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Oceanographic Laboratory

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Report from SMHI's monitoring cruise with R/V Svea – October 2024

Photo: Ola Kalén, SMHI

Survey period:	2024-10-18 to 2024-10-24
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 Agency (SMA)

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SUMMARY

As part of the Swedish pelagic monitoring program, the cruise visited the Skagerrak, Kattegat, Öresund, and the Baltic Proper.

The cooling of surface waters had begun, with temperatures ranging between 11–13°C, which is normal for the season.

Nutrient levels were relatively normal in the Skagerrak and Kattegat.
In the northern parts of the Baltic Proper (BY31), higher-than-normal levels of DIN were observed. These areas are typically influenced by a southward current carrying outflowing water from the Bothnian Sea.

The concentration of phosphate in surface waters was normal for the season, except in the southern part of the Western Gotland Basin (BY38), northwestern Baltic Proper (BY31), and BY20 in the Eastern Gotland Basin. Concentrations ranged from 0.2–0.5 µmol/l.

Acute oxygen deficiency, defined as oxygen levels below 2 ml/l, was observed from 70 meters depth in the Eastern and Western Gotland Basin. In the Hanö Bight and Bornholm Basin, oxygen deficiency occurred at shallower depths of 60 meters. In the Arkona Basin (BY2), acute oxygen deficiency was present near the bottom, while further west at BY1, oxygen levels were just above 4 ml/l, bordering on oxygen deficiency.

Hydrogen sulphide was detected from 80 meters depth in both the Western and Eastern Gotland Basin. Vertical profiles also showed that hydrogen sulphide levels, represented as negative oxygen, were significantly above normal in deep waters at many stations. In the Gotland Deep, hydrogen sulphide levels near the bottom were at a record high of 240 µmol/l.

The next routine cruise is scheduled to begin on November 8th.

RESULTS

The cruise was conducted aboard the R/V Svea, starting in Kalmar on October 18th and concluding in Lysekil on October 14th. During the first days at sea, wind speeds ranged between 7–14 m/s. Initially, the wind direction was southeasterly, but it calmed in the southern Baltic Sea before increasing again to 10–12 m/s in the Skagerrak and Kattegat. Air temperatures remained between 11–13°C.

Svea's instrument for continuous surface water measurements, Ferrybox, operated throughout the cruise. In the southern Baltic Sea, on the stretch between BY2 and the Hanö Bight, and from Fladen to P2 in the Kattegat, Svea's MVP (Moving Vessel Profiler) was used, providing profiles of temperature, salinity, oxygen, and chlorophyll fluorescence while underway.

One of Svea's two ADCPs (Acoustic Doppler Current Profilers), the OS 150 kHz, was also operational during the journey. At several stations in the Baltic Sea, water samples were collected from a depth of 3 meters for eDNA. This is part of the SAMBAH II project, which investigates the Baltic Sea's harbor porpoise population. Sampling is planned to continue during cruises through August 2025. The Swedish Museum of Natural History is responsible for the project.

During the cruise, two researchers from the ETH Department of Environmental Systems Science in Switzerland participated to collect samples for selenium concentration analysis.

The instrument used by SMHI to analyse nutrients malfunctioned during parts of the cruise, resulting in missing data for ammonium.

Information about SMHI's data hosting service and to download data:

https://www.smhi.se/en/services/open-data/national-archive-for-oceanographic-data/download-data-1.153150

More information about the algal situation is available in the Algaware-report:

https://www.smhi.se/en/publications/publications/algal-situation-reports-2-1056

The Skagerrak

The surface water temperature varied around 12°C, which is normal for the season at all stations. Salinity in the surface water ranged from 32–33 psu, with higher than normal salinity observed at P2. Cooling of the surface water had begun, and beneath the surface layer, a warmer layer was detected between 20–75 meters. Deeper down, the temperature decreased, becoming relatively stable below 100 meters toward the bottom. Salinity in the surface water was consistent down to approximately 20 meters, where a halocline was found between 20–50 meters. In the deep water, salinity remained stable.

Concentrations of dissolved inorganic nitrogen (DIN, excluding ammonium in this case) in surface waters were near the detection limit (0.1 µmol/l) but slightly higher near the coast (0.5–0.6 µmol/l). The concentration of dissolved inorganic phosphate (DIP) was normal, ranging between 0.1–0.2 µmol/l. Silicate levels varied from 0.7–2 µmol/l at offshore stations and reached 3 µmol/l at Släggö, a coastal location. Nutrient levels increased with depth in the water column, with both lower and higher than normal values observed.

Oxygen levels in offshore bottom waters were normal, ranging between 5.2–5.7 ml/l. At Släggö, oxygen levels had decreased since the last visit in September, now at 2.7 ml/l, which is below the hypoxia threshold (<4 ml/l) and close to the acute hypoxia threshold (<2 ml/l).

Chlorophyll fluorescence measurements with the CTD, an indicator of phytoplankton activity, showed slightly higher activity from the surface down to ~20 meters.

The Kattegat and the Sound

Surface water in the Kattegat had a temperature of around 13°C, which is normal for October. Salinity in the Kattegat's surface water was normal for the season at 21–23 psu, while it was above normal in Öresund at 22 psu. Stratification in terms of temperature and salinity occurred at depths of 10–20 meters.

In the Kattegat's surface water, phosphate concentrations were slightly lower than normal at around 0.1 µmol/l, whereas Öresund showed higher than normal levels at 0.5 µmol/l. DIN levels were below the detection limit, which is normal for the season. In Öresund, DIN levels were also higher, at 2.5 µmol/l, but within the normal range. Silicate levels were normal or slightly lower than normal, around 2 µmol/l in the Kattegat. In Öresund, silicate levels, like other nutrients, were higher at 13 µmol/l, which was still normal for the season.

Oxygen levels in bottom waters had generally increased since the September visit and were normal for the season, at around 4 ml/l in the Kattegat and slightly lower in Öresund, at 3 ml/l, indicating hypoxia.

Chlorophyll fluorescence measurements showed slightly higher activity from the surface down to the stratification at 10–20 meters, with no distinct fluorescence maxima. Below this, levels decreased rapidly. Secchi depth was 7 meters.

The Baltic Proper

Surface water temperatures were normal throughout the Baltic Proper, ranging between 11–13°C. Surface water salinity ranged from 6.5–8.0, with the highest values in the Arkona Basin and the lowest in the northwestern Baltic Proper. At some stations in the Eastern and Western Gotland Basins, surface water salinity was above normal.

A sharp thermocline and halocline coincided at depths of 20–30 meters. Further down, a secondary stratification layer was found at around 60–70 meters, which was more diffuse. In shallower areas of the southern Baltic Proper, no secondary stratification was observed; instead, bottom conditions were more influenced by inflowing water from the Kattegat, with large variations in both temperature and salinity.

Dissolved inorganic nitrogen concentrations in surface water were below the detection limit (0.1 µmol/l) at several stations. Higher than normal concentrations were observed in the northern parts of the Baltic Proper (BY31), likely influenced by the southward flow of water from the Bothnian Sea. Normal levels of around 0.3 µmol/l were recorded in the Eastern Gotland Basin (BY15 and BY20). In the southern parts, levels were also higher, around 0.1–0.5 µmol/l, but within the normal range.

Phosphate concentrations in surface water were normal for the season, except in the southern part of the Western Gotland Basin (BY38), northwestern Baltic Proper (BY31), and BY20 in the Eastern Gotland Basin. Levels ranged from 0.2–0.5 µmol/l.

Silicate concentrations in surface water were normal at all stations, ranging from 9 µmol/l in the northeastern Baltic Proper (BY29) to 14 µmol/l in the Arkona Basin (BY1).

In the deep waters of both the Eastern and Western Gotland Basins, nutrient levels were well above normal. In the shallower basins, levels also increased with depth but mostly remained within normal ranges.

Acute hypoxia, defined as oxygen levels below 2 ml/l, was observed from 70 meters in the Eastern and Western Gotland Basins, and at shallower depths of 60 meters in the Hanö Bight and Bornholm Basin. In the Arkona Basin (BY2), acute hypoxia was noted near the bottom, while further west at BY1, oxygen levels were now just above 4 ml/l, close to the hypoxia threshold.

Hydrogen sulphide was detected from 80 meters in both the Western and Eastern Gotland Basins. Vertical profiles also revealed that hydrogen sulphide levels, indicated as negative oxygen values, were well above normal in the deep waters at several stations. In the Gotland Deep, hydrogen sulphide levels near the bottom reached a record high of 240 µmol/l.

Chlorophyll fluorescence measurements with the CTD, indicating phytoplankton activity, showed activity from the surface down to the stratification. Secchi depth ranged between 6–7 meters.

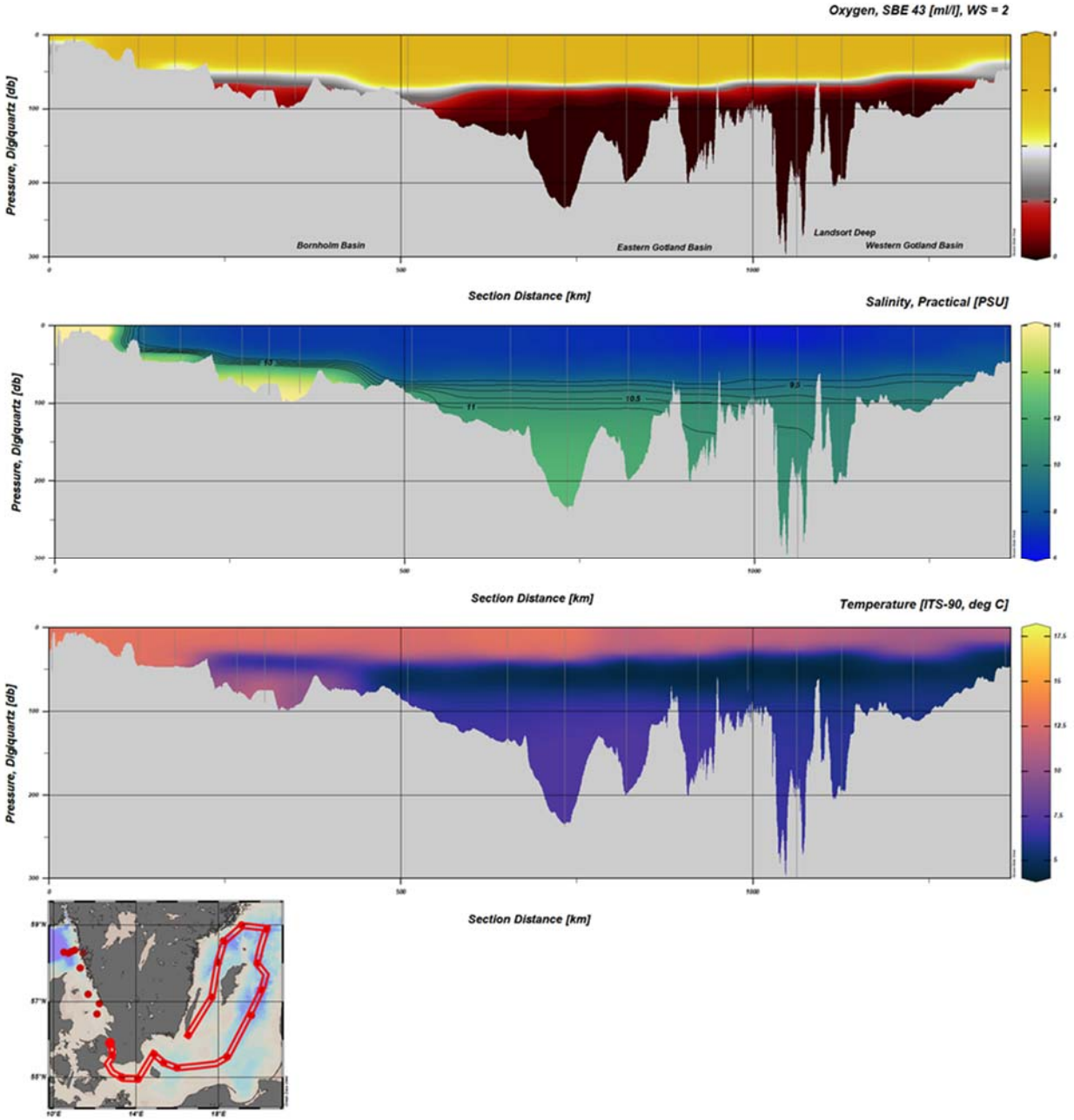


Figure 1. Transect showing CTD measurement of temperature, salinity and oxygen concentration from the Sound, through the Southern and Eastern Baltic Proper into the Western Baltic Proper.

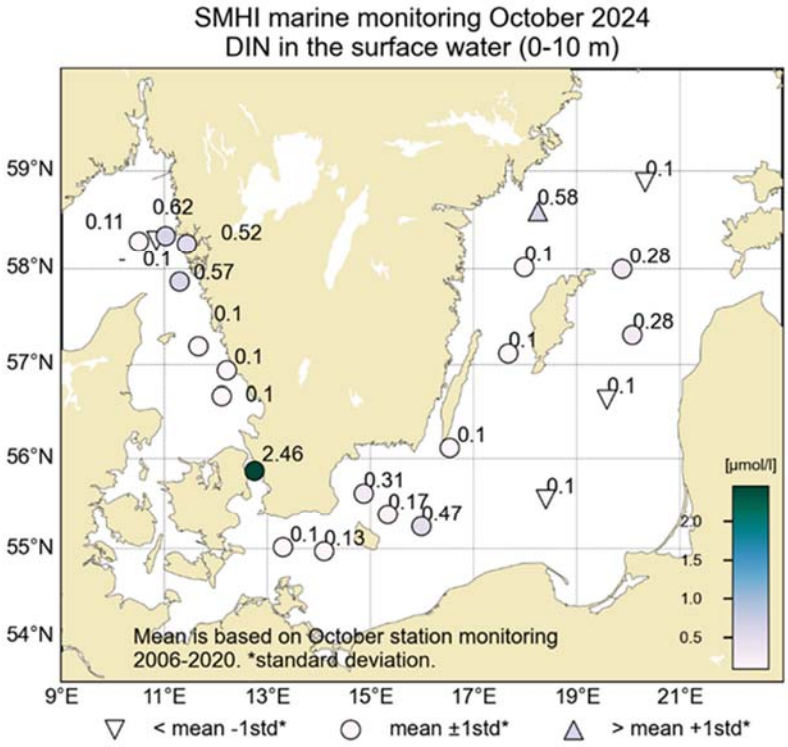


Figure 2. Concentration of dissolved inorganic nitrogen (DIN) in the surface water (0–10m). Mean is based on data from each station during the years 1991-2020.

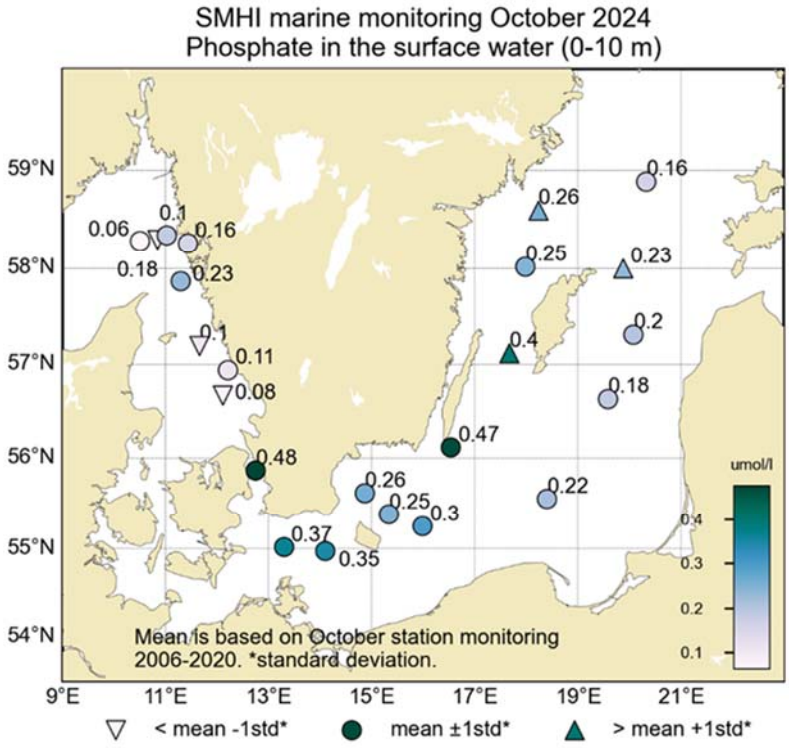


Figure 3. Concentration of phosphate in the surface water (0–10m). Mean is based on data from each station during the years 1991-2020.

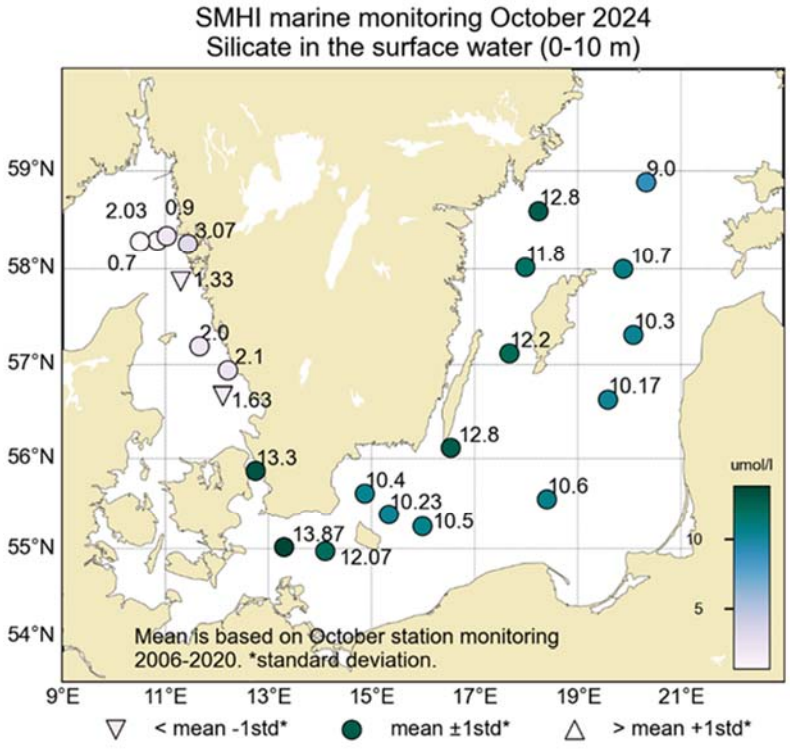


Figure 4. Concentration of silicate in the surface water (0–10m). Mean is based on data from each station during the years 1991-2020.

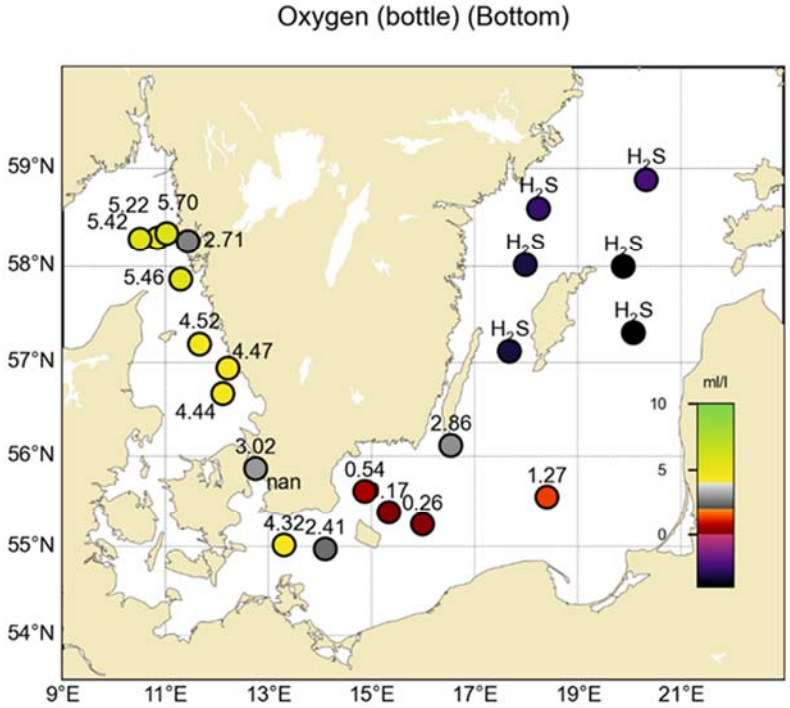


Figure 5. Concentration of dissolved oxygen in the bottom water, approximately 1 m above the sea bed. Note that values have not been compared with statistics as in similar figures and only circles are shown.

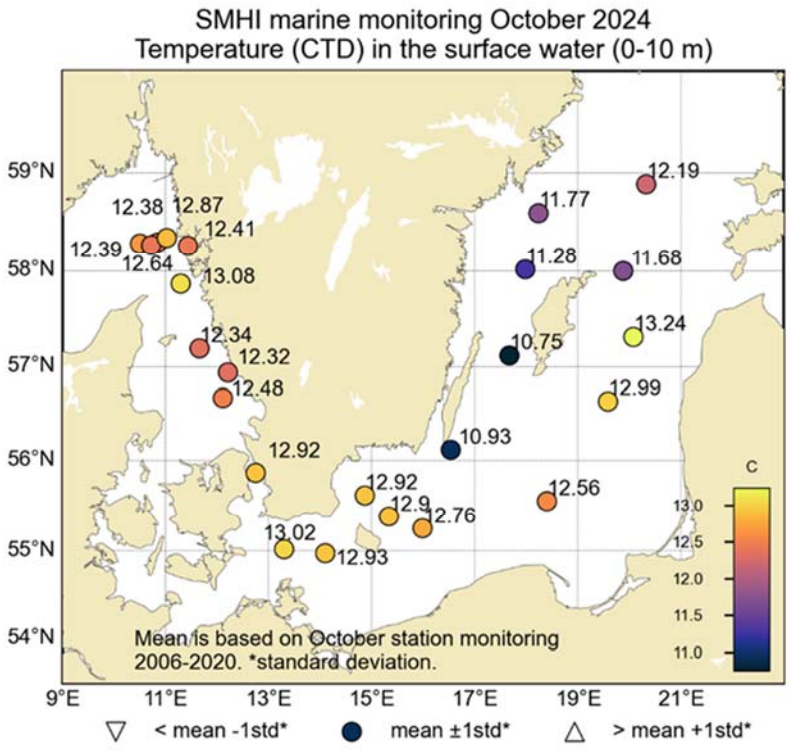


Figure 6. Temperature in the surface water (0–10m). Mean is based on data from each station during the years 1991-2020.

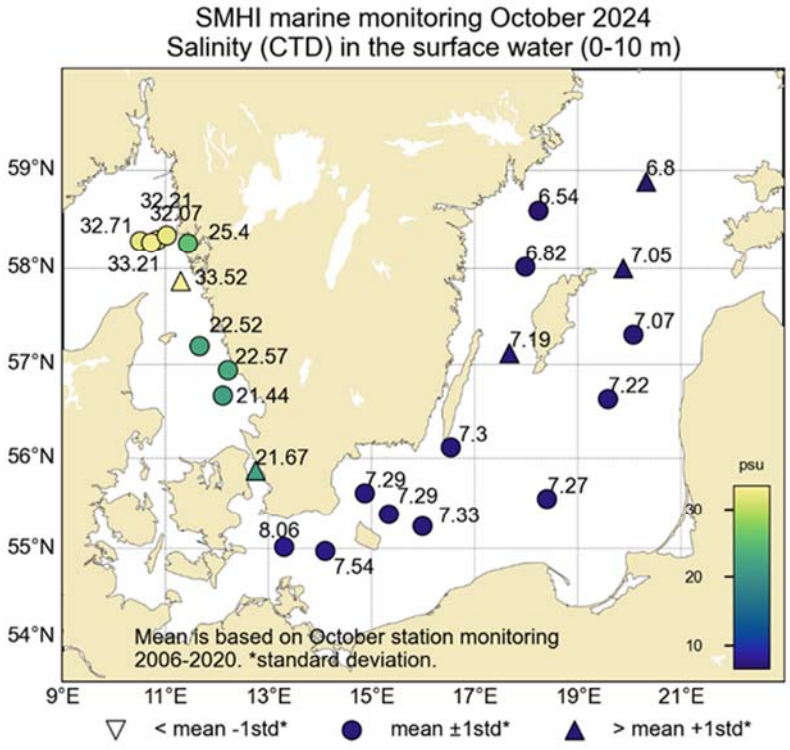


Figure 7. Salinity in the surface water (0–10m). Mean is based on data from each station during the years 1991-2020.

PARTICIPANTS

Name	Role	Institute
Daniel Bergman Sjöstrand	Chief Scientist, Marine technician	SMHI
Martin Hansson	Oceanographer	SMHI
Ola Kalén	Oceanographer	SMHI
Johan Håkansson	Marine chemist	SMHI
Johanna Linders	Oceanographer	SMHI
Pauline Béziat	Marine scientist	ETH Switzerland
Fannie Yiu	Marine scientist	ETH Switzerland

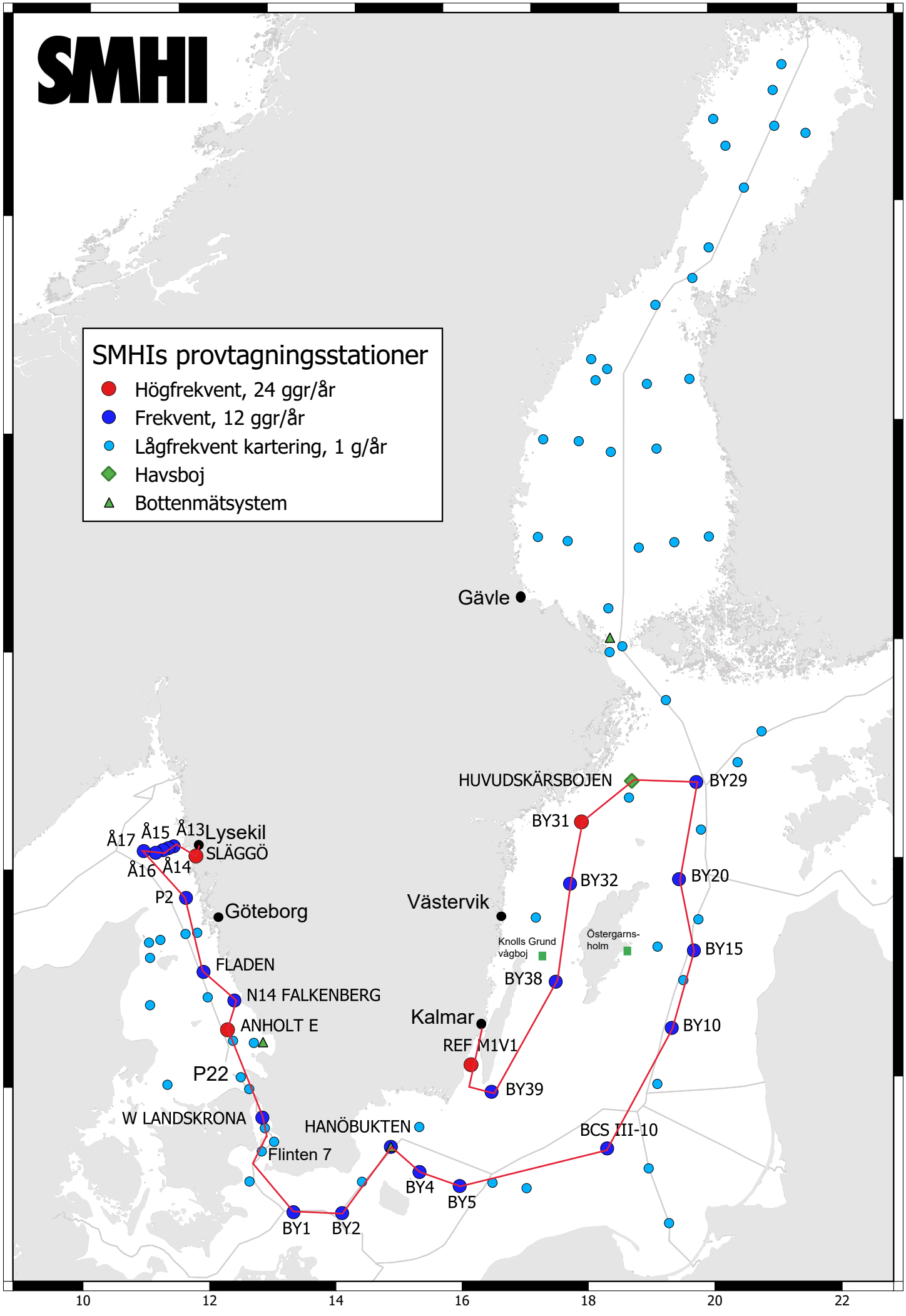
APPENDICES

- Track chart
- Table over stations, analysed 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

SWEDAC ACKREDITERING
Ackred. nr. 1420
Provning
ISO/IEC 17025


SMHI
SMHIs provtagningsstationer
Högfrekvent, 24 ggr/år
Frekvent, 12 ggr/år
Lågfrekvent kartering, 1 g/år
Havsboj
Bottenmätsystem
Gävle
HUVUDSKÄRSBOJEN
BY29
BY31
BY32
BY20
BY15
BY38
BY10
BY39
BCS III-10
Västervik
Knolls Grund vågboj
Östergarns-holm
Kalmar
REF M1V1
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Å13
Lysekil
SLÄGGÖ
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Göteborg
FLADEN
N14 FALKENBERG
ANHOLT E
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W LANDSKRONA
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Date: 2024-12-19
Time: 09:22

