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Oceanografiska Laboratoriet

2024–05–03
Dnr: 2024/33/3.1.3

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

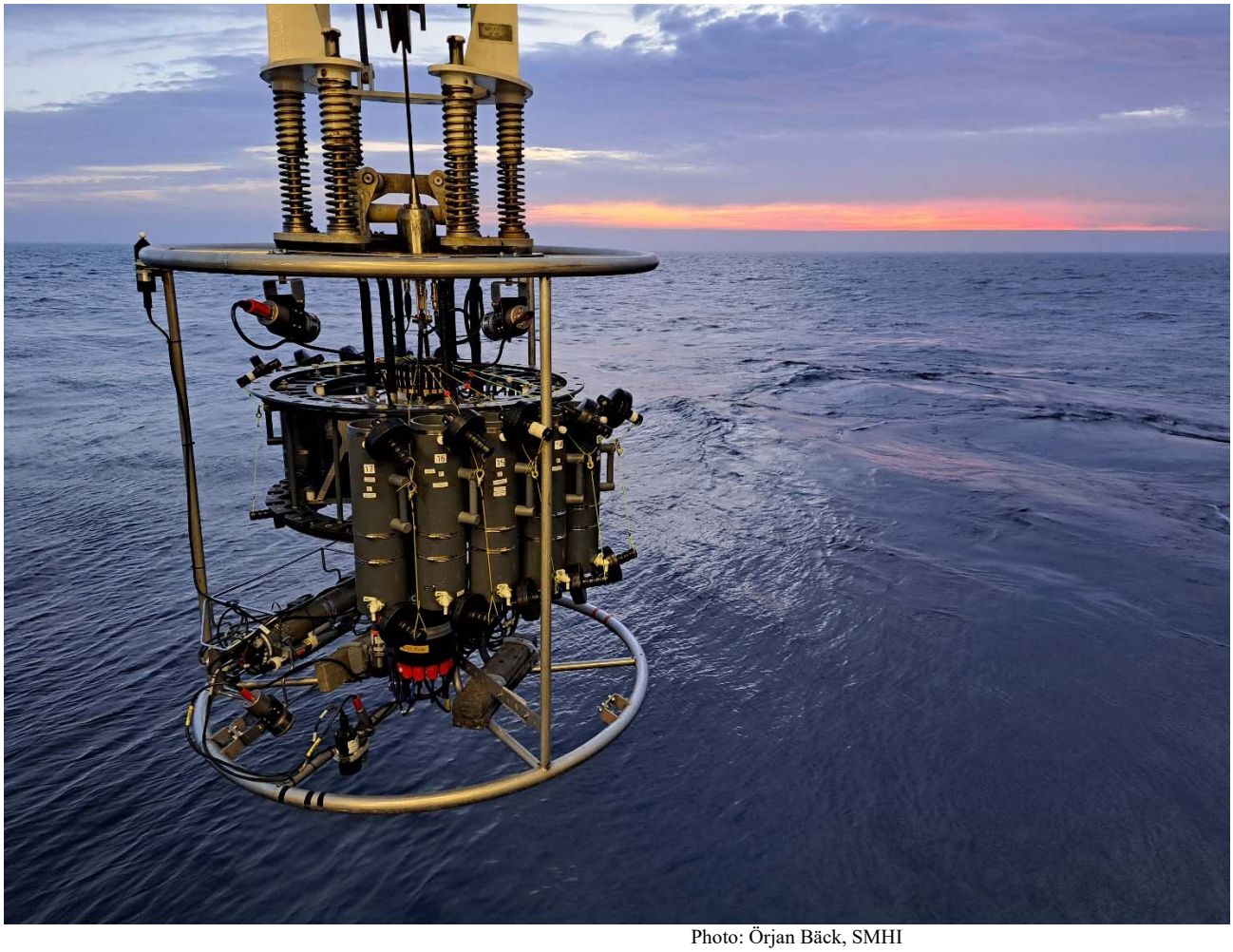

Photo: Örjan Bäck, SMHI

Survey period: 2024-04-09 to 2024-04-15

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 Kattegat, Öresund, the Baltic Proper and a coastal station in Skagerrak were visited during this cruise, which is part of the Swedish environmental monitoring program area coast and sea.

The surface water temperature was normal for the month, around 7 °C on the west coast and varied between 3 to 5 °C in the Baltic Sea. In the Southern Baltic Sea and Öresund, the salinity in the surface water was slightly below the monthly average, while in the Northern Baltic Sea, it was slightly above average.

The concentrations of nutrients were low both in the Kattegat and the Southern Baltic Sea but within the normal range. Inorganic nitrogen was largely depleted after the spring bloom. In the Eastern and Western Gotland Basins, the levels of both inorganic nitrogen and phosphorus were higher than normal near the surface. Below the halocline, values were also higher than normal at several stations, especially near the bottom. Silicate levels were somewhat higher than normal throughout the Baltic Sea.

The oxygen situation in the bottom water was good (>4 ml/l) at all stations in the Skagerrak, the Kattegat, Öresund and the Arkona Basin west of Bornholm, no oxygen deficiency was noted. In Hanö Bay and the Bornholm Basin east of Bornholm, the oxygen levels in the bottom water varied between 2 to 3 ml/l, just above the threshold for acute oxygen deficiency (<2 ml/l). In the Eastern and Western Gotland Basins, hydrogen sulphide was noted from about 80 metres depth, and the concentration increased towards the bottom. At all stations with hydrogen sulphide in the deep water, concentrations were higher than the monthly average for the reference period and have been so at these stations for the past few years.

RESULTS

The expedition was conducted with the research vessel R/V Svea and started in Kalmar on April 9 and ended in Lysekil on April 15. The weather during the expedition was mostly cloudy and windy with gale force winds in the northeastern Baltic Proper and storm gusts on the west coast. In the April issue of Weather and Water (only available in Swedish), one can read about high waves in Skagerrak and a wind record in Halland on April 14, which coincided with Svea's passage through Kattegat and Skagerrak, https://www.smhi.se/klimat/klimatet-da-och-nu/manadens-vader-och-vatten-sverige. The air temperature varied between 5 and 9 degrees Celsius.

Due to strong winds and high waves, almost all sampling stations in Skagerrak had to be cancelled, with only the coastal station Släggö in the fiord Gullmarn being sampled. Several stations in the Eastern Baltic Proper were also cancelled: BY15, BY10, and BCSIII-10, due to safety concerns following disturbances and a potential attack in Kaliningrad. As a replacement for BY15, station BY13, located slightly further west within the Swedish economic zone, was sampled. Winch problems at BY31 prevented the collection of net samples for both phytoplankton and zooplankton.

Svea's ferrybox operated for almost the entire expedition, but there were some short stops due to maintenance and sensor replacement. A reference sample for chlorophyll analysis was taken daily from the ferrybox. The Moving Vessel Profiler (MVP) instrument, used for measuring profiles underway, was only operated from Östergarnsholm to BY13 and across the Stolpe Channel in the southern Baltic Proper due to speed restrictions until its cable has been replaced. Since one of Svea's two ADCPs (Acoustic Doppler Current Profilers) was broken, it could not be operated at full capacity.

At the ocean buoy at Huvudskär, an extra wave buoy used for reference measurements and comparison with the ocean buoy's wave sensor was retrieved.

At Östergarnsholm, a measurement buoy was deployed by a technician from Uppsala University who participated throughout the expedition; however, the recovery of a bottom-mounted ADCP failed, likely due to a malfunctioning remote releaser.

Four guests from Lund University also participated in the expedition, focusing on identifying chemical alarm signals between phytoplankton and zooplankton.

This report is based on data that has undergone initial quality control and is compared against the monthly average for the period 1991–2020. After further quality review, some values may change. The values reported have been rounded to the nearest tenth and may therefore differ from published values. Data is published as soon as possible on the data host's website, normally within a week after the expedition. Some analyses are conducted post-expedition and are published later, thus not included in this report.

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

Since only Släggö could be sampled in the Skagerrak due to strong winds and high seas, only results from there are reported. These results are not representative of the entire Skagerrak as Släggö is located near the coast inside the fiord Gullmarn.

Measured values were within the normal range for the month, with only silicate showing slightly higher values than usual. The temperature was just over 7 °C in the surface and changed only one degree down to the bottom. A halocline was observed at around 15 metres, with a salinity of about 23 psu at the surface and 34 psu at the bottom.

The concentration of dissolved inorganic nutrients was normal for the month, lower above the halocline and then increasing towards the bottom.

Oxygen concentration decreased with depth, reaching a minimum of 4.5 ml/l near the bottom.

Fluorescence measurements with the CTD[1] showed activity in the surface layer down to 15 metres, with very low values below that.

The Kattegat and Öresund

The surface water temperature was around 7 °C, which is normal for the month. Below the halocline, slightly lower temperatures were measured, between 5 and 6 °C. The salinity in the surface water was normal in Kattegat, between 17 and 21 psu, and slightly higher than normal in Öresund, around 22 psu. The halocline was found at 8 metres in Öresund and at just under 15 metres in Kattegat.

The concentrations of dissolved inorganic nutrients in the surface water were low but within the normal range, with inorganic nitrogen being almost depleted in the surface layer. Below the halocline, nutrient levels increased, most notably at Fladen just below the halocline, between 15 and 30 metres, where DIN (Dissolved Inorganic Nitrogen) and silicate were significantly higher than normal. Otherwise, normal values for the season were measured.

Oxygen levels in the bottom water were normal for the season, just over 6 ml/l at all stations in the Kattegat and just under 6 ml/l in Öresund.

Fluorescence measurements with the CTD showed activity in the surface layer above the halocline.

The Baltic Proper

The surface temperature was normal for the month at all stations in the Baltic Sea, ranging from around 3 °C in the north to just over 5 °C in the south. The temperature increased slightly below the halocline to a maximum of just over 7 °C, with temperatures in both the Eastern and Western Gotland Basins being somewhat higher than the monthly average.

The salinity in the surface layer was lower than normal in both the Arkona and Bornholm Basins, ranging between 7.1 and 7.3 psu. In the northern part of the Eastern and Western Gotland Basins,

[1] CTD is a profiling measurement instrument which stands for Conductivity, Temperature and Depth. SMHI's CTD is also equipped with sensors that measure dissolved oxygen and fluorescence among other things.

the salinity was instead slightly higher than normal, around 7 to 7.5 psu. The halocline in the Baltic Sea started at 37 metres in the Arkona Basin, at just under 50 metres in the Hanö Bay, and around 45 metres in the Bornholm Basin. At other stations, the halocline started at around 60 metres; at BY38, the halocline was weak with a minor stratification at 90 metres and an even weaker one at 30 metres.

In the Arkona and Bornholm Basins, the concentration of nutrients in the surface water was low, with DIN (Dissolved Inorganic Nitrogen) almost depleted down to the halocline. In the Eastern and Western Gotland Basins, DIN levels were instead higher than normal near the surface, but also below the halocline values were higher than normal at several stations, especially near the bottom. The highest concentration was measured near the bottom at BY20, at just under 20 µmol/l.

Phosphate levels at the stations around Bornholm were at normal levels both above and below the halocline, possibly slightly low near the bottom in the Bornholm Basin. In the Eastern and Western Gotland Basins, phosphate concentrations were slightly higher than normal throughout the water column, peaking at the bottom at BY20 with just over 5 µmol/l. Silicate levels were slightly higher than normal throughout the Baltic Sea, with a maximum of just over 80 µmol/l at the bottom at BY20.

In the Arkona Basin, the oxygen situation in the bottom water was good, although the oxygen concentration near the bottom at BY1 was somewhat lower than normal. In the Bornholm Basin and Hanö Bay, the oxygen concentration was low, between 2 and 3 ml/l, which is normal for these stations compared to the reference period 1991–2020. At the shallow station BY39, the oxygen level at the bottom was almost 9 ml/l, which is also normal for April, as this station is usually shallower than the permanent halocline, and the entire water column is well mixed with little variation between the surface and the bottom. At other stations, hydrogen sulphide was present at the bottom; hydrogen sulphide forms only when all oxygen is depleted. Generally, hydrogen sulphide was observed from around 80 metres depth, with increasing concentrations towards the bottom. At all stations with hydrogen sulphide in the deep water, concentrations were higher than the monthly average for the reference period and have been so at these stations in recent years, with the highest concentration measured at the bottom at BY20, at 90 µmol/l.

Fluorescence measurements showed phytoplankton activity throughout the Baltic Sea, primarily in the surface layer down to 20-25 metres, but sometimes down to 40 metres, with the highest values measured at the northernmost stations.

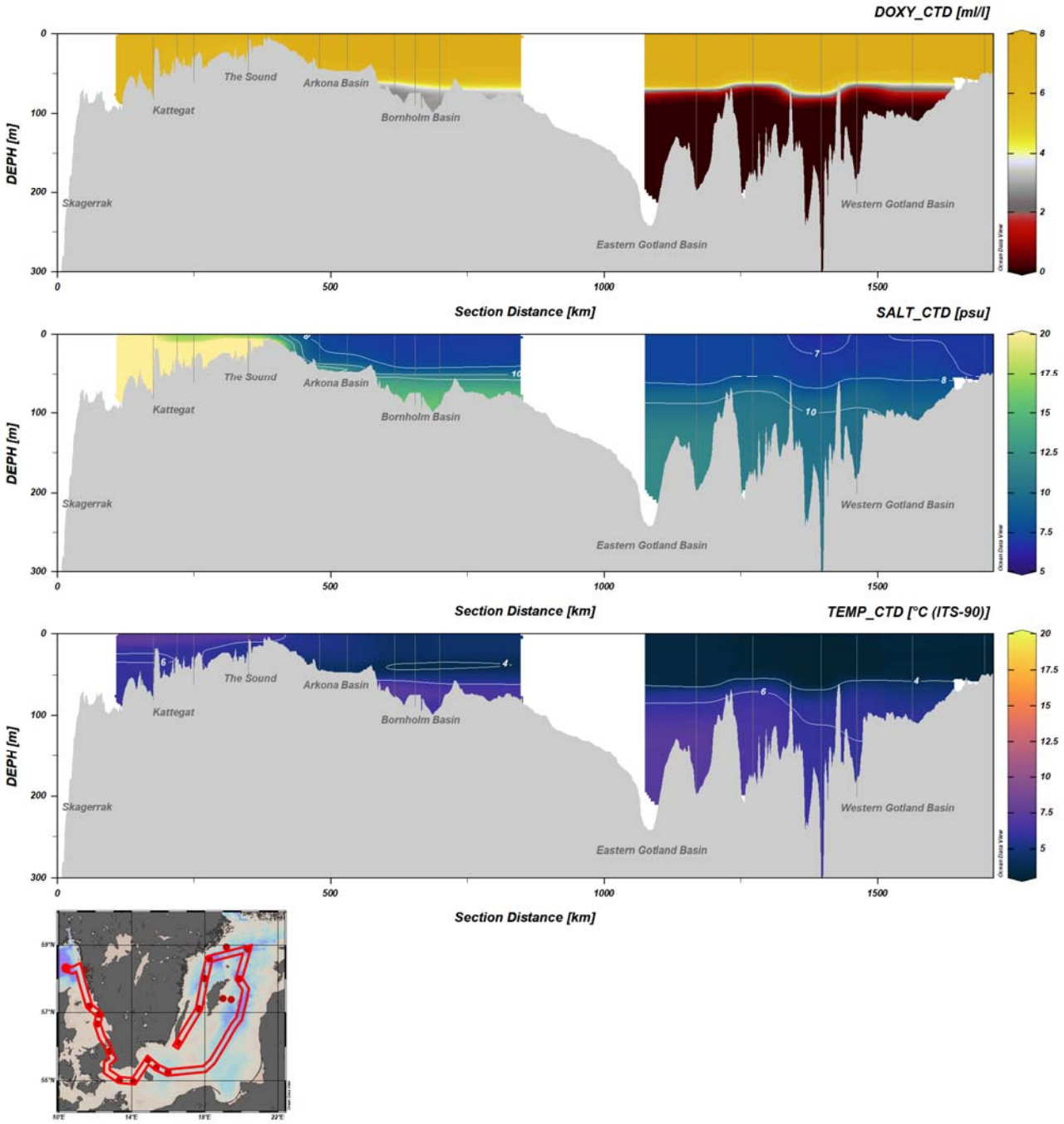


Figure 1. Transect showing CTD measurements of dissolved oxygen concentration, salinity and temperature from the Skagerrak, through the Kattegat and Öresund, further into the Baltic Proper, also shown in the map (bottom). Gaps in the transect visualise areas with cancelled stations.

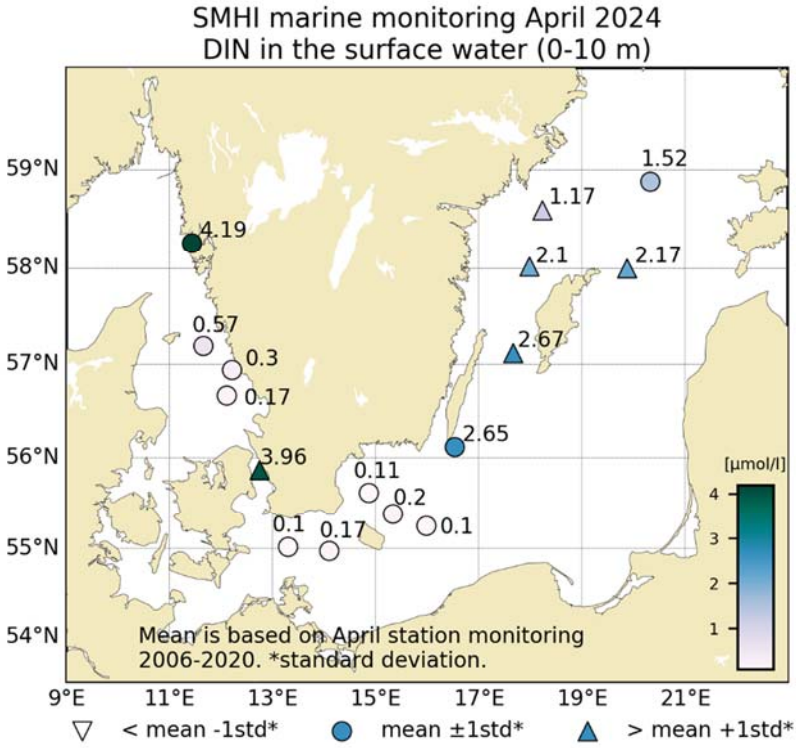


Figure 2. Concentration (µmol/l) of dissolved inorganic nitrogen (DIN) in the surface water (0-10m). Mean is based on data from the month within each basin during the years 1991 – 2020.

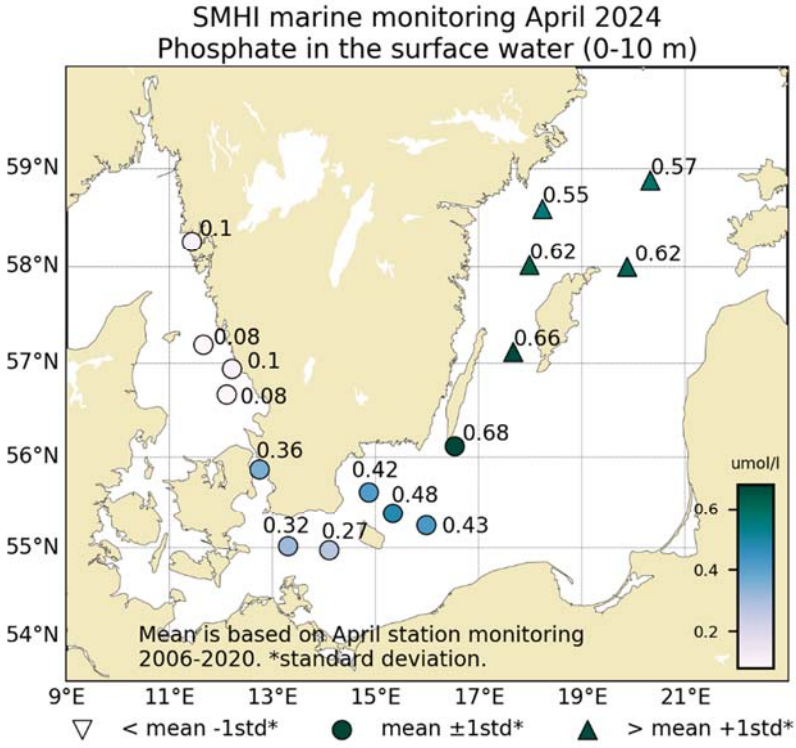


Figure 3. Concentration (µmol/l) of phosphate in the surface water (0-10m). Mean is based on data from the month within each basin during the years 1991 – 2020.

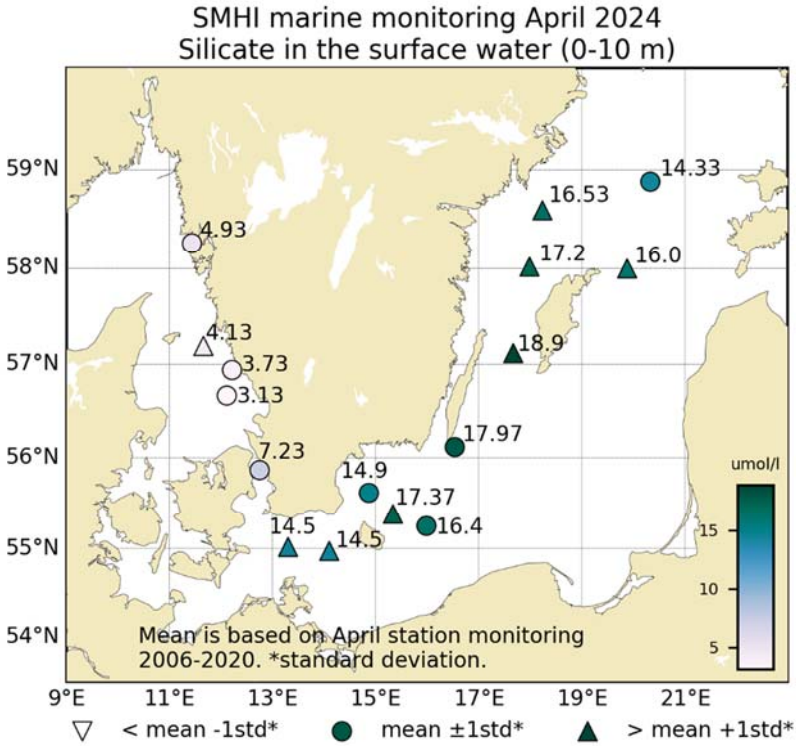


Figure 4. Concentration (µmol/l) of silicate in the surface water (0-10m). Mean is based on data from the month within each basin during the years 1991 – 2020.

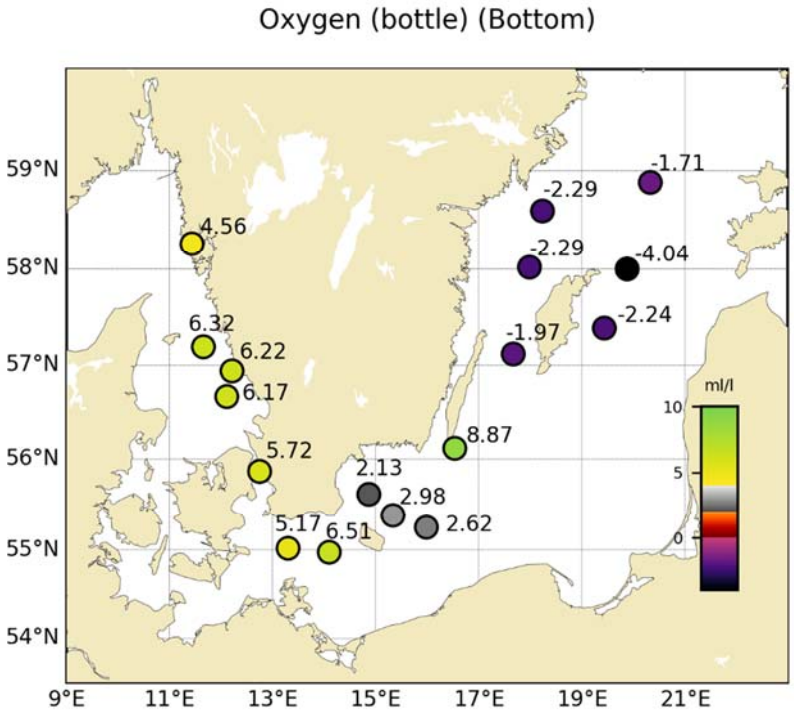


Figure 5. Dissolved oxygen concentration (ml/l) in the bottom water, approximately one meter above the seabed. Note that the values have not been compared to statistics in the same way as other similar figures, that's why only circles are shown. Presence of hydrogen sulphide is shown as negative oxygen.

