Karin Wesslander

Swedish Meteorological and Hydrological Institute
Oceanographic Laboratory

2020-06-12
Dnr: S/Gbg-2020-60

Cruise Report

June, R/V Svea
Swedish National Marine Monitoring Programme

Survey period:	2020-06-01 - 2020-06-08
Survey area:	Skagerrak, Kattegat, the Sound and the Baltic Proper
Principal:	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)

Address:
Sven Källfelts Gata 15
426 71 Västra Frölunda

Telephone:
+4611-495 80 00

E-mail:
Karin.Wesslander@smhi.se
WWW:
http://www.smhi.se/

SUMMARY

During the cruise, which is part of the Swedish pelagial monitoring programme, the Skagerrak, the Kattegat, the Sound and the Baltic Proper were visited.

The surface water temperature varied between 10-16 °C, which is normal for the season. At most stations in the Baltic Proper, the temperature in the entire depth profile was above normal. The cooling that normally occurs during winter was 2019/2020 very weak. The salinity in the Baltic Proper was above normal at all stations visited, both in the surface and in the deep water.

Dissolved inorganic nitrogen in the surface water was below detection limit from the surface to 20-40 m in all sea areas, which is normal after the spring bloom. Phosphate levels were higher than normal in the Baltic Proper except from the Western Gotland Basin. The silicate levels were above normal at most stations visited in the Kattegat and the Baltic Proper and also at some stations in Skagerrak.

The oxygen situation in the Baltic Sea continues to be severe. Completely oxygen-free conditions, when toxic hydrogen sulphide is formed, were found in the Western and Eastern Gotland Basin from 80-90 meters deep. Acute oxygen deficiency (<2 ml/l) was found from 70-80 meters depth throughout the area. In Hanö Bight and in the Bornholm Basin, oxygen levels in the bottom water have continued to decline. In March they were above 2 ml / l, which is the limit for acute oxygen deficiency, and during this expedition in June about 0.4 ml / l. The oxygen situation was good in the Skagerrak and Kattegat.

The inflow that occurred in November/December 2019 was still visible at the southeastern Baltic Proper. Oxygen levels just above 1.0 ml/l were observed close to the bottom at BCSIII-10 and at intermediate depth, 80-125 meters, at BY10.

SMHI's next expedition is scheduled for 7-13 July with R/V Svea.

Front: R/V Svea in Lysekil harbour after completed cruise.

RESULTS

The cruise was performed onboard R/V Svea and started in Västervik on the 1st of June and ended in Oxelösund on the 8th of June. The winds were weak to moderate and from varying wind directions throughout the expedition. The air temperature varied between 9 and 16.6°C.

A bottom system that measures temperature, salinity and oxygen was deployed at station L9 in Laholmsbukten in Kattegat.

Samples were also taken from water and plankton samples for measuring selenium for EAWAG in Switzerland (Swiss Federal Institute of Aquatic Science and Technology).

Additional sampling was also performed at the national station BY39.

In addition to the regular sampling program, Svea's instruments were also used to measure profiles during cruising, a so-called, Moving Vessel Profiles (MVP). The instrument was operated between regular sampling stations and the results show that the measurements can be a good complement to the regular monitoring program. Unfortunately, a malfunction was discovered and the MVP will be sent for service. Svea's ferrybox was also operational during the cruise.

During SMHI's expedition, phytoplankton samples are collected for later analysis at SMHI's laboratory. The results are presented in the AlgAware algal report shortly after the expedition is completed. https://www.smhi.se/en/publications/algal-situation-reports-2-1056

This report is based on data that has undergone an initial quality control. After further quality controls, certain values or quality flags may have changed. Data from this cruise is published as soon as possible on the data host's website, normally this is done within a week after the cruise is completed. Some analyzes are done after the cruise and will be published later.