Ship: 77SE
Year: 2024

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	CZPP	No de	No btl	Temp_btl	Temp_ctd	Salt_btl	Salt_ctd	Ph	Doxy_btl	Doxy_ctd	H2s	Phos	Ptot	Ntri	Ntra	Ntrz	Amon	Ntot	Alky	Sio3-si	Humus	Comnt_visit	Comnt_samp
0934	22	BPSE49	BAS...	BY39 ÖLANDS S UDDE	5606.99	01632.07	20241018	2230	50		17	7	12.7	1022	9990	xx--	8		x	x	x	x	-	x	x	-	x	-	x	x	x	x	-	x	x	-	x	-
0935	22	BPWX45	BAS...	BY38 KARLSÖDJ	5707.04	01740.26	20241019	0640	110		16	10	11.8	1020	2640	x---	14		x	x	x	x	-	x	x	x	x	-	x	x	x	x	-	-	x	x	x	-
0936	22	BPWX38	BAS...	BY32 NORRKÖPINGSDJ	5800.97	01758.84	20241019	1250	202	6	17	7	12.9	1020	2630	x---	17		-	x	-	x	x	x	x	x	x	-	x	x	x	-	-	x	x	-	x	x
0937	22	BPNX37	BAS...	BY31 LANDSORTSDJ	5835.63	01814.13	20241019	1720	448		16	10	12.2	1024	9990	xx--	20		-	x	-	x	x	x	x	x	x	-	x	x	x	-	-	x	x	x	x	-
0938	22	BPNX00	EXT...	HUVUDSKÄR 4.5 NNV	5900.63	01907.03	20241020	0030	78		17	11	11.8	2024	9990	----	11		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-
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0950	22	SOSX00	EXT...	FLINTEN7	5535.24	01250.83	20241022	1935	0		27	9	12.7	1026	9990	----	4		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0951	22	SOCX39	BAS...	W LANDSKRONA	5551.97	01244.89	20241022	2210	52		26	11	12.1	1027	9990	x---	9		x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0952	22	KAEX29	BAS...	ANHOLT E	5640.22	01206.76	20241023	0505	54		26	12	11.8	1026	9990	xx-x	10		x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	-
0953	22	KANX50	BAS...	N14 FALKENBERG	5656.38	01212.65	20241023	0750	32	7	26	10	11.9	1027	2830	x--x	7		x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	-	-
0954	22	KANX25	BAS...	FLADEN	5711.56	01139.58	20241023	1130	81	7	25	8	12.1	1028	2830	x---	12		x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	x	x	-	-	-
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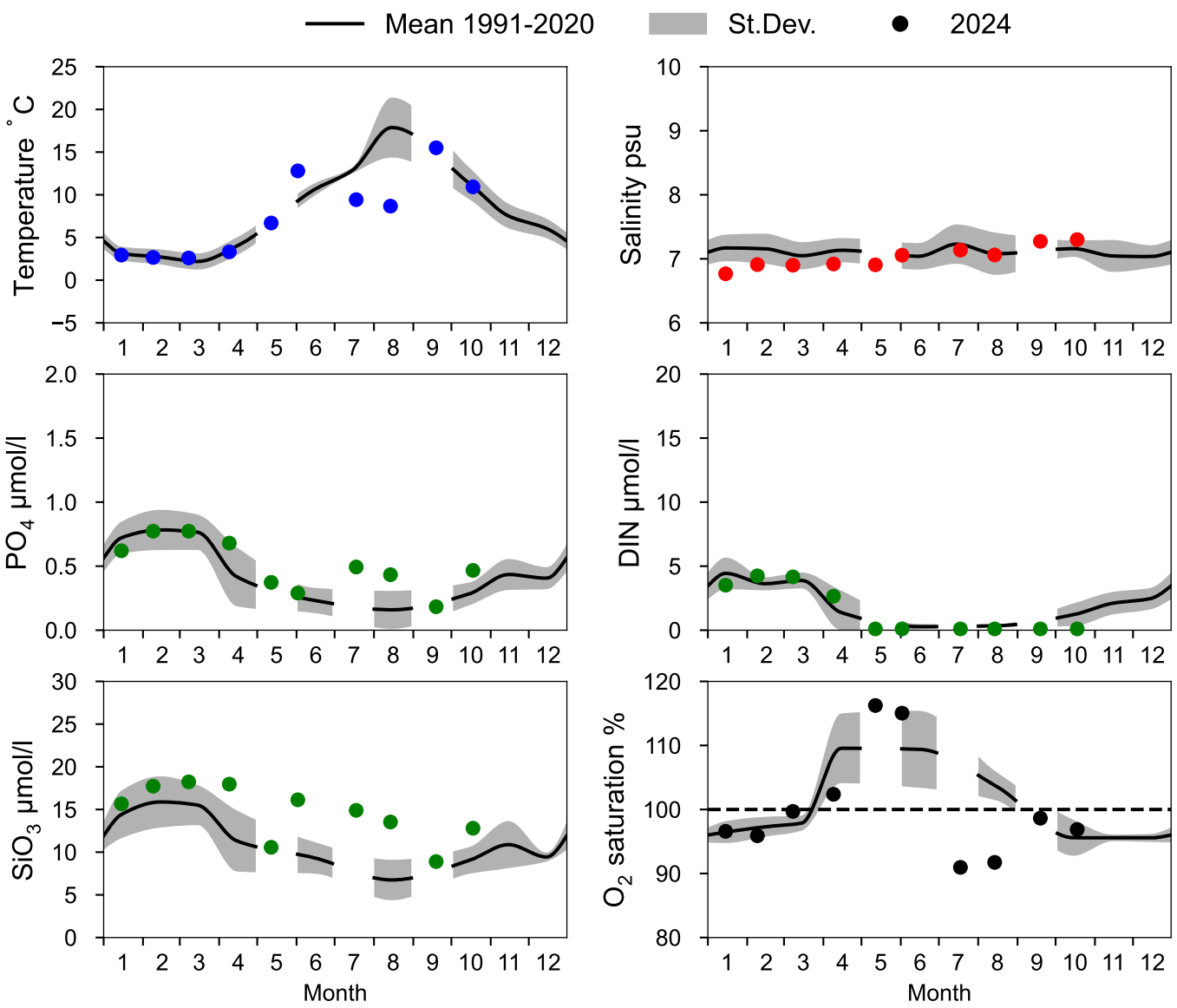
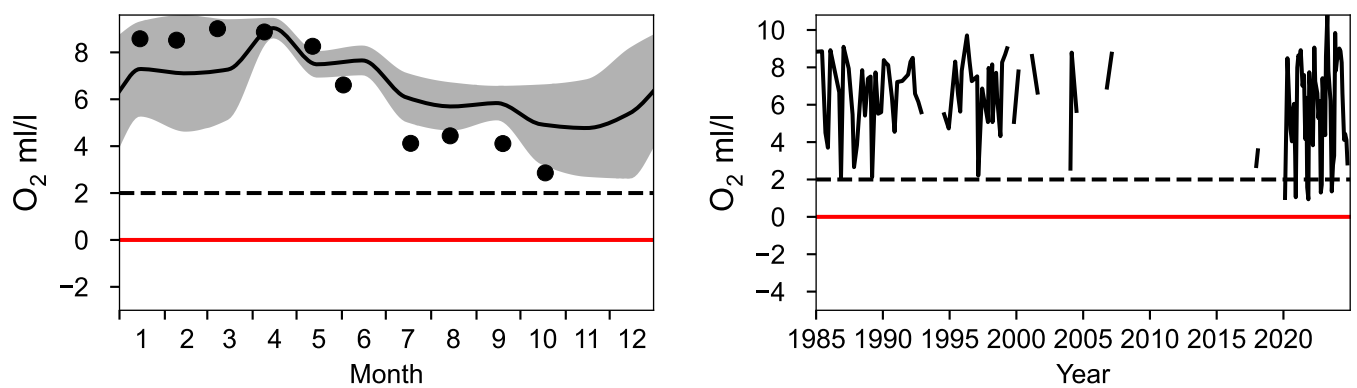
0959	22	SKEX14	BAS...	Å13	5820.48	01101.47	20241024	0200	108		24	12	12.5	1029	9990	x---	10		-	x	-	x	-	x	x	-	x	x	x	x	x	x	x	x	x	-	-	x
0960	22	FIBG27	BAS...	SLÄGGÖ	5815.56	01126.13	20241024	0450	78		23	7	12.0	1021	9990	xx--	9		x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	x	x	-	-	x

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

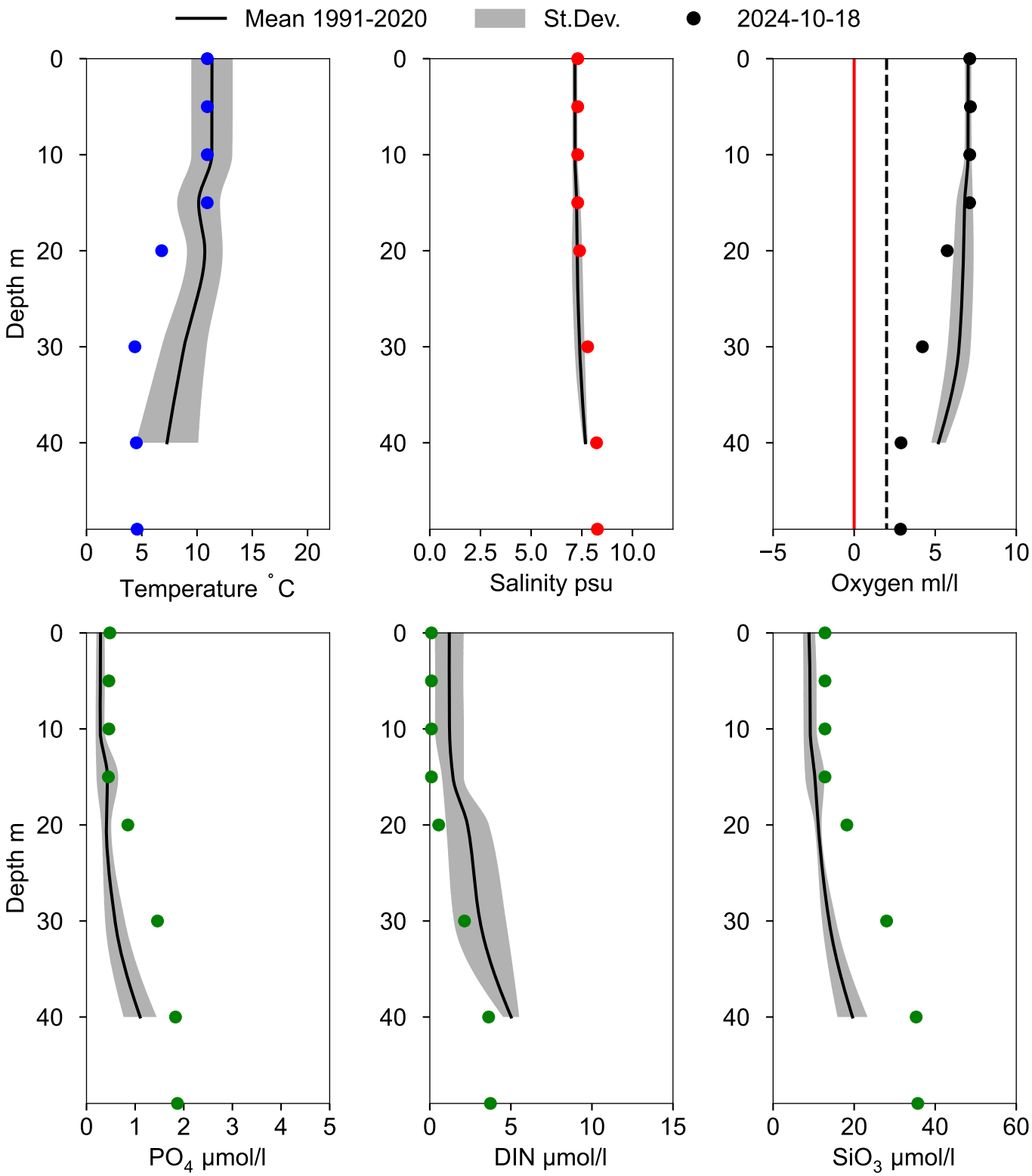
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

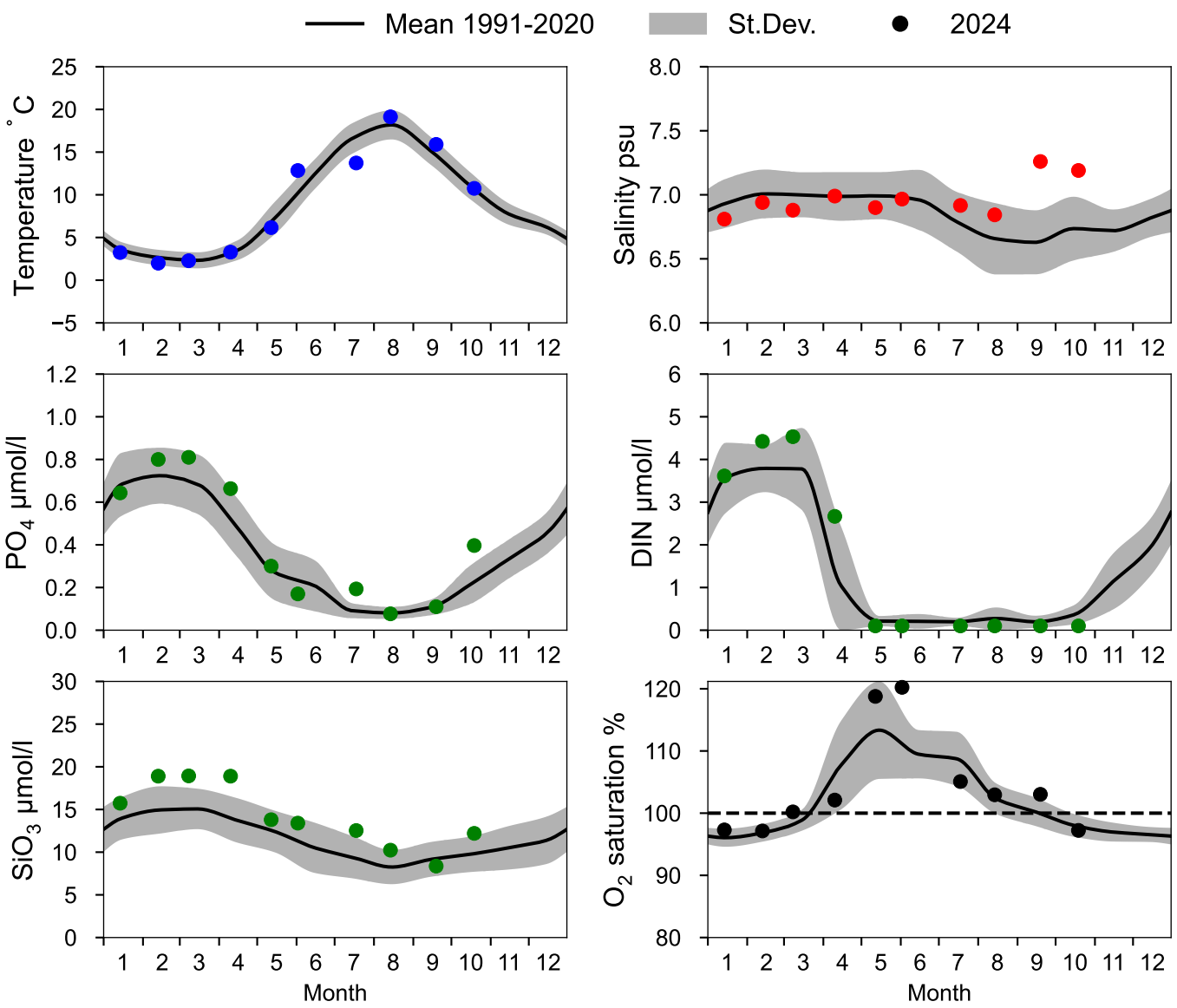


Vertical profiles BY39 ÖLANDS S UDDE
October

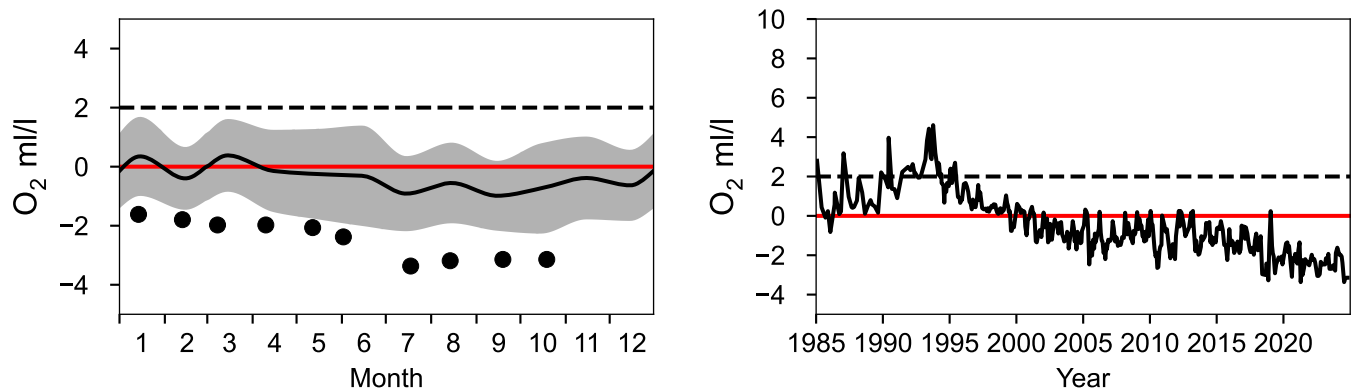


STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

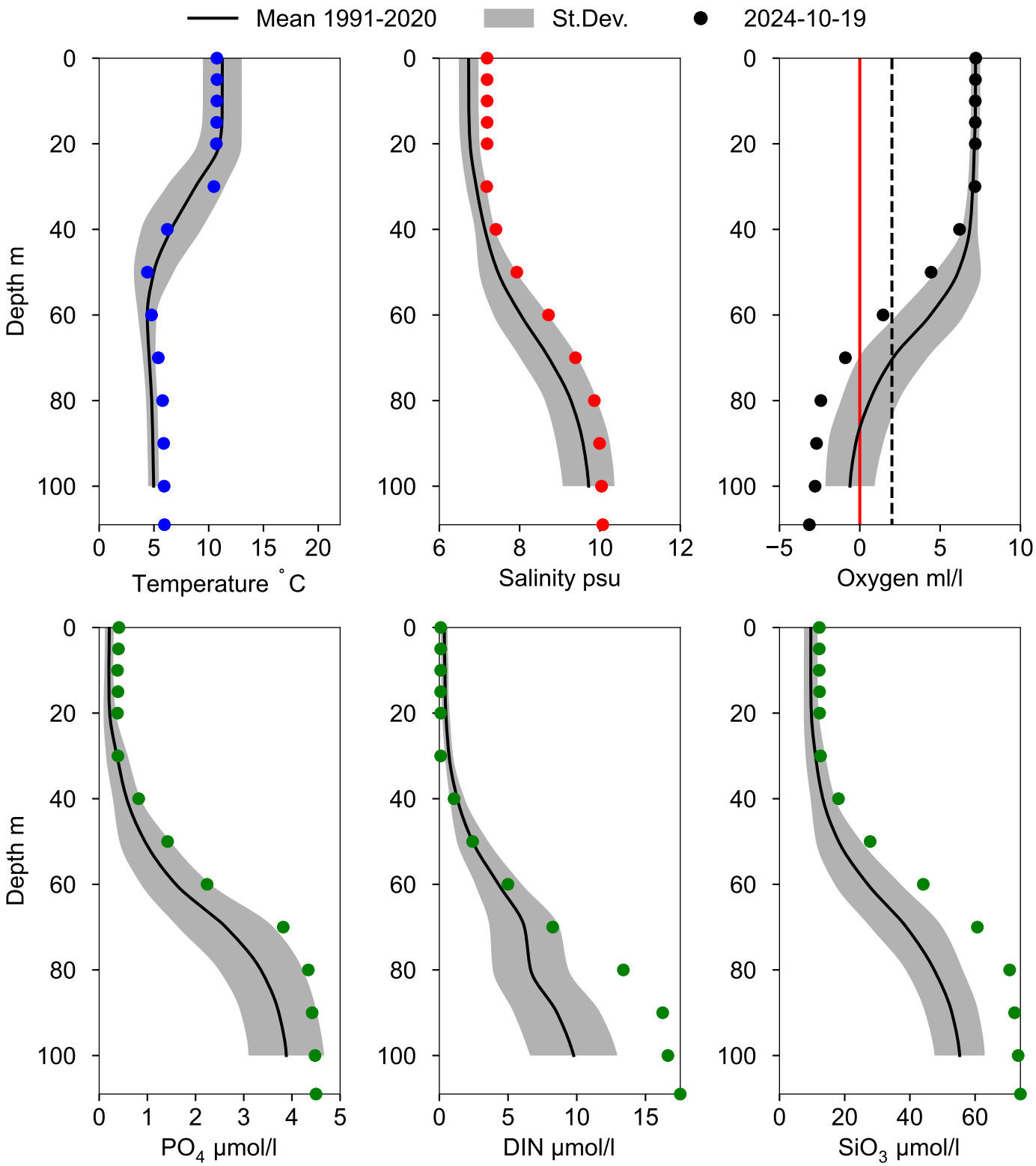
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

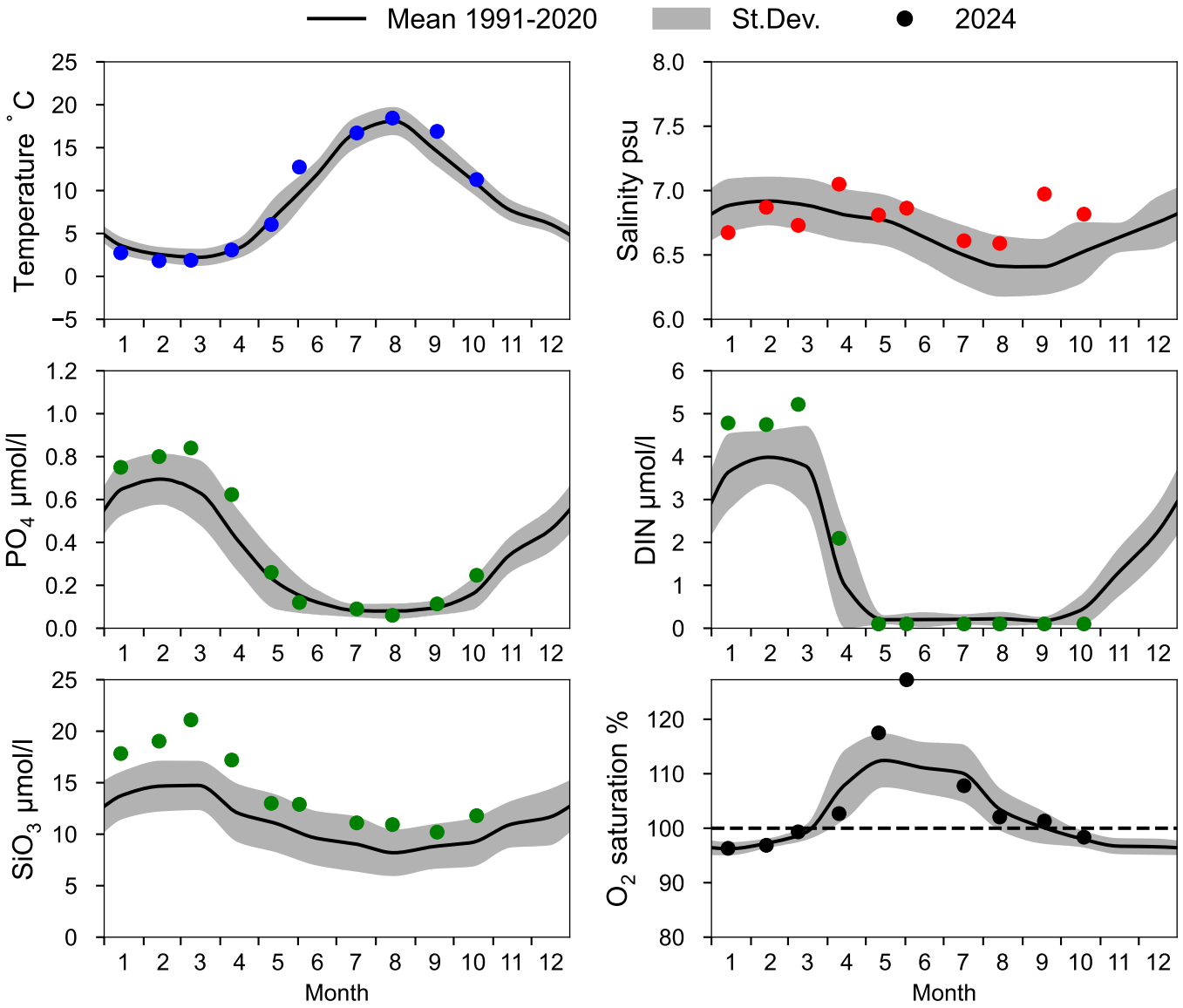


Vertical profiles BY38 KARLSÖDJ
October

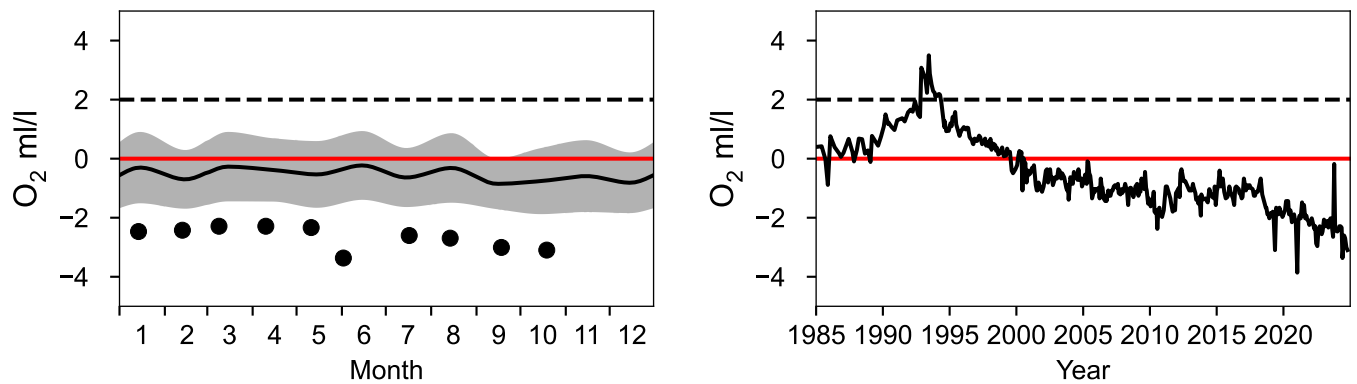


STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

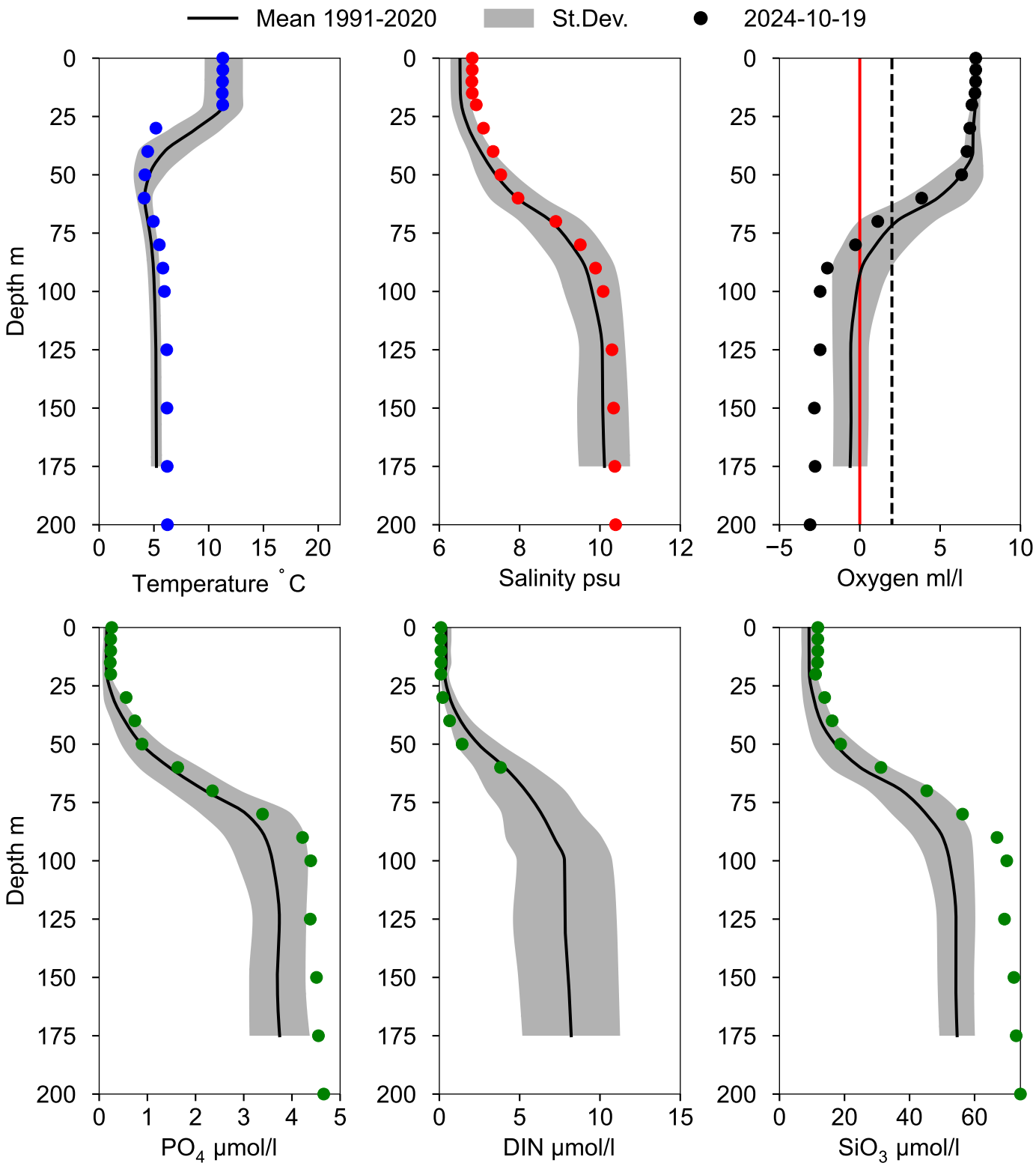
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

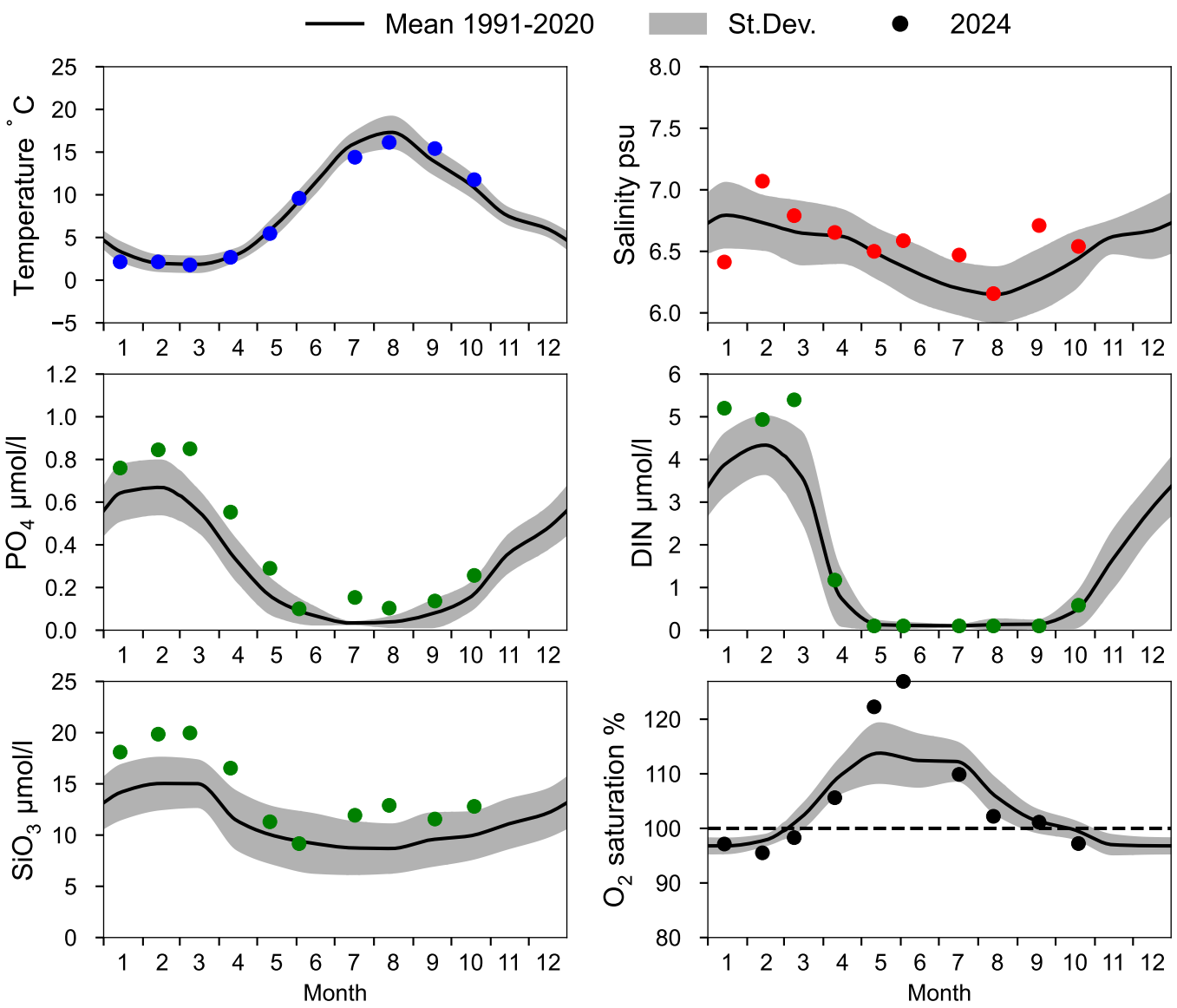


Vertical profiles BY32 NORRKÖPINGSDJ
October

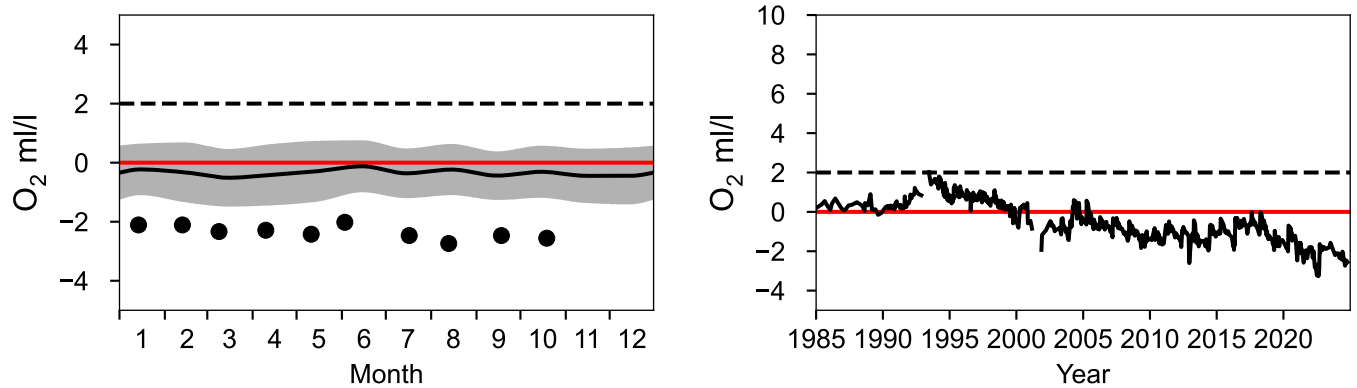


STATION BY31 LANDSORTSDJ SURFACE WATER (0-10 m)