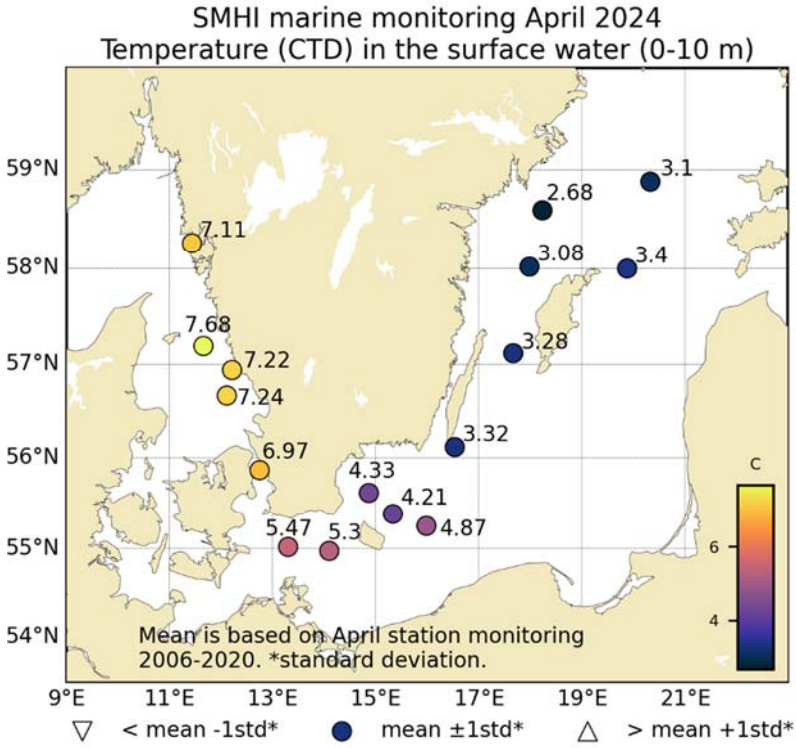


Figure 6. Temperature in the surface water (0-10m). Mean is based on data from the month within each basin during the years 1991 – 2020.

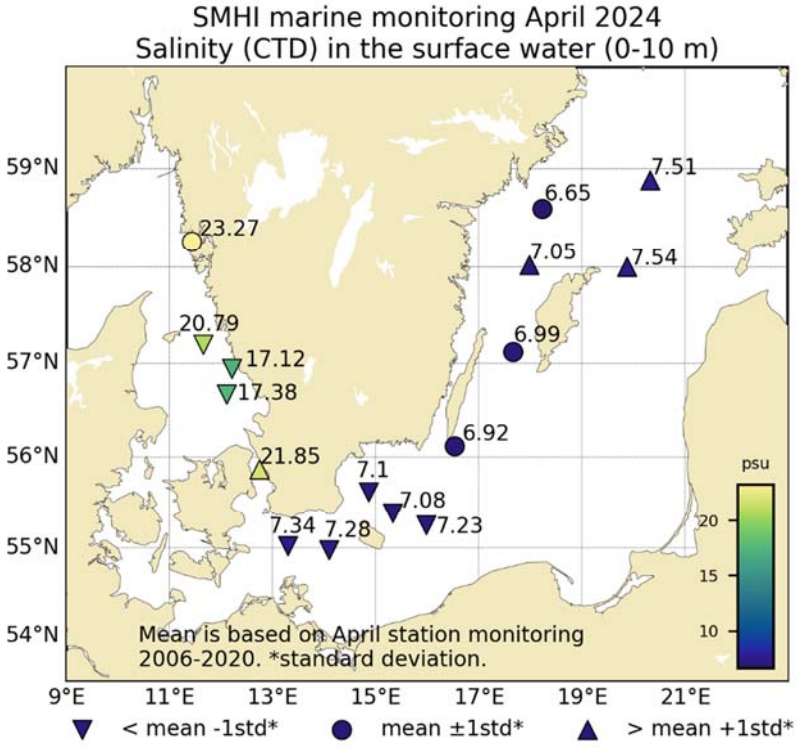


Figure 7. Salinity in the surface water (0-10m). Mean is based on data from the month within each basin during the years 1991 – 2020.

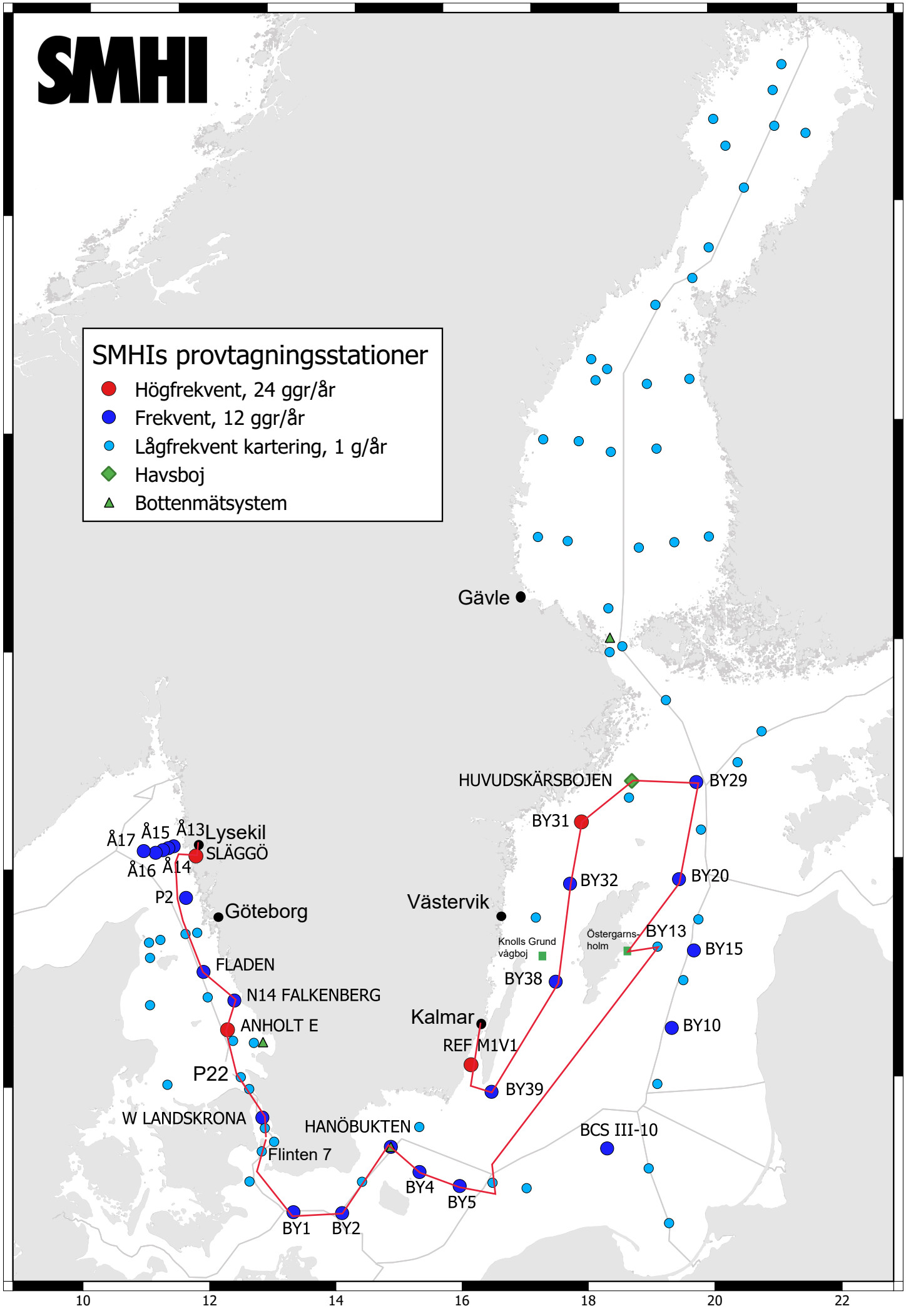
PARTICIPANTS

Name	Role	From
Örjan Bäck	Chief Scientist, Oceanographer	SMHI
Ann-Turi Skjevik	Marine biologist	SMHI
Sari Sipilä	Chemist	SMHI
Johan Kronsell	Oceanographer	SMHI
Johan Håkansson	Quality Manager, Chemist	SMHI
Ada Behncké Serra	MSc student	Lund University
Paula Gonzalo Valmala	MSc student	Lund University
Andrra Zhjeqi	MSc student	Lund University
Luisa Jaeger Marques	MSc student	Lund University
John Prytherch	Technician	Uppsala University

APPENDICES

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

SMHI SWEDAC ACKREDITERING Ackred. nr. 1420 Provning ISO/IEC 17025 Havs och Vatten myndigheten


SMHI
SMHIs provtagningsstationer
Högfrekvent, 24 ggr/år
Frekvent, 12 ggr/år
Lågfrekvent kartering, 1 g/år
Havsboj
Bottenmätsystem
Gävle
HUVUDSKÄRSBOJEN
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BY31
BY32
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BY13
BY15
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Time: 09:39

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 (Weath Cloud Waves Iceob)	CZPP (Chla Zoop Phytop Pp)	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
0255	09	BPSE49	BAS...	BY39 ÖLANDS S UDDE	5607.00	01632.11	20240409	1830	50		10	8.4	5.8	1008	4820	xxx-	8	8	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	x	-
0256	09	BPWX45	BAS...	BY38 KARLSÖDJ	5707.03	01740.15	20240410	0215	114		25	6	5.3	1008	9990	x---	14	14	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x	x	-	-
0257	09	BPWX38	BAS...	BY32 NORRKÖPINGSDJ	5801.01	01759.08	20240410	0805	205	9	20	9.6	5.7	1012	1330	x---	17	17	x	x	-	x	-	x	x	x	x	x	x	x	x	x	x	-	x	-	-	-
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0259	09	BPNX00	EXT...	HUVUDSKAR BUOY	5856.12	01909.87	20240410	1810	96		24	14	6.3	1015	9990	----	12		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0260	09	BPNX35	BAS...	BY29 / LL19	5852.90	02019.71	20240410	2250	178		25	14	5.4	1018	9999	x---	16	16	x	x	-	x	-	x	x	x	x	x	x	x	x	x	x	-	x	-	-	-
0261	09	BPEX26	BAS...	BY20 FÅRÖDJ	5759.87	01952.73	20240411	0630	203	8	22	12	5.4	1024	1730	x---	17	17	x	x	-	x	-	x	x	x	x	x	x	x	x	x	x	-	x	-	-	-
0262	09	BPEX00	EXT...	OSTERGARNSHOLM	5725.45	01859.94	20240411	1400	23		23	11	6.4	1020	1730	----	6		-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-
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0264	09	BPSB07	BAS...	BY5 BORNHOLMSDJ	5514.97	01559.05	20240412	1455	91	9	24	9	7.3	1025	4820	xxxx	12	12	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	x
0265	09	BPSB06	BAS...	BY4 CHRISTIANSÖ	5523.00	01520.11	20240412	1915	94		24	12	7.6	1022	9990	x---	12	12	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0266	09	BPSH05	BAS...	HANÖBUKTEN	5537.04	01452.07	20240412	2155	80		20	8	7.2	1022	9999	x---	11	11	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0267	09	BPSA03	BAS...	BY2 ARKONA	5458.28	01405.95	20240413	0340	47		25	9	6.9	1022	9990	xxx-	8	8	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-
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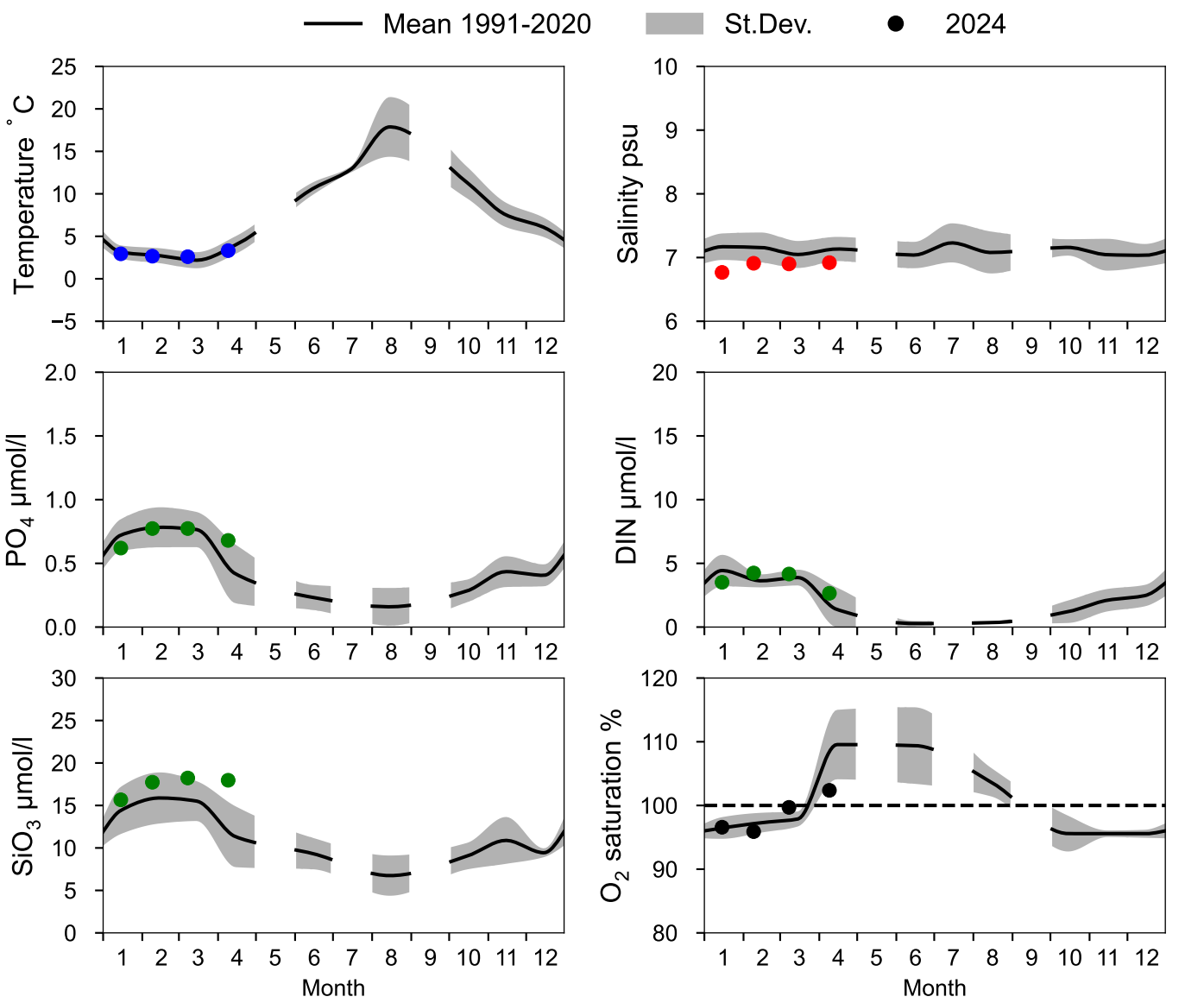
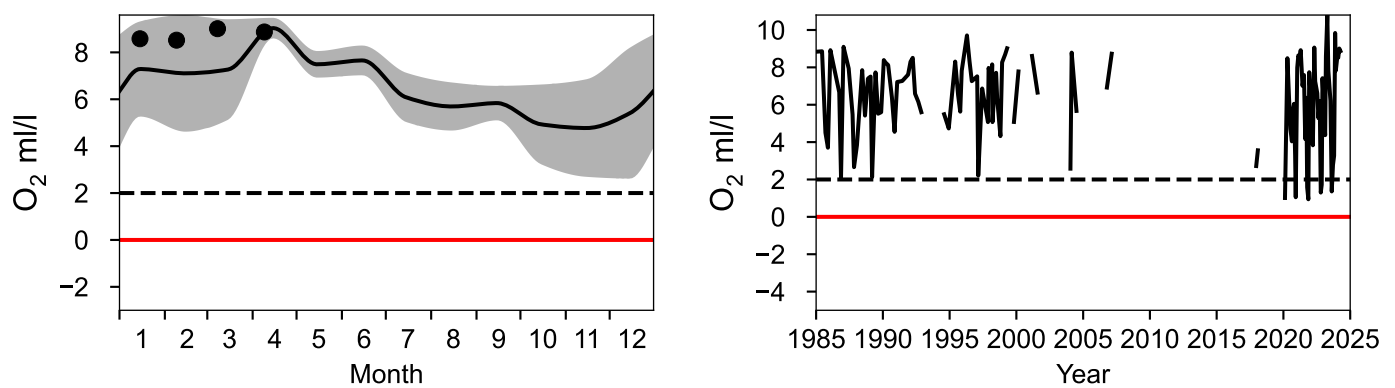
0269	09	SOCX39	BAS...	W LANDSKRONA	5552.00	01244.89	20240413	1510	50	7	27	4	13.4	1018	2820	x---	9	9	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0270	09	KAEX29	BAS...	ANHOLT E	5640.13	01206.71	20240413	2100	62		22	9	8.9	1011	9990	xxx-	10	10	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-
0271	09	KANX50	BAS...	N14 FALKENBERG	5656.37	01212.79	20240414	0015	30		23	10	8.8	1007	9990	xxx-	7	7	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0272	09	KANX25	BAS...	FLADEN	5711.55	01139.48	20240414	0615	84		27	18	7.3	1006	1550	x--x	13	13	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	-	x
0273	09	FIBG27	BAS...	SLÄGGÖ	5815.60	01126.14	20240414	1745	74	5	25	13	8.2	1007	1430	xxx-	9	9	x	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)

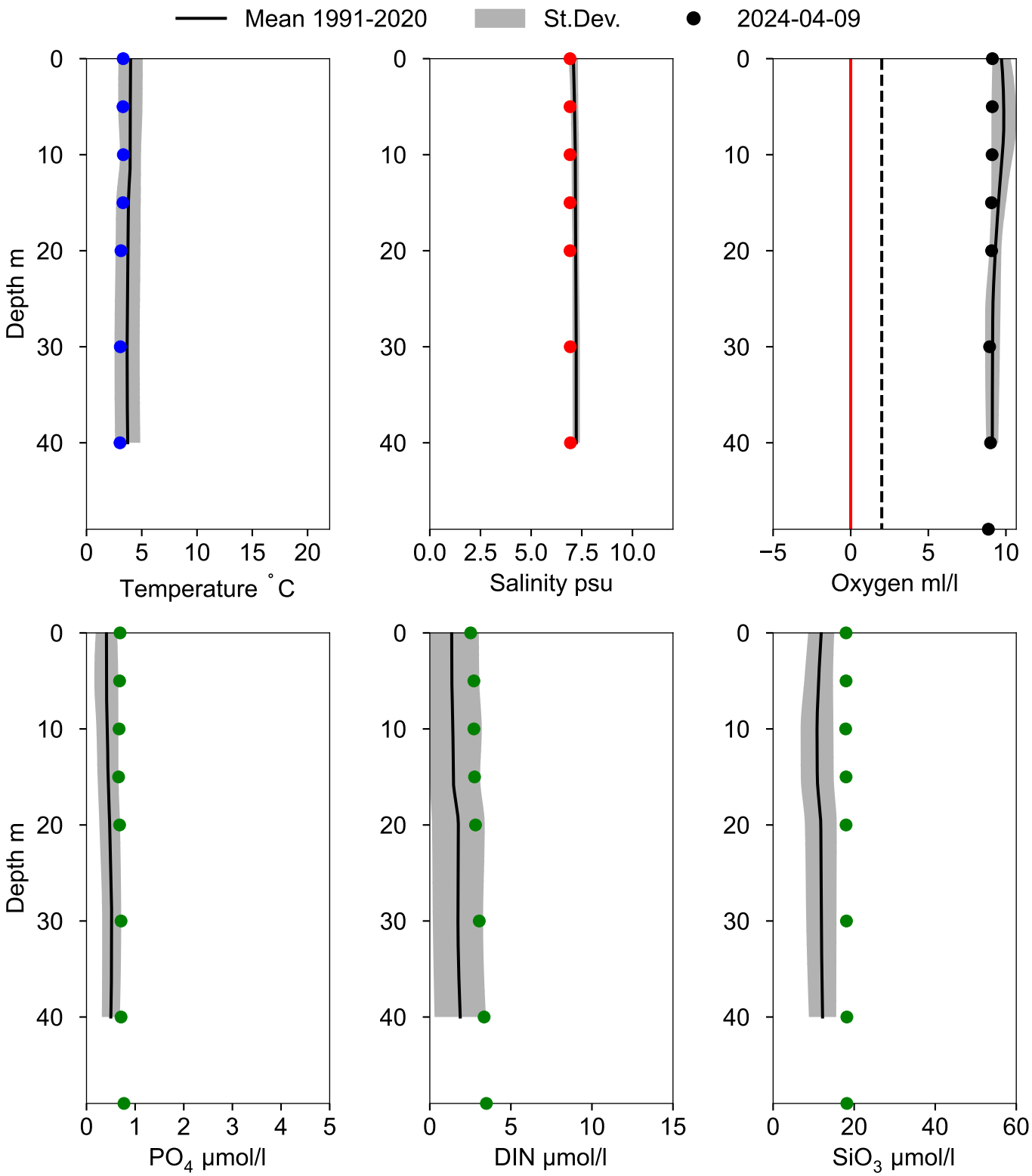
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