Data and cruise reports can be downloaded here:
https://www.smhi.se/en/theme/marine-environment-2-885

The Skagerrak

The surface water temperature, 0-10m, varied between 11-15°C which was normal for the season except from the middle Skagerrak where it was colder. It was warmest near the coast. Deeper in the water column, the temperature was also normal or slightly above normal. The salinity in the surface water was between 22-30 psu and was normal at all stations except at P2 where it was lower. The stratification was well developed and the thermocline and the halocline coincided at a depth of 10-25 meters.

The concentration of nutrients was low from the surface to 20 m, which is normal for the season after the spring bloom. In the surface water, 0-10 m, normal levels were noted at all stations and the phosphate levels varied between 0.04-0.07 µmol/l, the silicate levels varied between 0.1-1.5 µmol/l. The content of dissolved inorganic nitrogen (DIN) was below detection limit (<0.1 µmol/l) at all stations. In the deep water, the concentrations of nutrients were normal except from below 125 m in offshore Skagerrak, where it was lower than normal.

Plankton activity, measured by CTD fluorescence, was noted at all stations and coincided in depth with stratification in salinity and temperature. Fluorescence peaks were noted at most stations at about 25 meters depth. At Å17, the fluorescence peak was higher and it was also higher concentrations of oxygen. The Secchi disk depth was 7-8 meters.

The oxygen situation was good at all stations in the Skagerrak, with values normal for the season. The lowest concentration was noted at Släggö, 4.1 ml/l at 50 meters.

The Kattegat and the Sound

The surface water temperature was normal for the season and varied between 13-15°C. The salinity in the surface water was also normal and varied between 19 and 21 psu, lowest in the Sound and highest in the northern Kattegat. Thermocline and halocline coincided and were found at a depth of 10-20 meters. In the deep water, below the stratification, the salinity was slightly lower than normal and the temperature was generally normal or slightly above normal.

Dissolved inorganic nitrogen and phosphate were consumed by the spring bloom down to stratification. Phosphate levels in the surface water varied between 0.05-0.09 µmol/l. In the Sound the concentration was slightly higher, 0.33 µmol/l, where the surface water is strongly influenced by outflowing water from the southern Baltic Sea where nutrient levels are higher. The content of dissolved inorganic nitrogen was below detection limit (<0.1 µmol/l) at all stations. The silicate concentrations were above normal at all stations and varied between 3.8-6 µmol/l in Kattegat to14.9 µmol/l in the Sound. The nutrient levels in the deep water were normal for the season.

Fluorescence measurements from the CTD indicated plankton activity from the surface down to a depth of 15-20 meters. Minor fluorescence peaks were noted at all stations coinciding with thermocline and halocline. The Secchi disk depth varied between 6-7 meters in the area.

At all the stations visited, the oxygen content in the bottom water was good. In Kattegat the bottom water oxygen concentration ranged from 5.2 to 5.7 ml/l and in the Sound it was 4.3 ml/l.

The Baltic Proper

The surface water temperature, 0-10 m, was now normal throughout the entire Baltic Proper and varied between 10-13°C, coldest in the north and warmest in the southwest. The temperature in the deep water below the halocline has for some time been above the long time mean value and now is the water temperature above the halocline also warmer than normal. This is a consequence of the mild winter where the cooling of the surface layer has been less this year. The salinity in the surface water was, like in May, above normal at all stations visited, and varied between 7 and 8.4 psu. The salinity was generally higher than normal also in the deep water. The halocline was found at about 70-80 meters depth in the Eastern and Western Gotland Basin, in the Bornholm Basin and Hanö Bight slightly shallower from 50-60 meters depth and in Arkona at about 30 meters depth. The thermocline coincided with the halocline that delimits the surface layer from the deep water, but a secondary thermocline was also found in the surface water at some stations at 10-20 meters depth, where the heating of the surface water had progressed further.