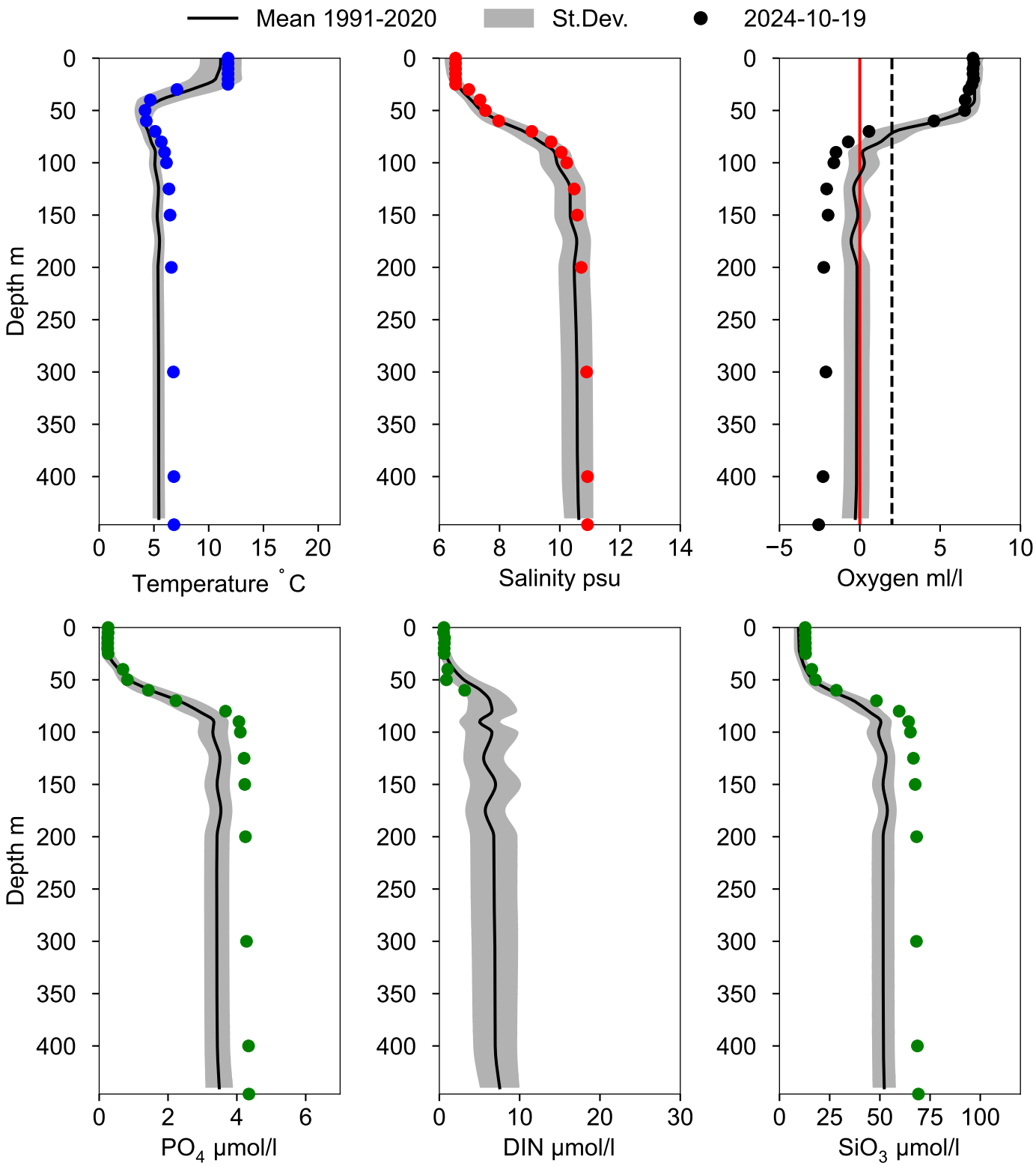
Annual Cycles



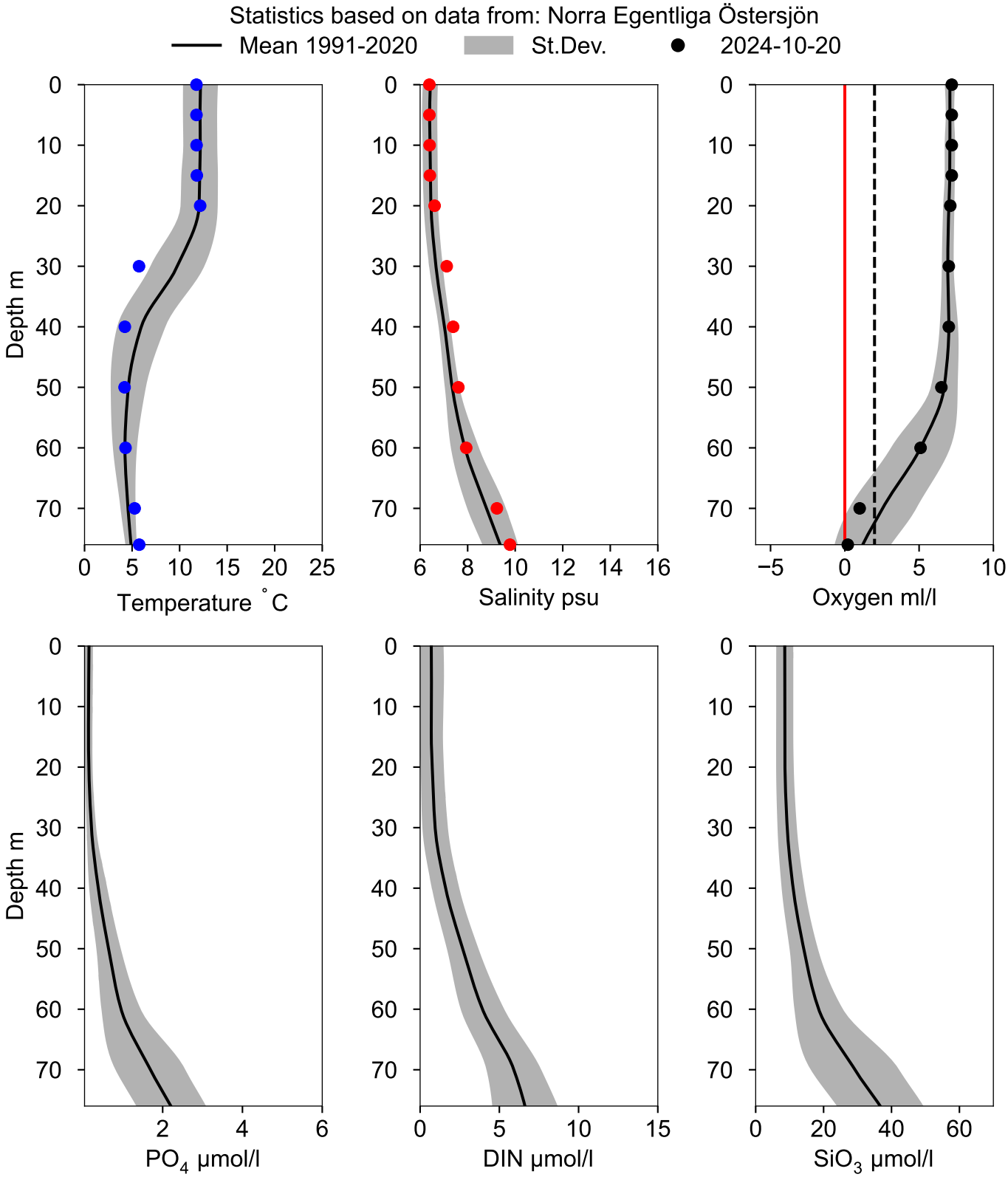
OXYGEN IN BOTTOM WATER (depth >= 419 m)



Vertical profiles BY31 LANDSORTSDJ
October

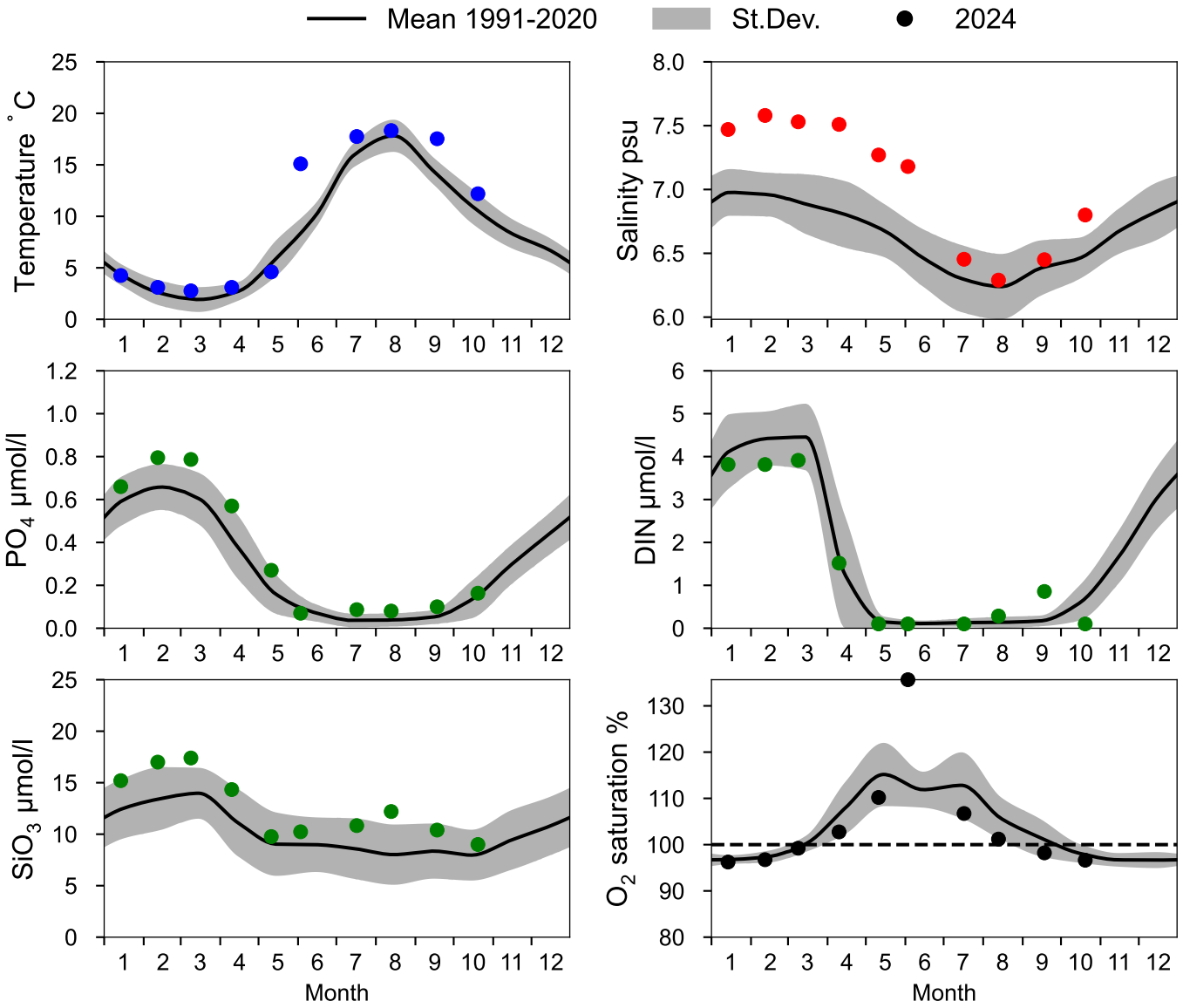


Vertical profiles HUVUDSKÄR 4.5 NNV
October

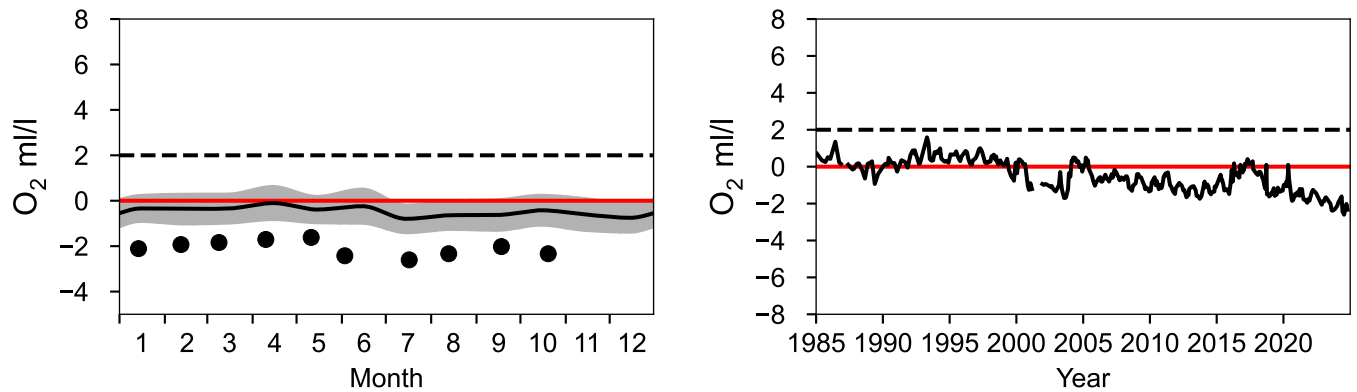


STATION BY29 / LL19 SURFACE WATER (0-10 m)

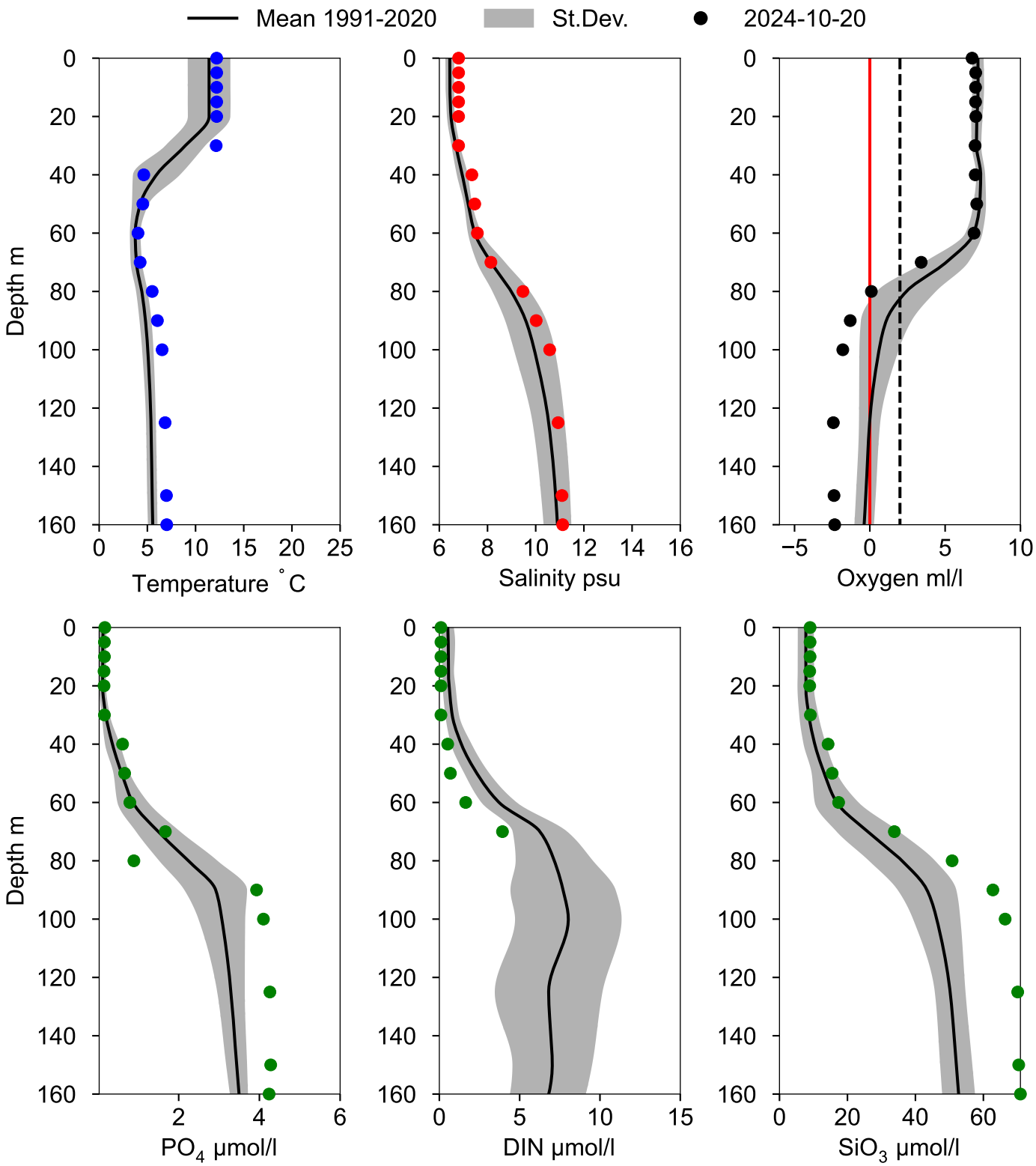
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 150 m)

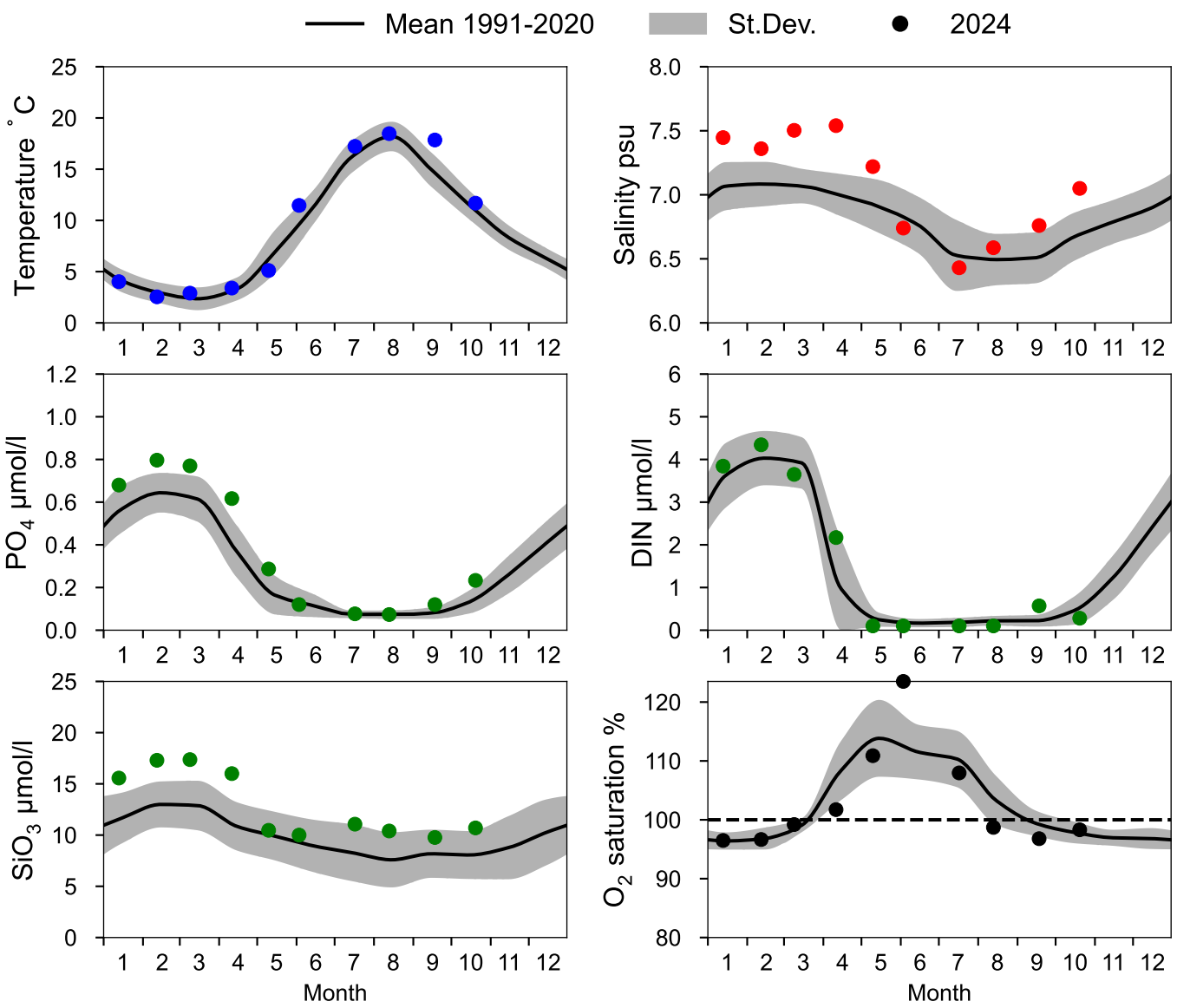


Vertical profiles BY29 / LL19
October

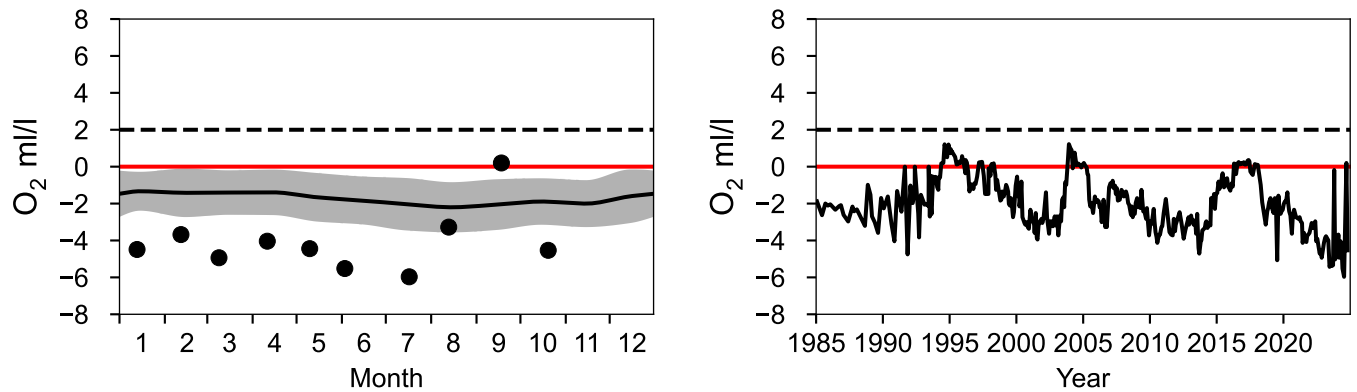


STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

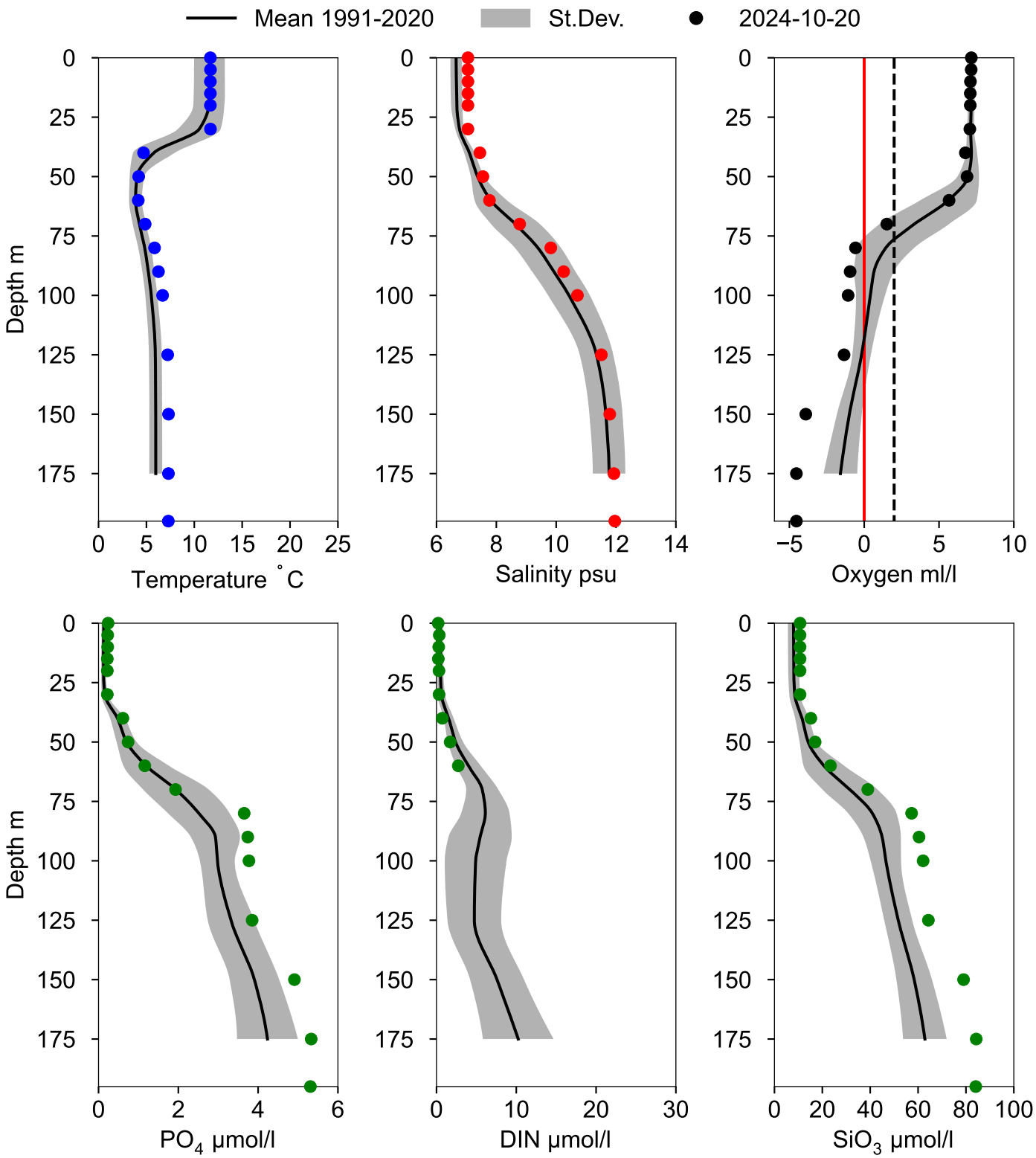
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

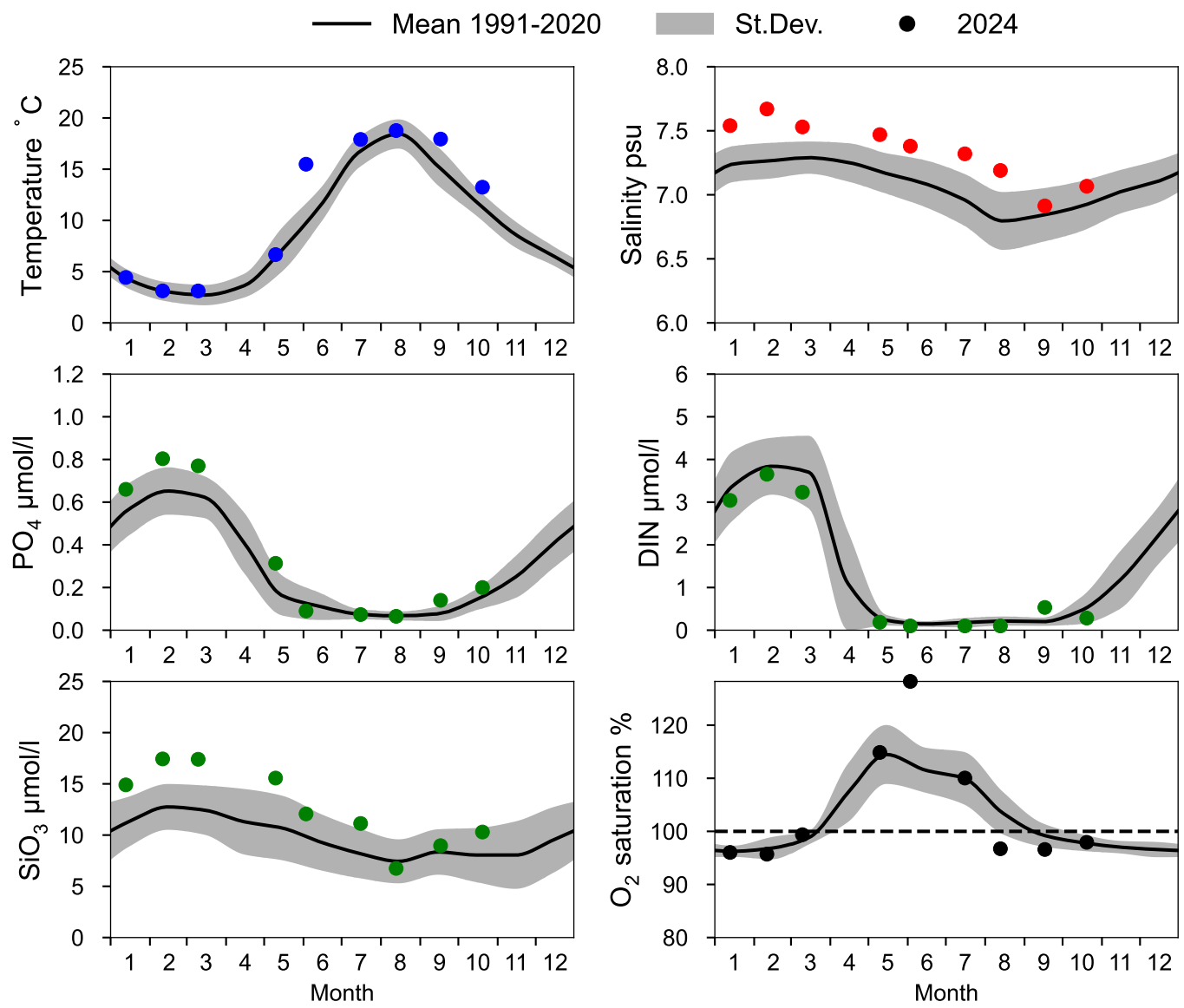


Vertical profiles BY20 FÅRÖDJ
October

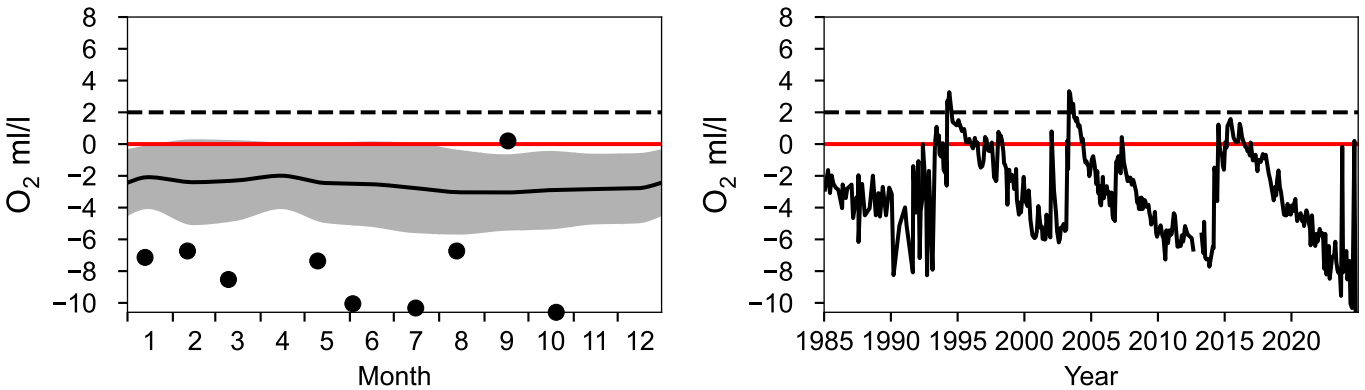


STATION BY15 GOTLANDSDJ SURFACE WATER (0-10 m)