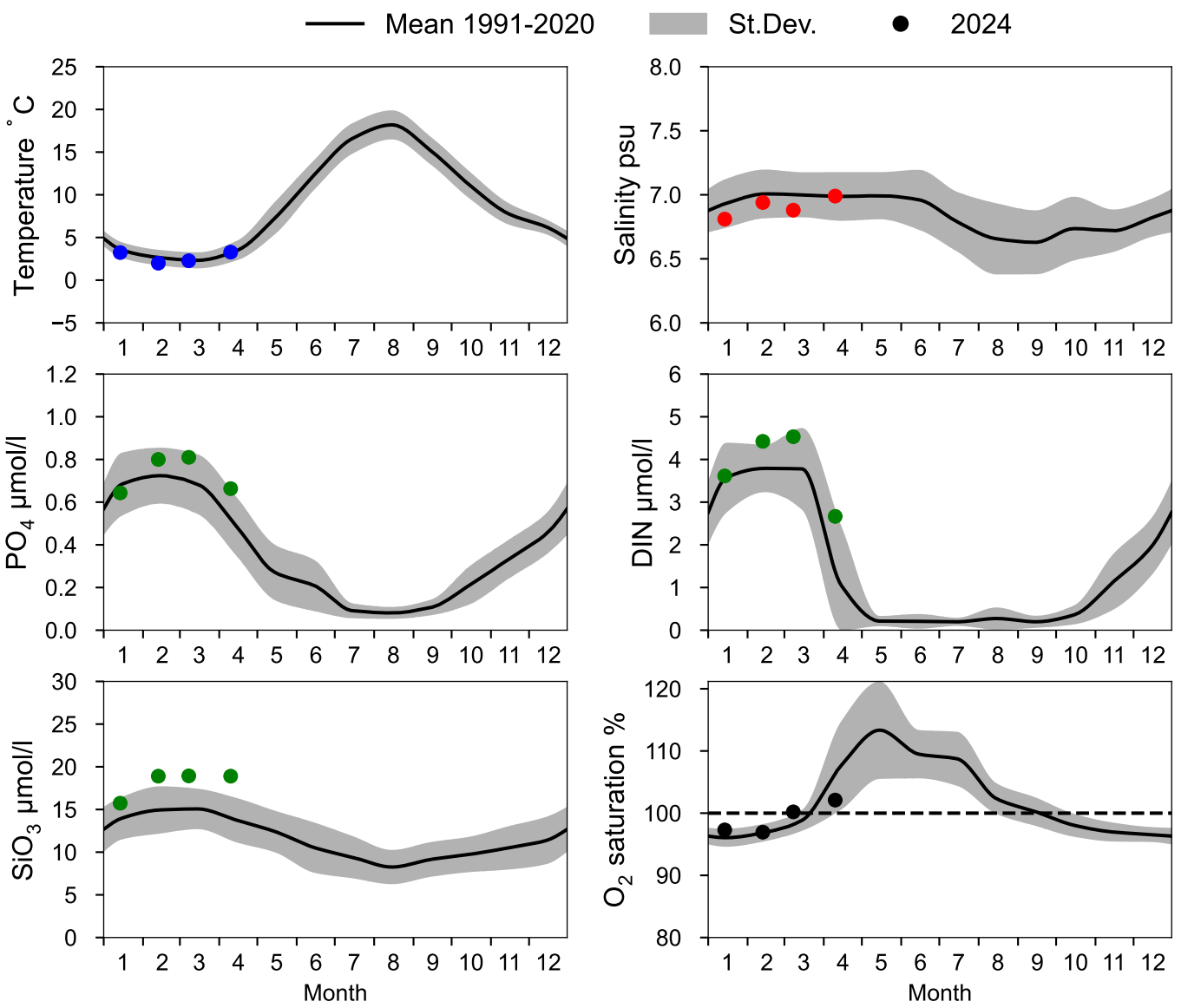


Vertical profiles BY39 ÖLANDS S UDDE
April

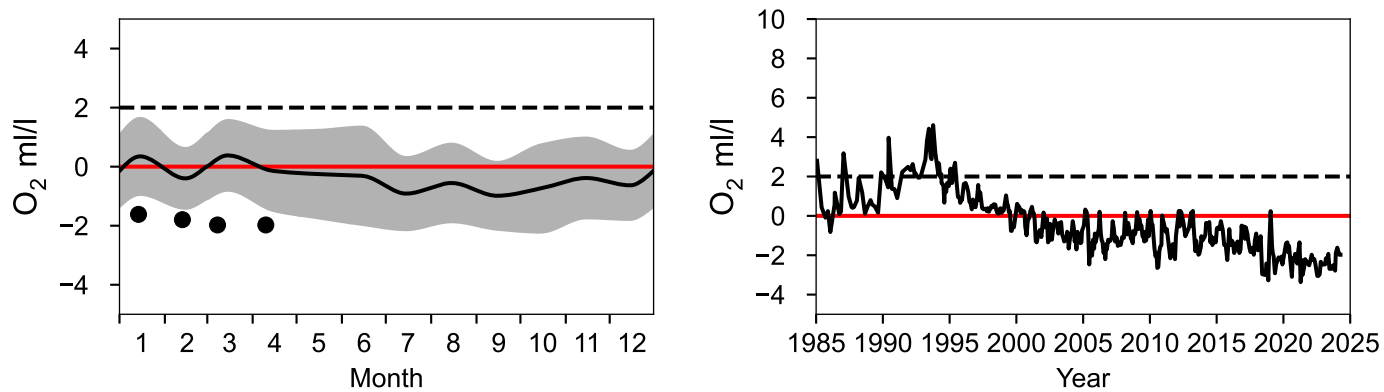


STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

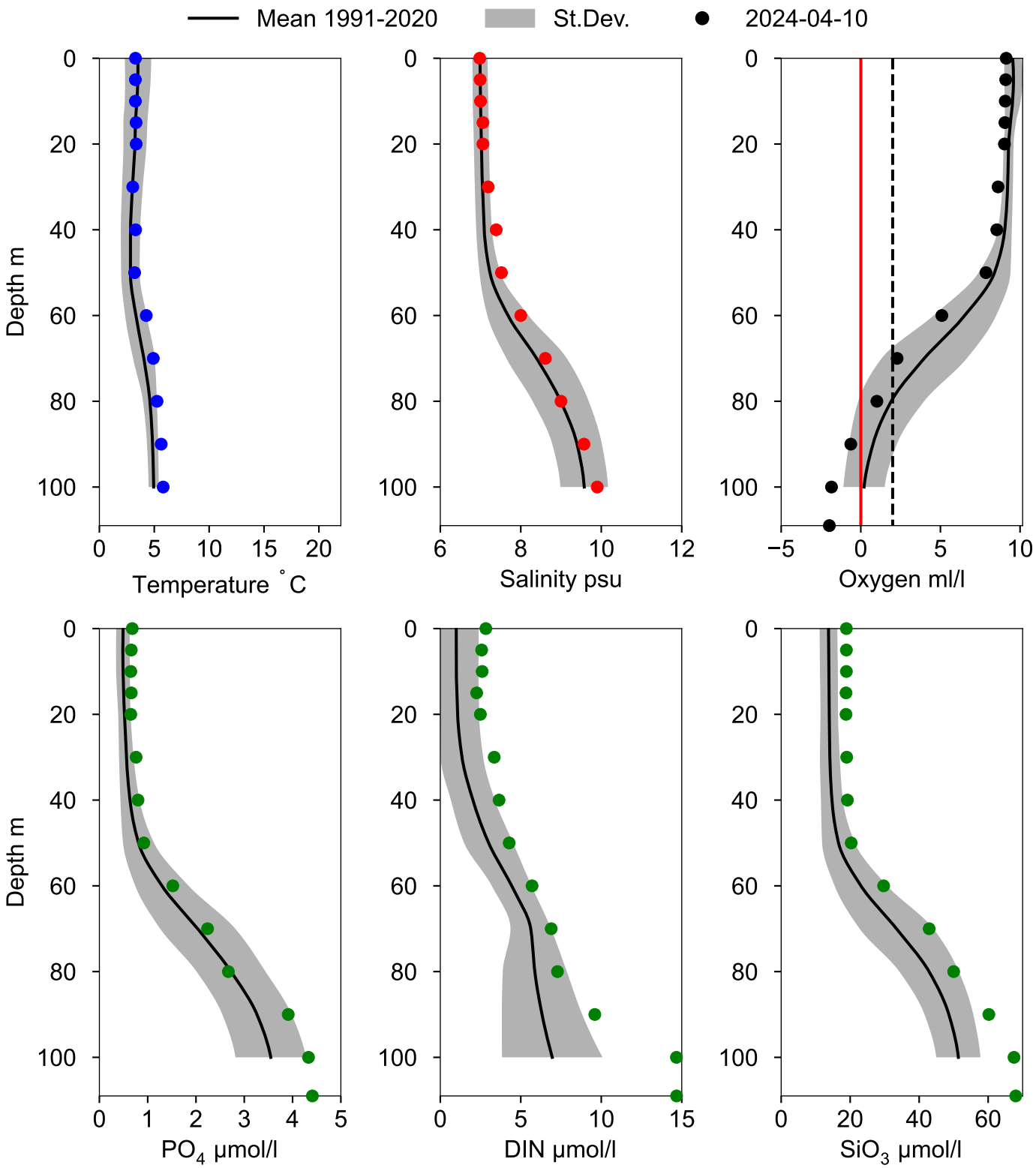
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

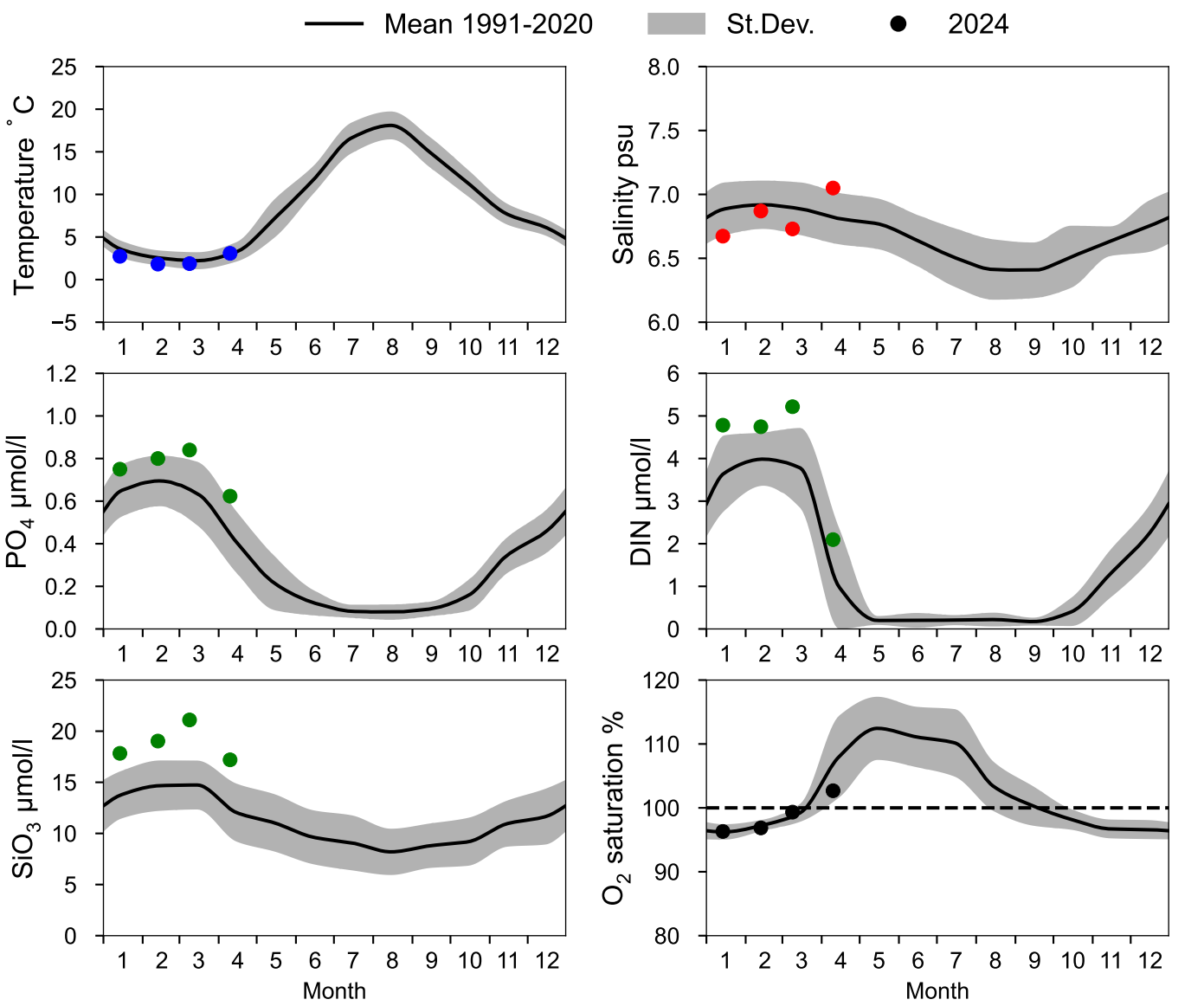


Vertical profiles BY38 KARLSÖDJ
April

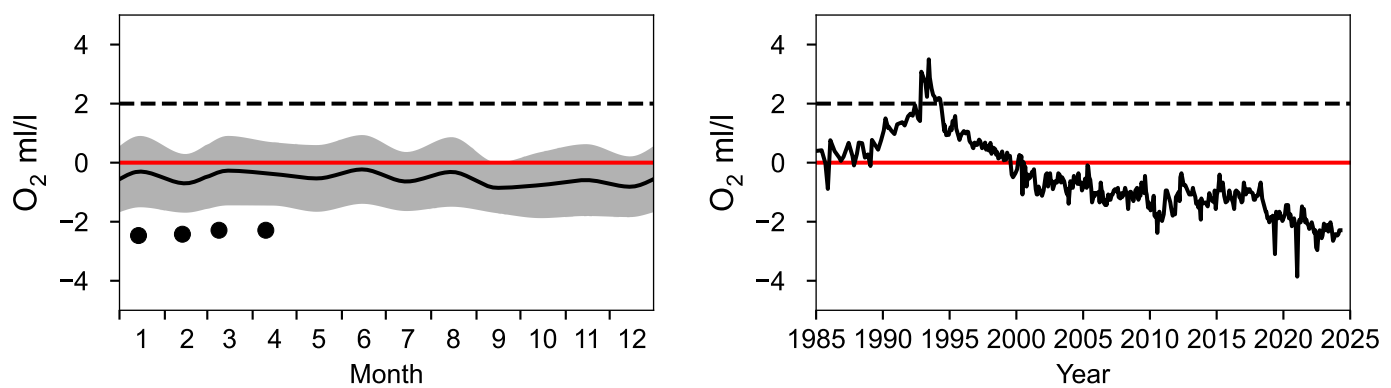


STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

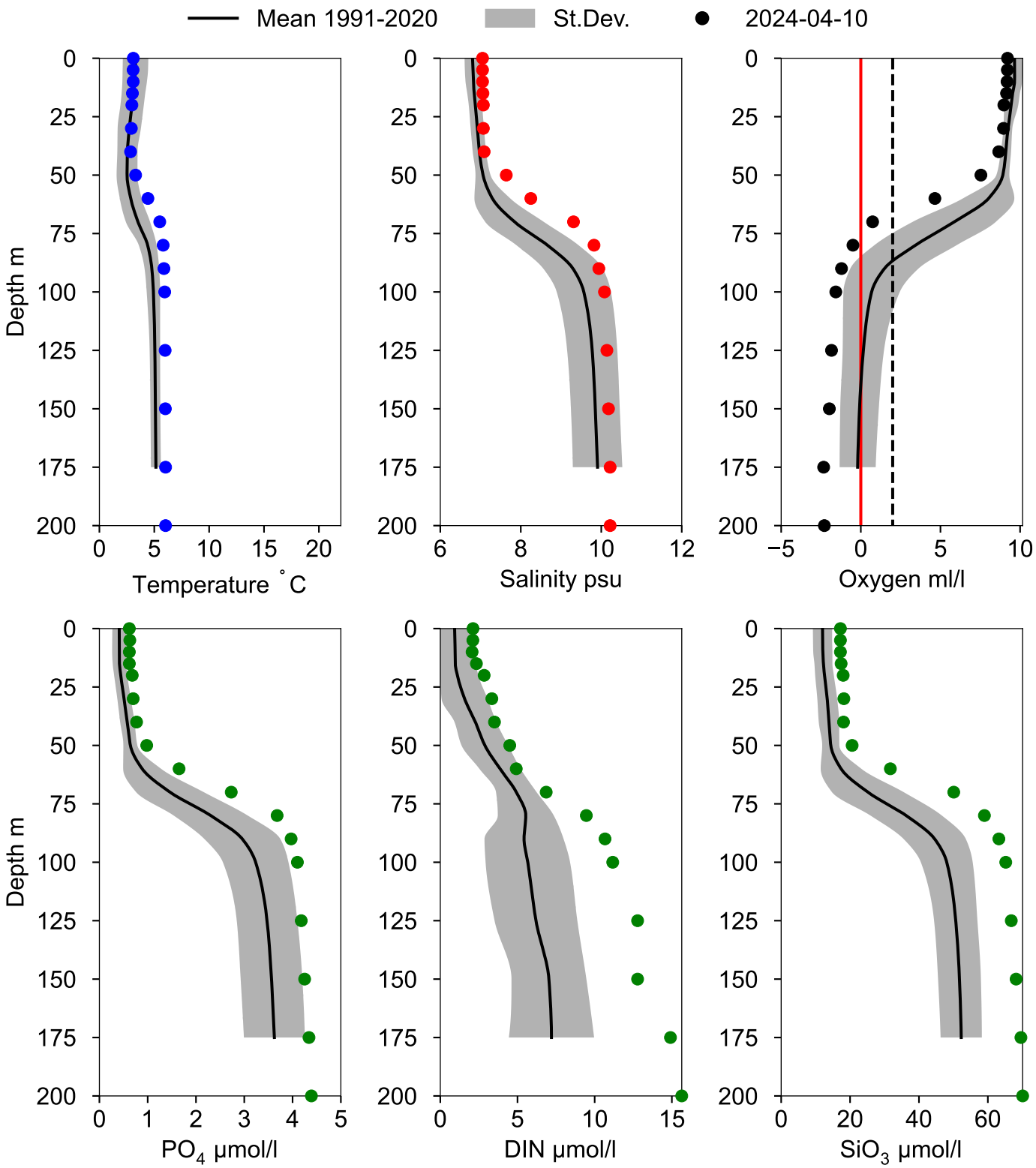
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

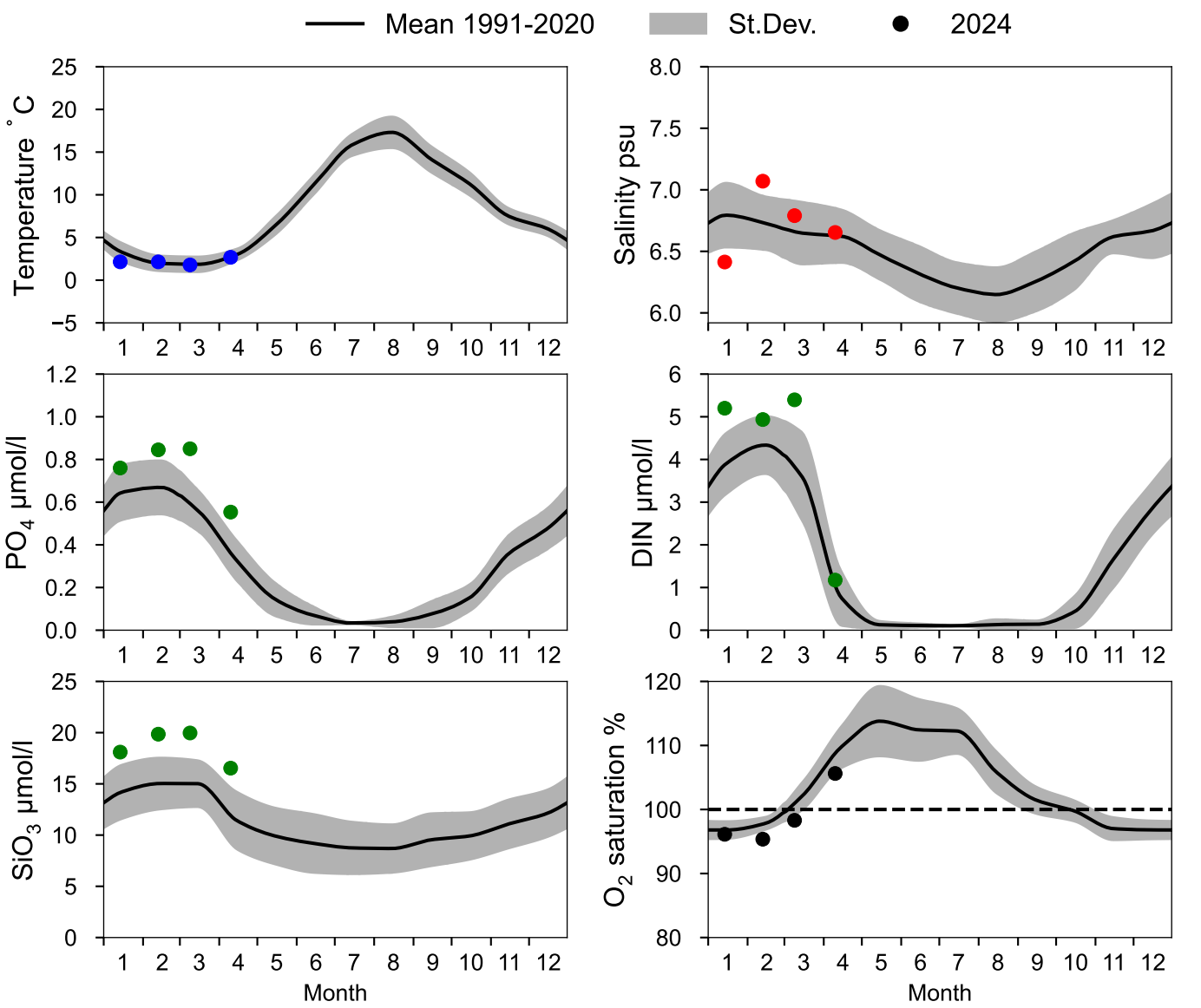


Vertical profiles BY32 NORRKÖPINGSDJ
April

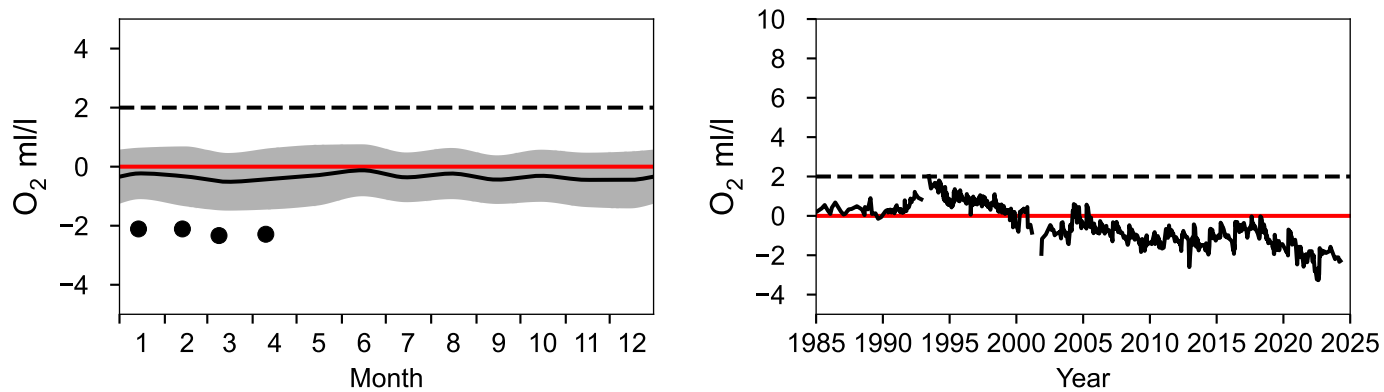


STATION BY31 LANDSORTSDJ SURFACE WATER (0-10 m)

