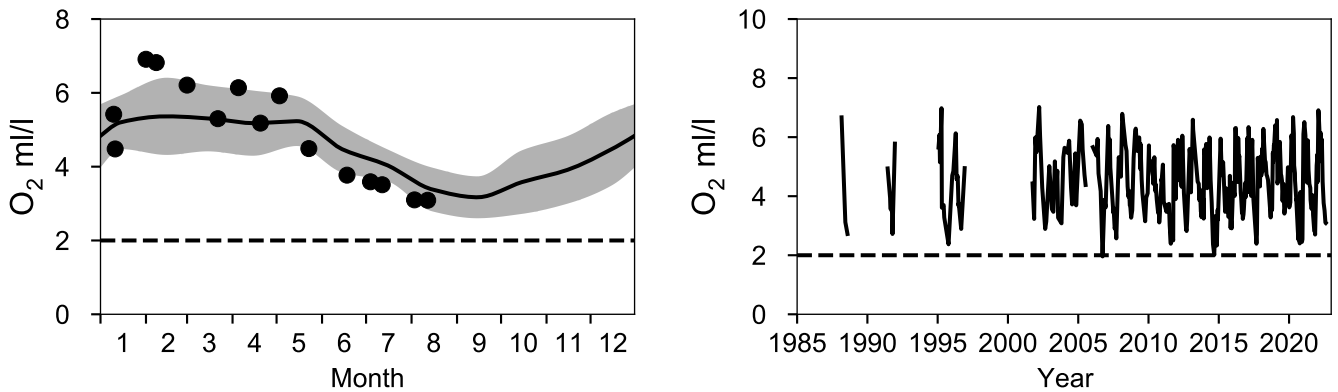
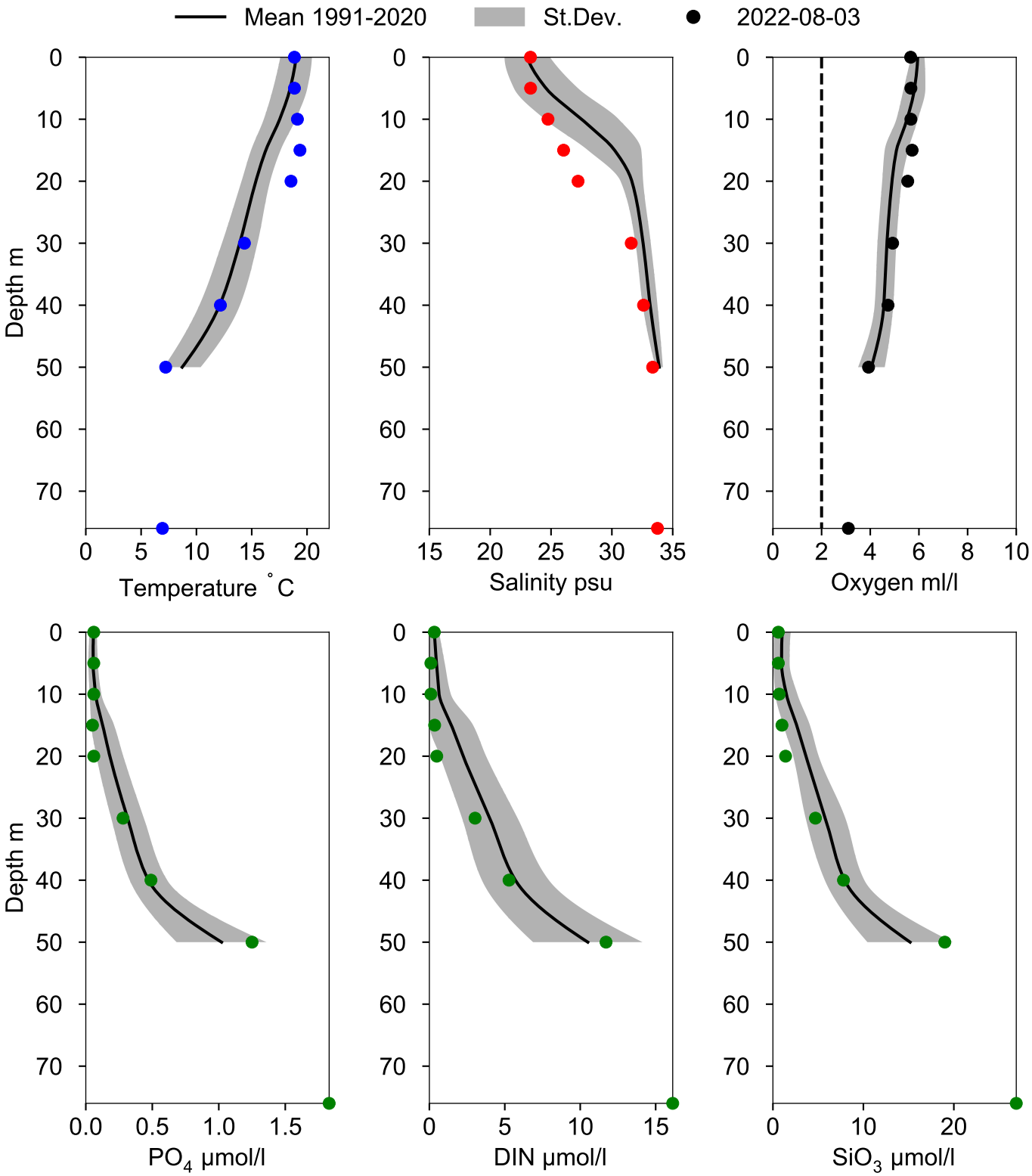


STATION SLÄGGÖ SURFACE WATER (0-10 m)

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)



Vertical profiles SLÄGGÖ
August