The levels of phosphate in the surface water were higher than normal except in the Western Gotland Basin and varied between 0.2–0.4 µmol/l. Dissolved inorganic nitrogen was below the detection

limit (<0.10 µmol/l) from the surface down to 40 meters, which is normal after the spring bloom has consumed all available nitrogen. In the deep water, the concentrations of dissolved inorganic nitrogen were higher than normal in the Western Gotland Basin and parts of the Eastern Gotland Basin. The dissolved inorganic nitrogen was also above normal in the Bornholm Basin. The silicate content in the surface water was above normal throughout the entire Baltic Proper, except in the Western Gotland Basin where it was normal. The levels varied between 9-18 µmol/l. The silicate content was generally elevated throughout the surface layer down to the halocline.

The oxygen situation in the Baltic Proper continues to be severe. Absolutely oxygen-free conditions or anoxia, when toxic hydrogen sulphide is formed, were found in the Western and Eastern Gotland Basin from 80-90 meters depths. Acute oxygen deficiency or hypoxia (<2 ml/l) was found from 70-80 meters deep throughout the area and even shallower from about 60 meters deep in the Hanö Bight. In Hanö Bight and the Bornholm Basin, oxygen levels in the bottom water have continued to decline. In March they were above 2 ml/l, which is the limit for acute oxygen deficiency, and now in June at 0.4 ml/l.

The inflow that occurred in November/December 2019 was still visible at the southeastern Baltic Proper. Oxygen levels just above 1.0 ml/l were observed close to the bottom at BCSIII-10 and at intermediate depth, 80-125 meters, at BY10. This inflow had not yet reached BY15.

Plankton activity, estimated from the chlorophyll fluorescence on the CTD probe, occurred throughout the investigated area, with some fluorescence maxima at 20 meters. The Secchi disk depth varied between 6-8 meters.