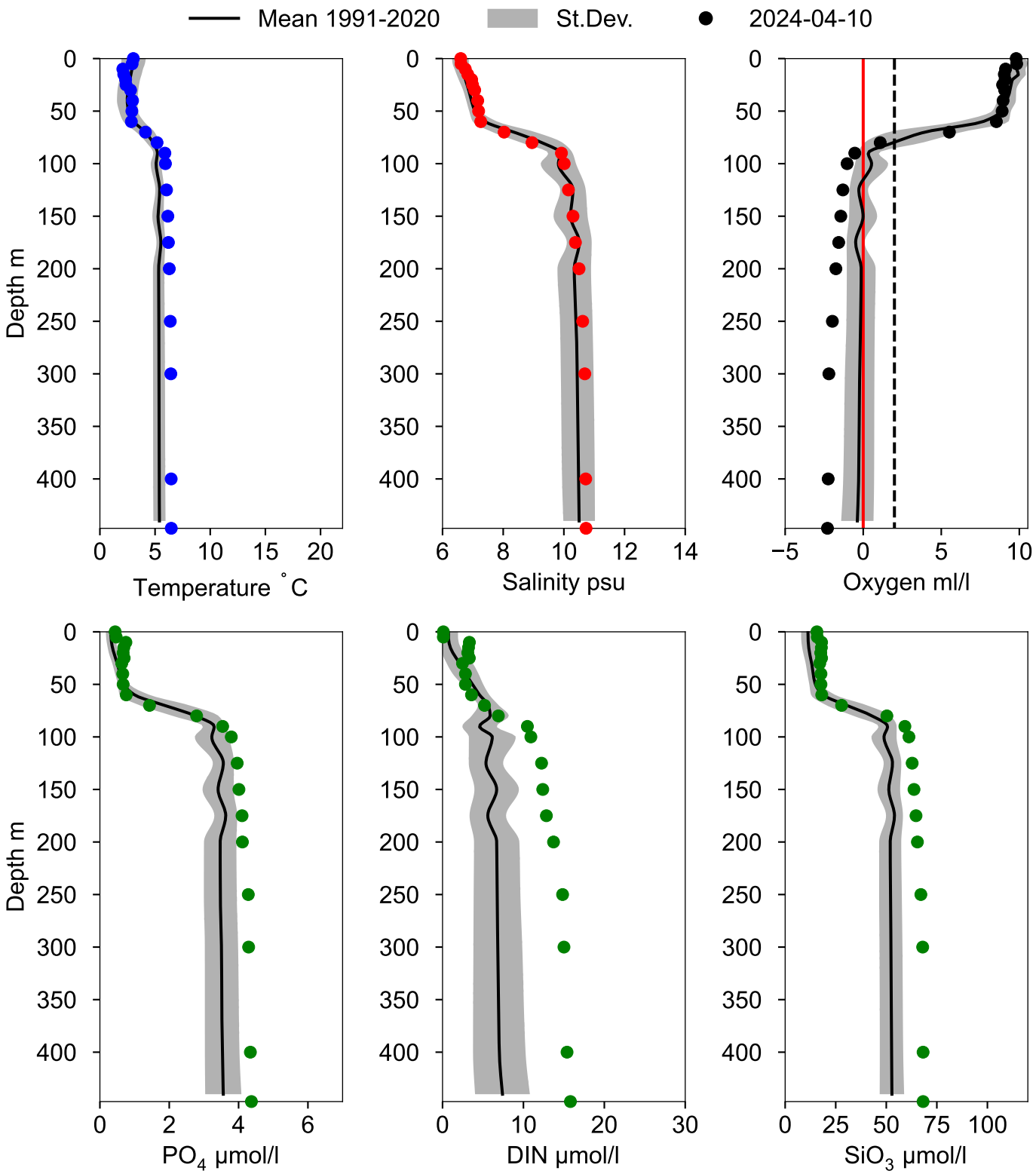
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 419 m)

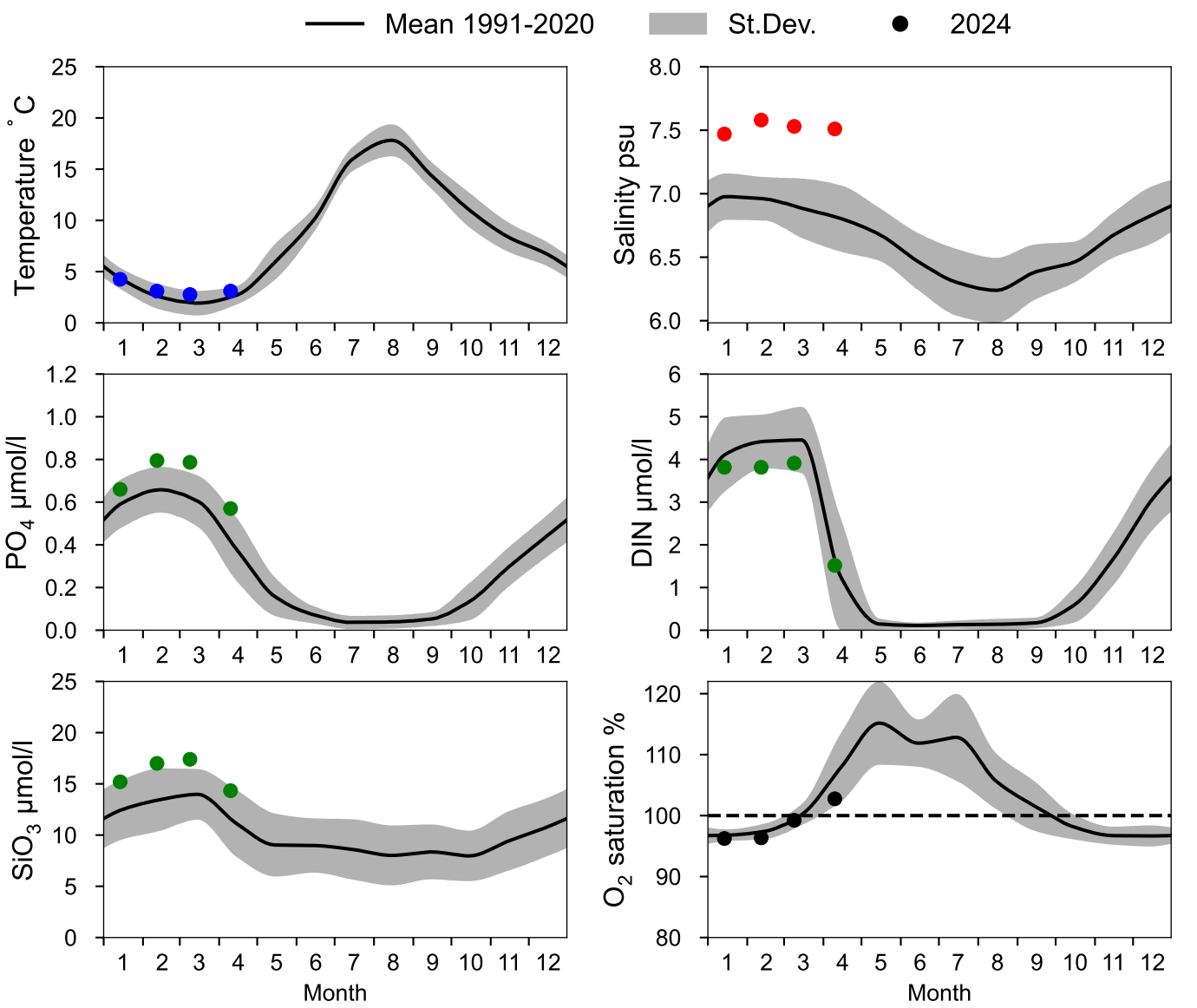


Vertical profiles BY31 LANDSORTSDJ
April

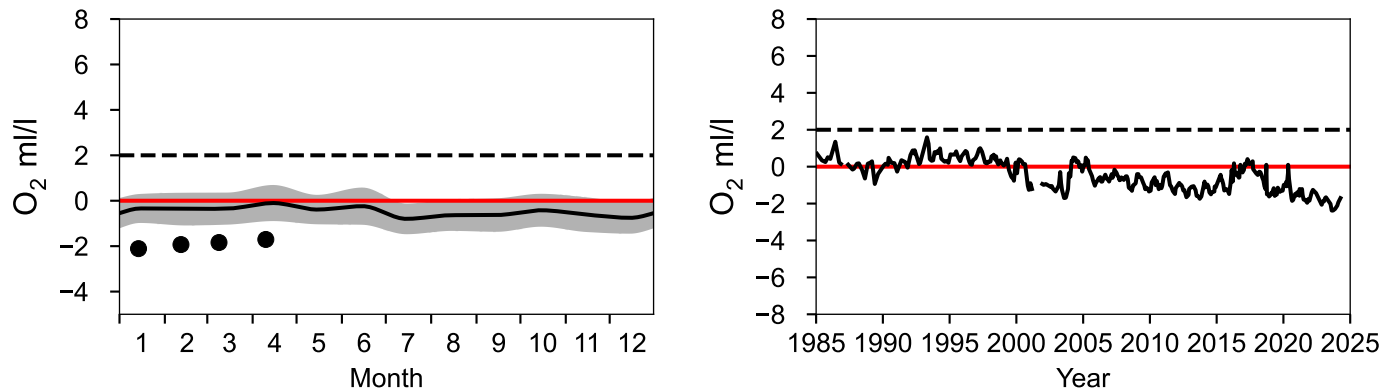


STATION BY29 / LL19 SURFACE WATER (0-10 m)

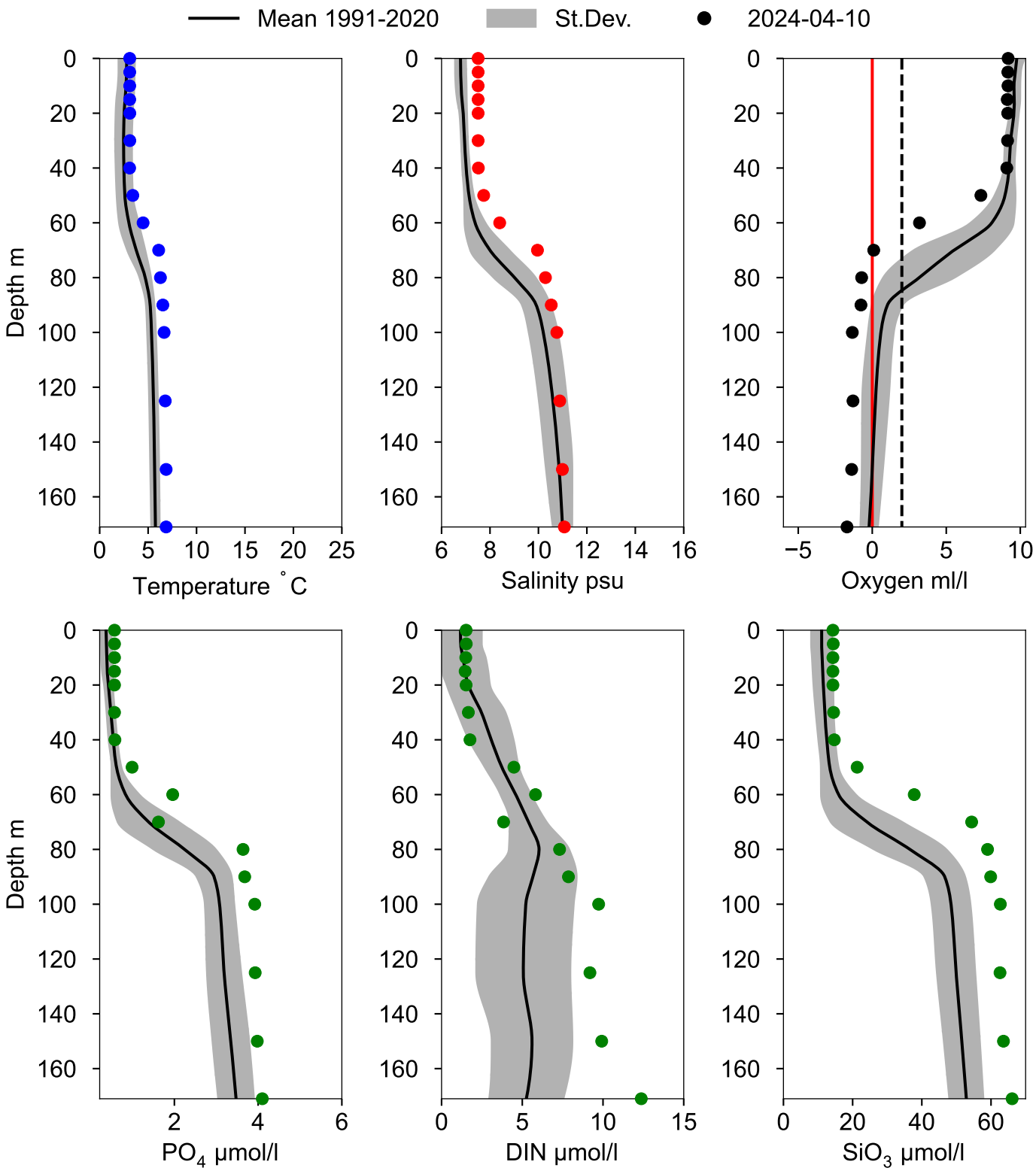
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 150 m)

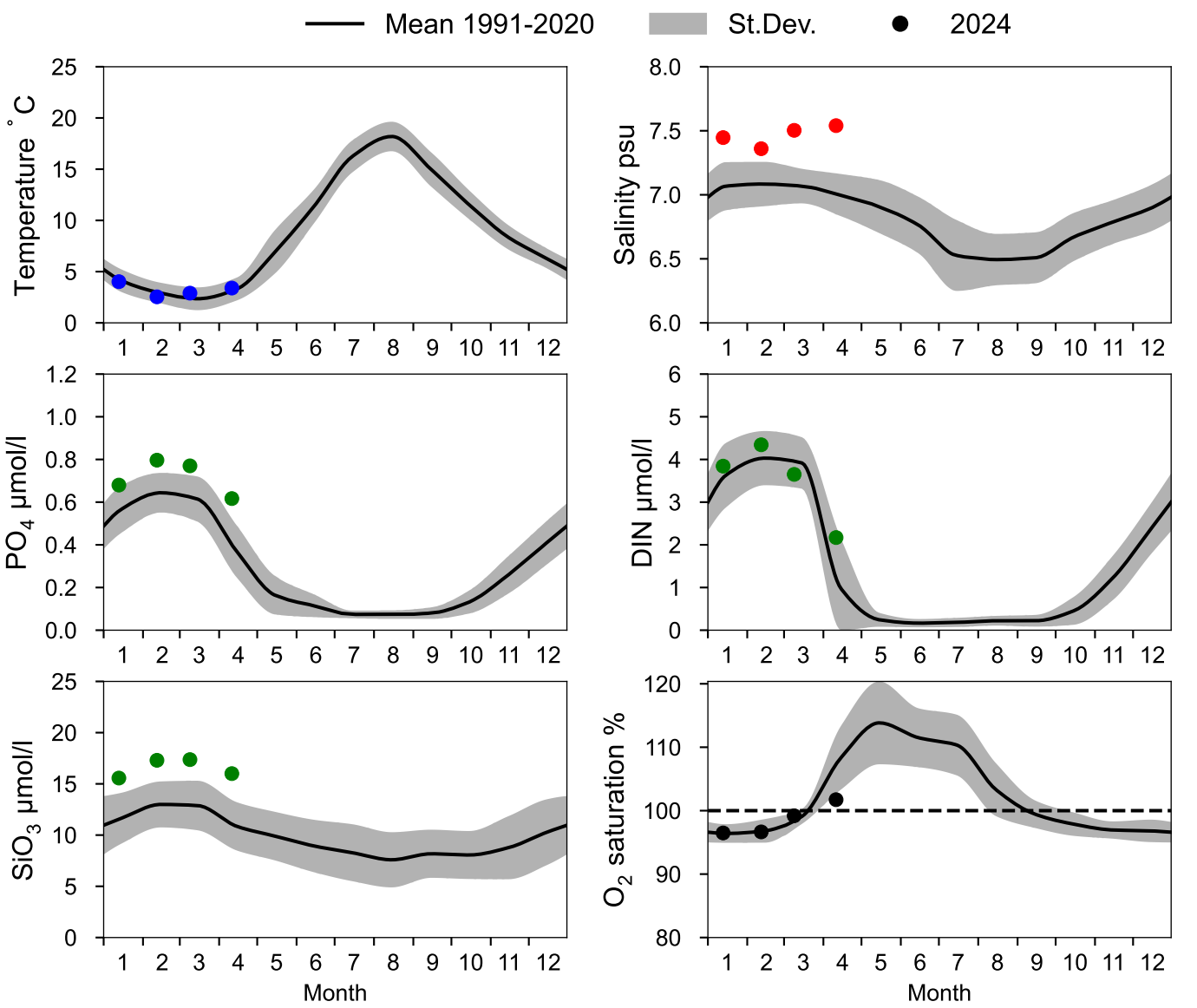


Vertical profiles BY29 / LL19
April

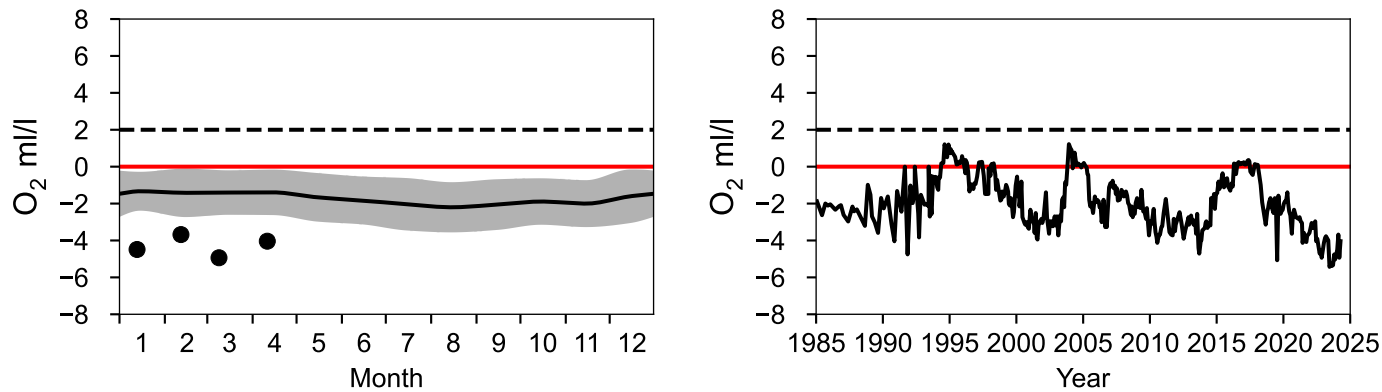


STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

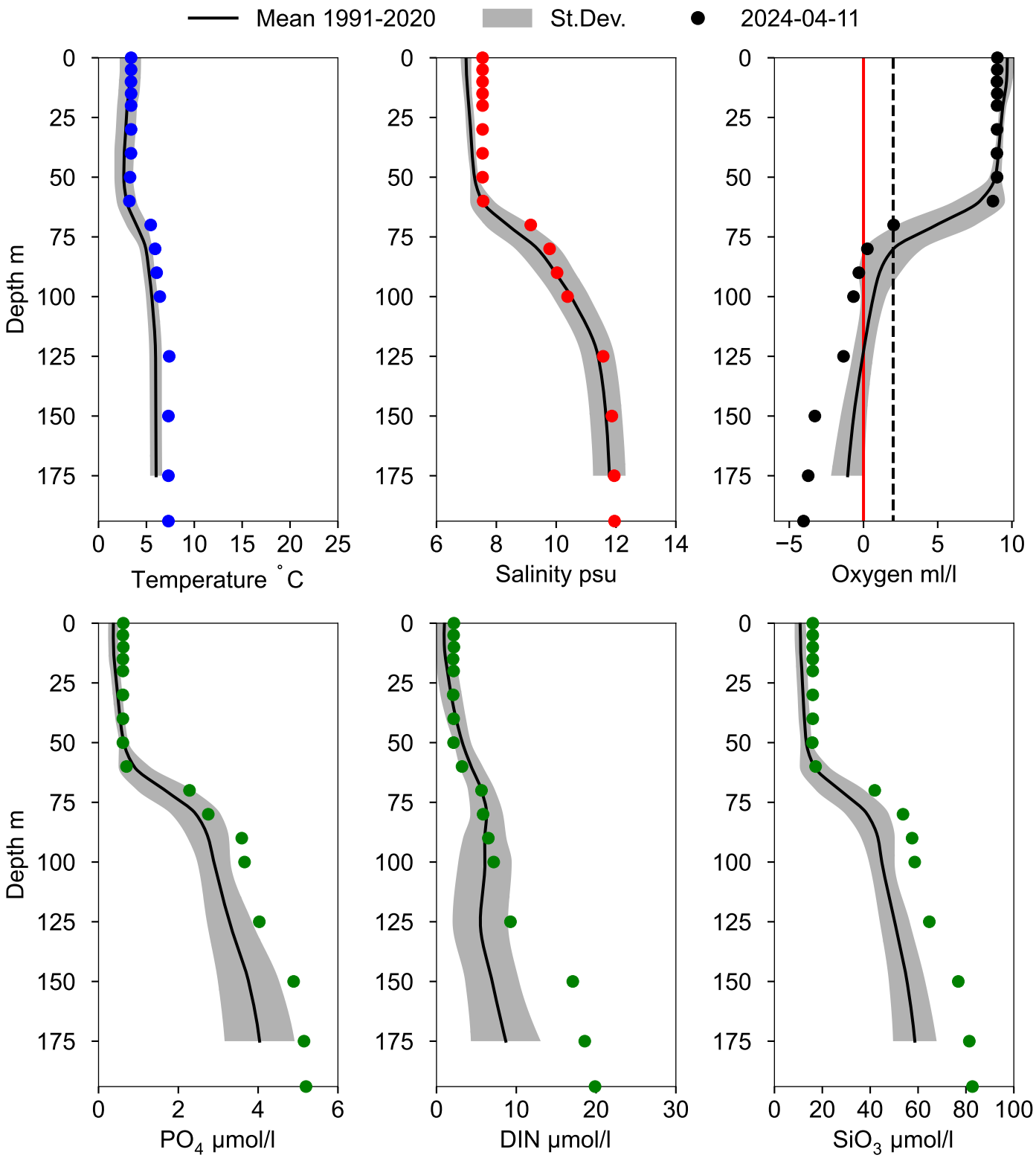
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)