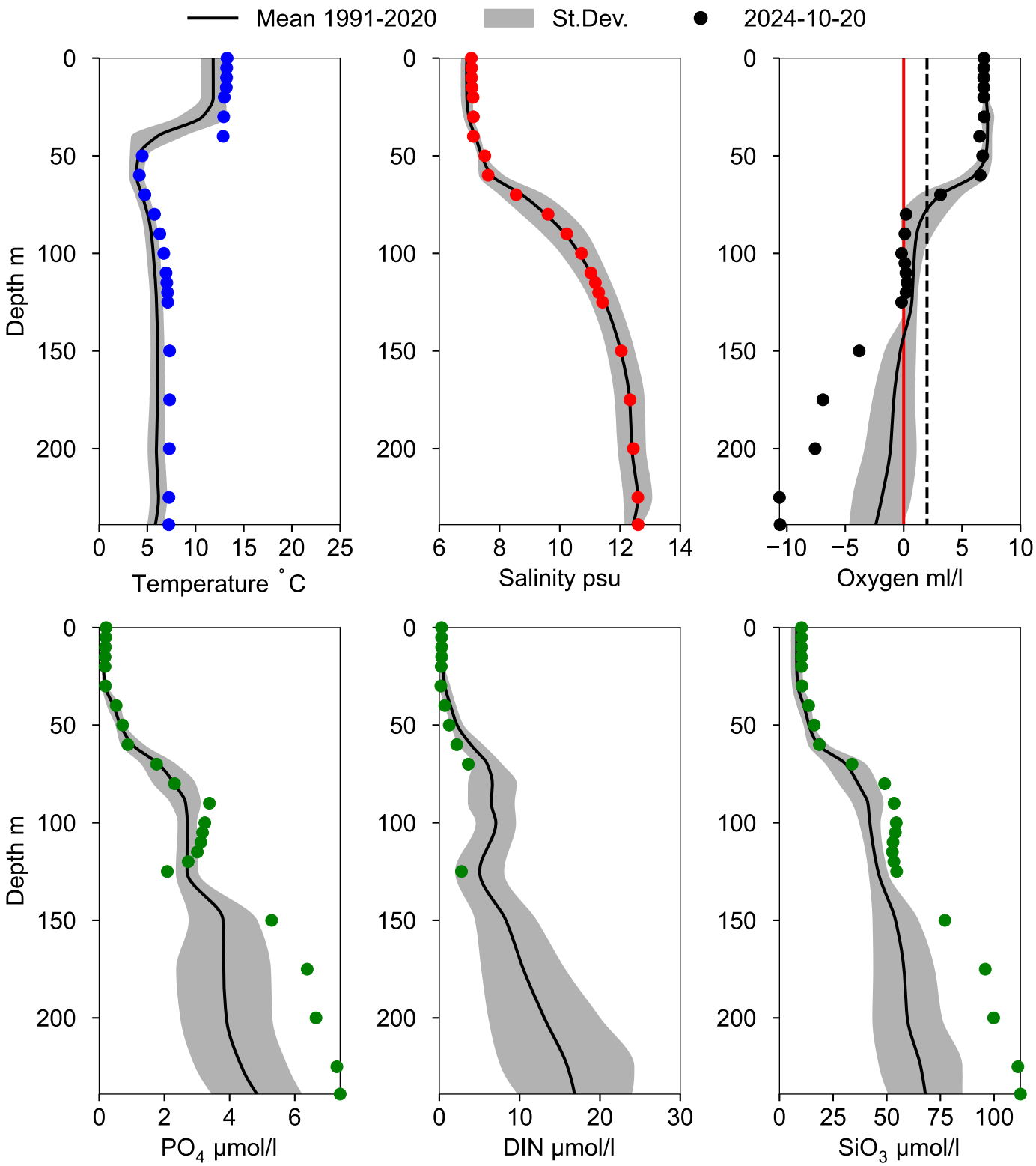
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 225 m)

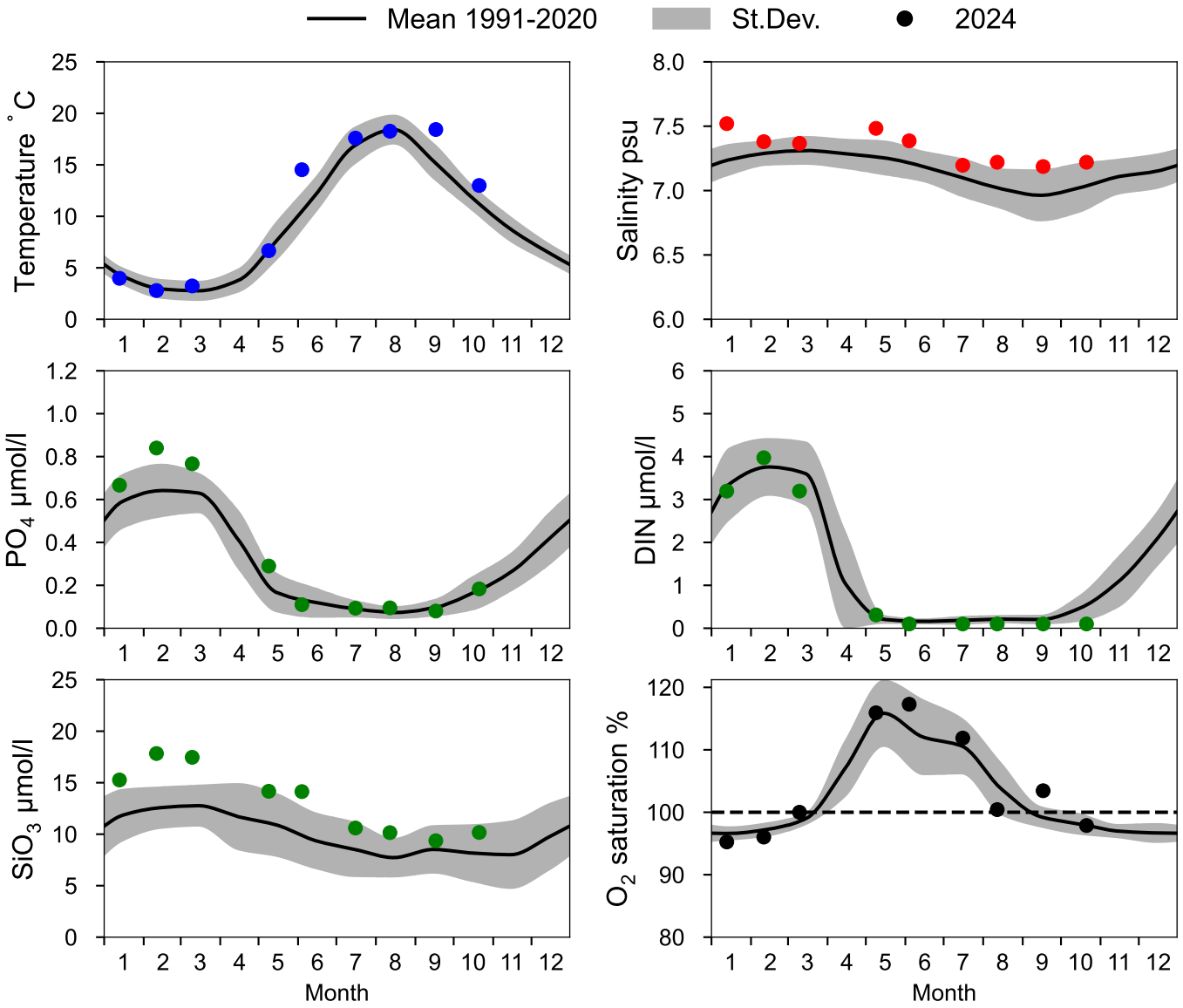


Vertical profiles BY15 GOTLANDSDJ
October

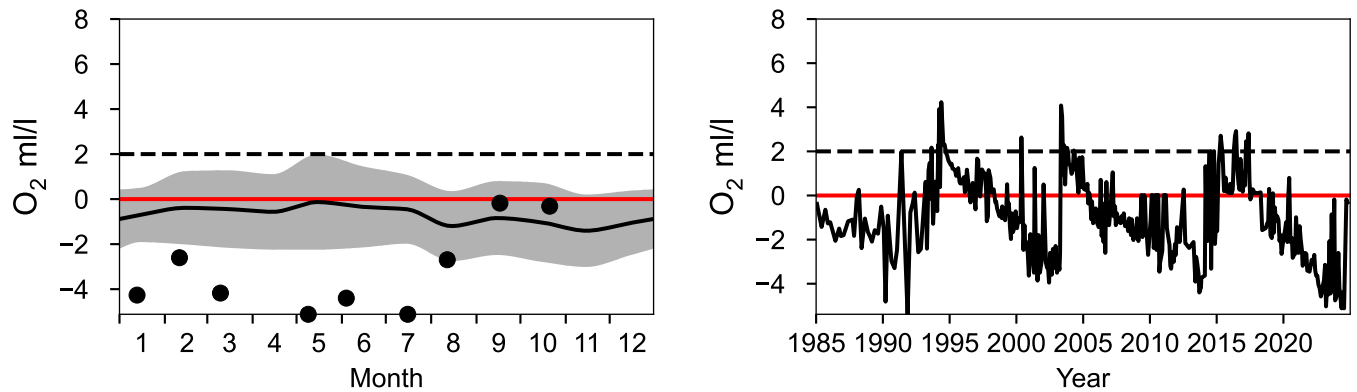


STATION BY10 SURFACE WATER (0-10 m)

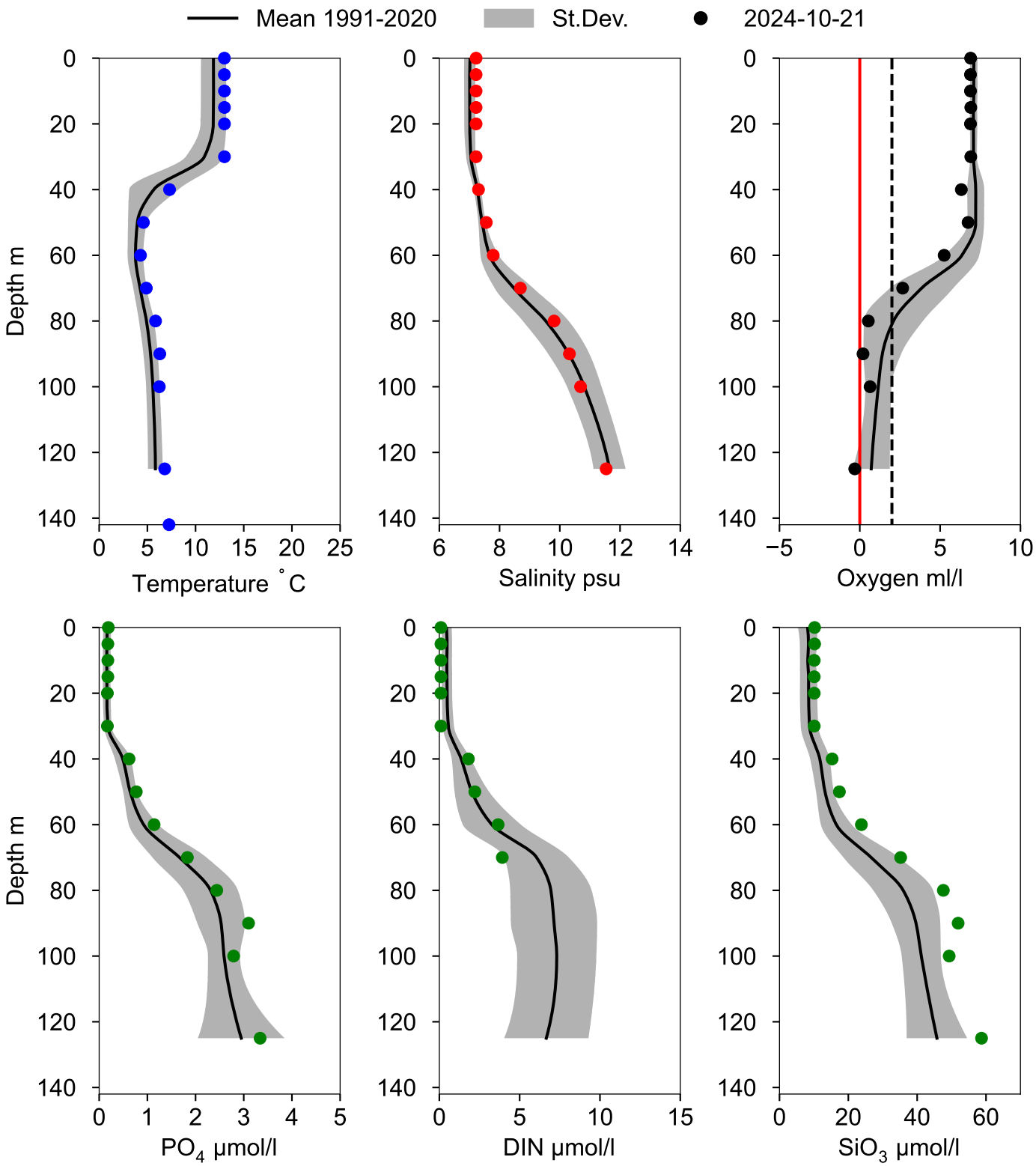
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

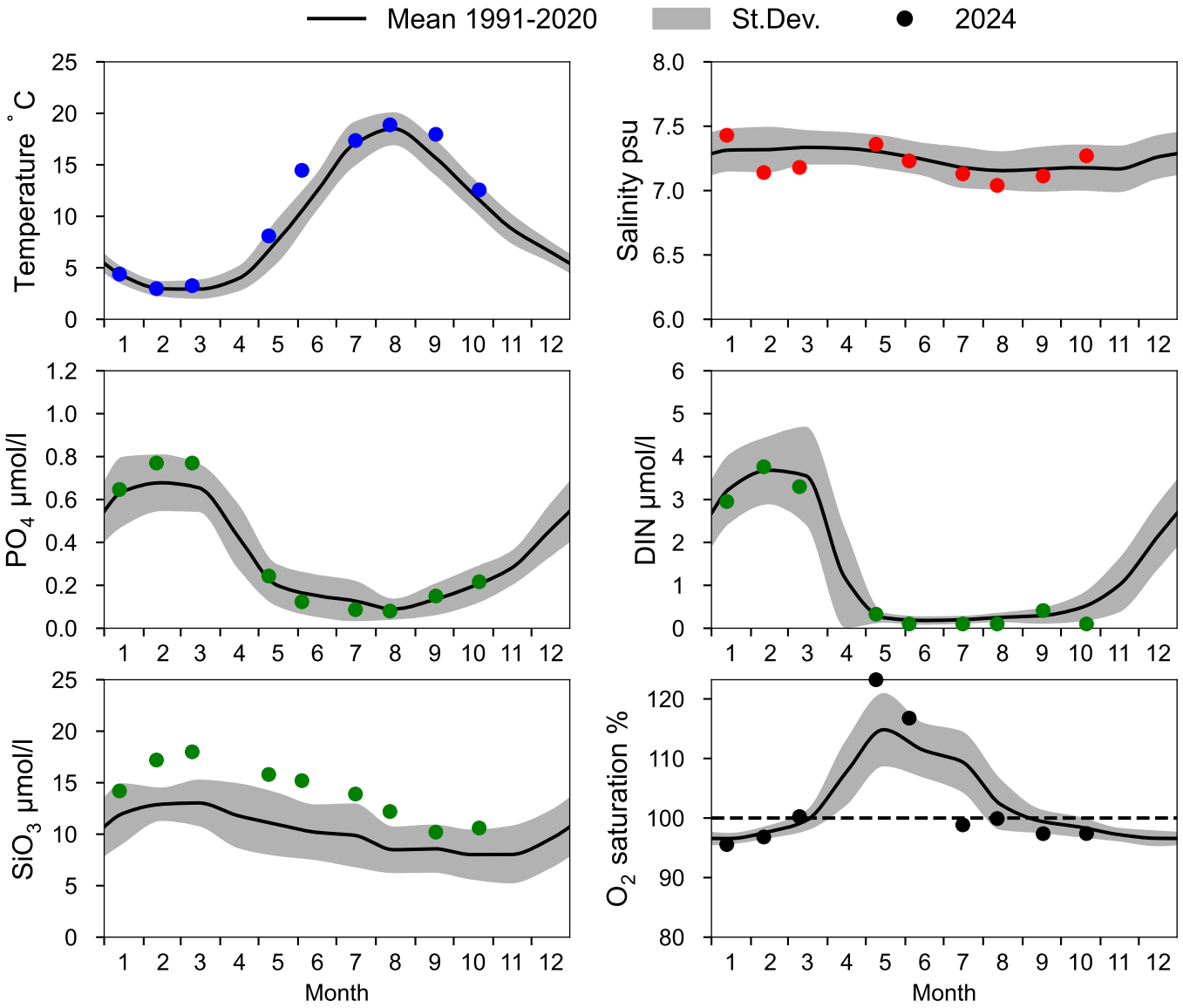


Vertical profiles BY10
October

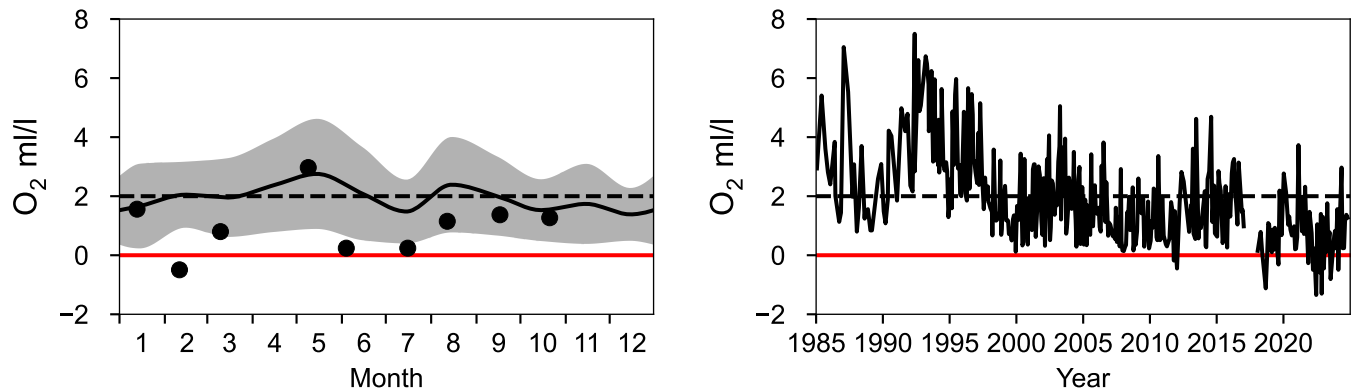


STATION BCS III-10 SURFACE WATER (0-10 m)

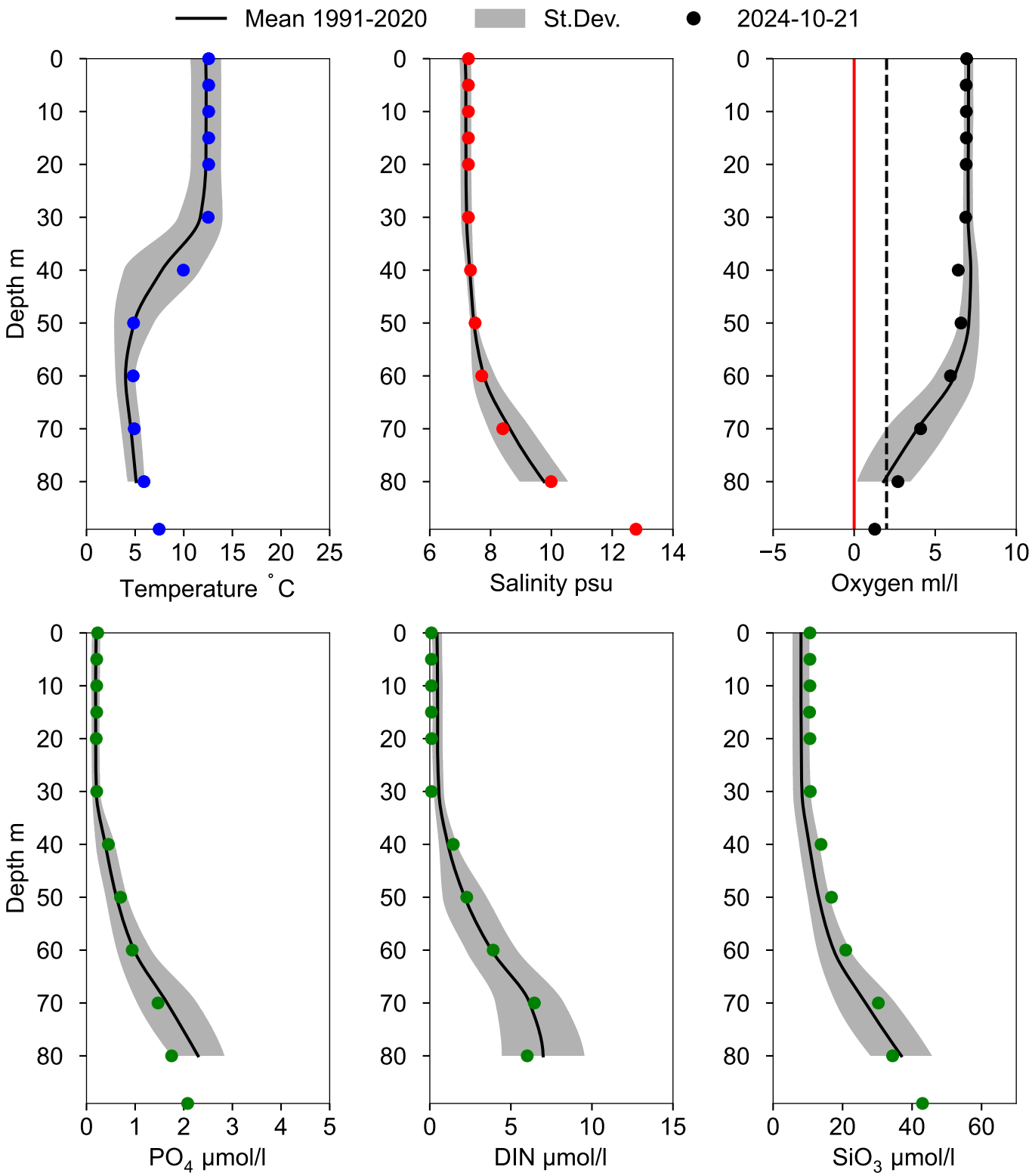
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

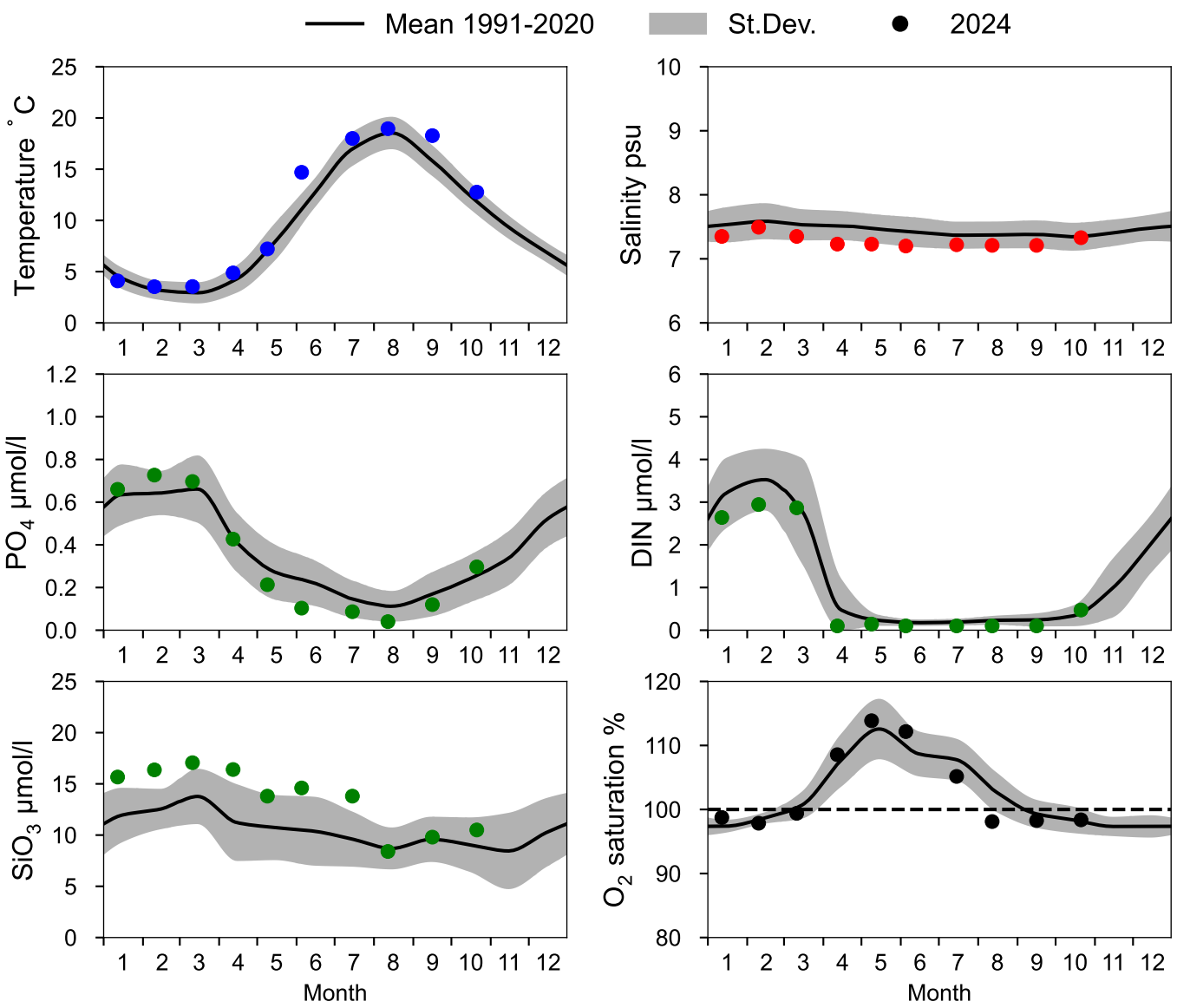


Vertical profiles BCS III-10
October

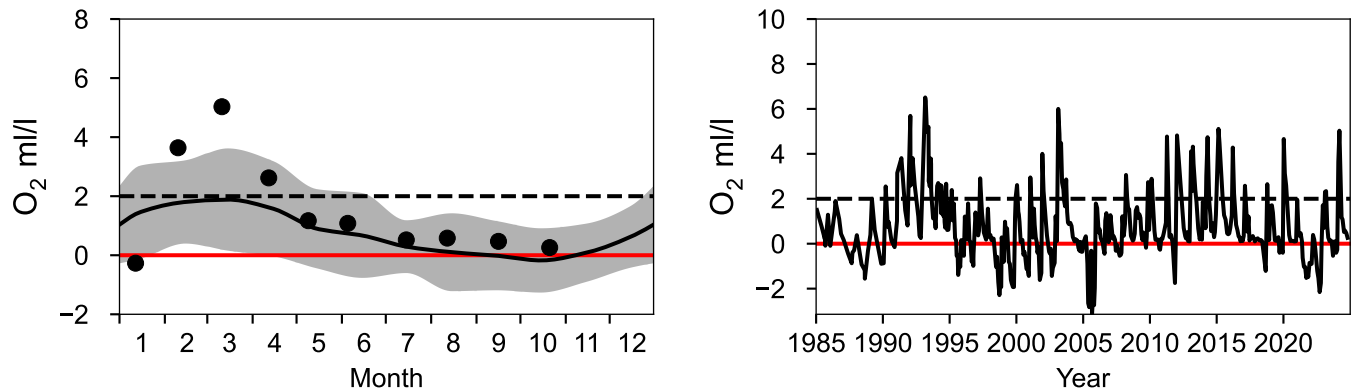


STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

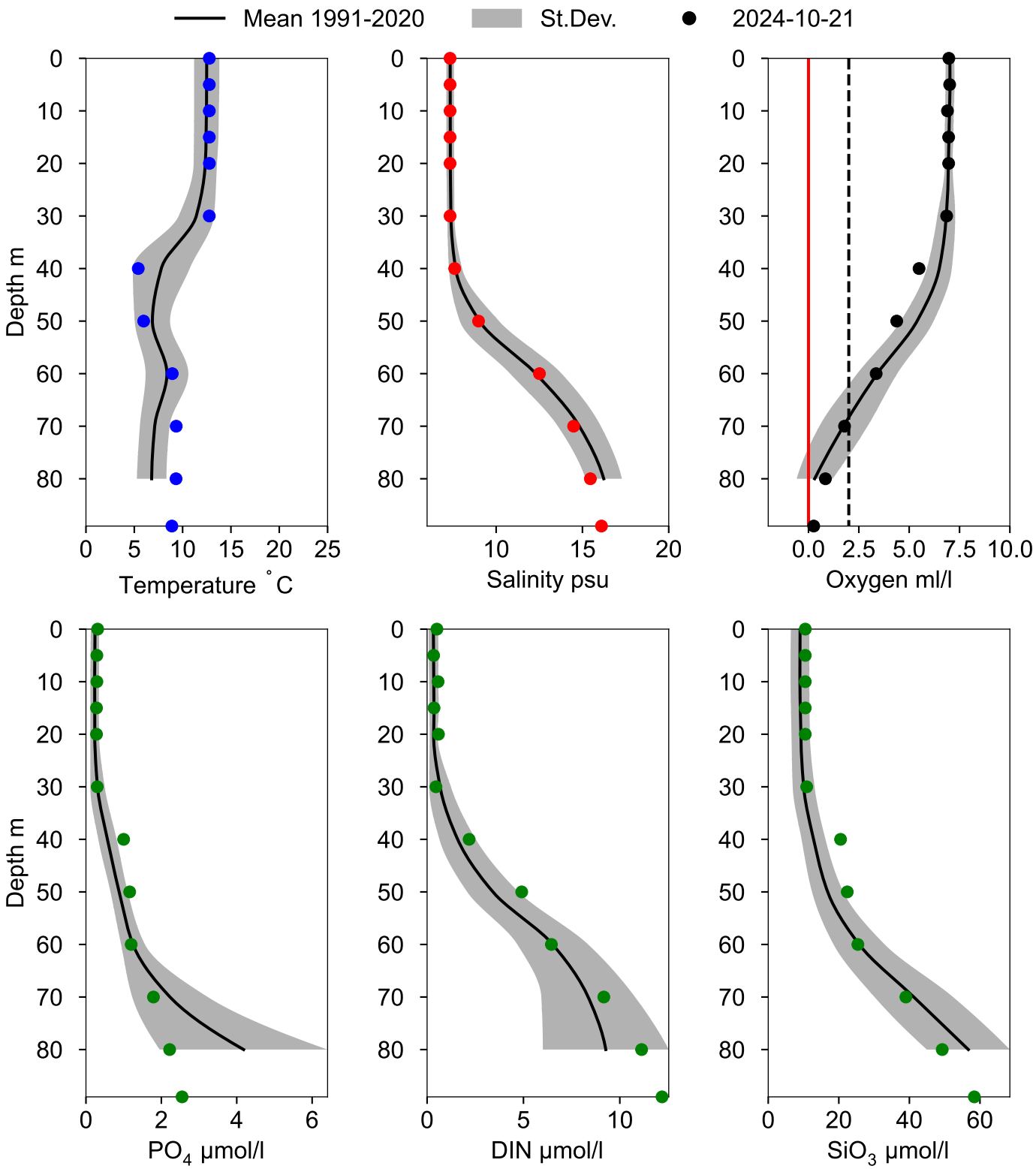
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