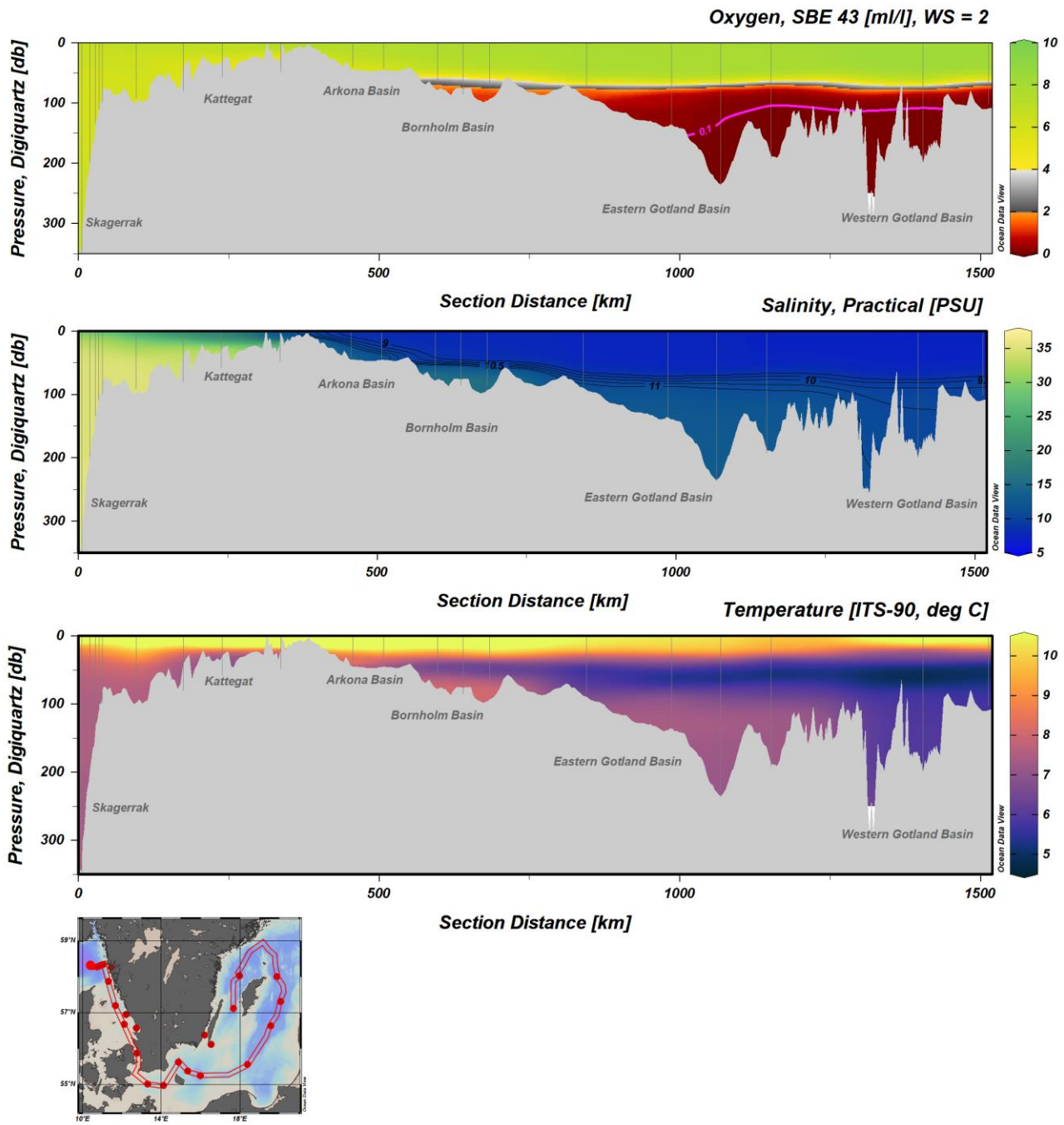

Figure 1. Transect showing dissolved oxygen, salinity and temperature from the Skagerrak, Kattegat, the Sound, through the Baltic Proper, to the Western Gotland Basin.

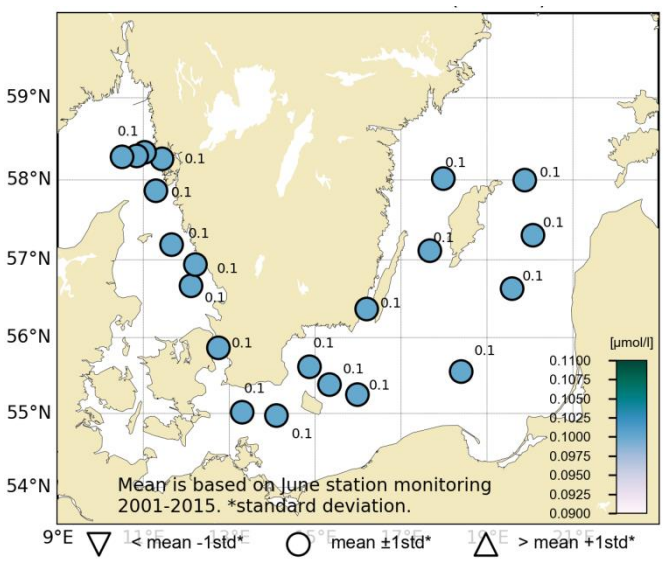

Figure 2: Concentration of dissolved inorganic nitrogen in the surface water (0-10m).