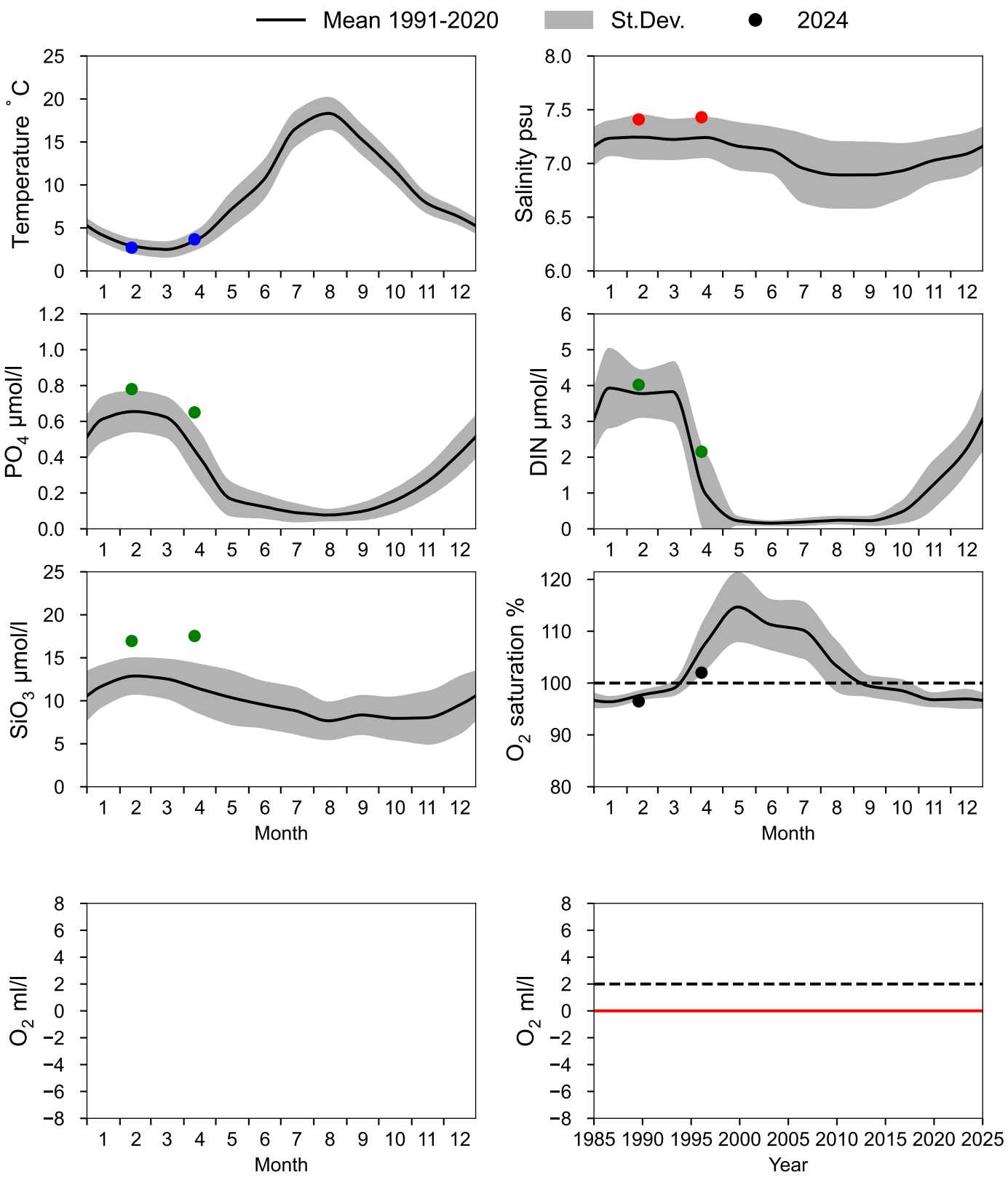
Vertical profiles BY20 FÅRÖDJ
April



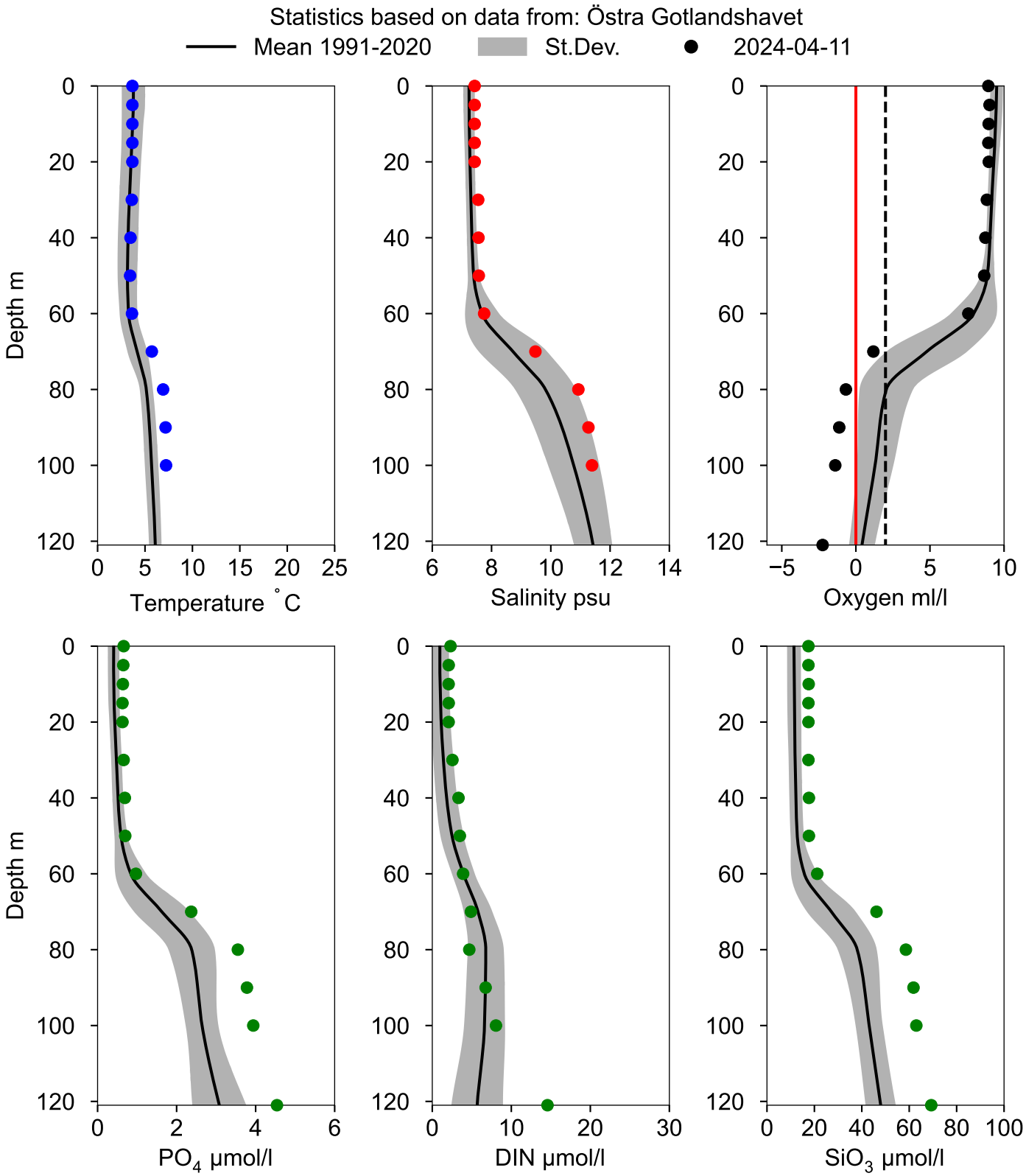
STATION BY13 SURFACE WATER (0-10 m)

Annual Cycles

Statistics based on data from: Östra Gotlandshavet

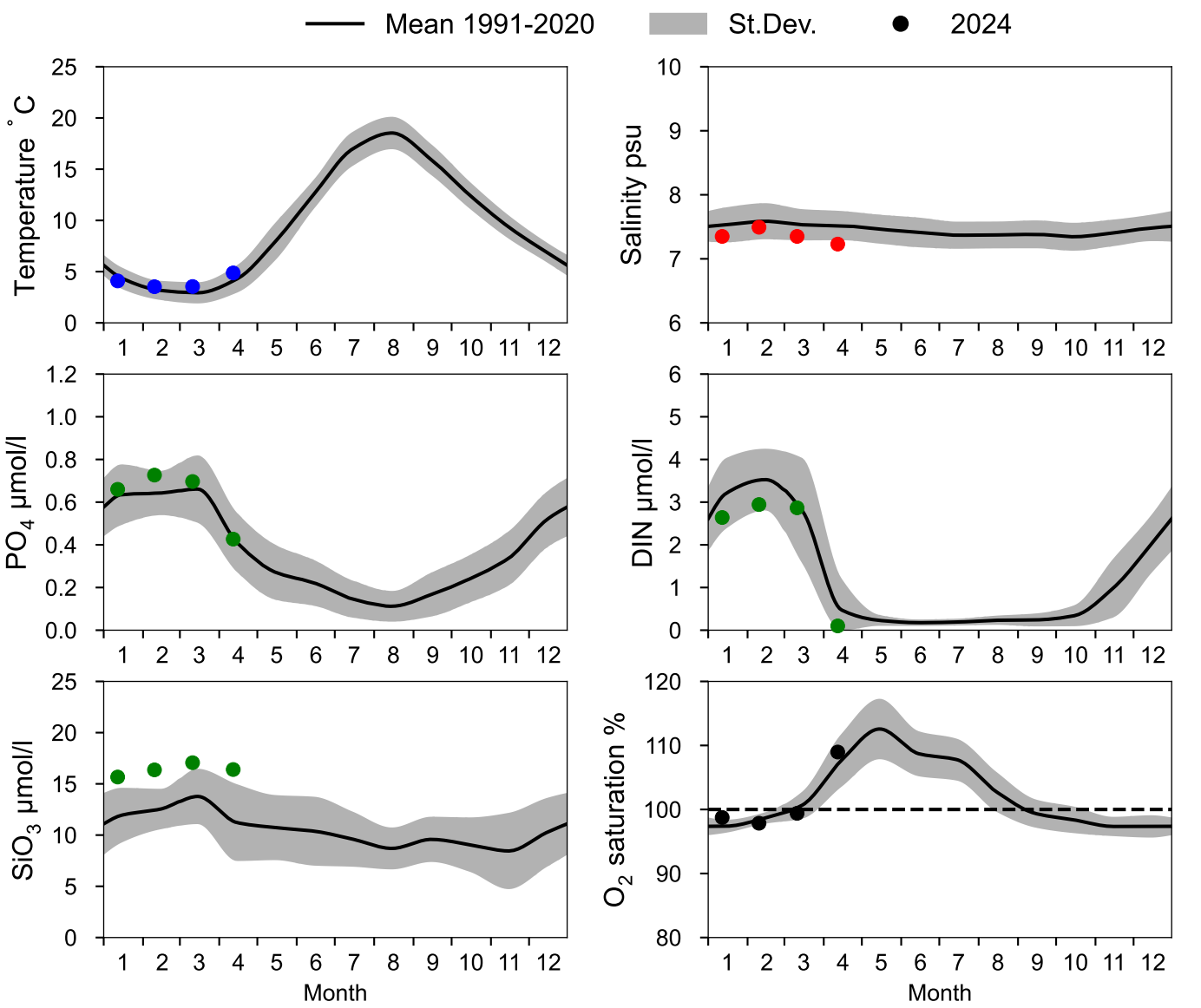


Vertical profiles BY13
April

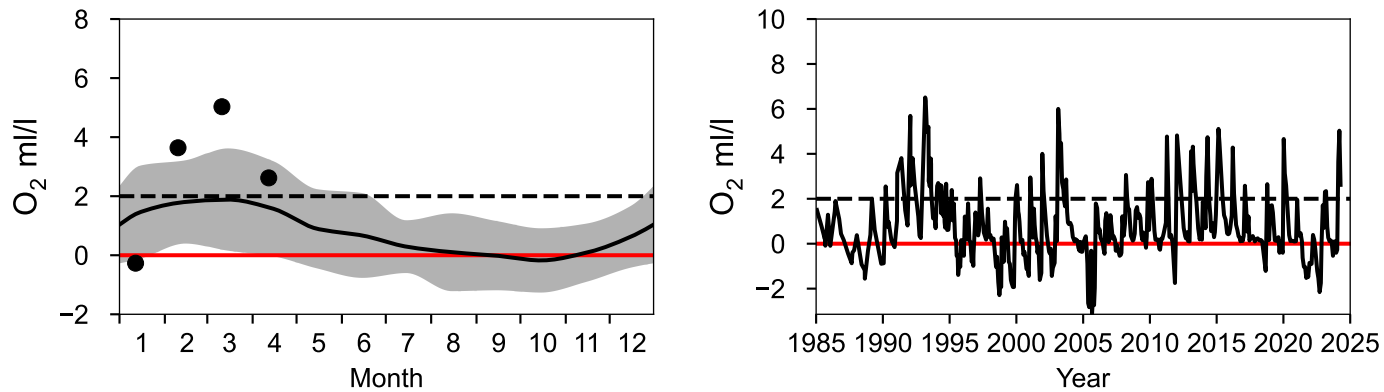


STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

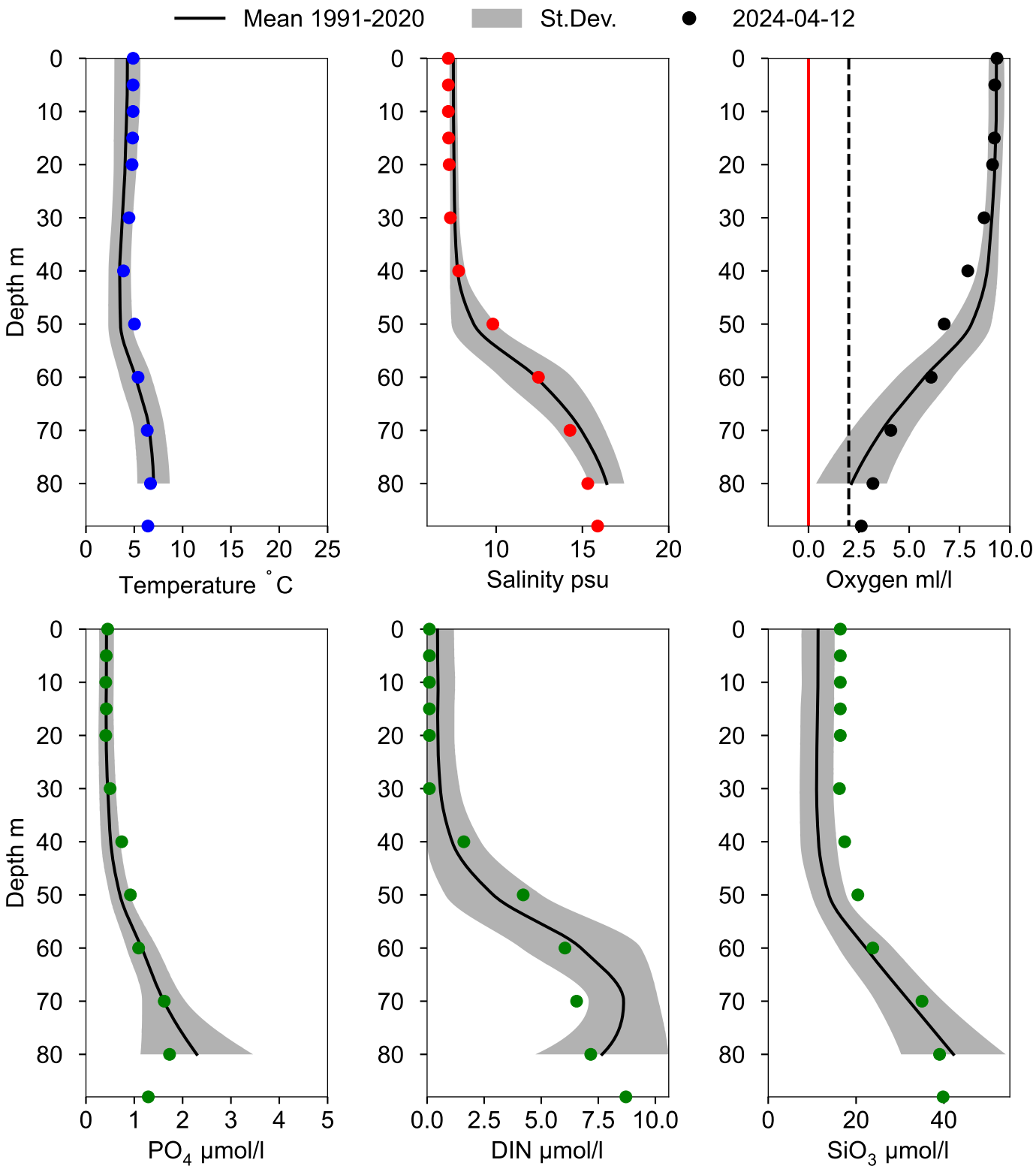
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

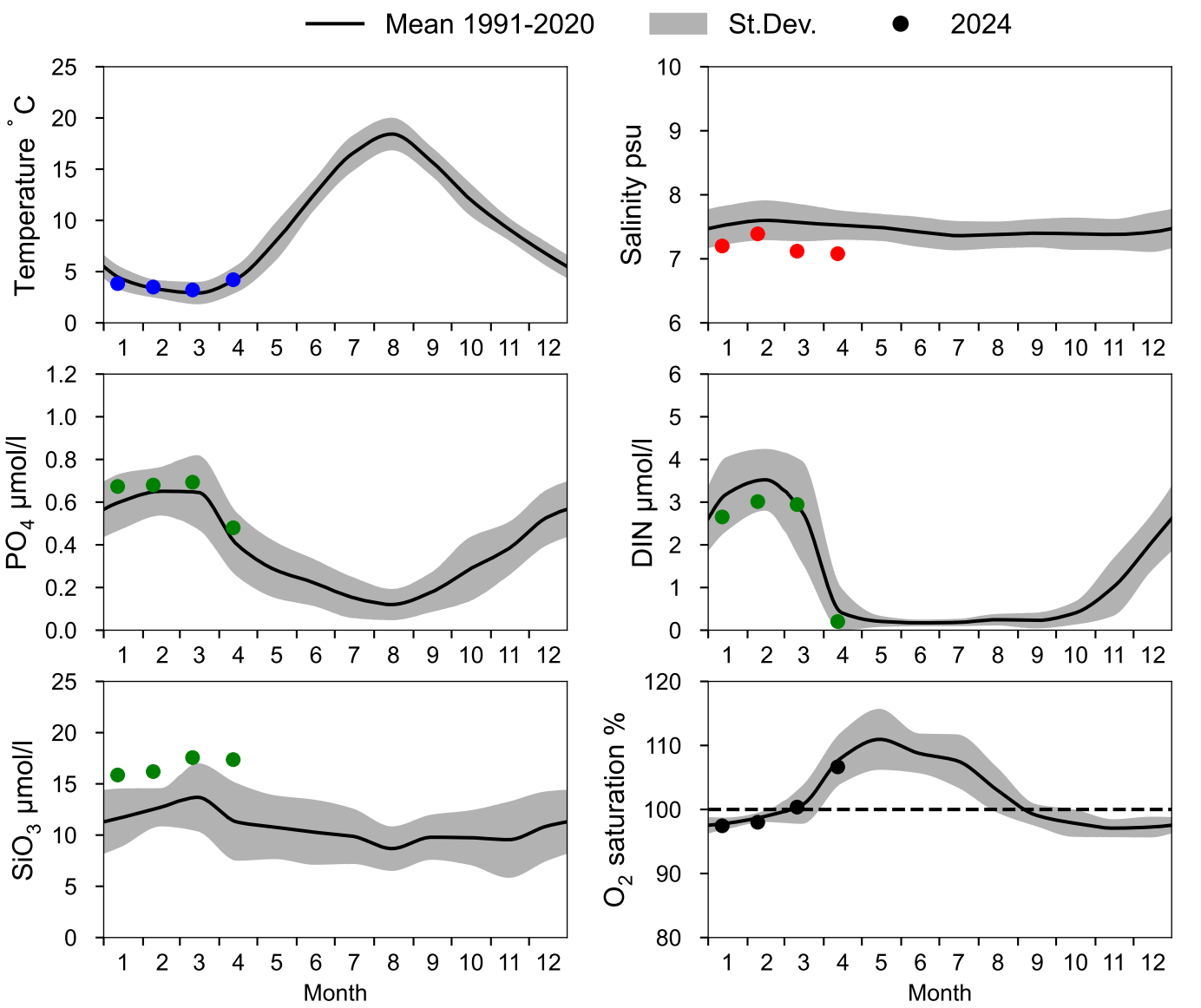


Vertical profiles BY5 BORNHOLMSDJ
April

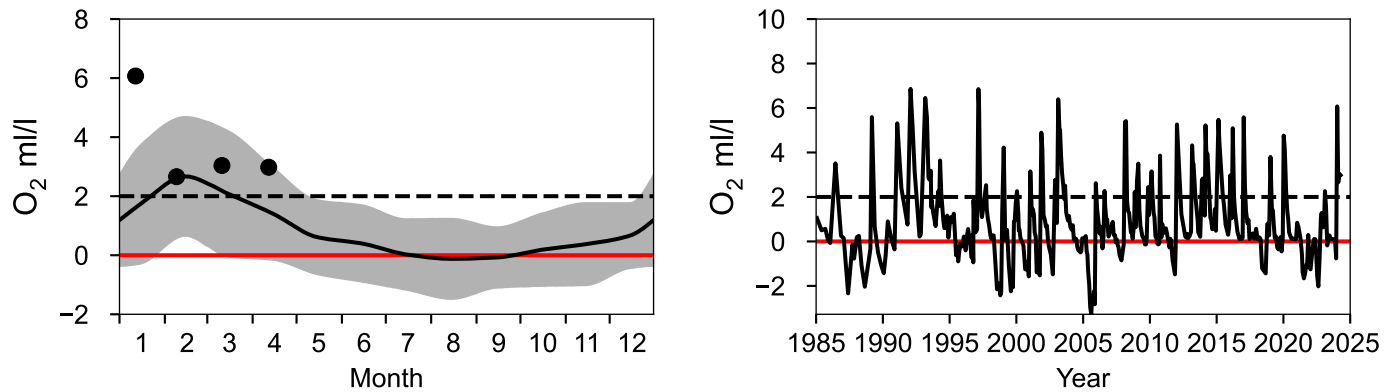


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

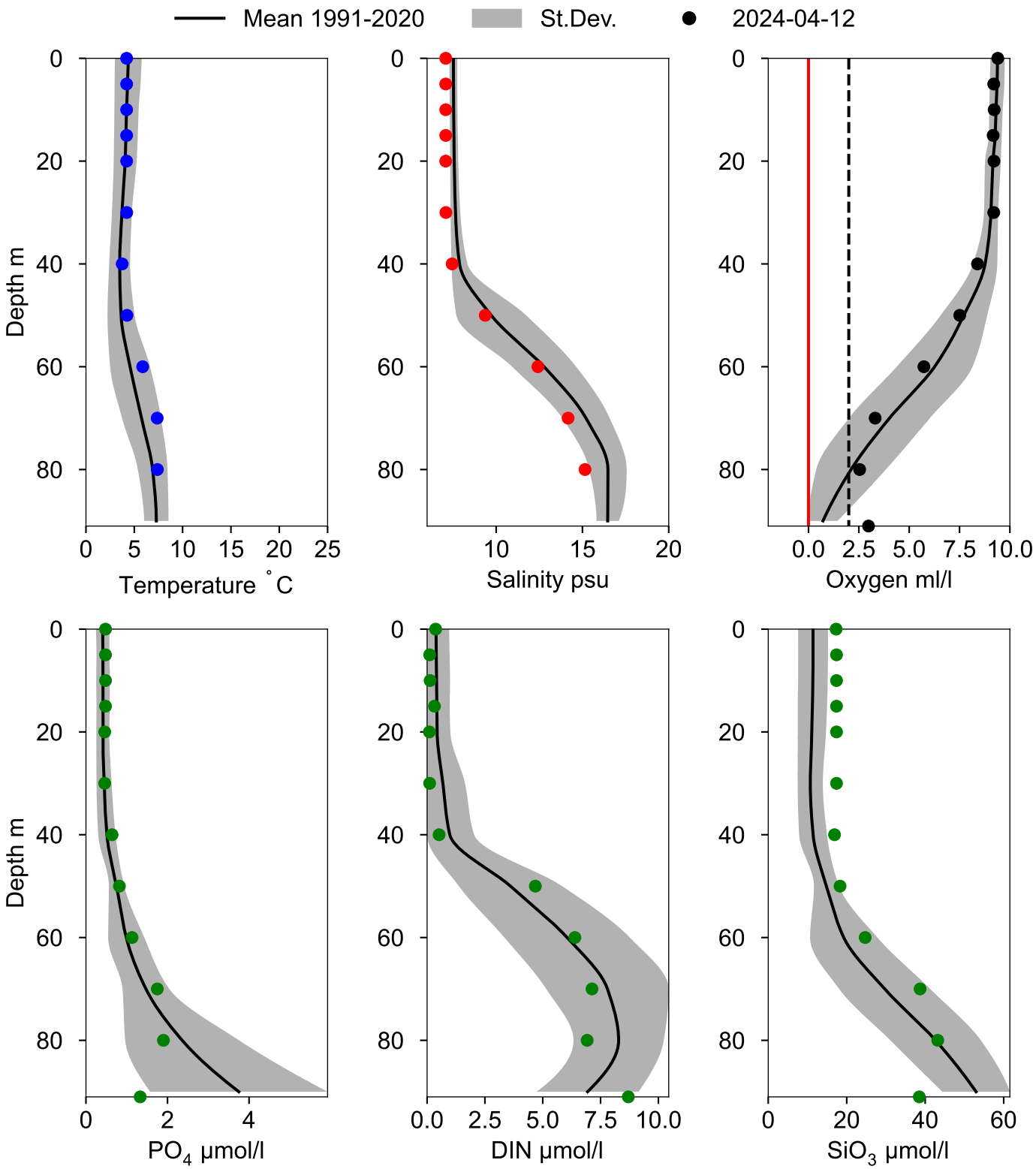
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