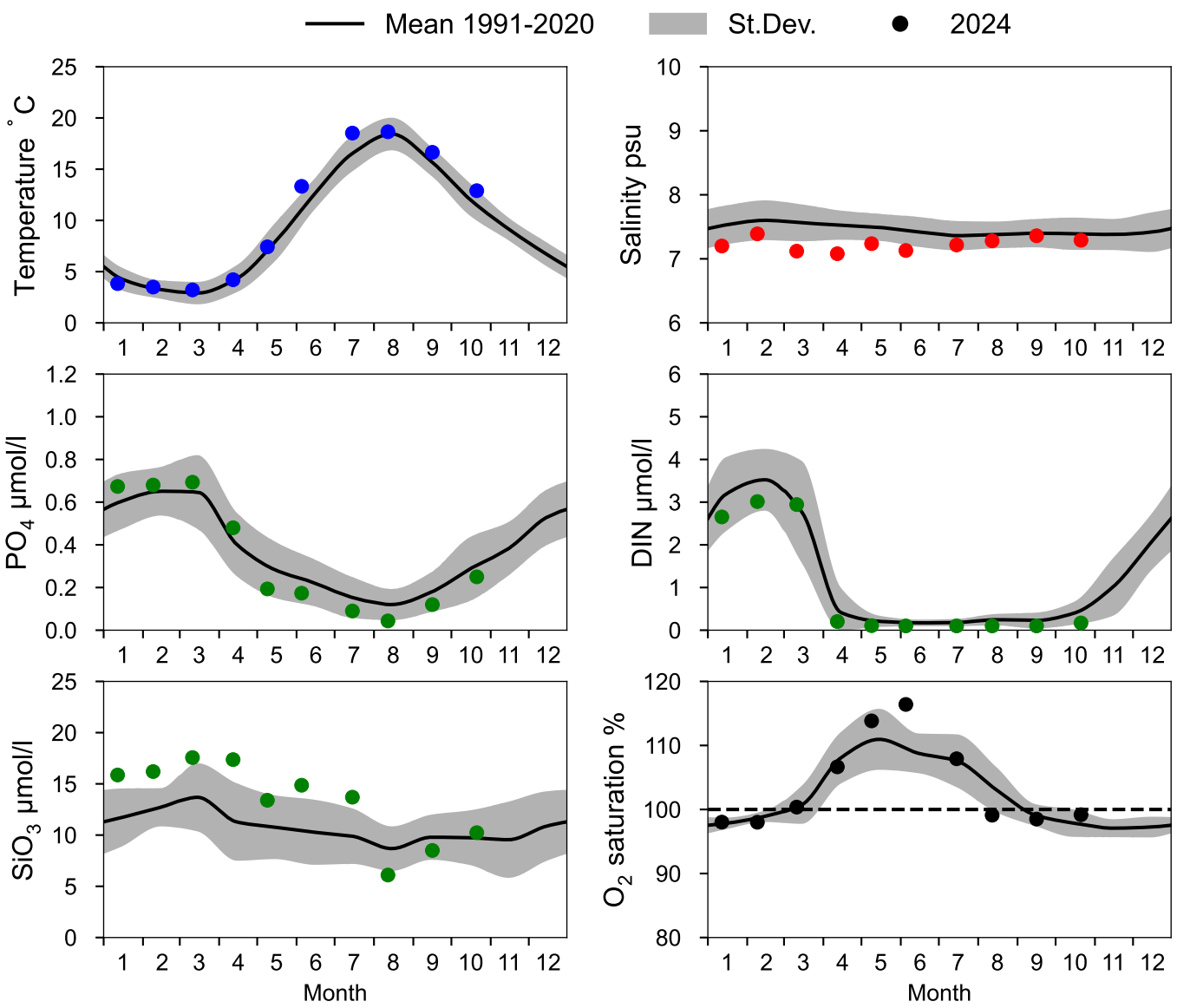


Vertical profiles BY5 BORNHOLMSDJ
October

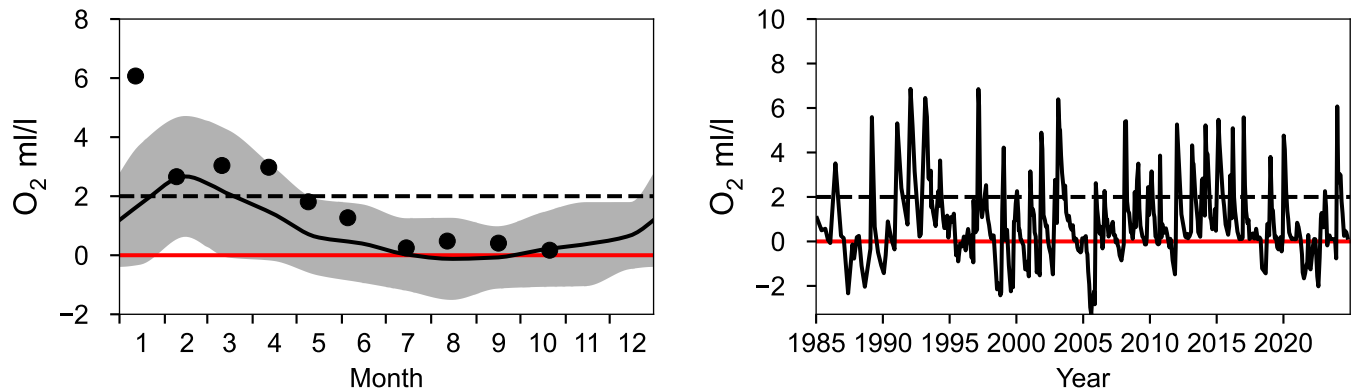


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

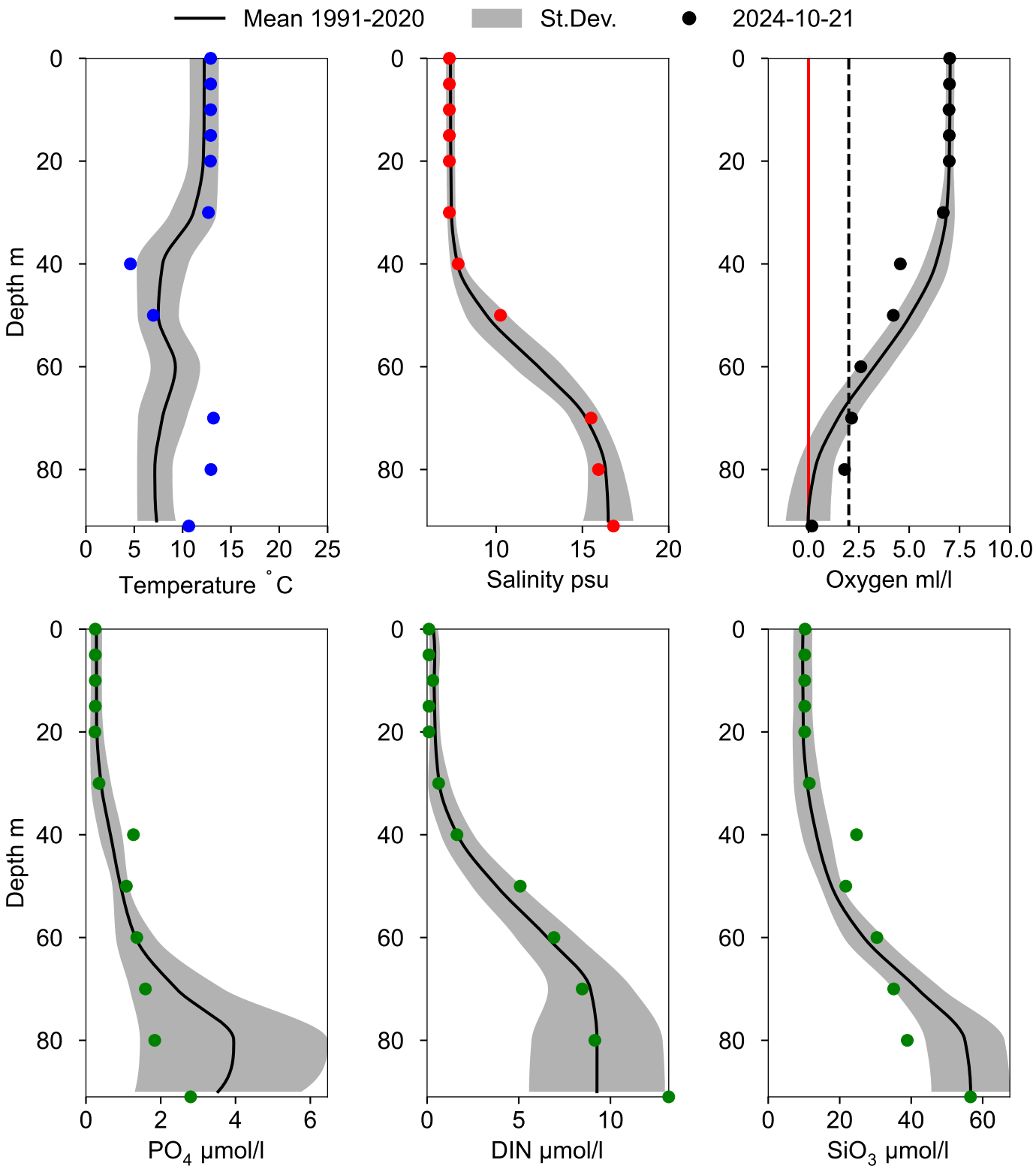
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

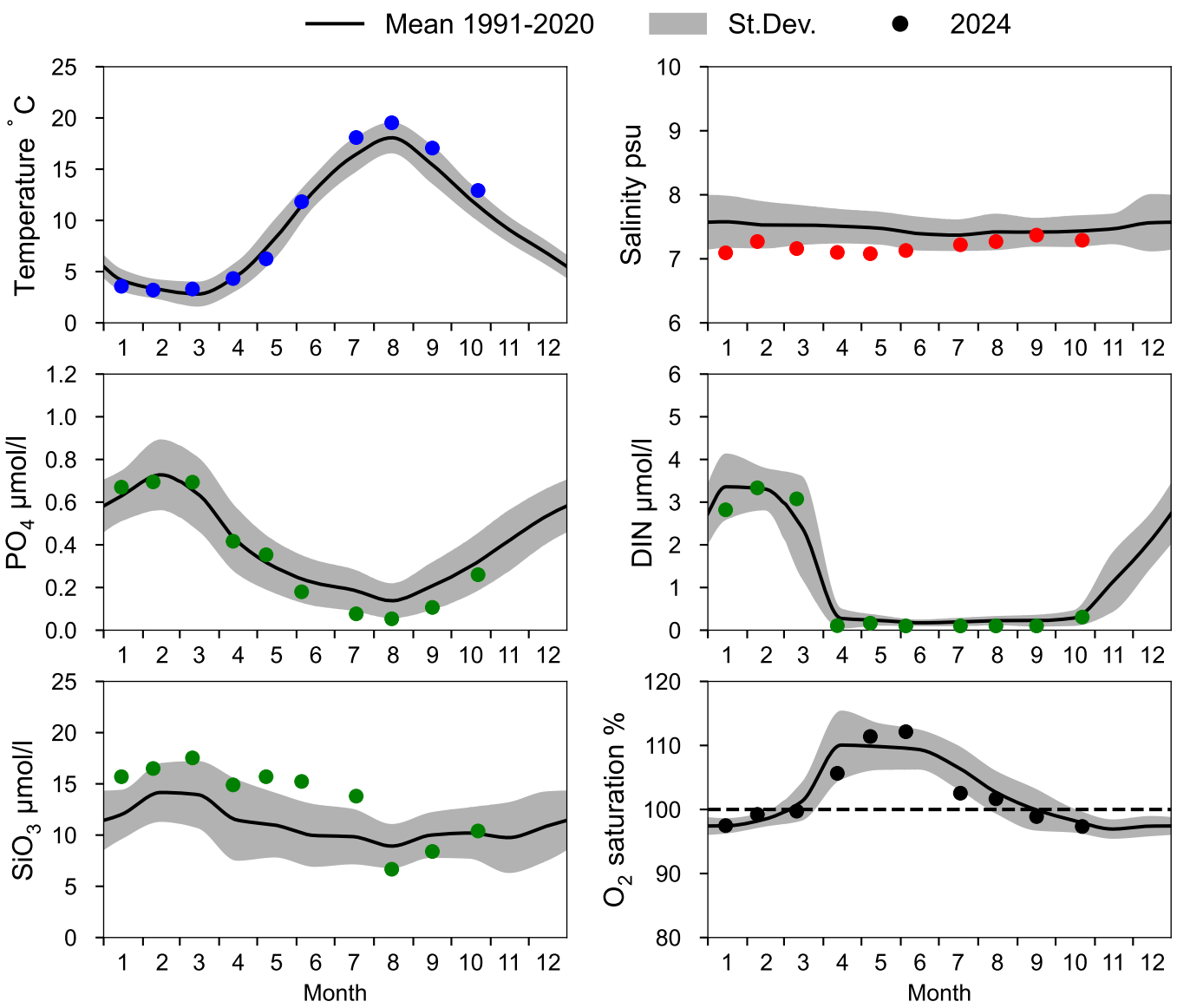


Vertical profiles BY4 CHRISTIANSÖ
October

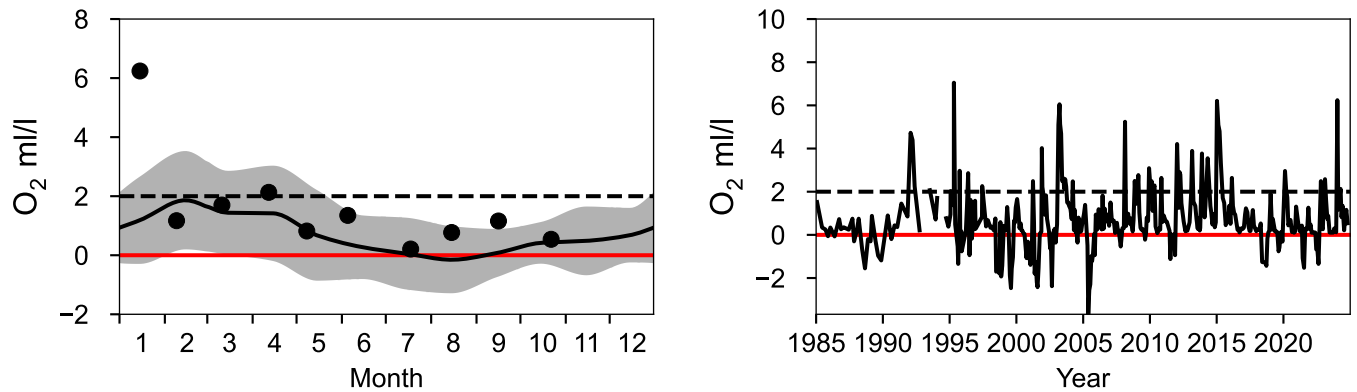


STATION HANÖBUKTEN SURFACE WATER (0-10 m)

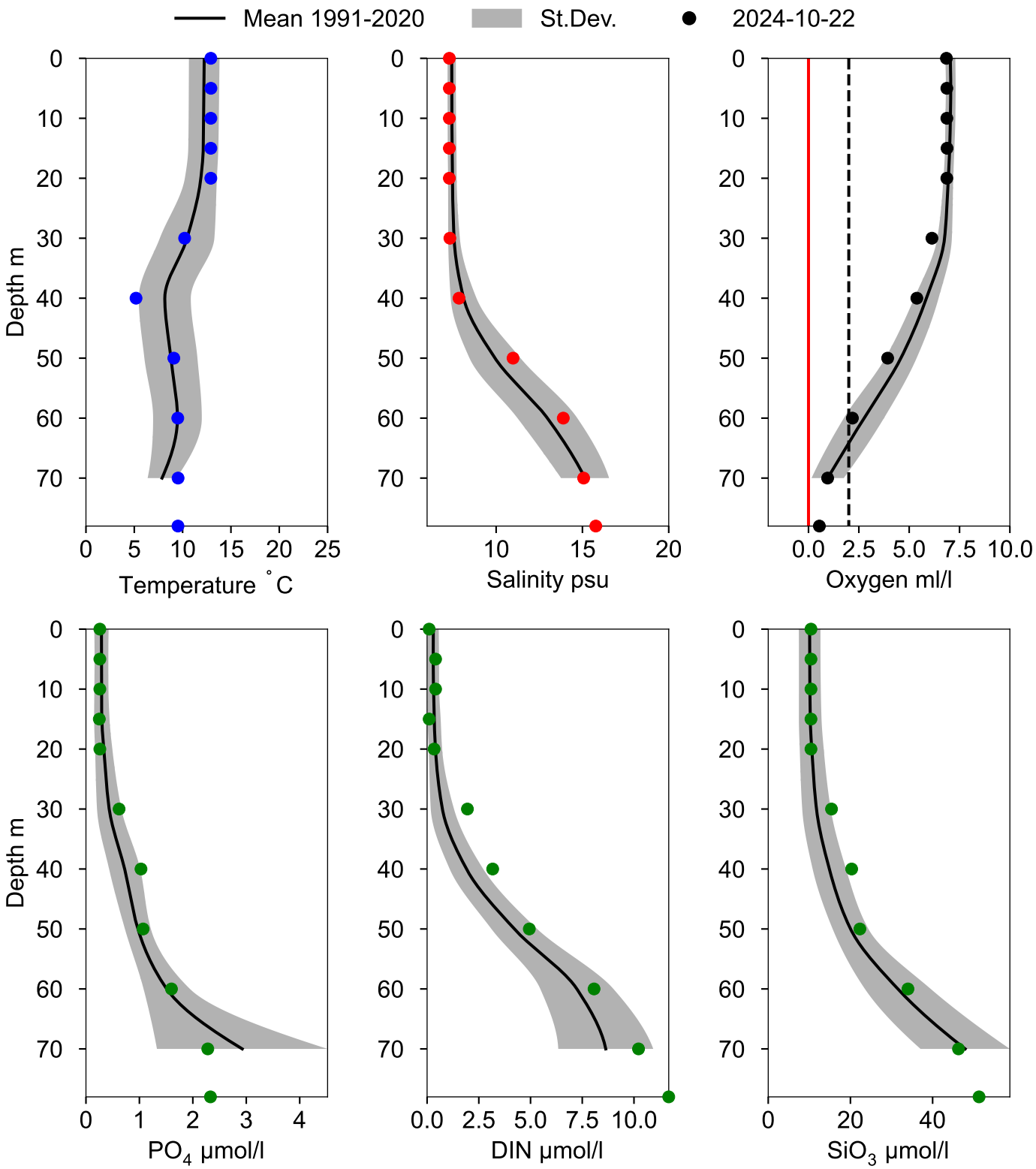
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)

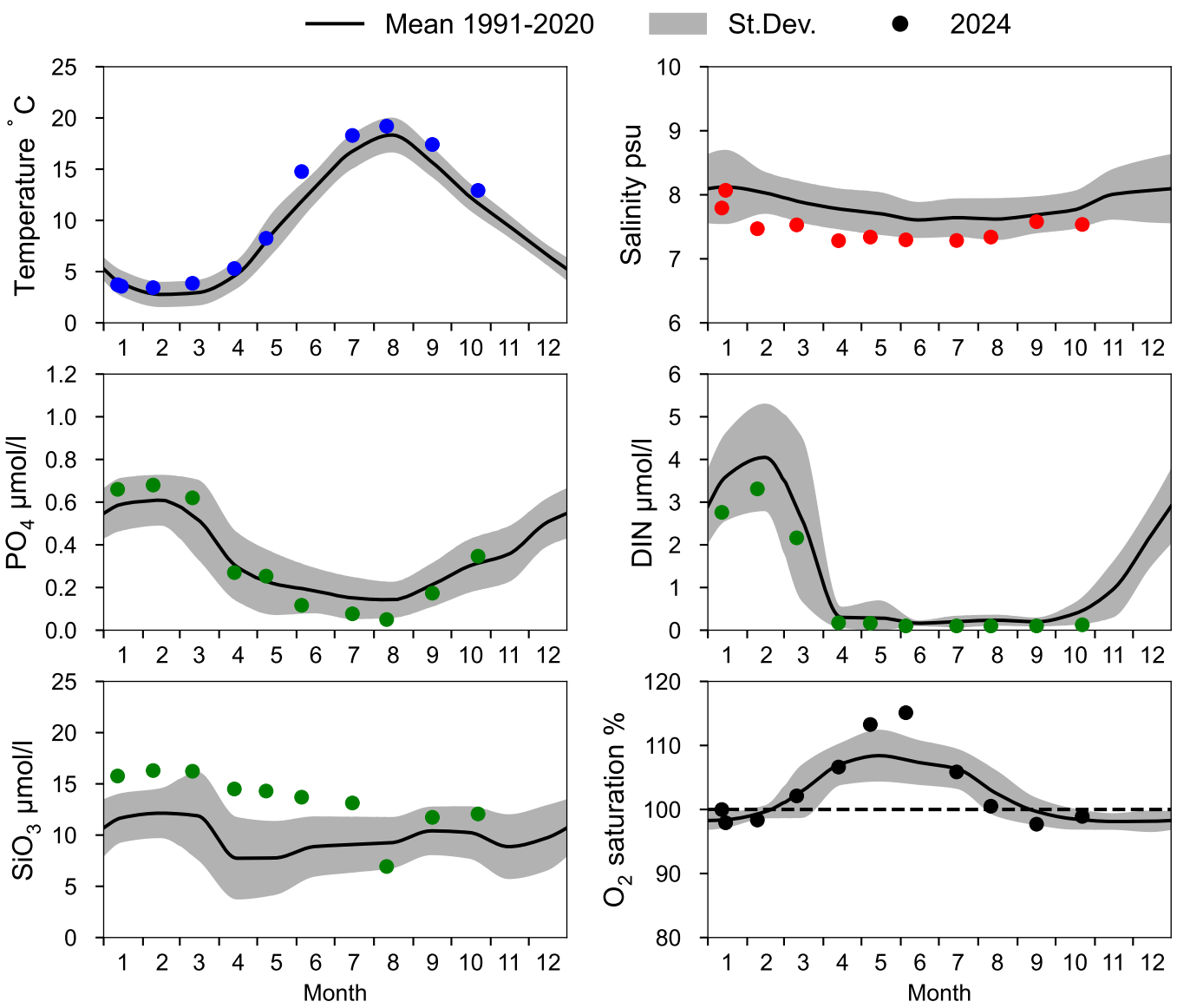


Vertical profiles HANÖBUKTEN
October

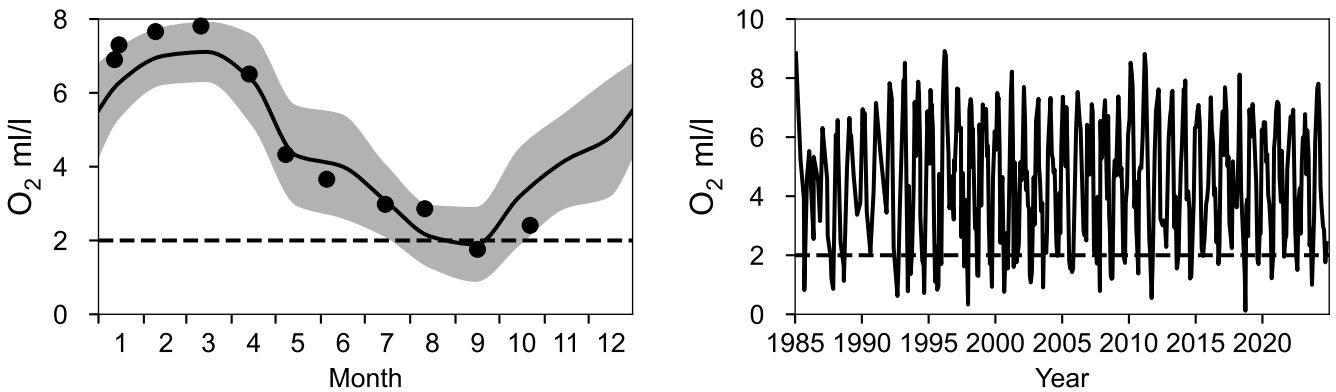


STATION BY2 ARKONA SURFACE WATER (0-10 m)

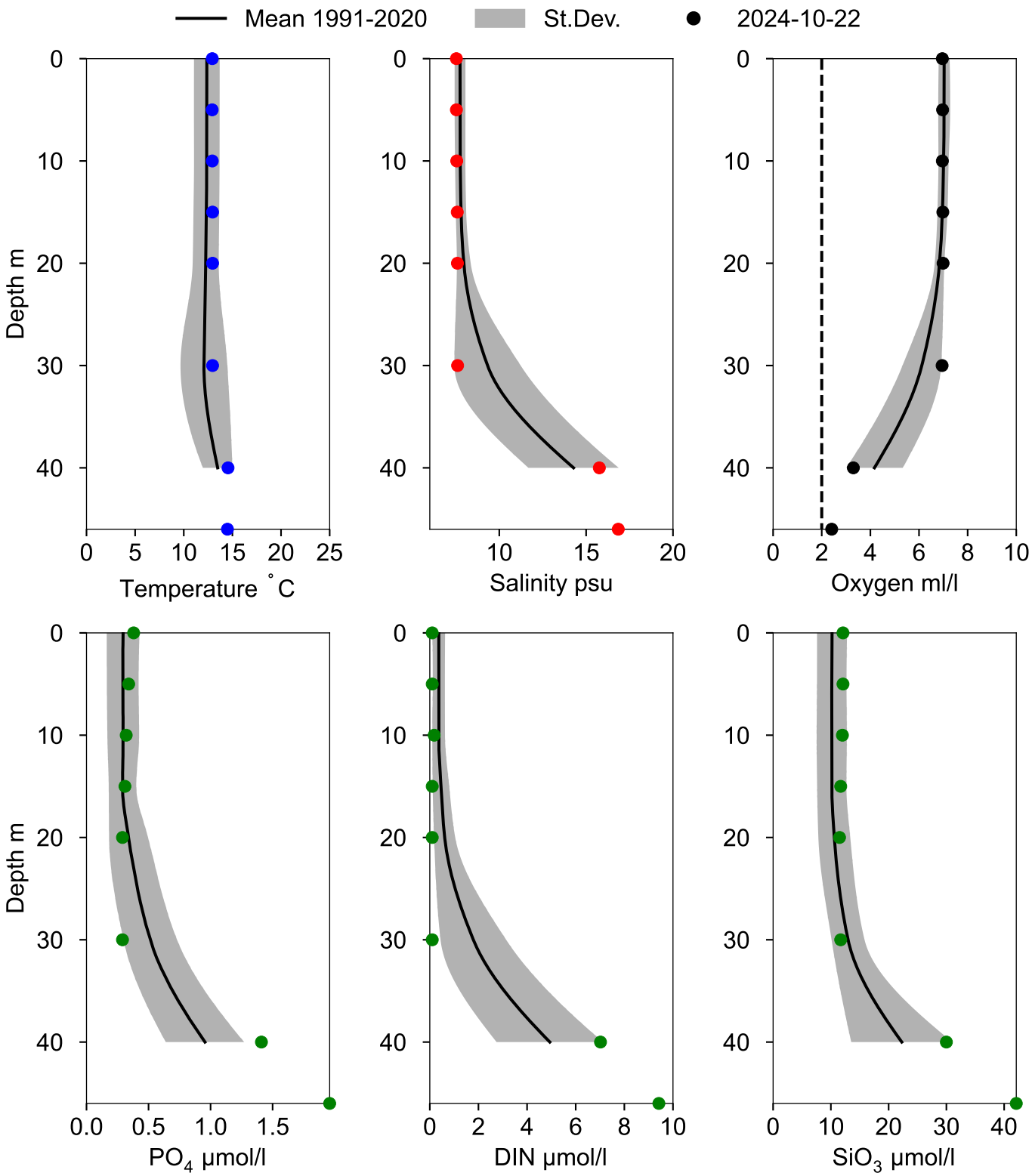
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

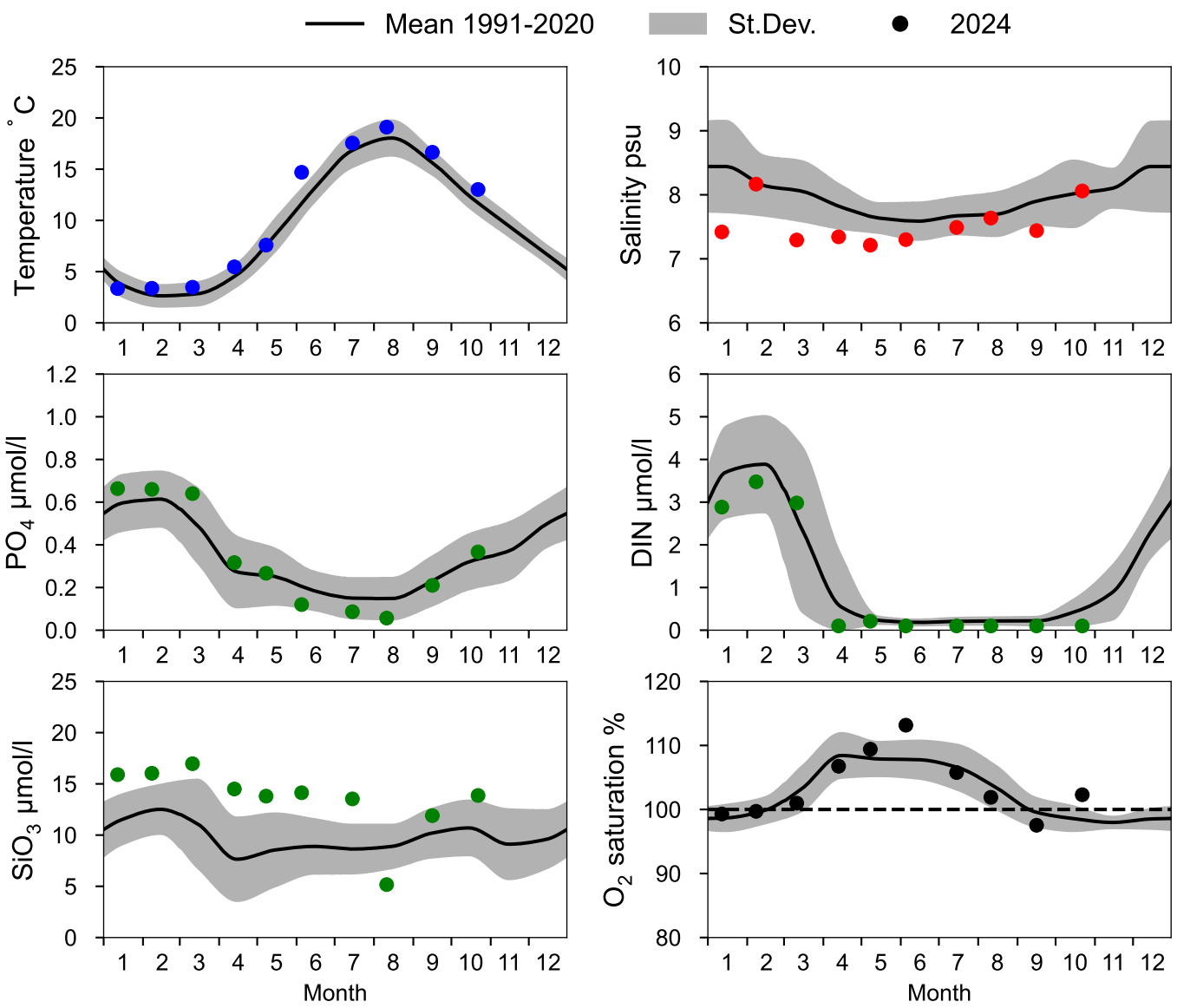


Vertical profiles BY2 ARKONA
October

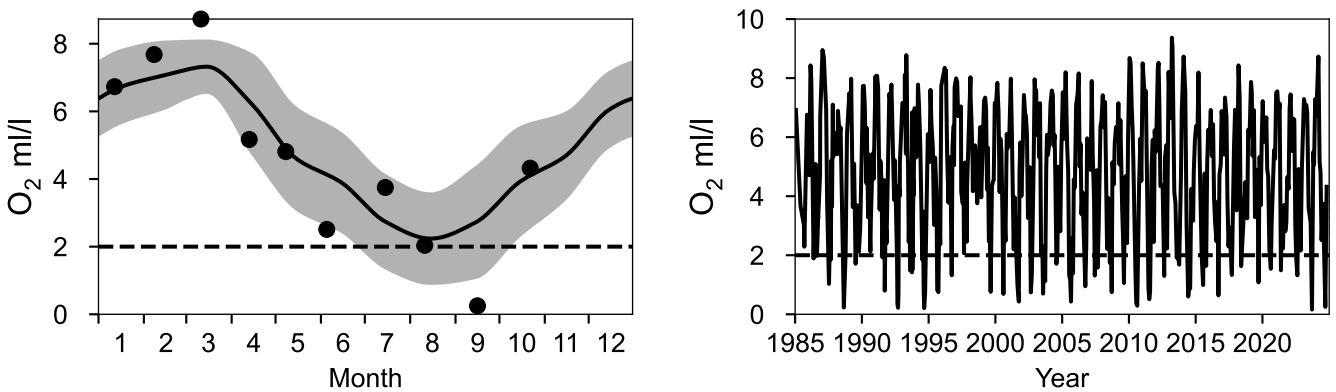


STATION BY1 SURFACE WATER (0-10 m)