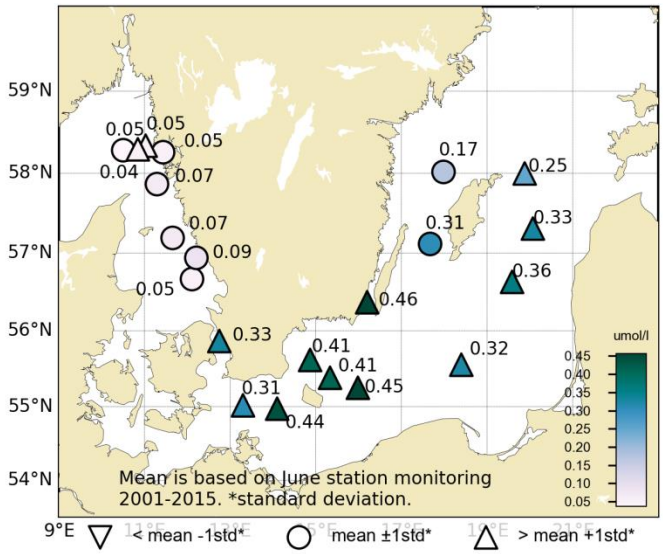

Figure 3: Concentration of phosphate in the surface water (0-10m).

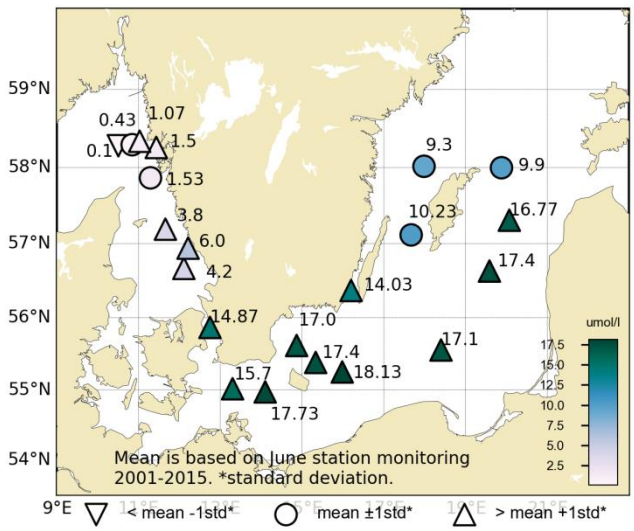

Figure 4: Concentration of silicate in the surface water (0-10m).

PARTICIPANTS

Name		Leg	From
Anna-Kerstin Thell	Chief Scientist		SMHI
Örjan Bäck			SMHI
Martin Hansson			SMHI
Madeleine Nilsson			SMHI
Monica Lindner			SMHI
			SMHI
			SMHI
			SMHI
			SMHI

APPENDICES

- Track chart
- Table over stations, sampled parameters and number of sampling depths
- Map showing bottom oxygen concentrations and surface salinity, temperature and nutrient concentrations
- Vertical profiles for regular monitoring stations
- Monthly average surface water plots for regular monitoring stations