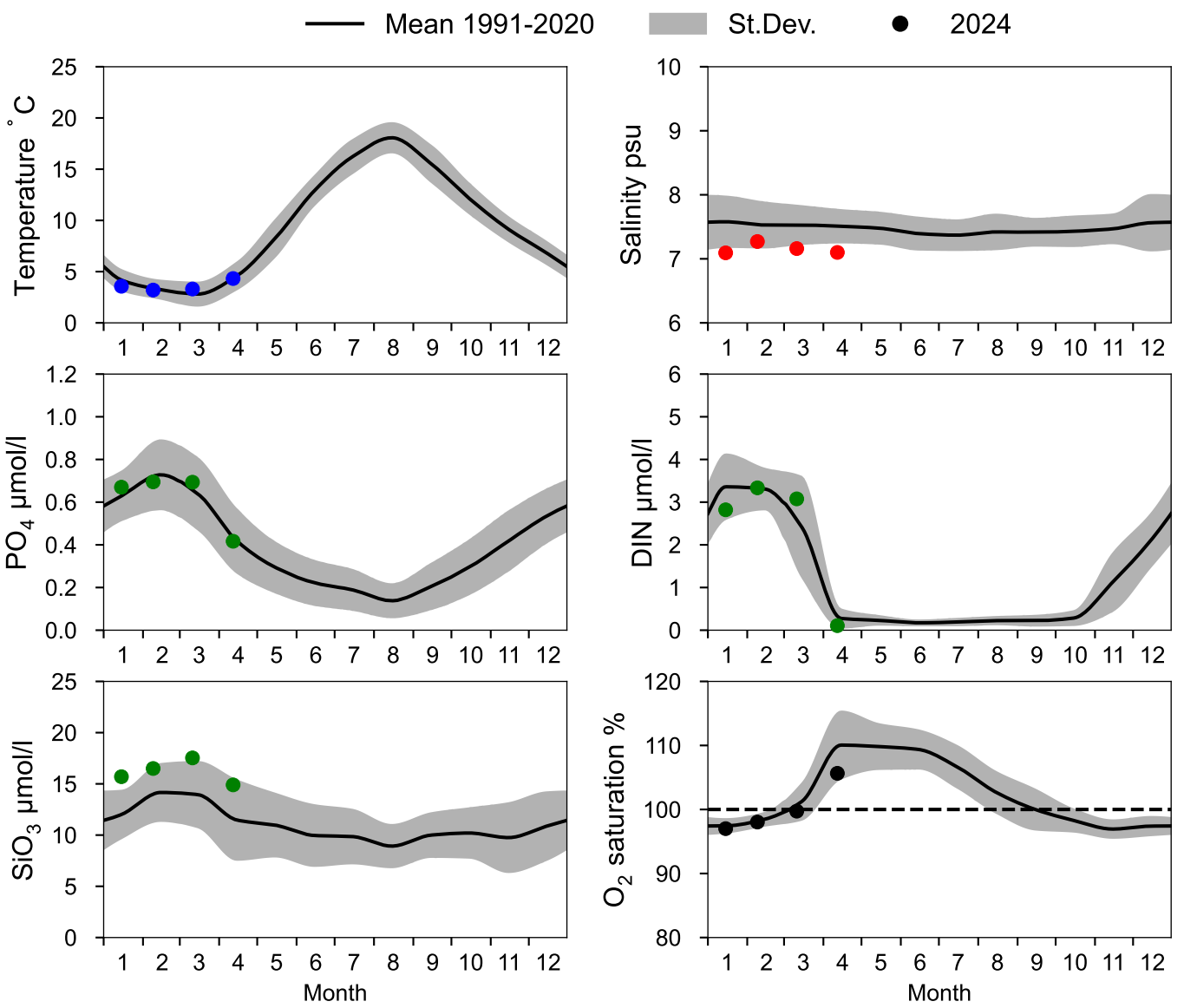


Vertical profiles BY4 CHRISTIANSÖ
April

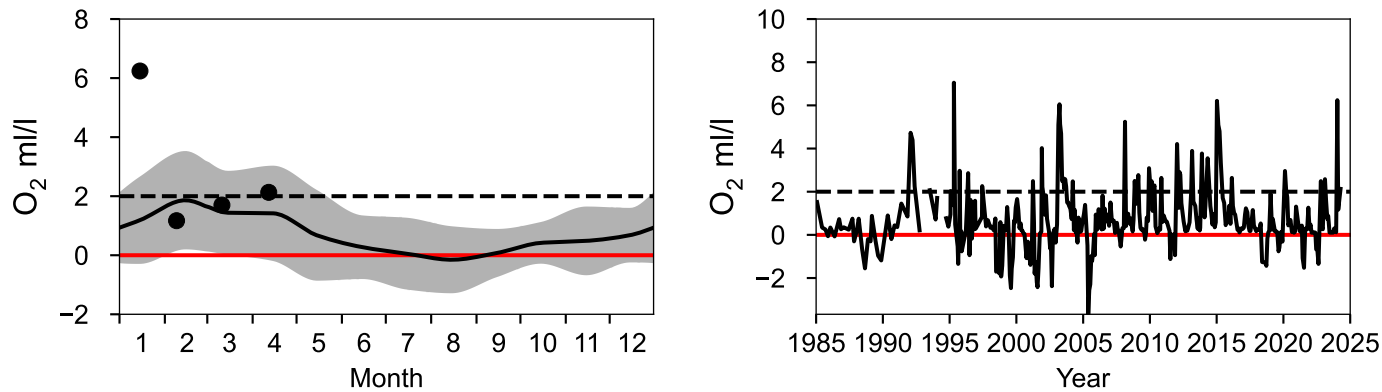


STATION HANÖBUKTEN SURFACE WATER (0-10 m)

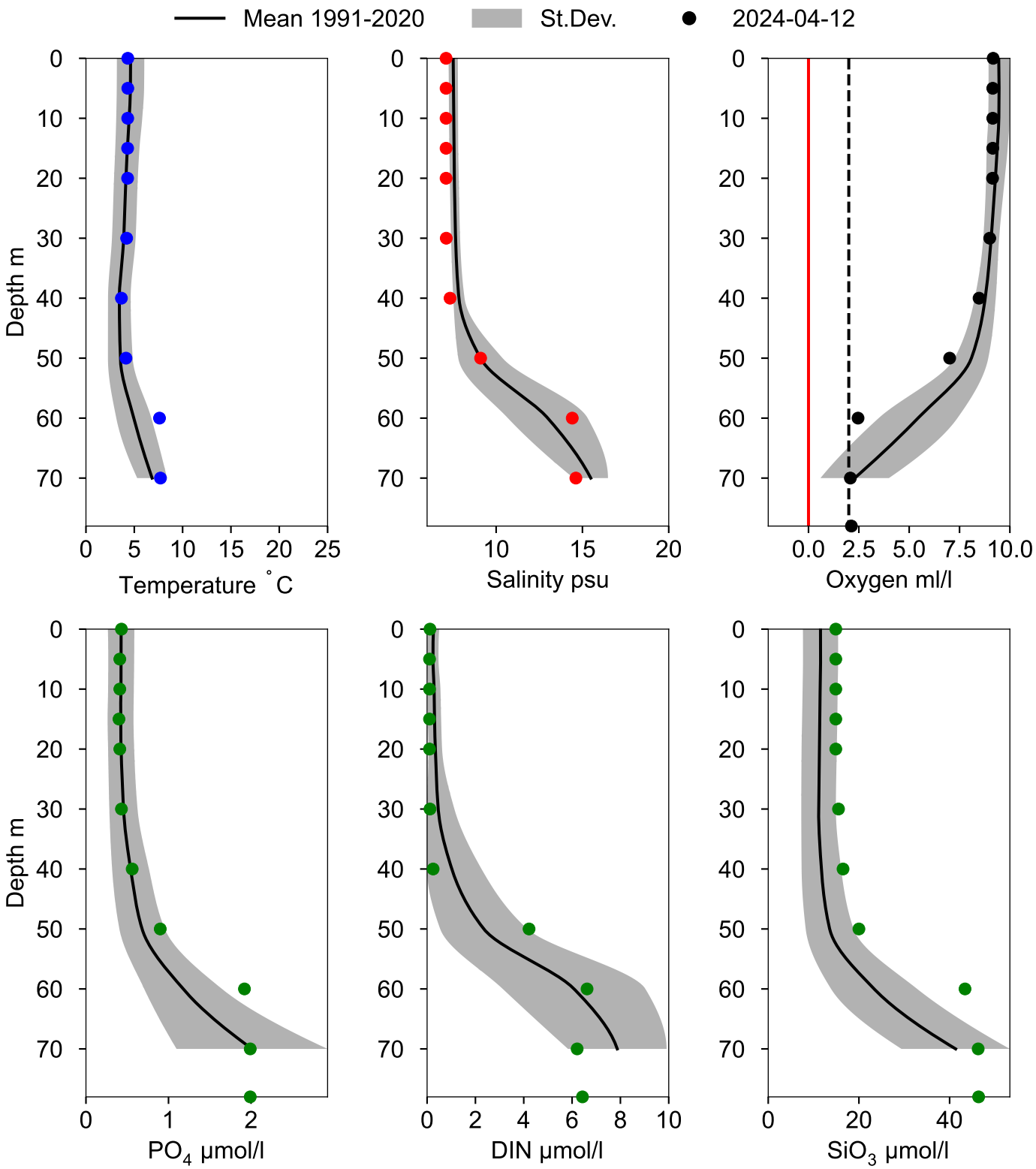
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)

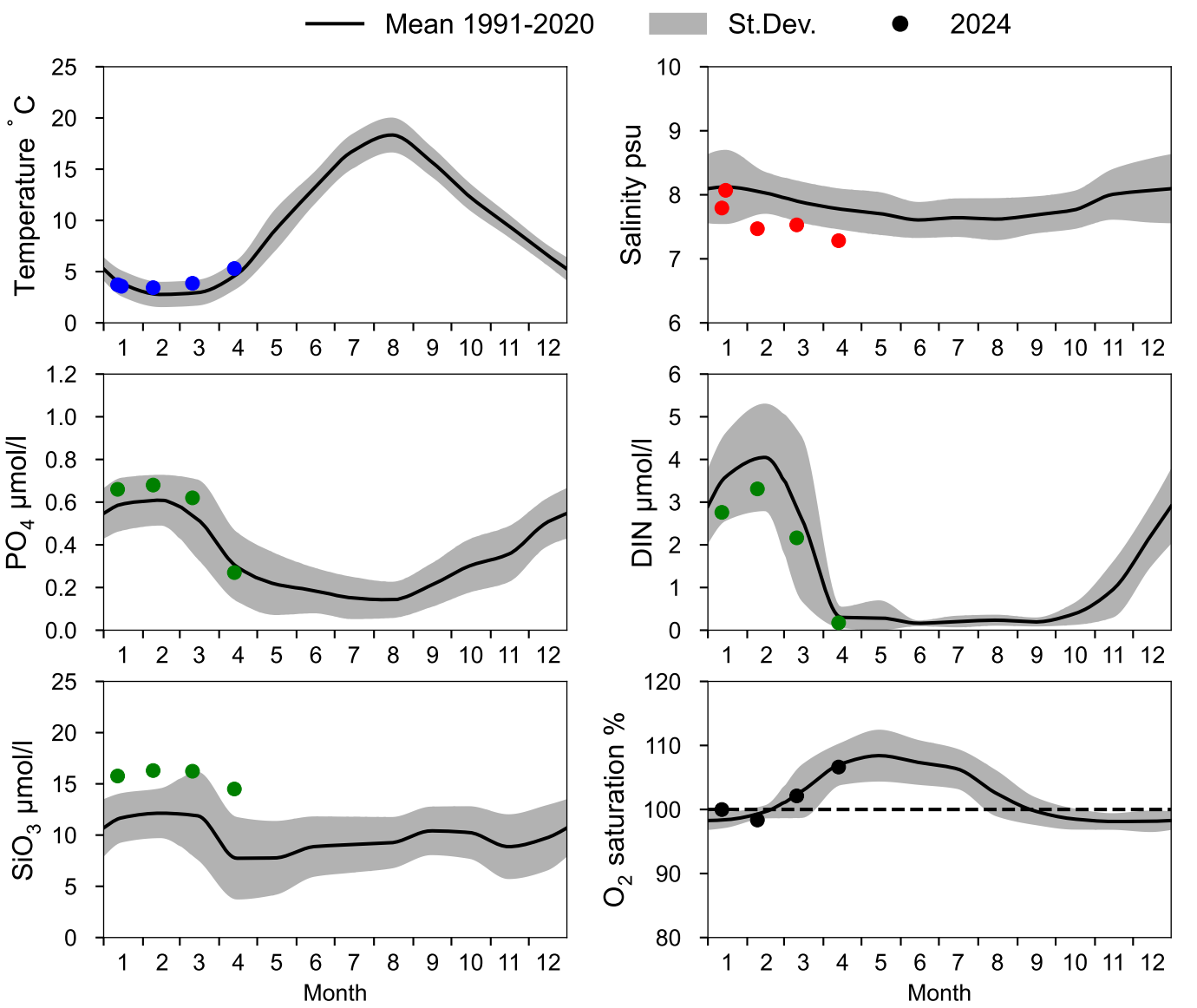


Vertical profiles HANÖBUKTEN
April

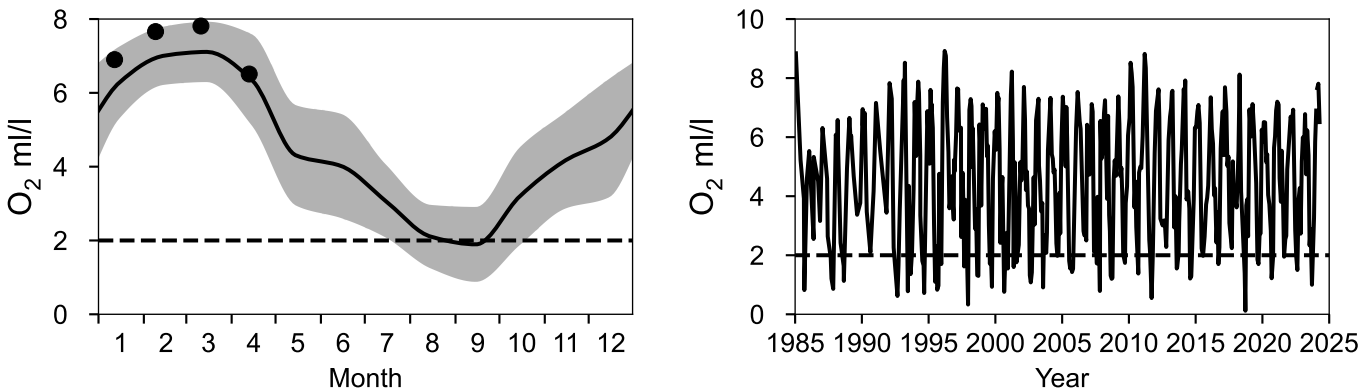


STATION BY2 ARKONA SURFACE WATER (0-10 m)

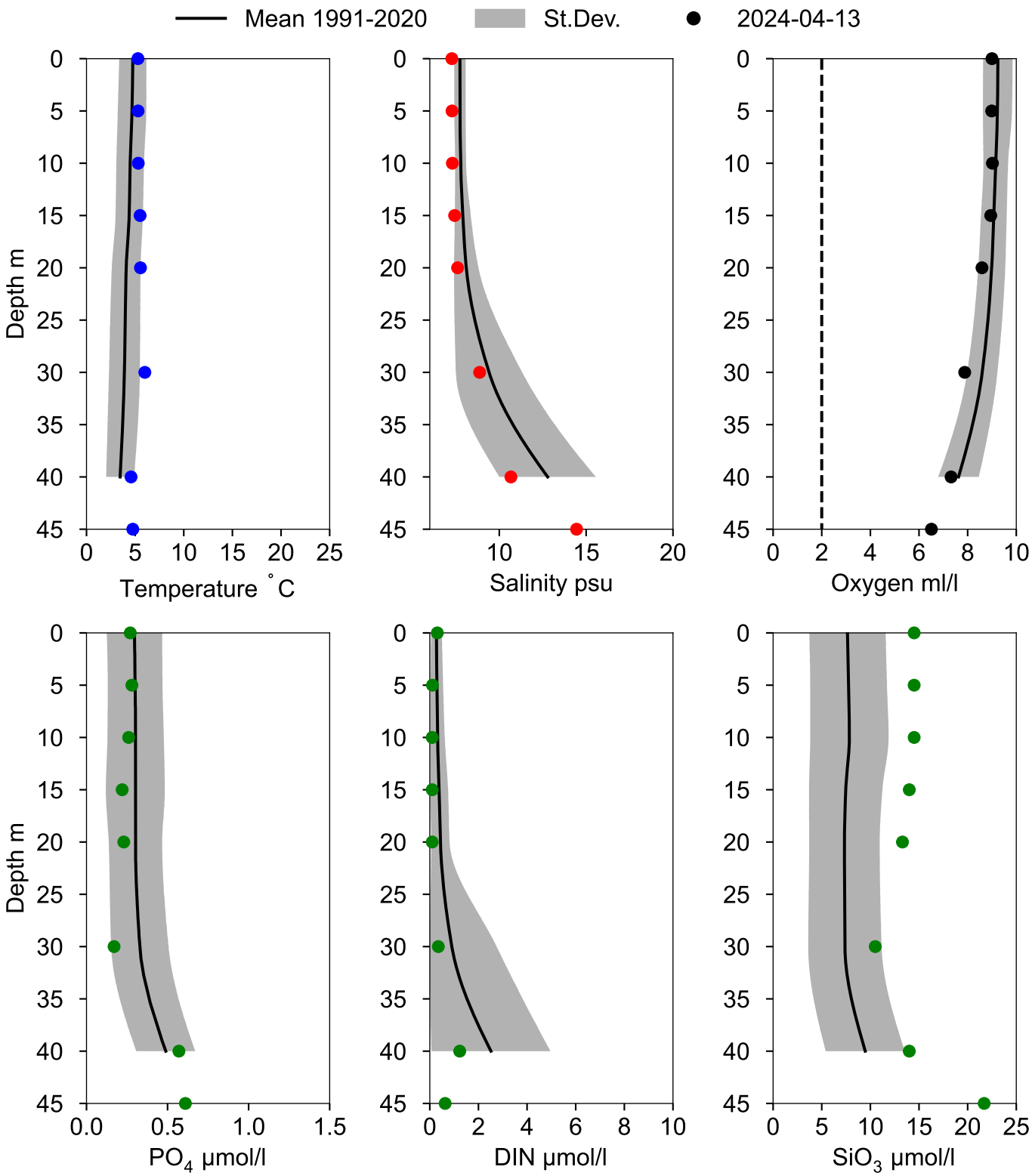
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

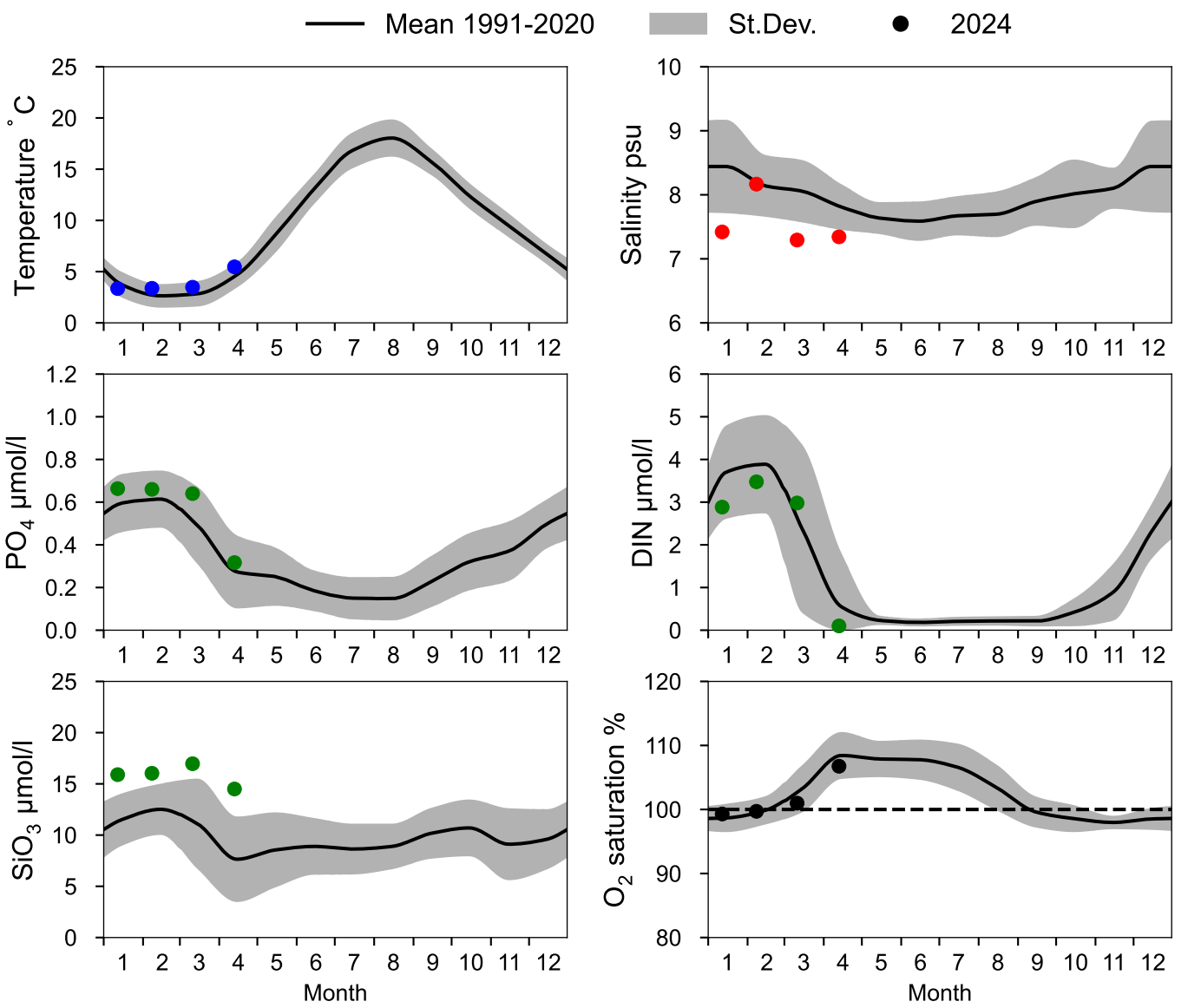


Vertical profiles BY2 ARKONA
April

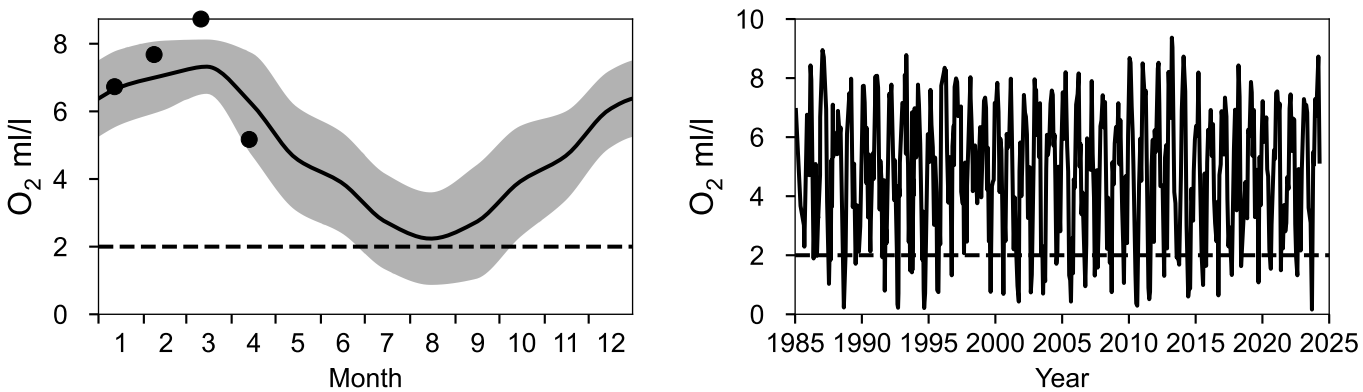


STATION BY1 SURFACE WATER (0-10 m)