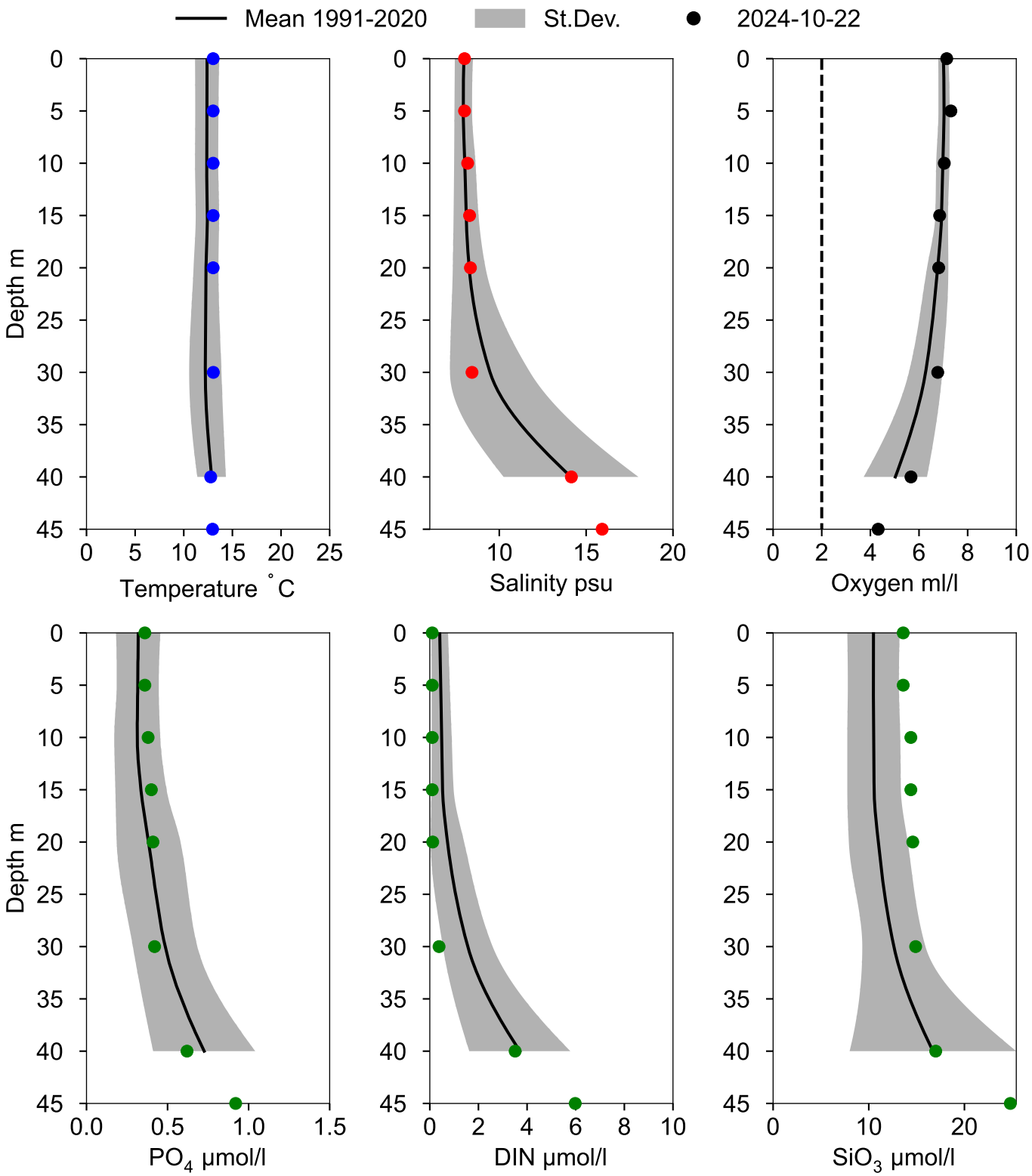
Annual Cycles



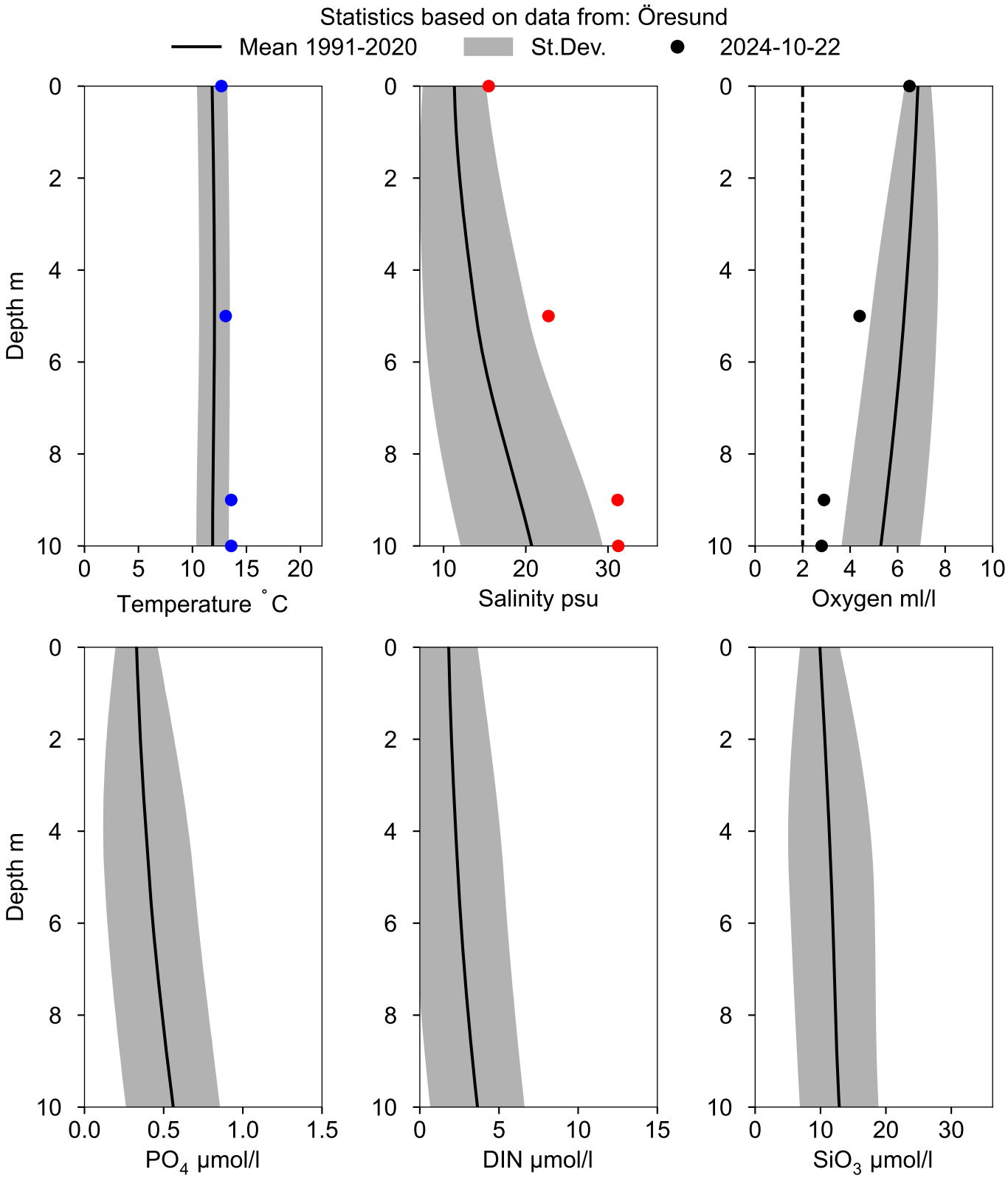
OXYGEN IN BOTTOM WATER (depth >= 39 m)



Vertical profiles BY1
October

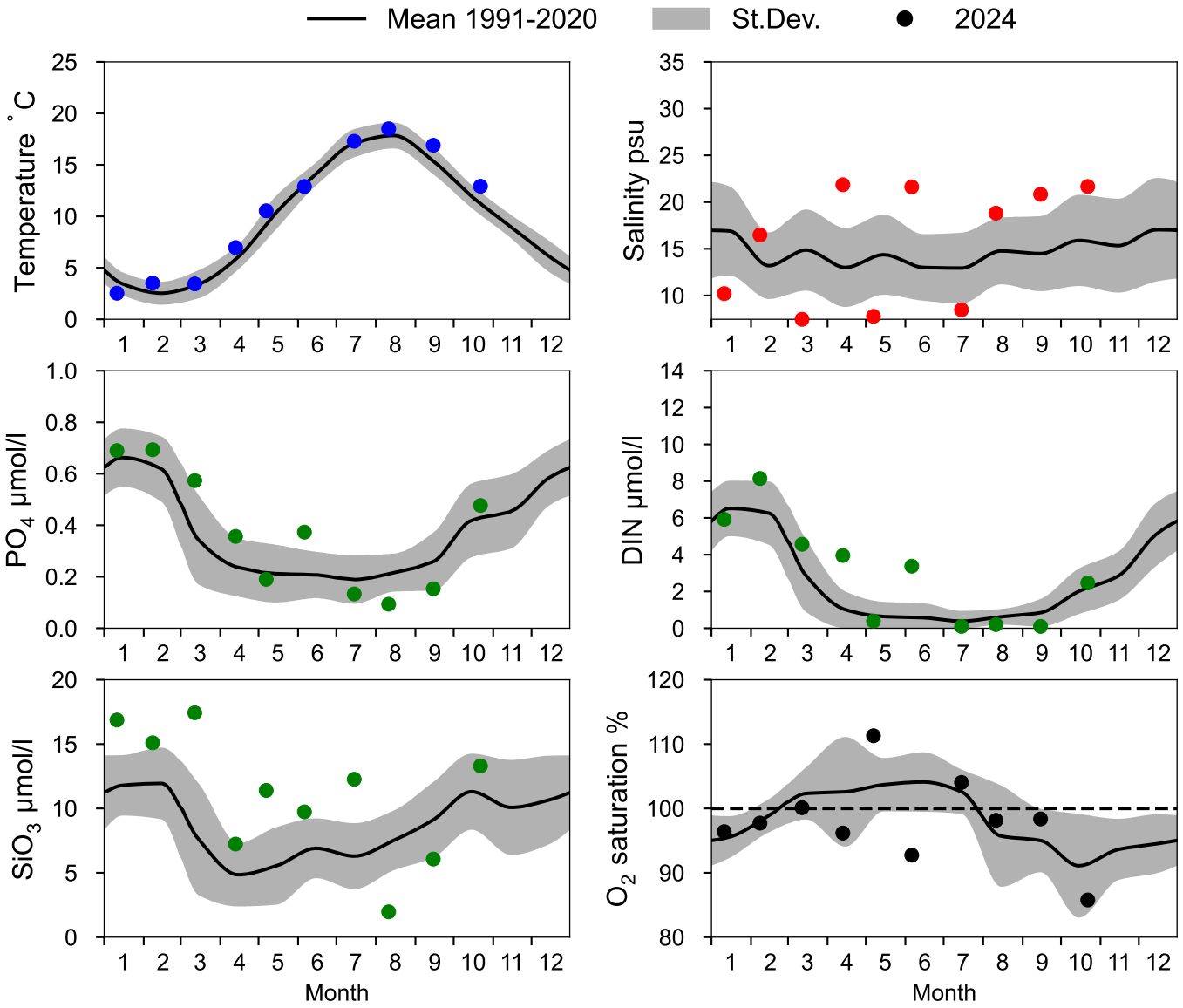


Vertical profiles FLINTEN7
October

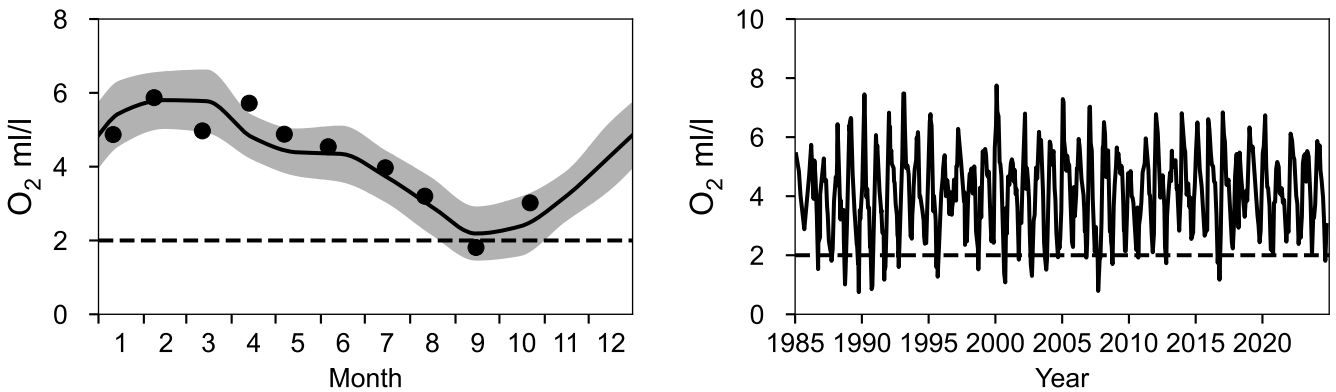


STATION W LANDSKRONA SURFACE WATER (0-10 m)

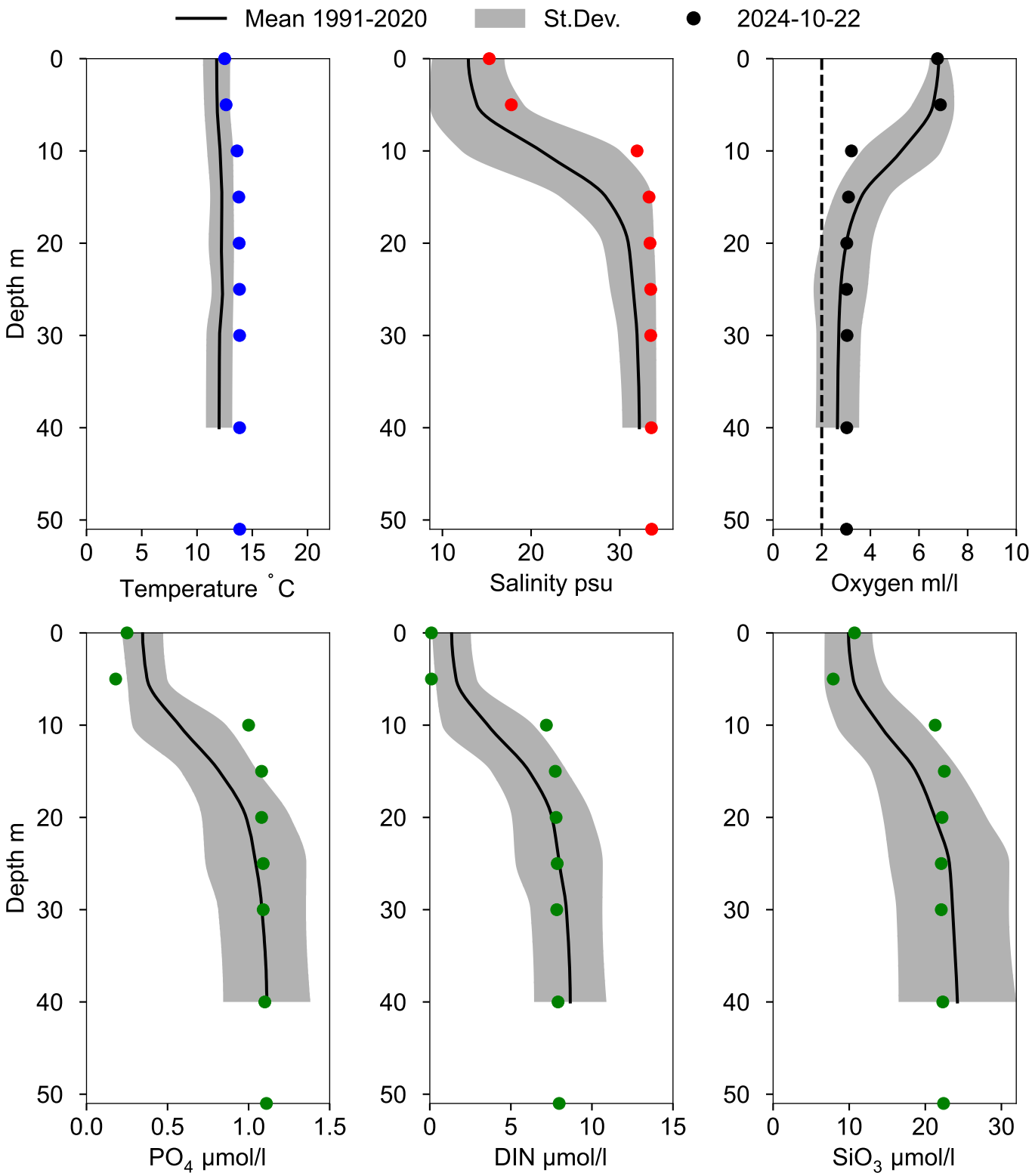
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

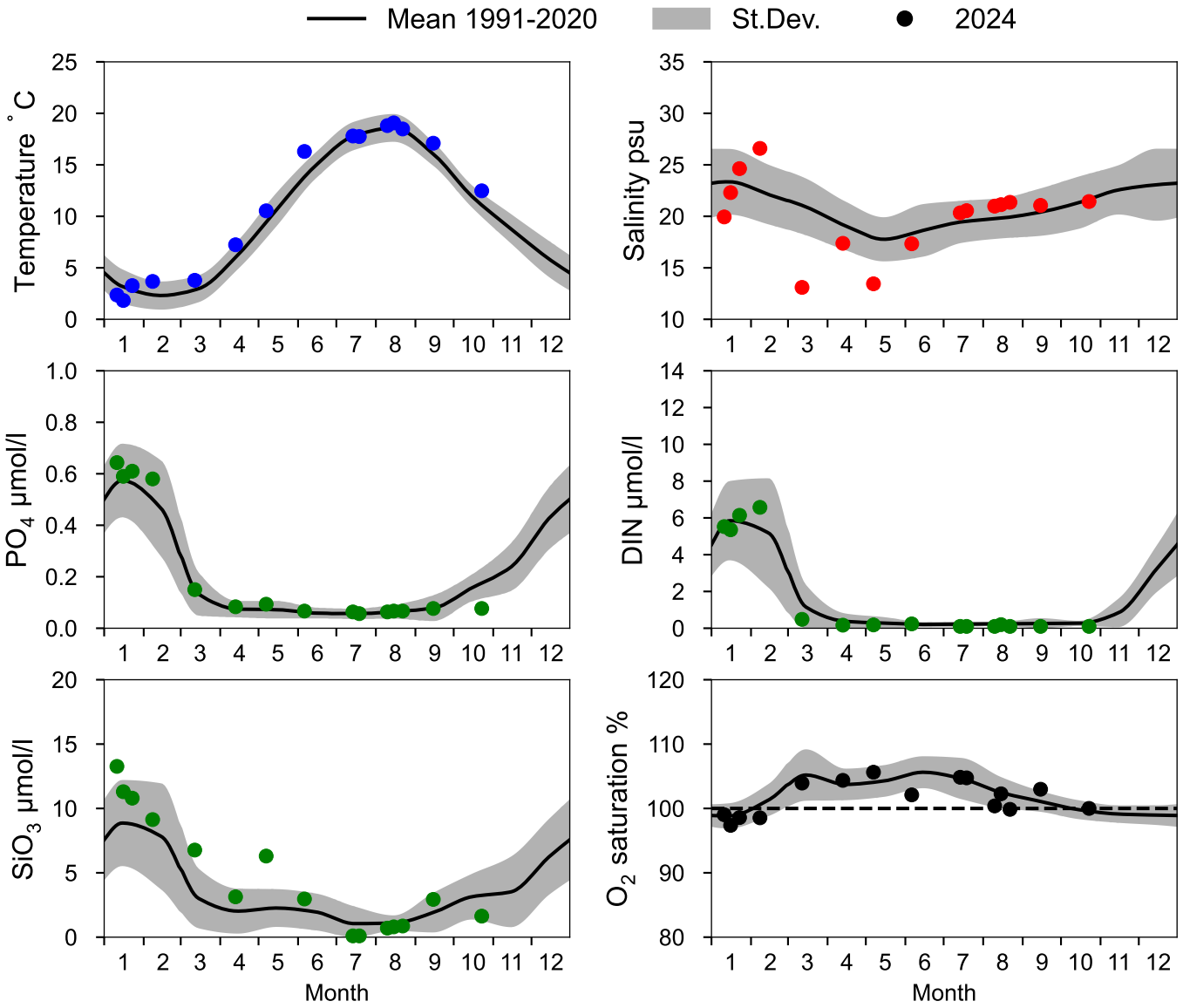


Vertical profiles W LANDSKRONA
October

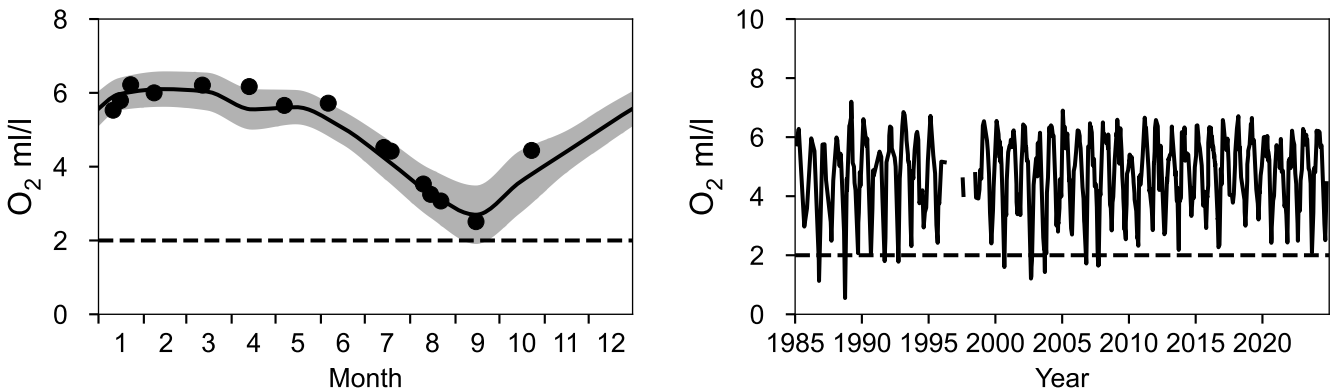


STATION ANHOLT E SURFACE WATER (0-10 m)

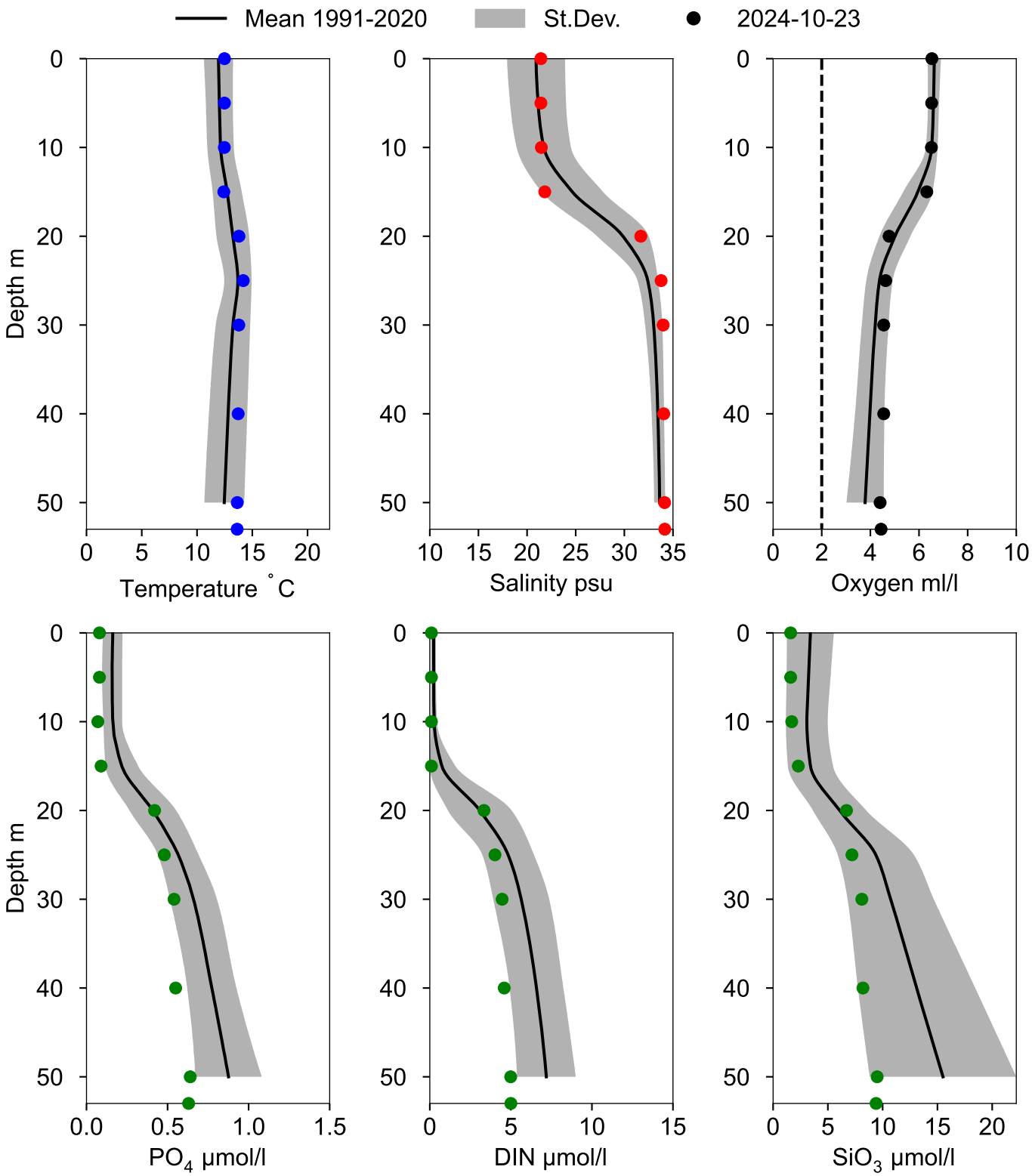
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

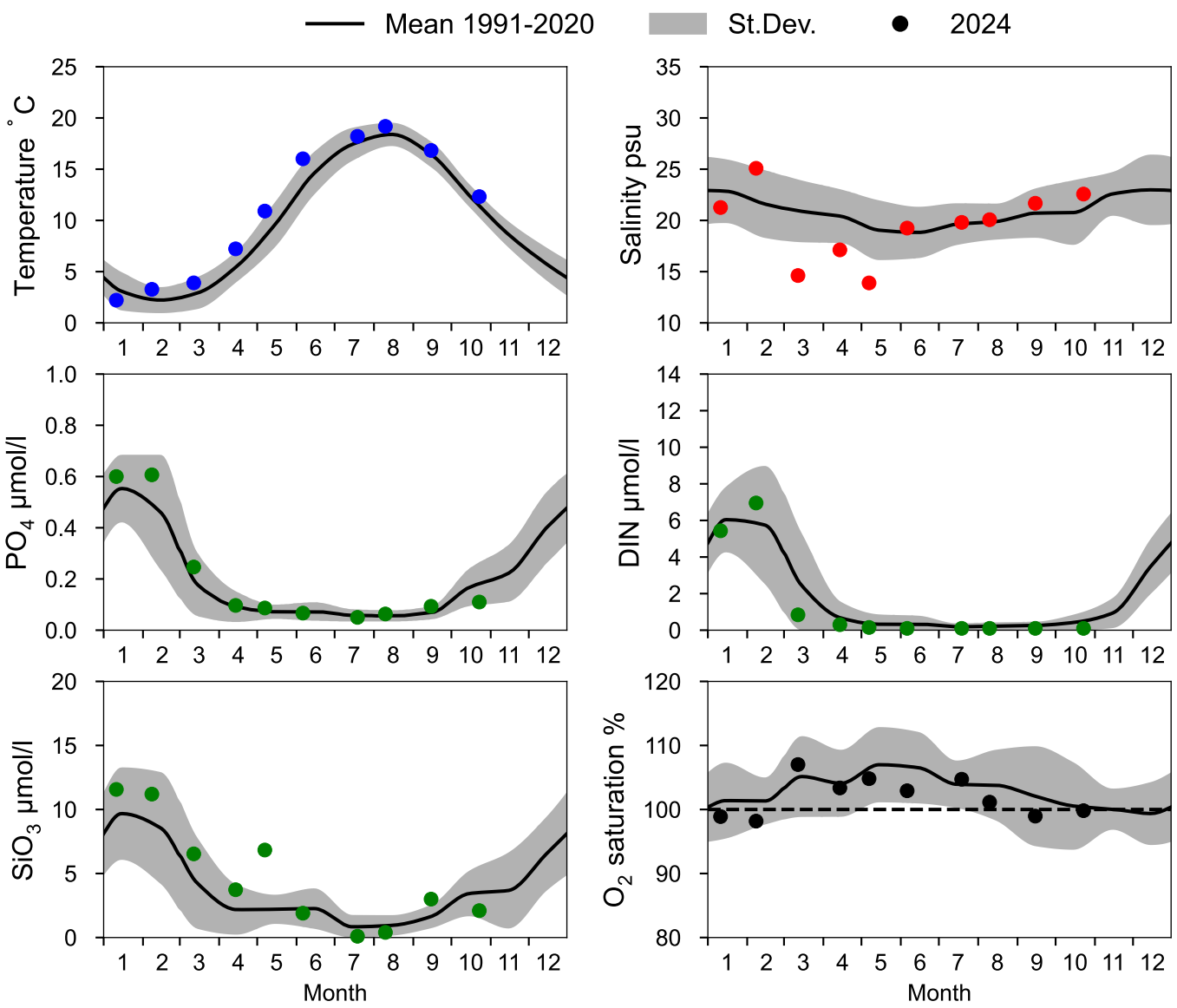


Vertical profiles ANHOLT E
October

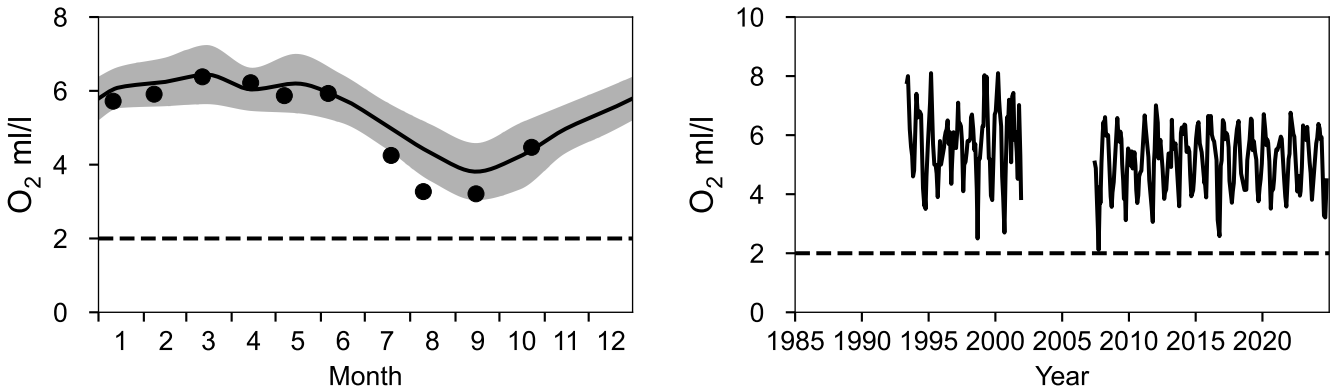


STATION N14 FALKENBERG SURFACE WATER (0-10 m)