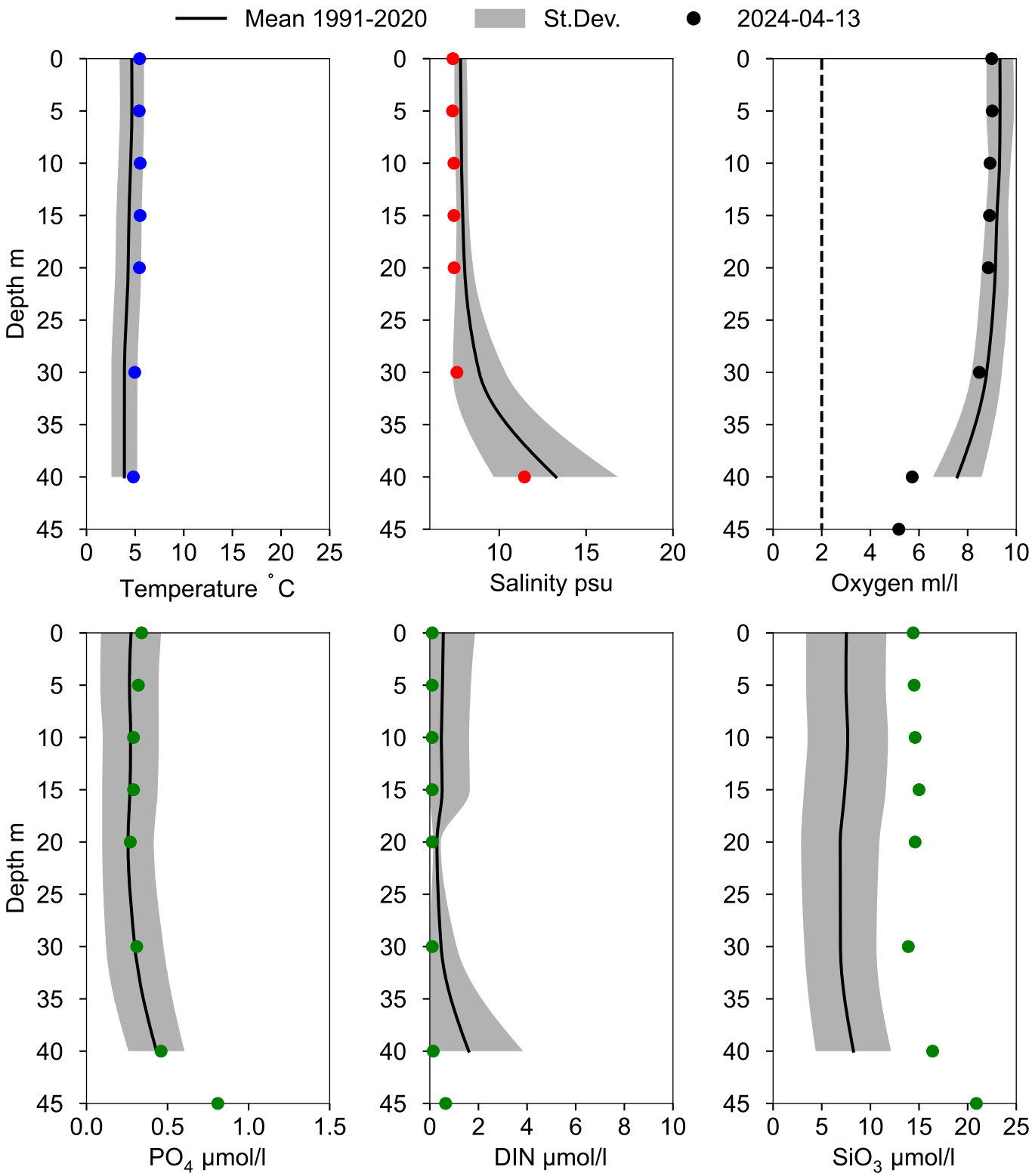
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 39 m)

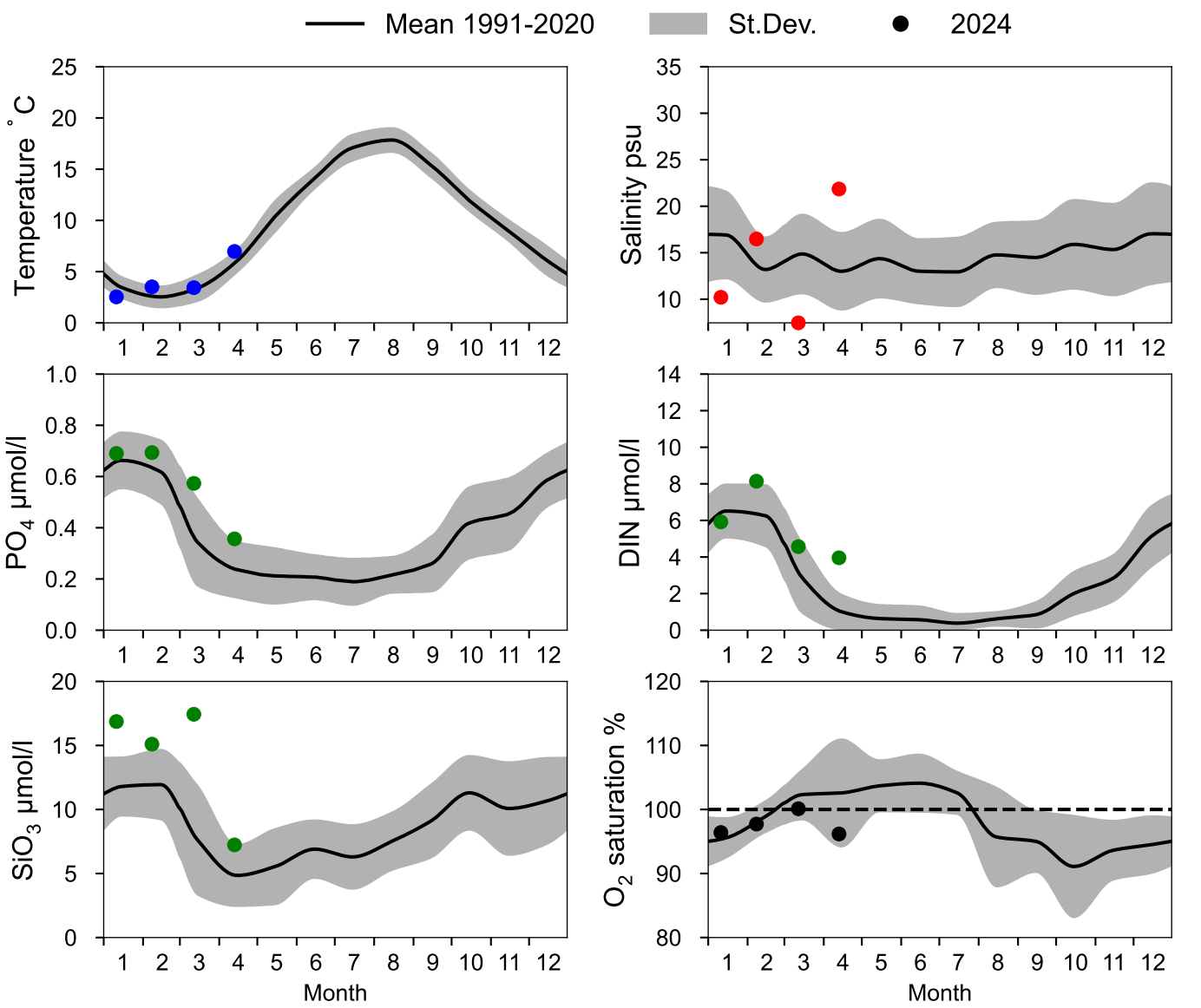


Vertical profiles BY1
April

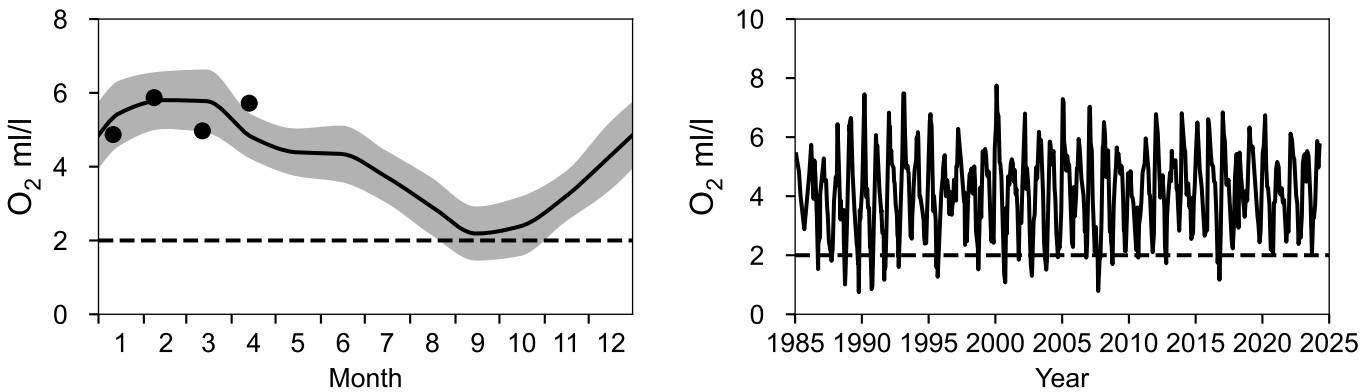


STATION W LANDSKRONA SURFACE WATER (0-10 m)

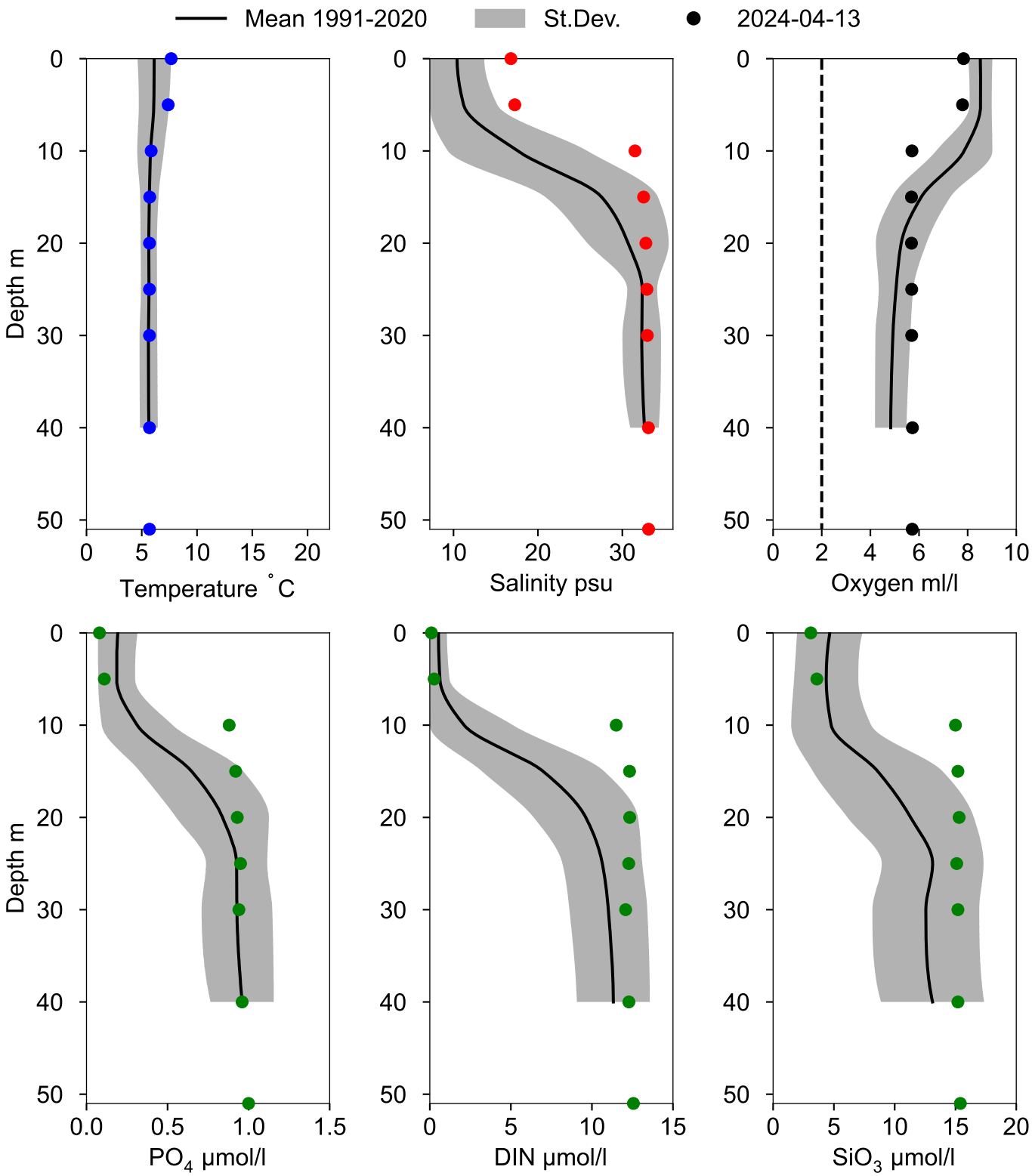
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

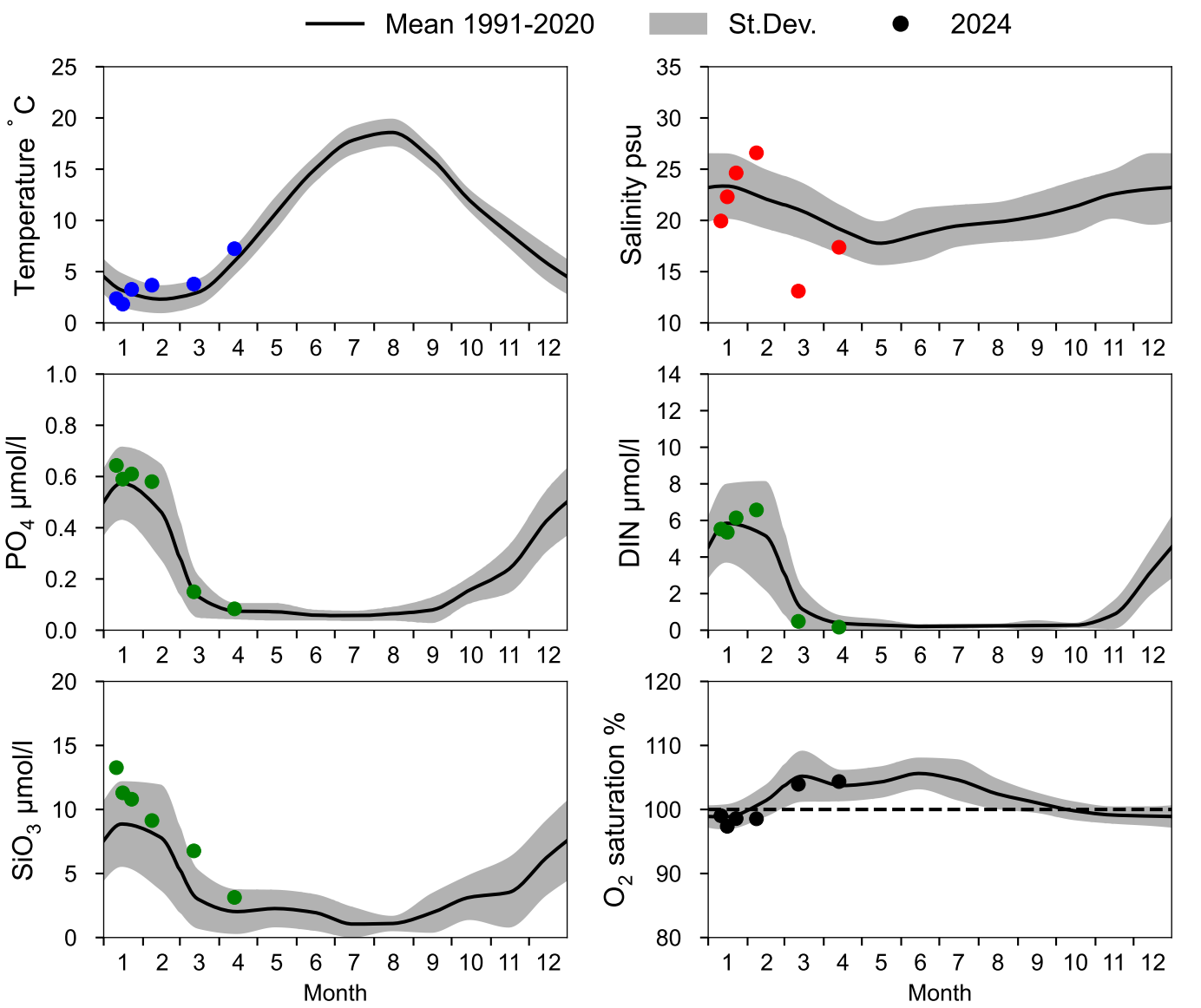


Vertical profiles W LANDSKRONA
April

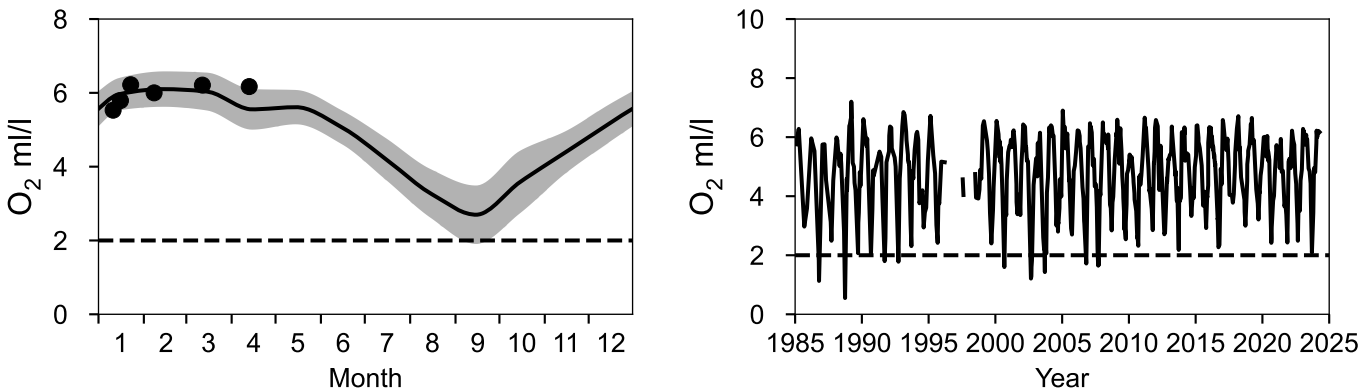


STATION ANHOLT E SURFACE WATER (0-10 m)

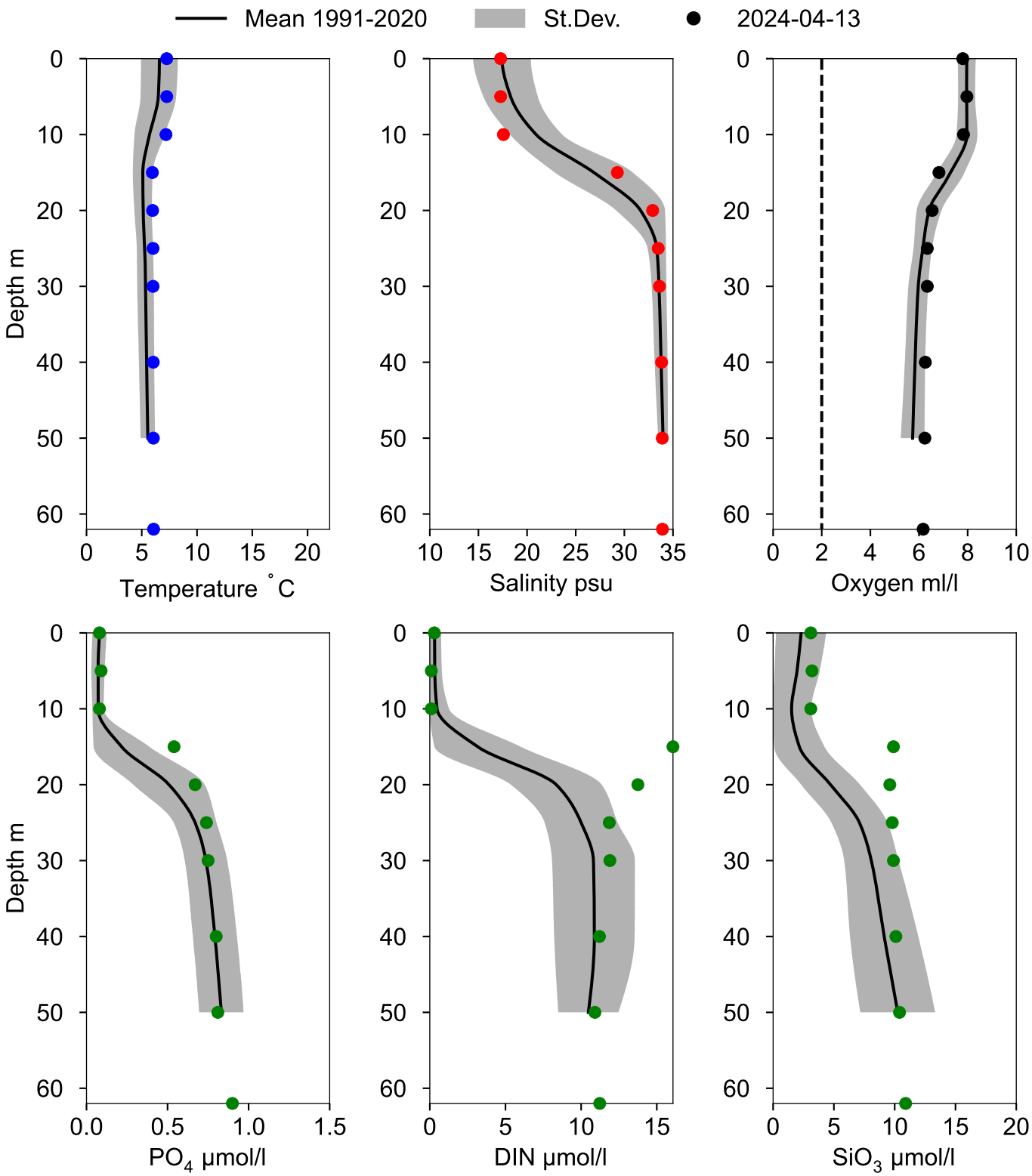
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

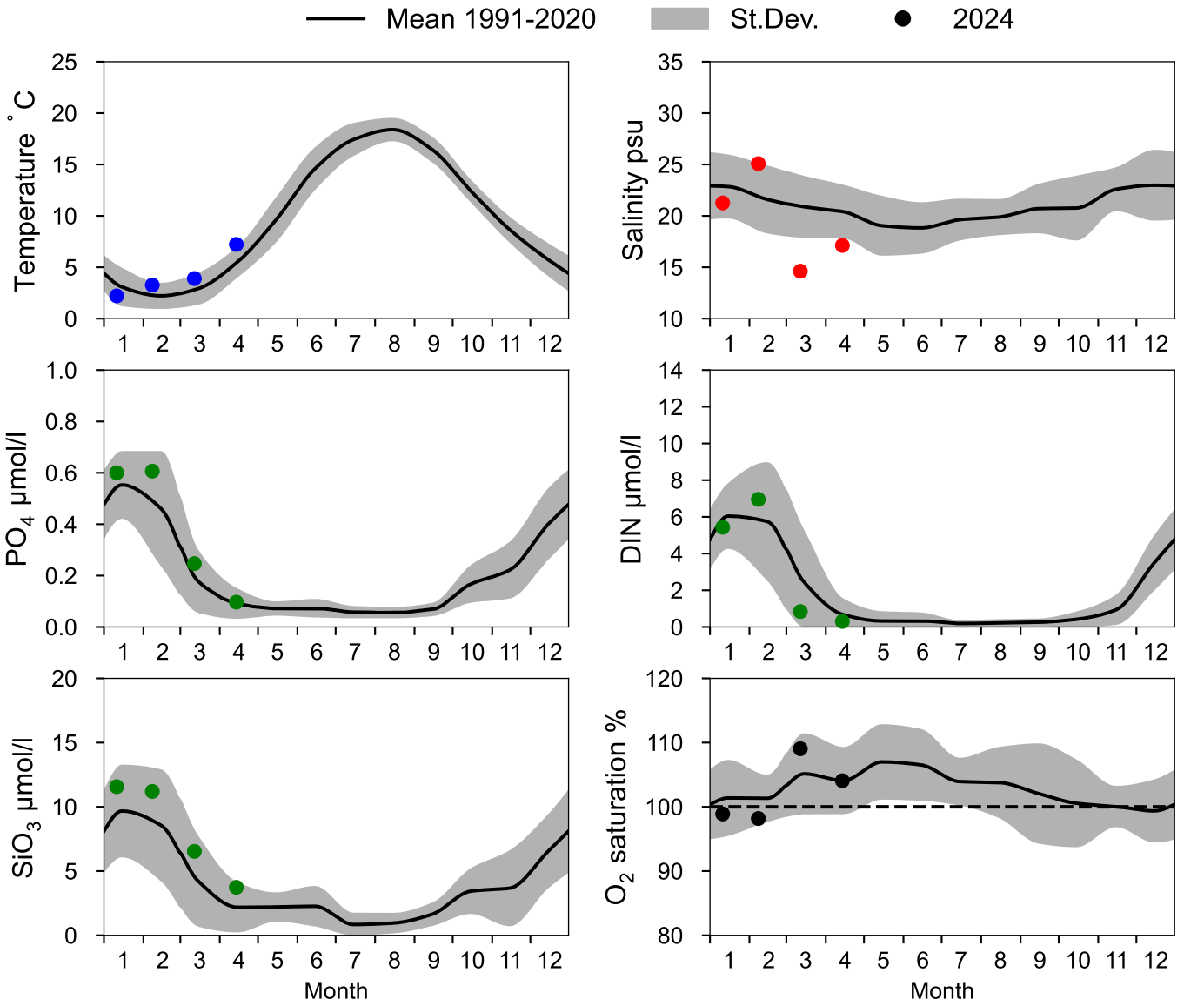


Vertical profiles ANHOLT E
April

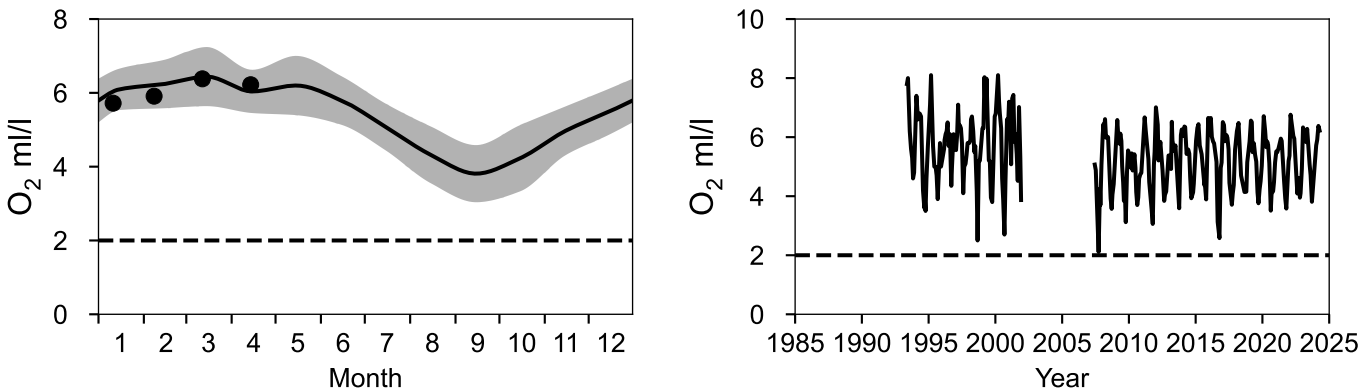


STATION N14 FALKENBERG SURFACE WATER (0-10 m)

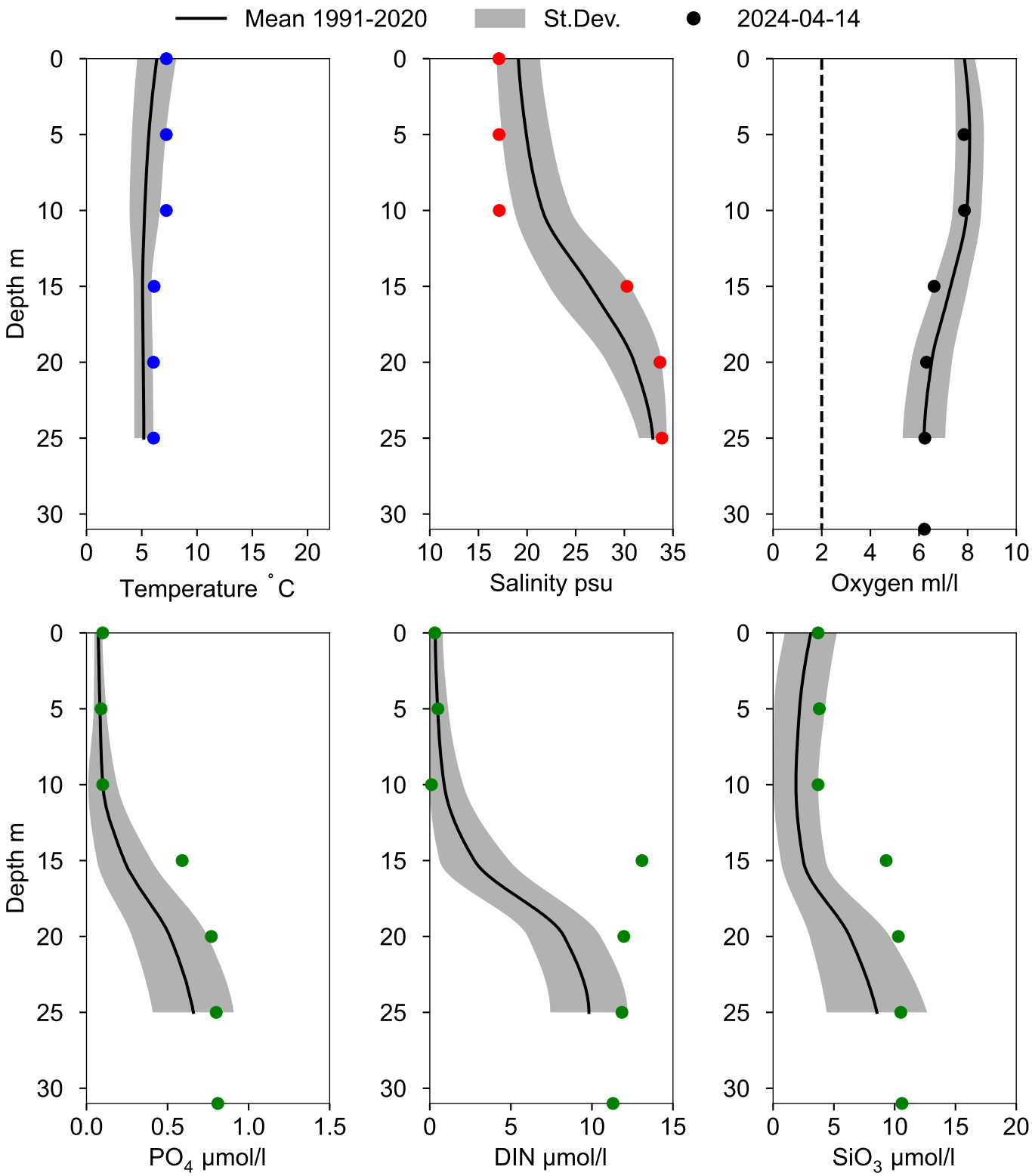
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 25 m)

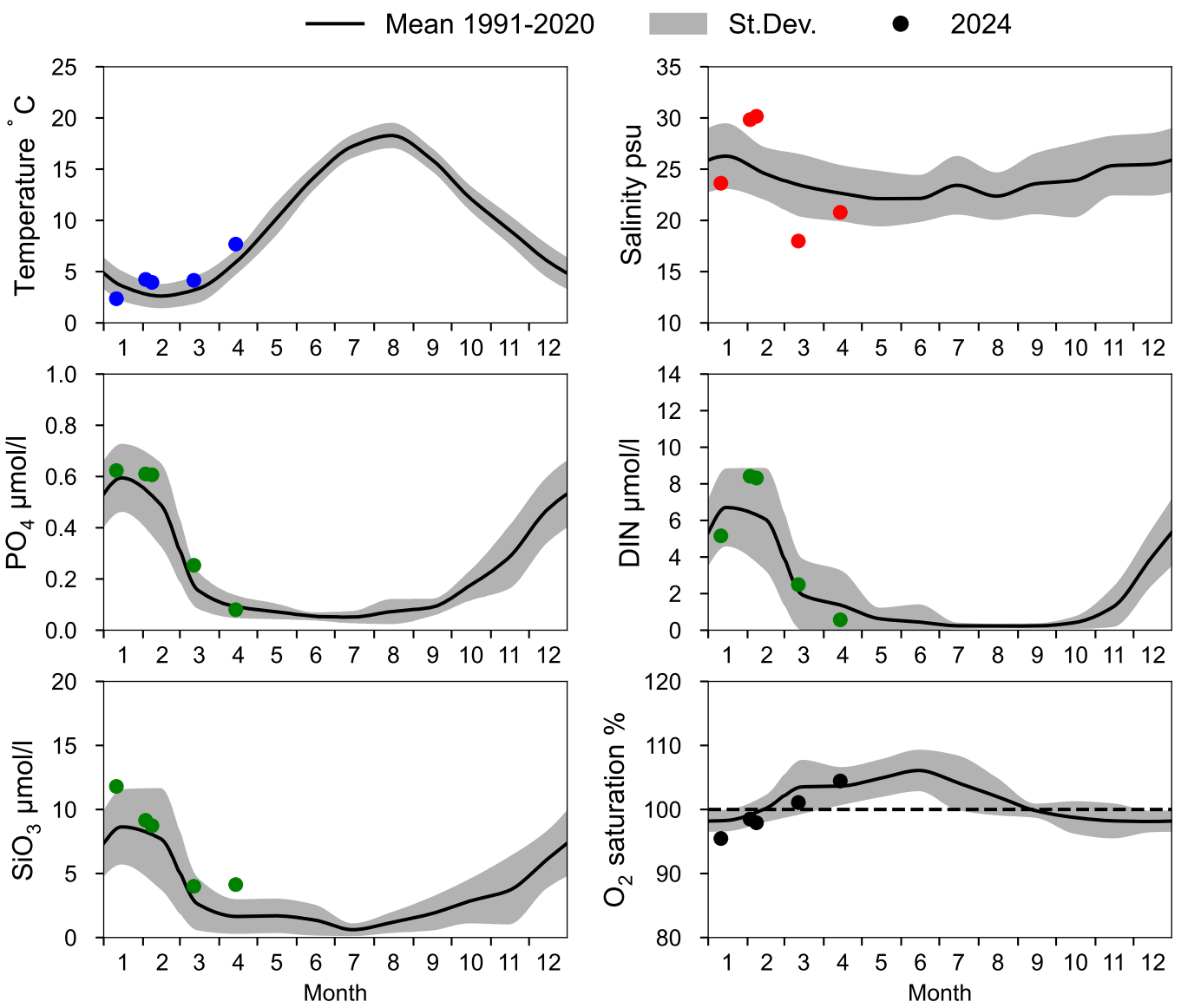


Vertical profiles N14 FALKENBERG
April

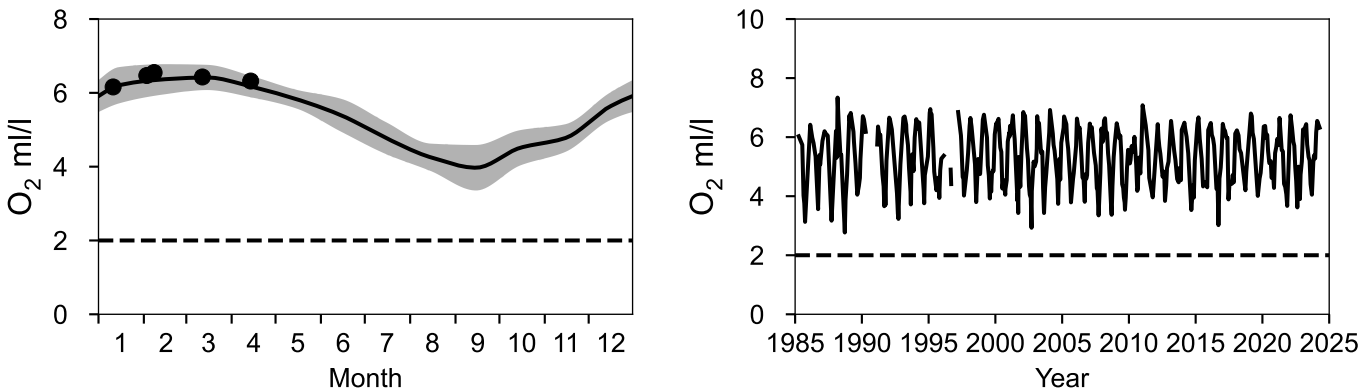


STATION FLADEN SURFACE WATER (0-10 m)

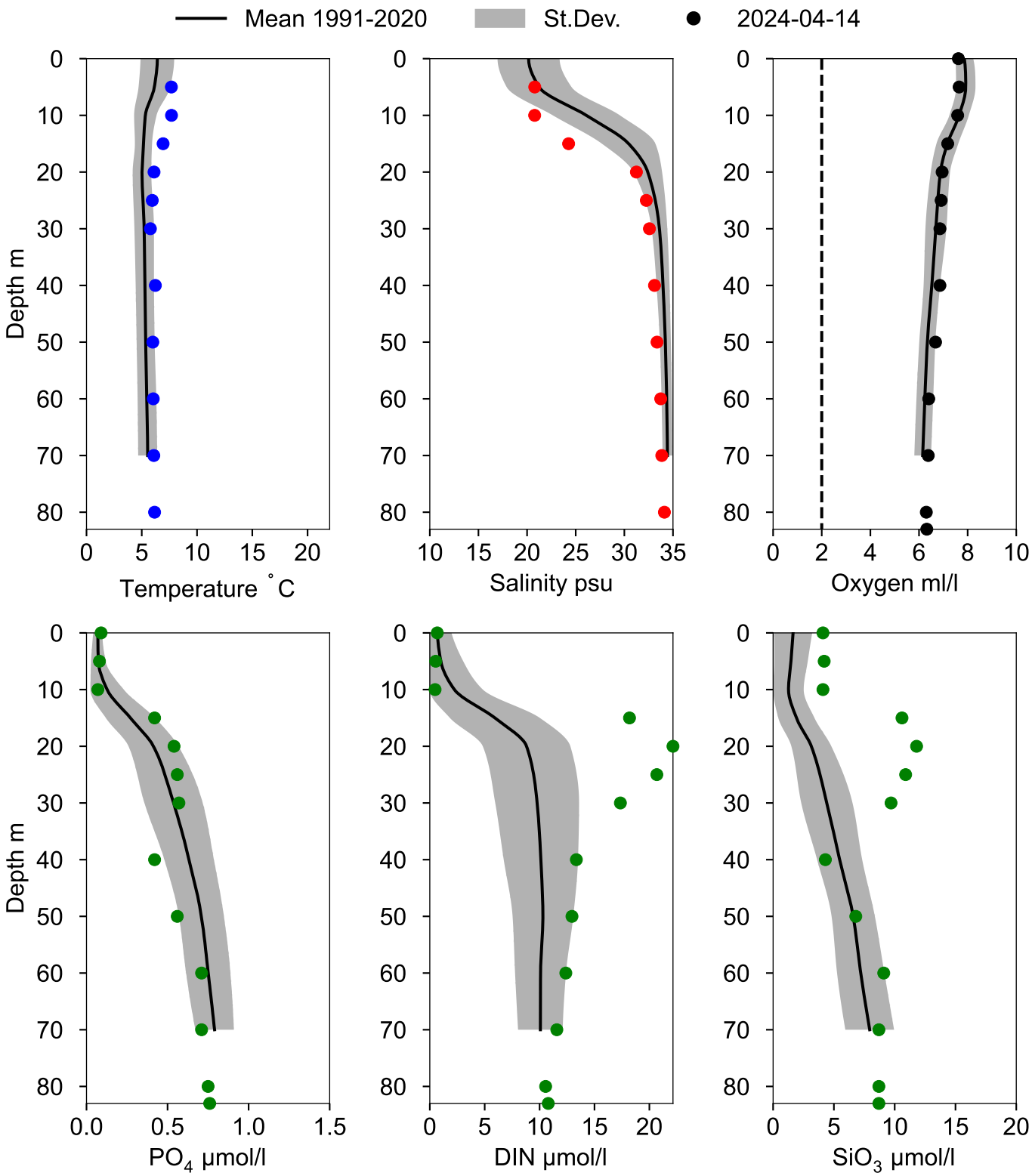
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 74 m)

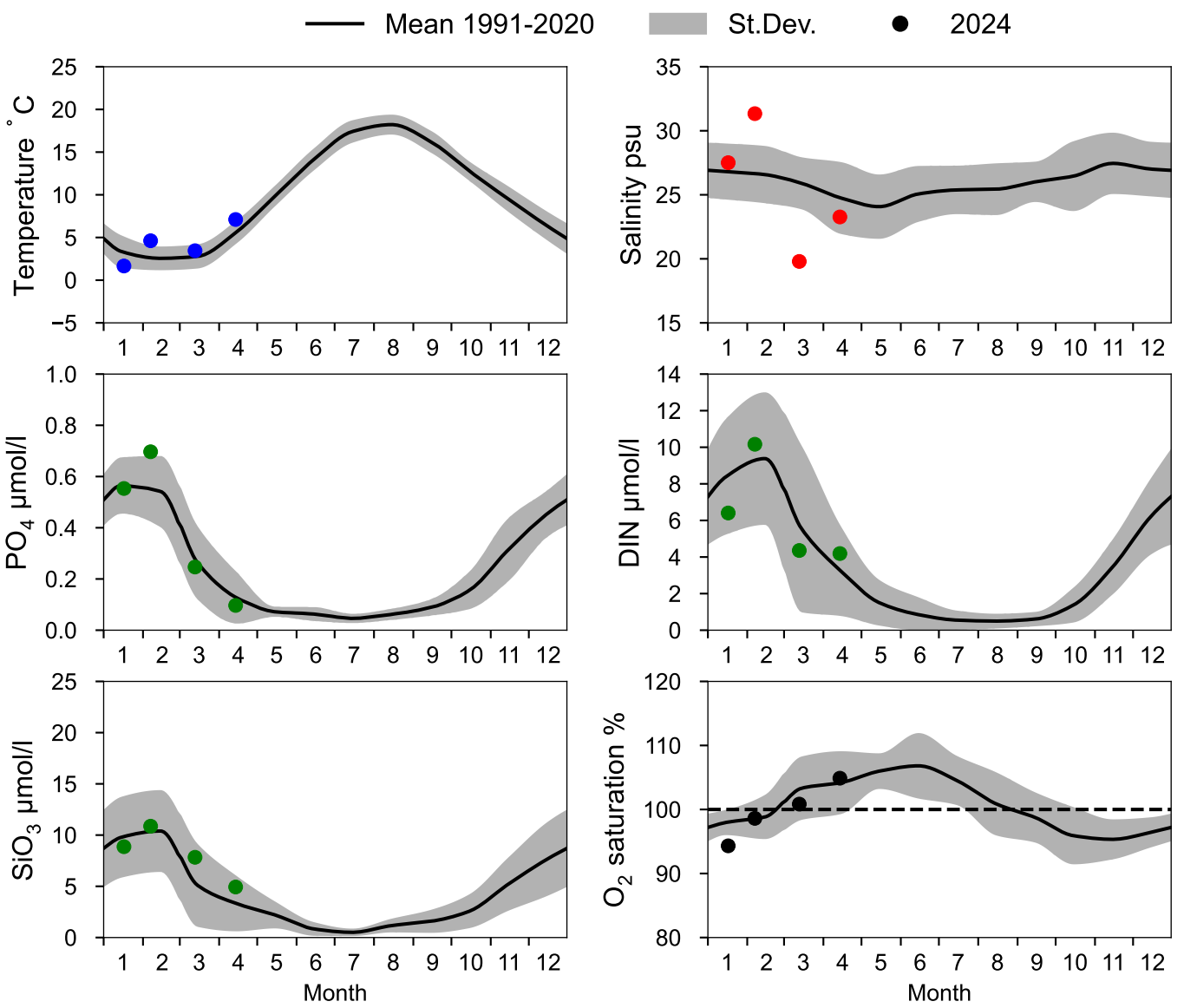


Vertical profiles FLADEN
April

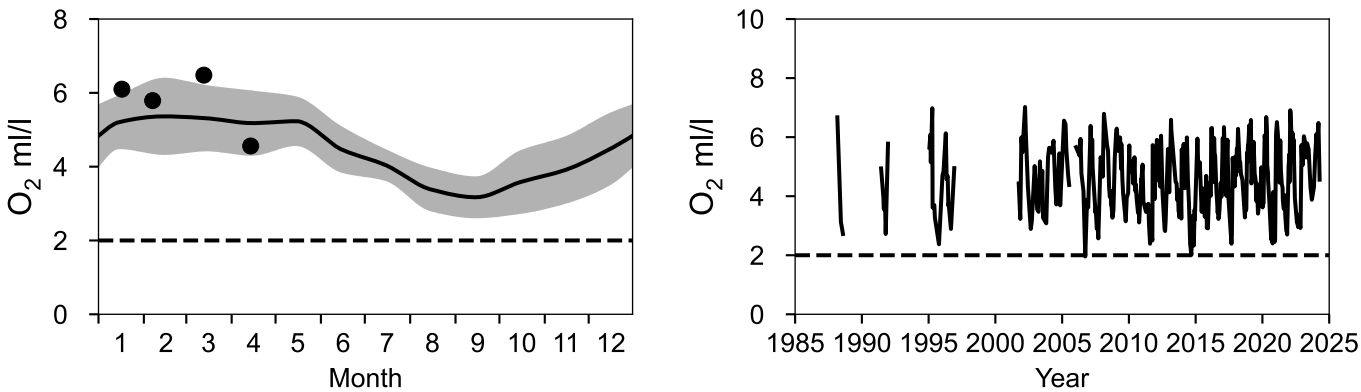


STATION SLÄGGÖ SURFACE WATER (0-10 m)

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)



Vertical profiles SLÄGGÖ
April