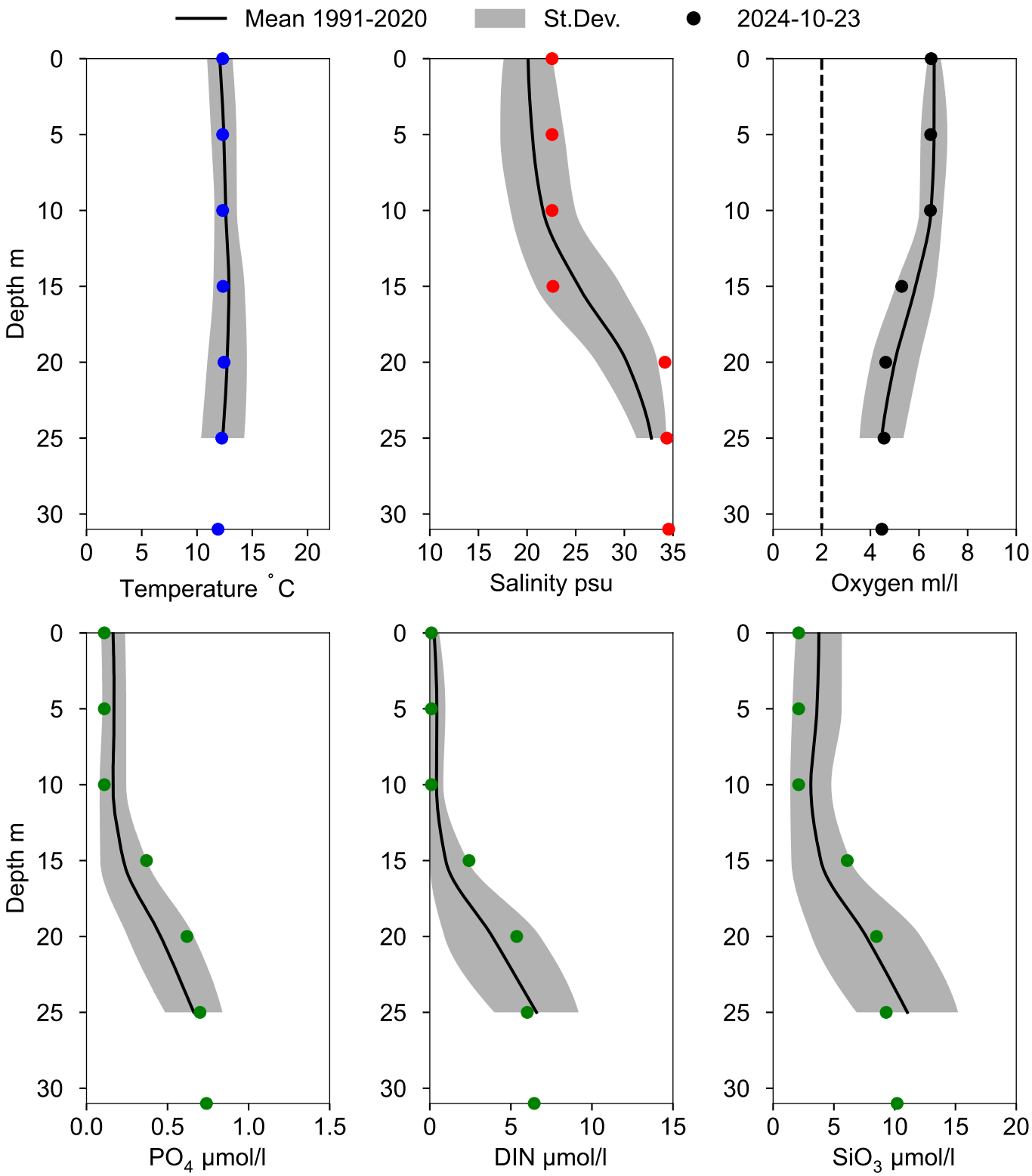
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 25 m)

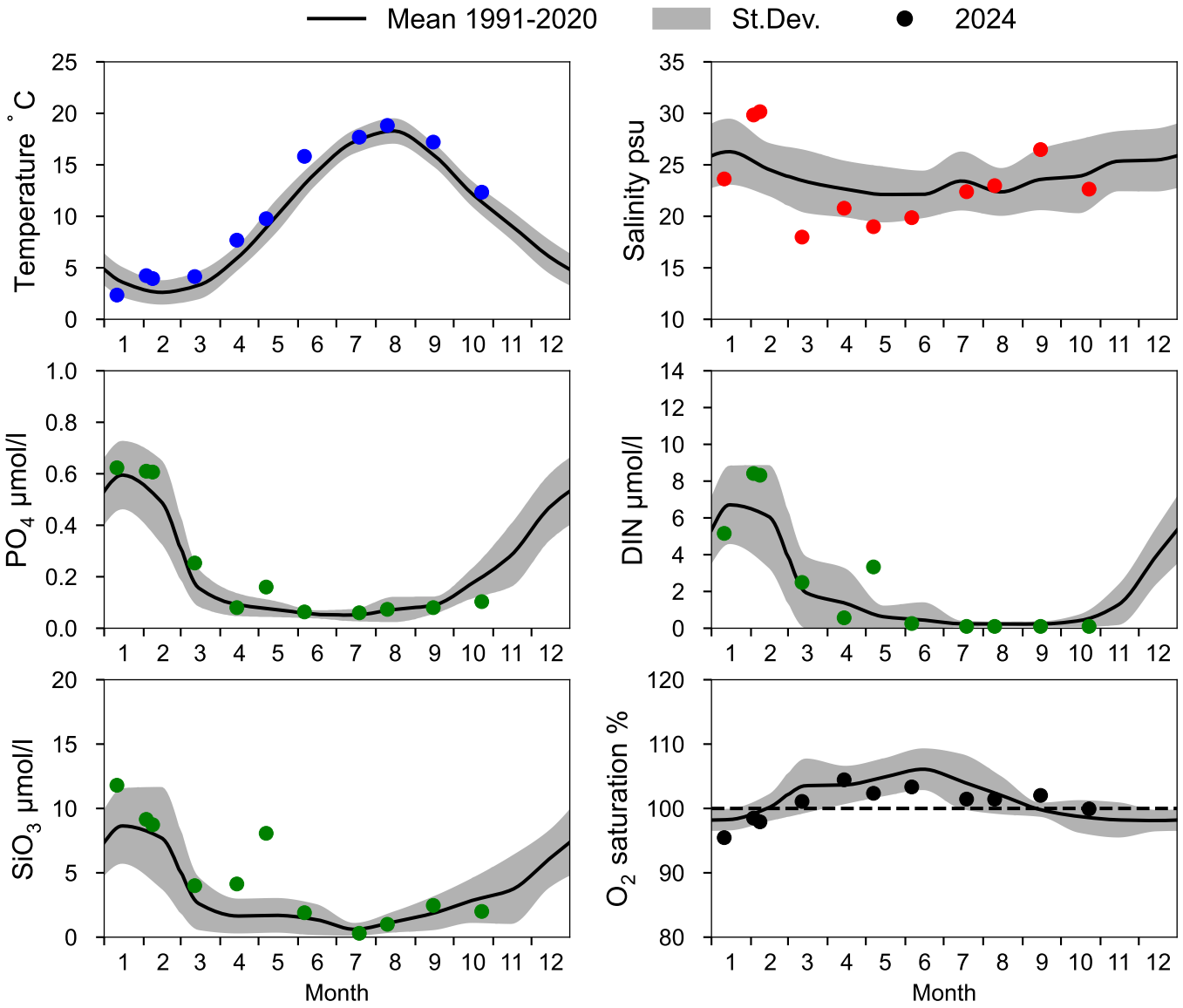


Vertical profiles N14 FALKENBERG
October

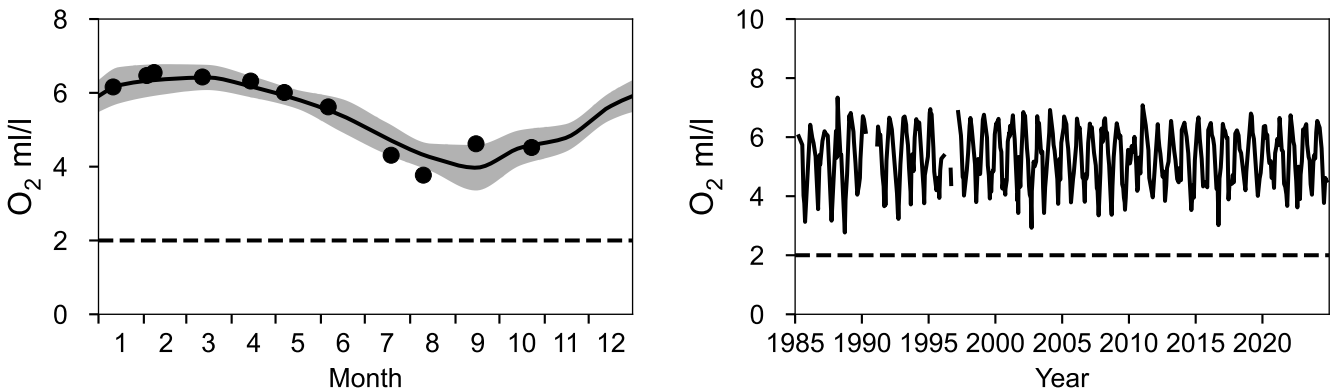


STATION FLADEN SURFACE WATER (0-10 m)

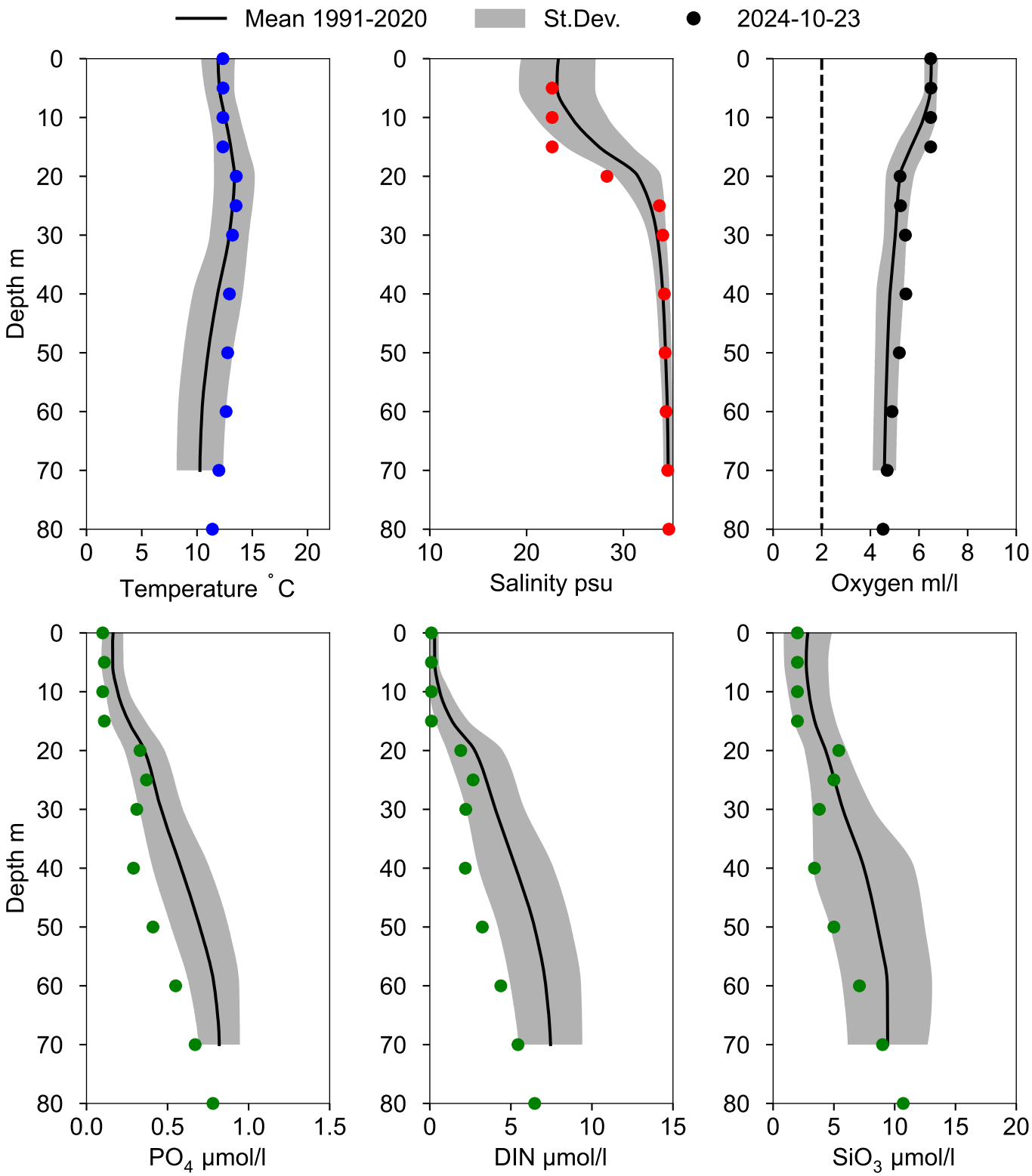
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 74 m)

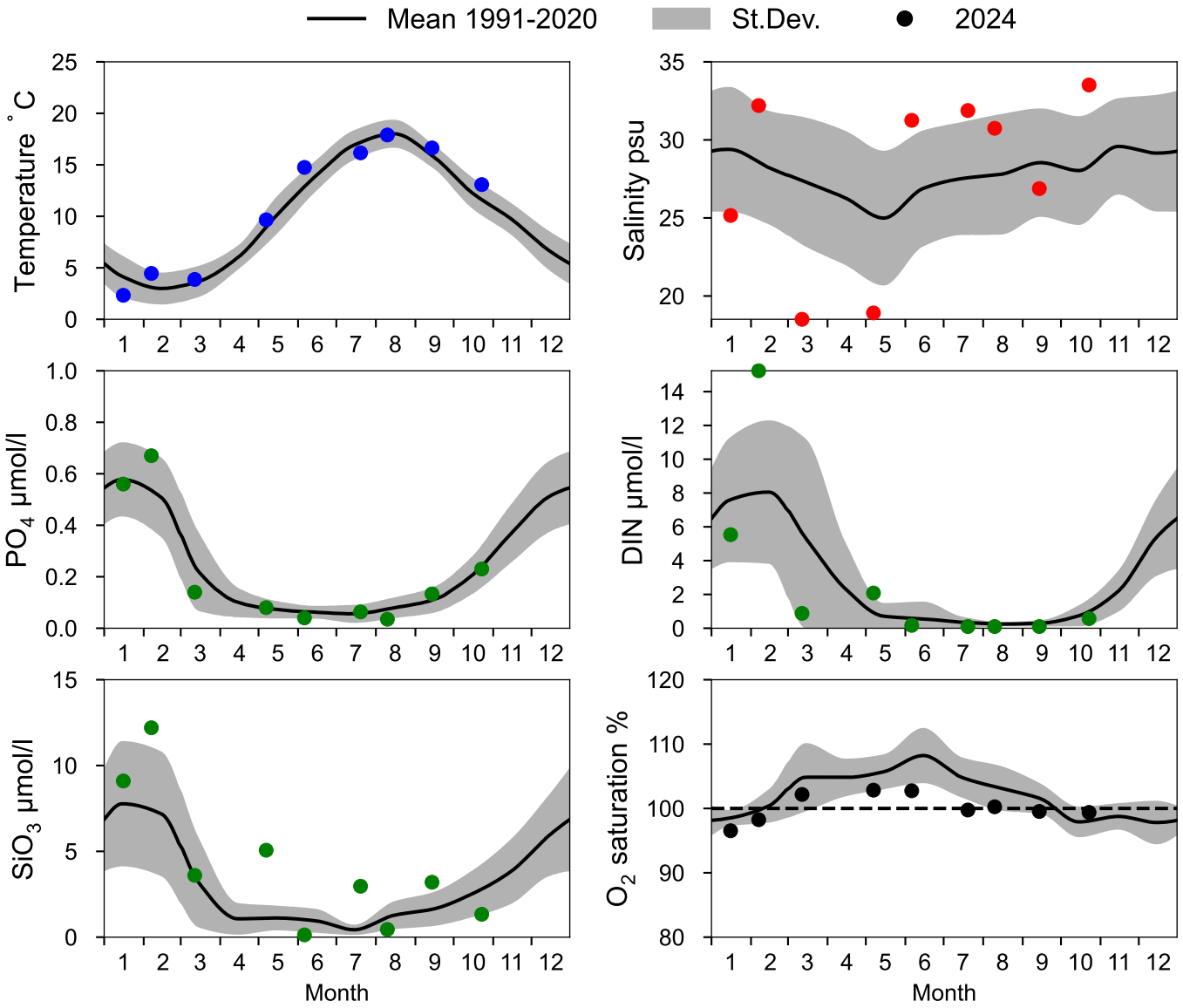


Vertical profiles FLADEN
October

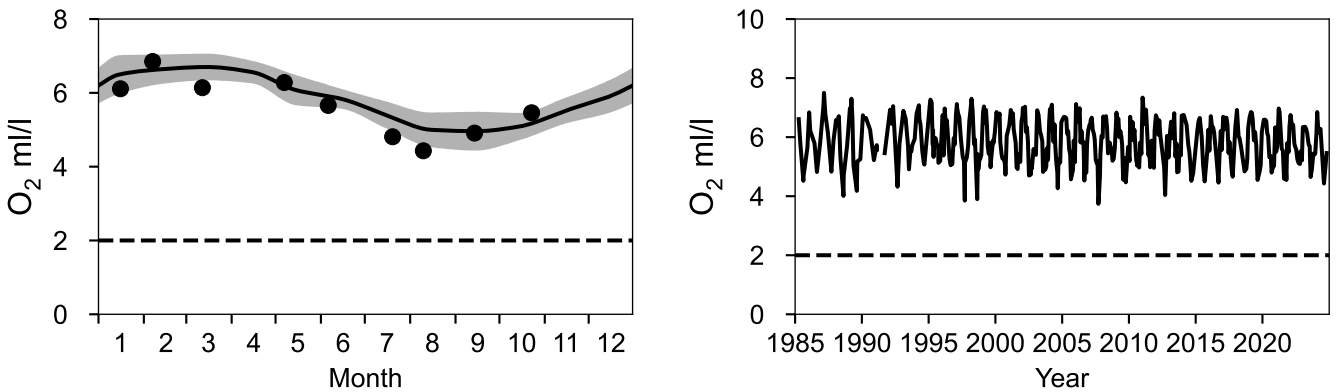


STATION P2 SURFACE WATER (0-10 m)

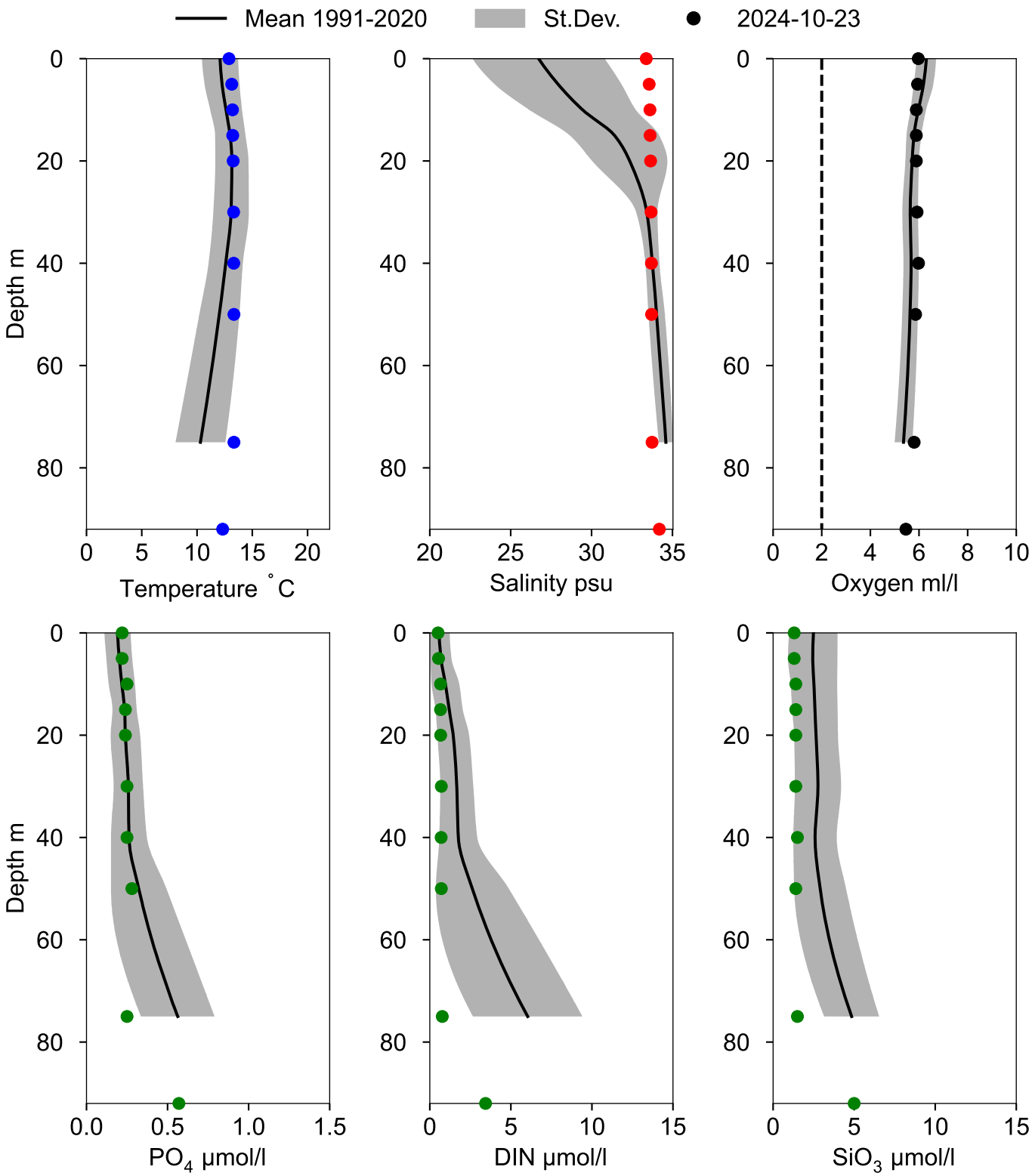
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 75 m)

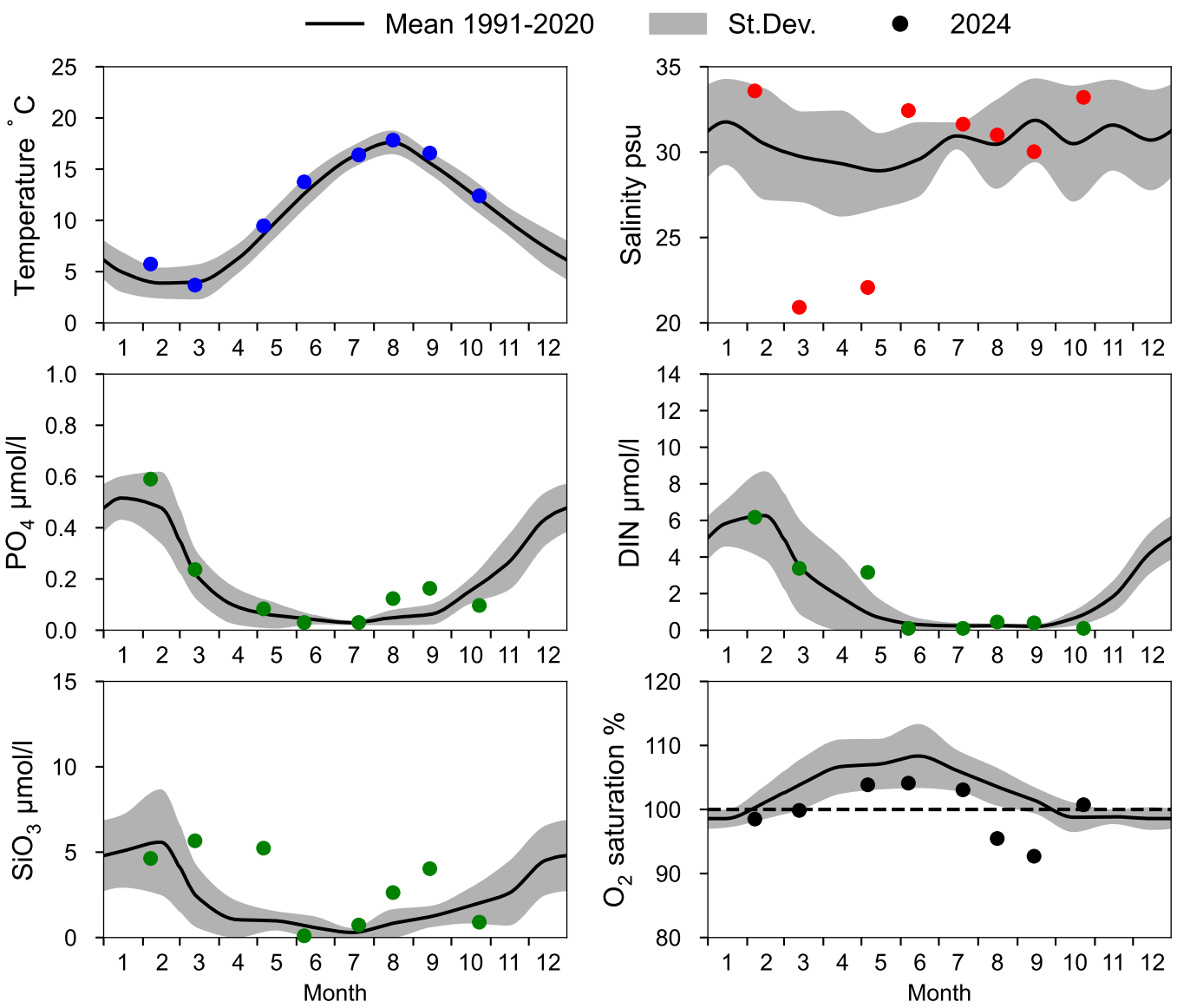


Vertical profiles P2
October

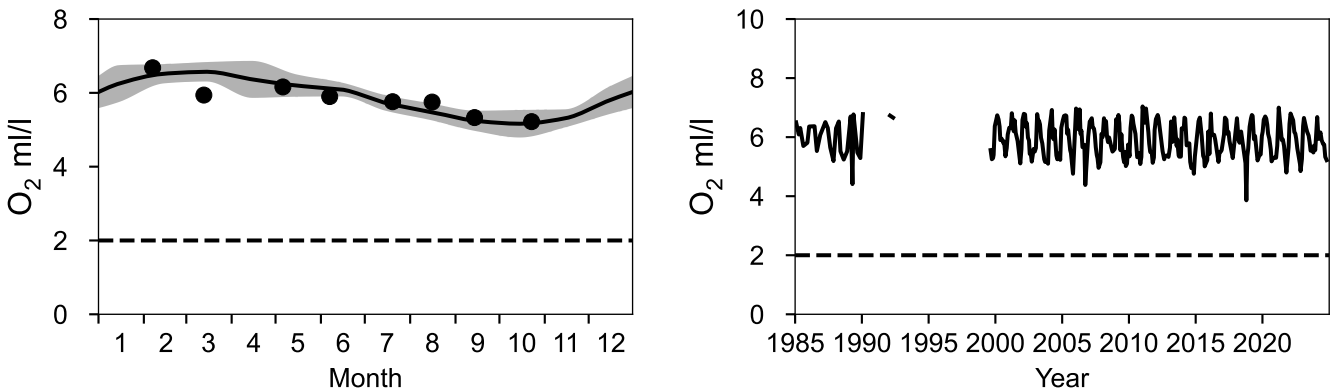


STATION Å15 SURFACE WATER (0-10 m)

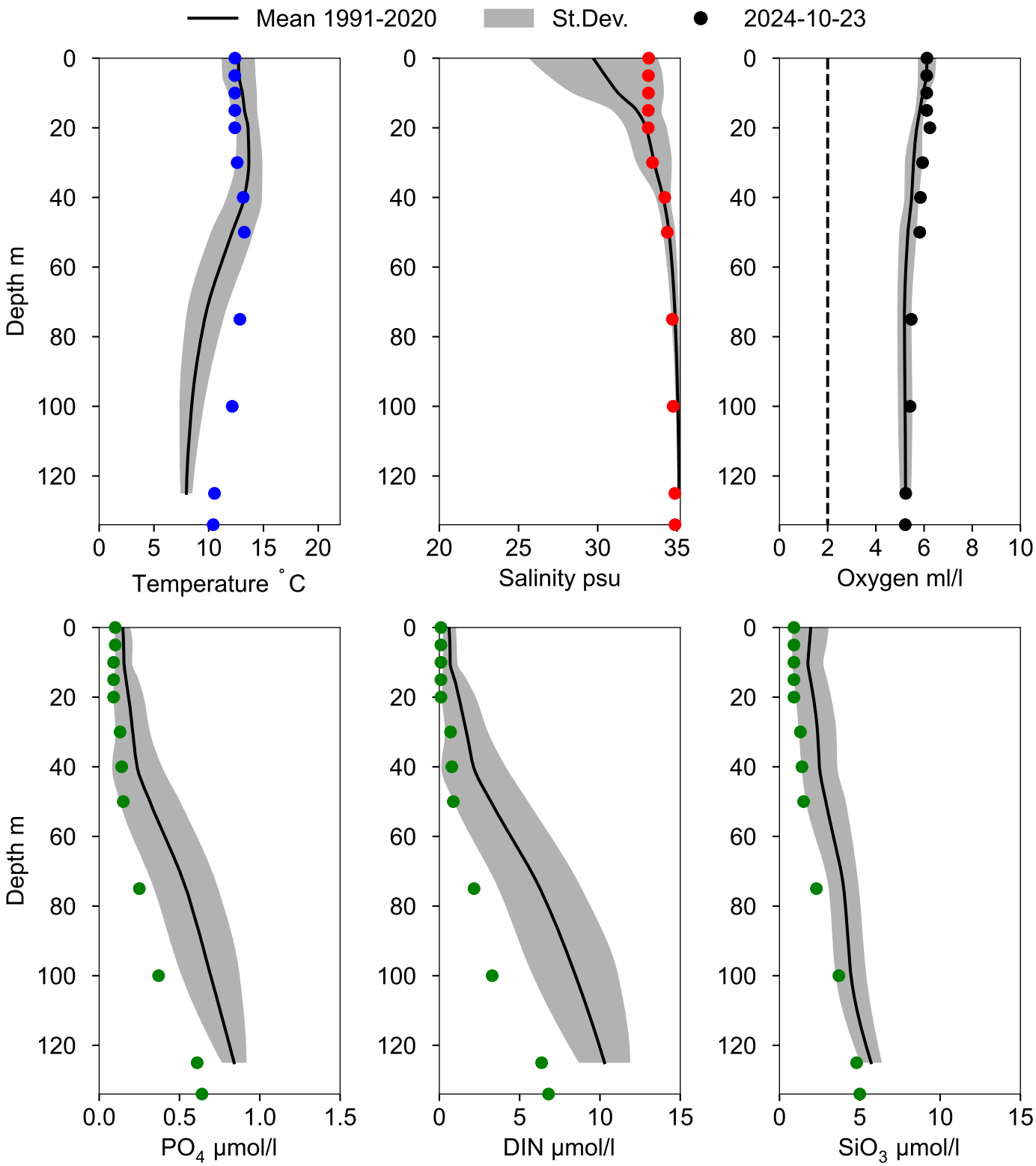
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

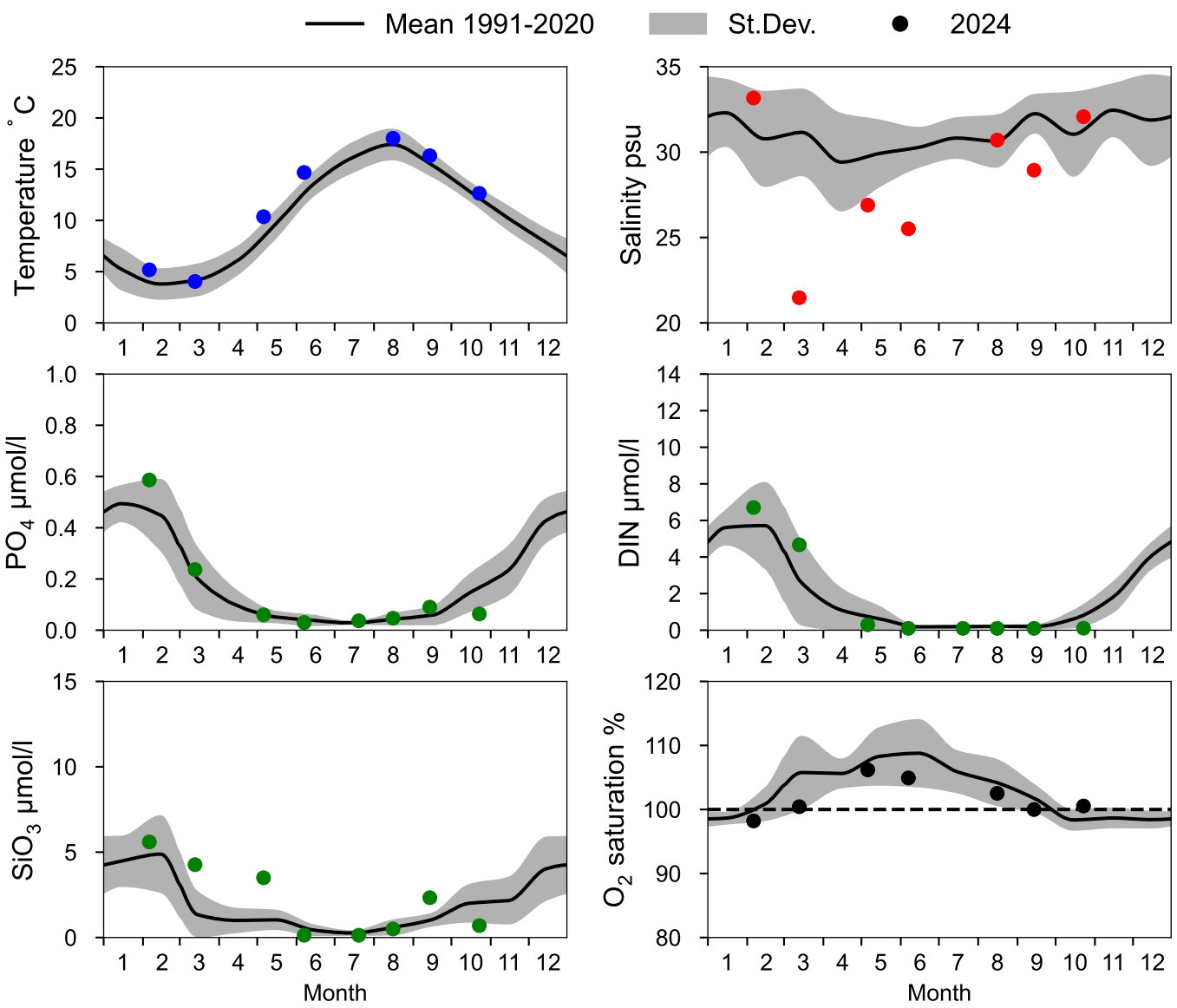


Vertical profiles Å15
October

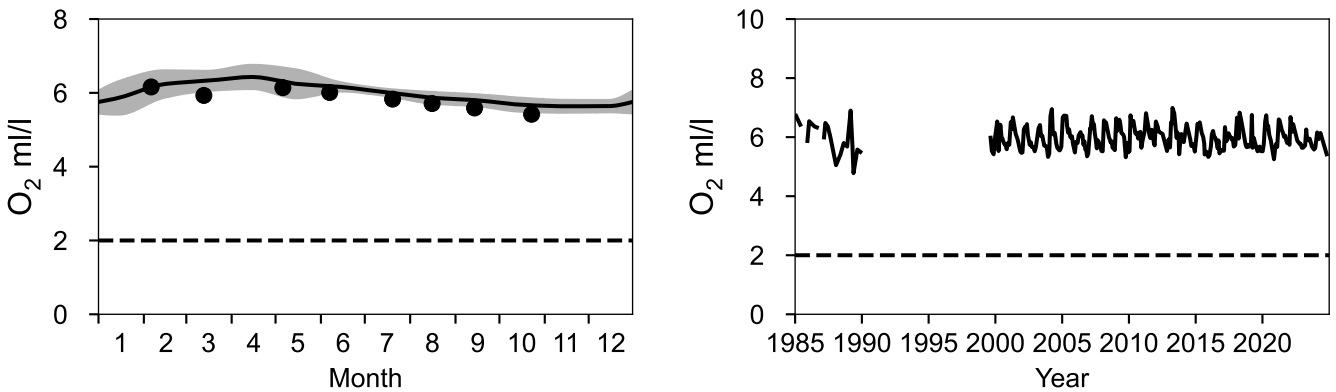


STATION Å17 SURFACE WATER (0-10 m)

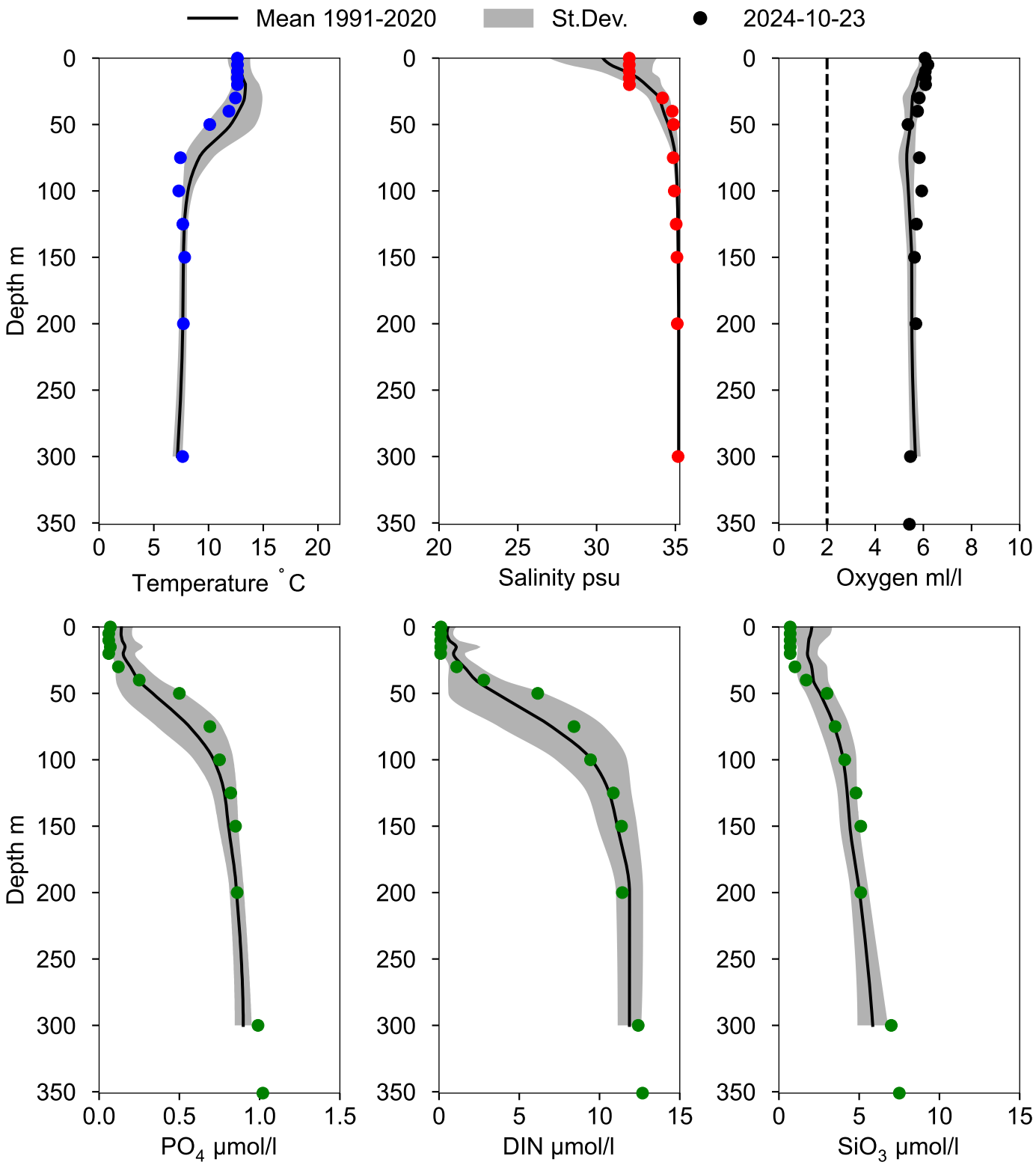
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 300 m)

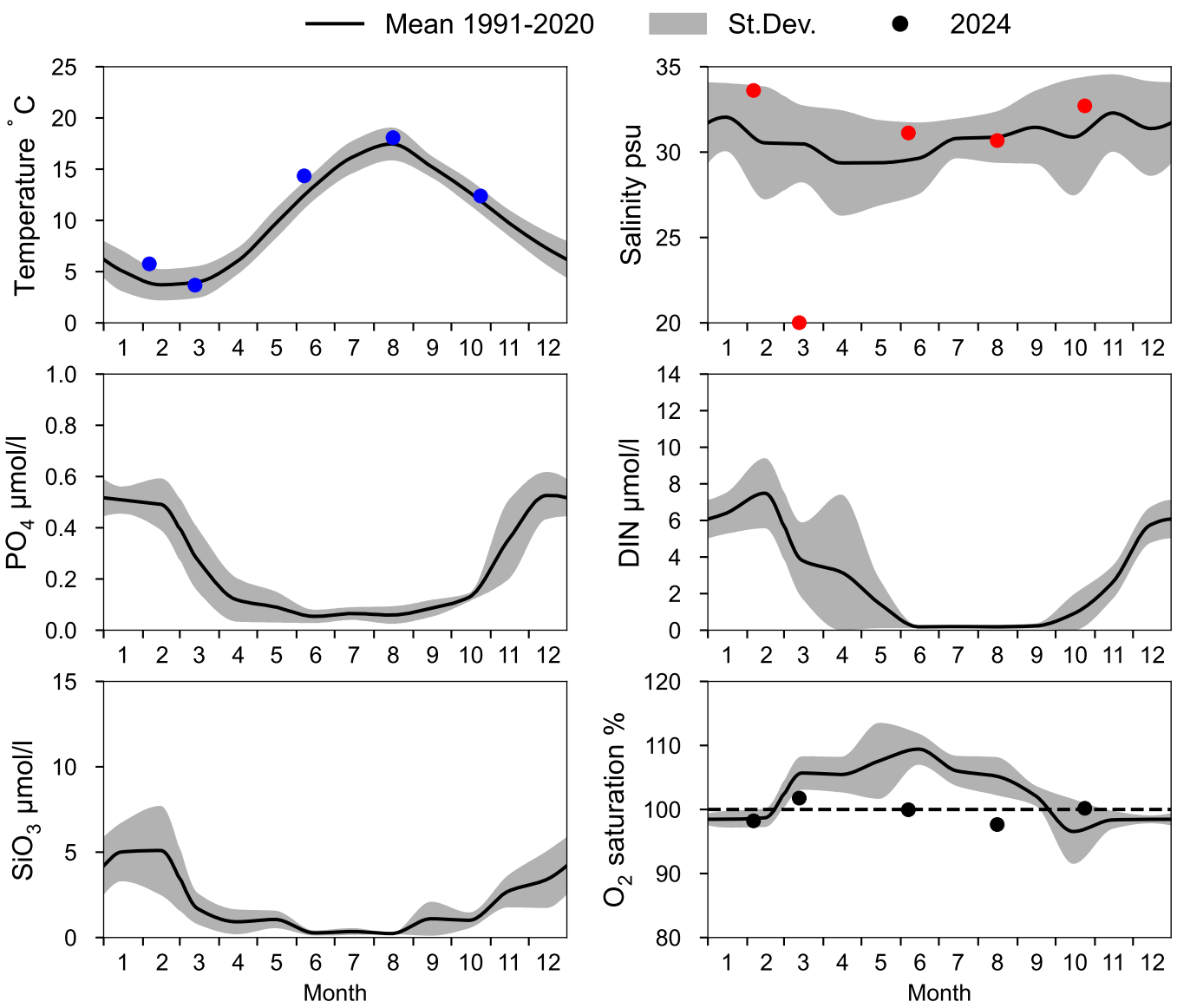


Vertical profiles Å17
October

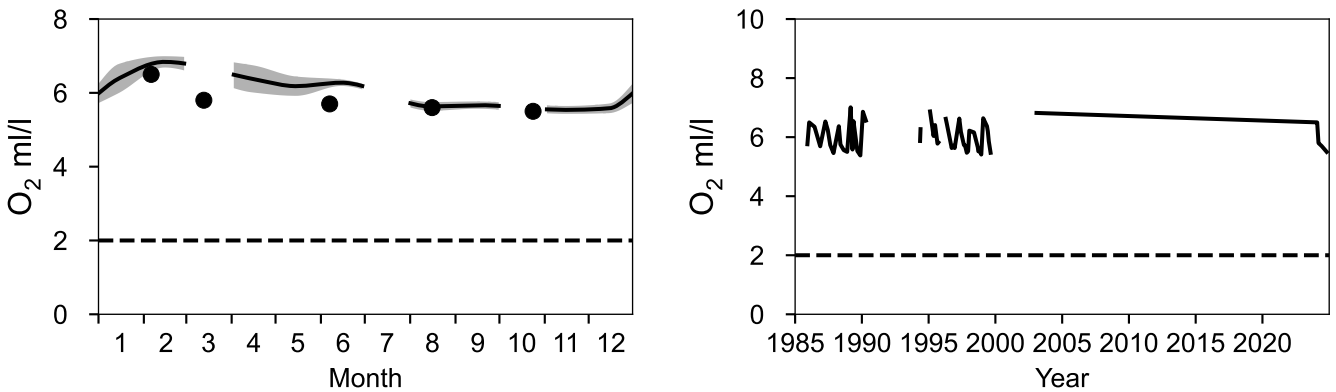


STATION Å16 SURFACE WATER (0-10 m)

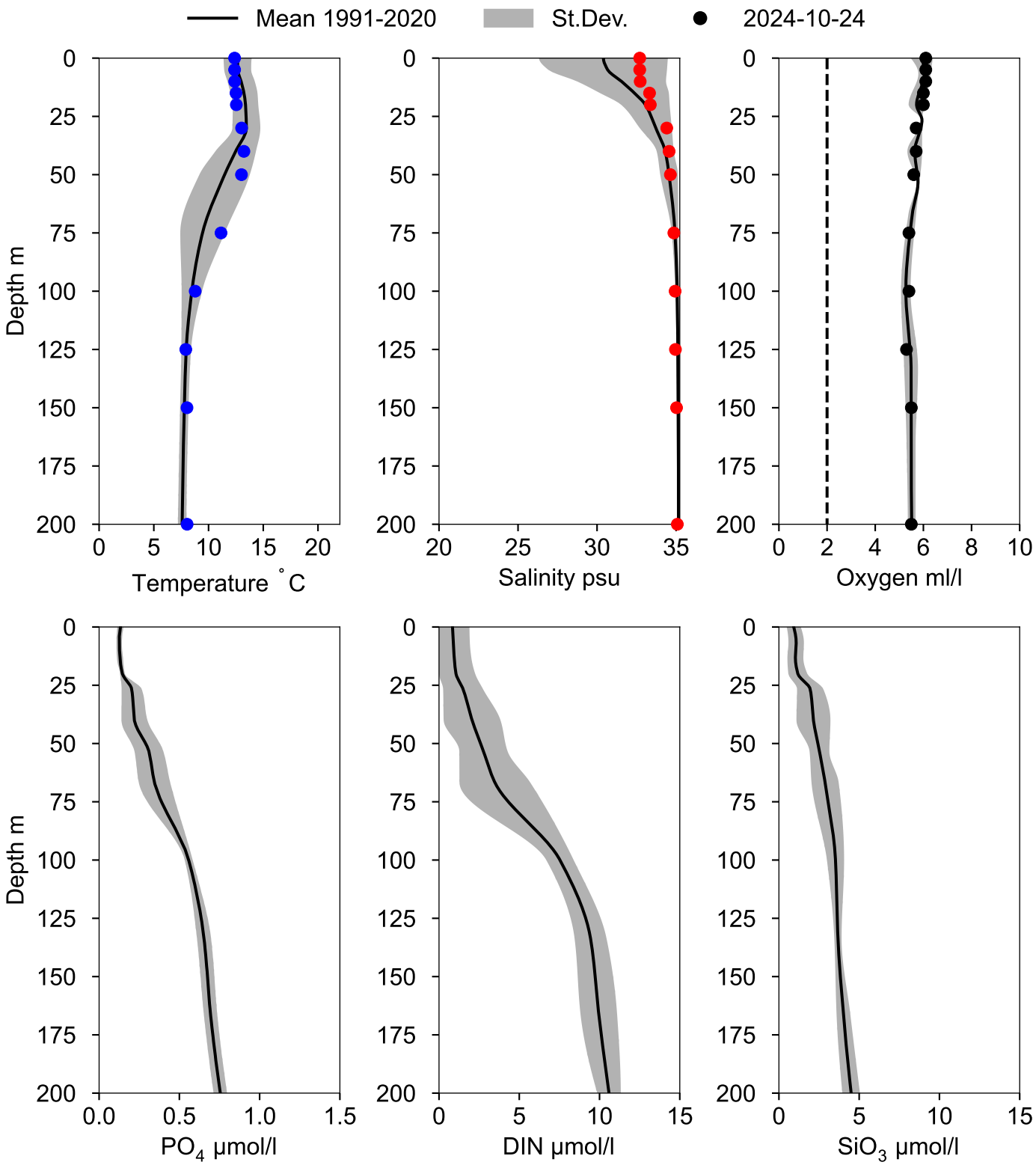
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 193 m)

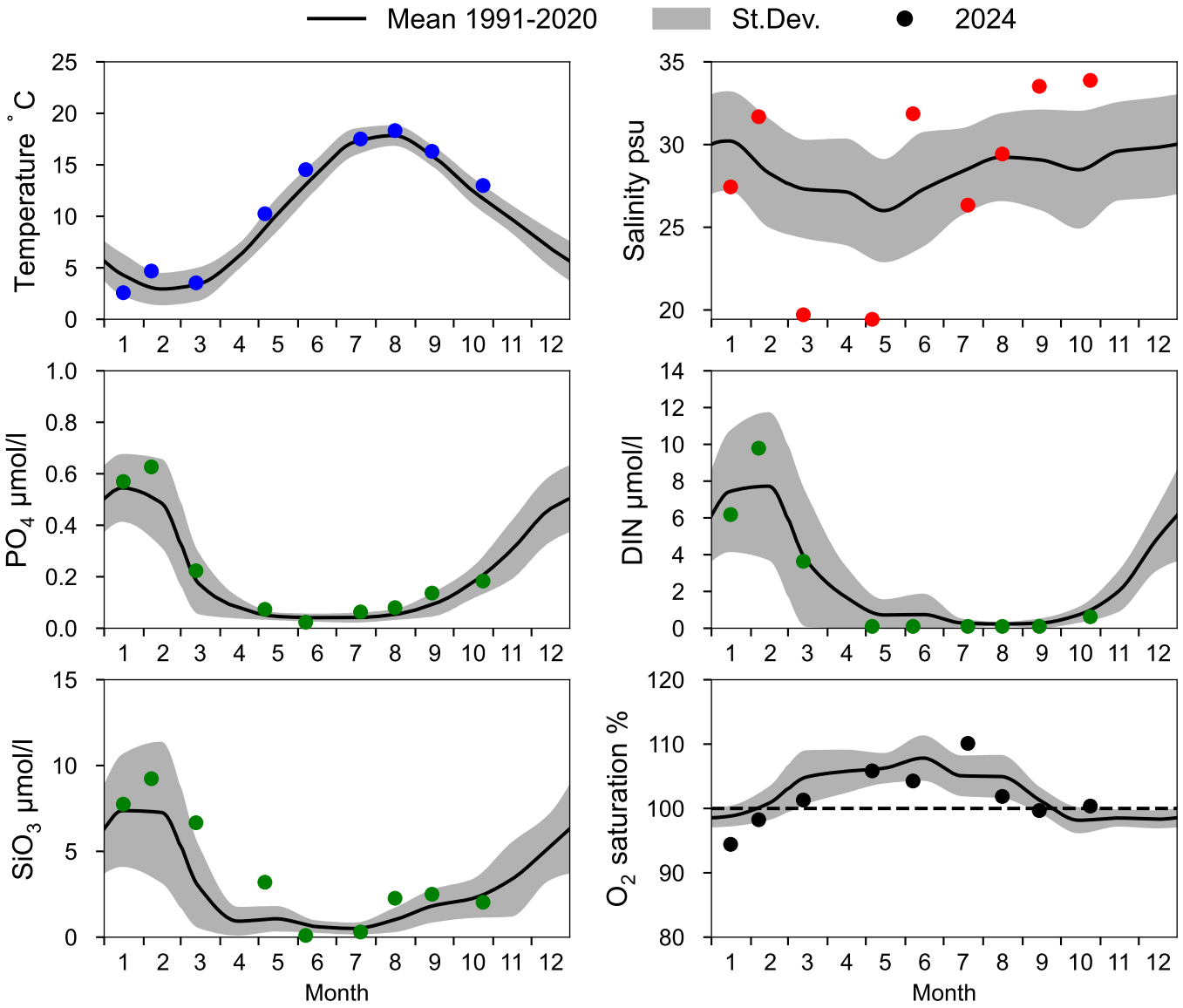


Vertical profiles Å16
October

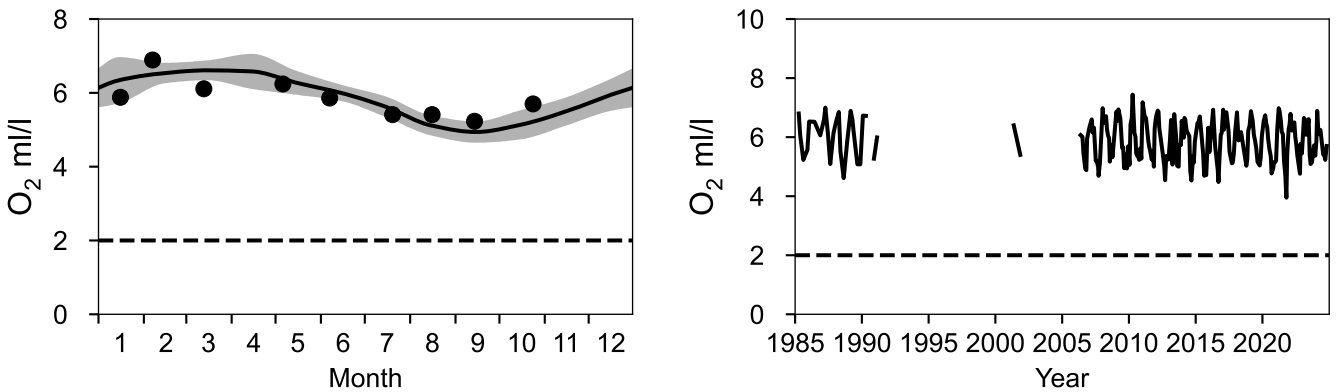


STATION Å13 SURFACE WATER (0-10 m)

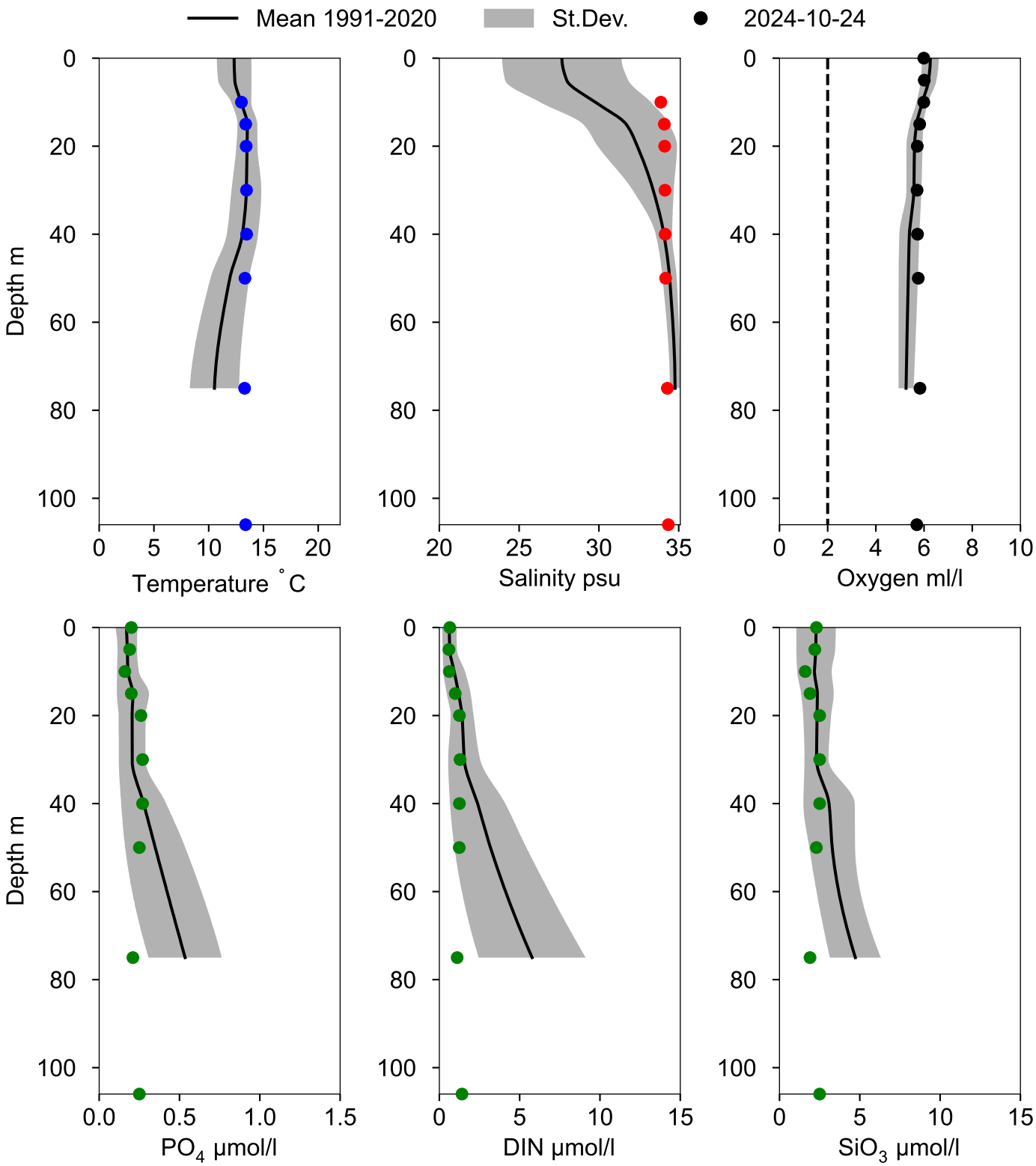
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 82 m)

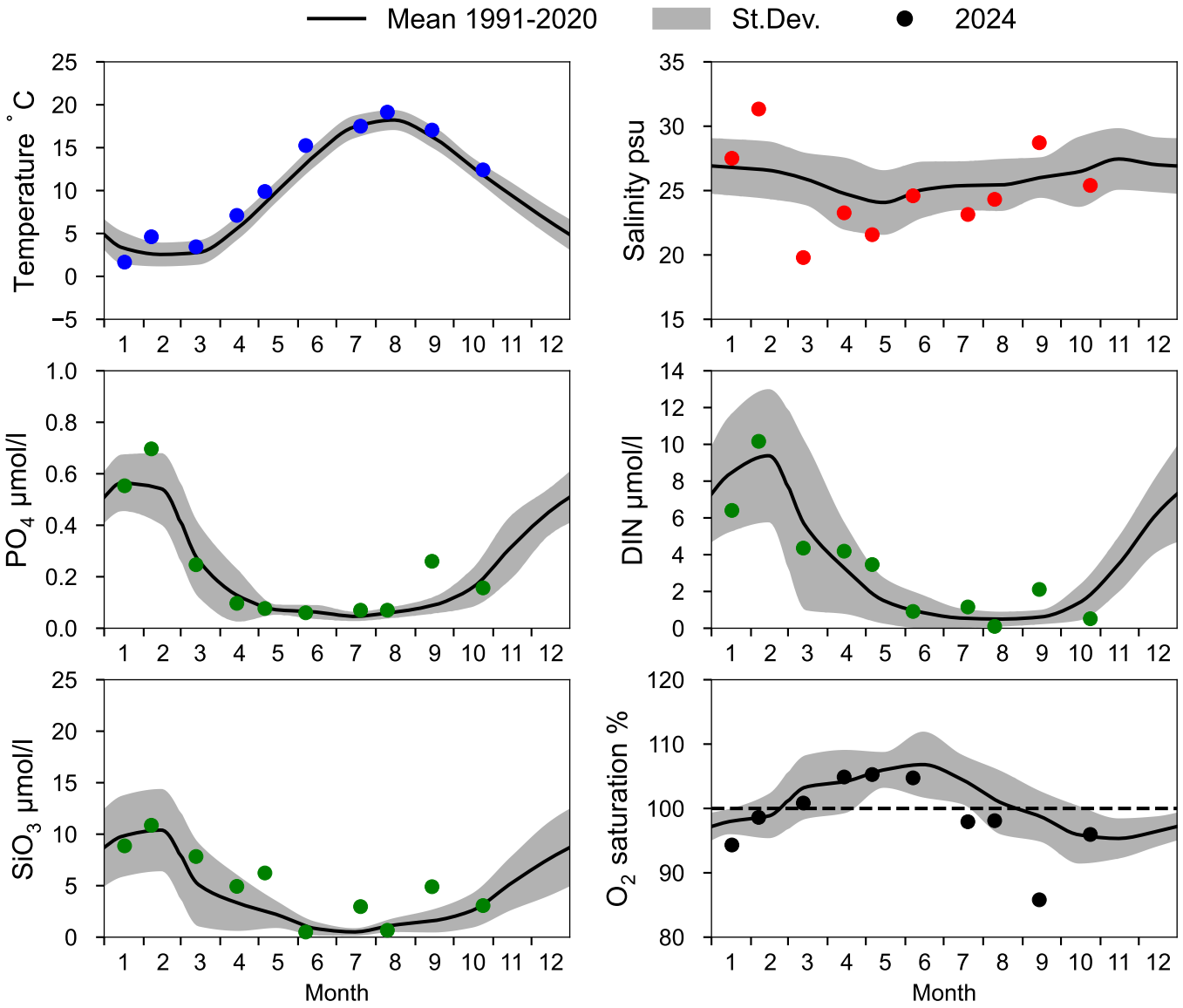


Vertical profiles Å13
October

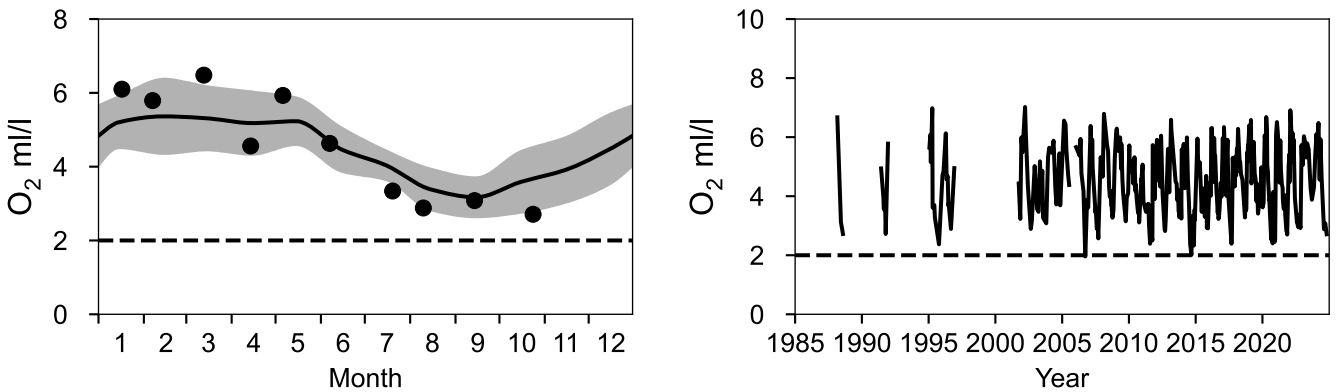


STATION SLÄGGÖ SURFACE WATER (0-10 m)

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)



Vertical profiles SLÄGGÖ
October