SMHI

Havs
och Vatten
myndigheten

TRACKCHART
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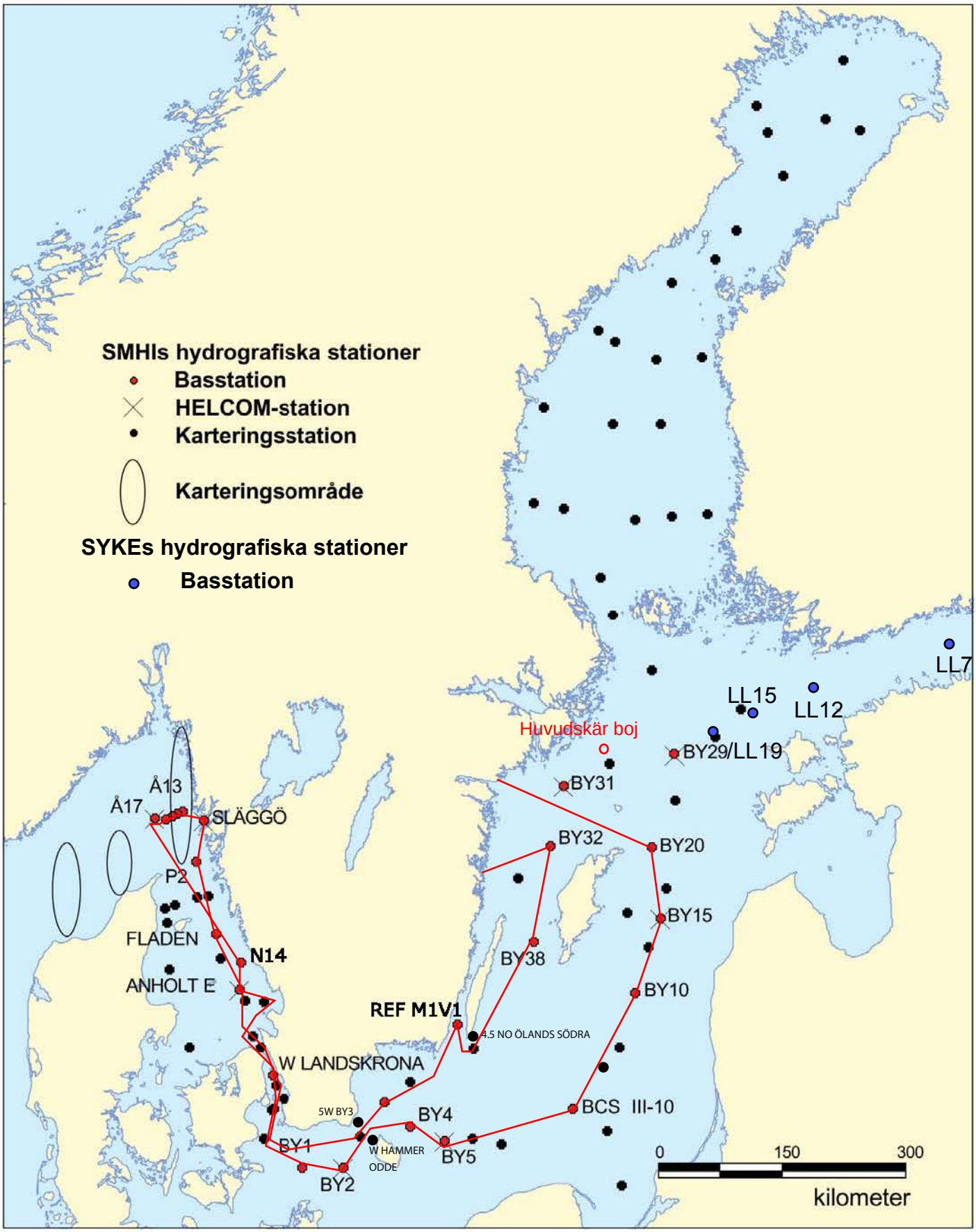
Series: 0439-0464



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Time: 17:25

Ship: SE
Year: 2020

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	Phos	Nitr	Nitr	Nitr	Amm	Alk	Silk	Sum3-si	Hum	Cond_vis	Cond_sim	Cond_temp
0439	11	BPWX38	BAS...	BY32 NORRKÖPINGSDJ	5801.01	01759.07	20200602	0630	205	6	05	5	12	1018	0120	x---	17	17	x	x	-	x	-	x	x	x	x	x	x	x	x	x	-	x	-	x	x
0440	11	BPWX45	BAS...	BY38 KARLSÖDJ	5706.97	01740.22	20200602	1330	114		19	1	12	1015	0020	x---	14	14	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	x	x	x	x
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0448	11	FIBG27	BAS...	SLÄGGÖ	5815.58	01126.11	20200604	1530	74	7	22	4	16.9	995	1620	xxx-	9	9	x	x	x	x	-	x	x	-	x	x	x	x	x	x	-	x	-	x	x
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0464	11	BPEX26	BAS...	BY20 FÅRÖDJ	5759.88	01952.80	20200607	2110	203		20	2	10.6	1009	9990	x---	17	17	x	x	-	x	-	x	x	x	x	x	x	x	x	-	x	-	-	-

Bottom water oxygen concentration (ml/l)

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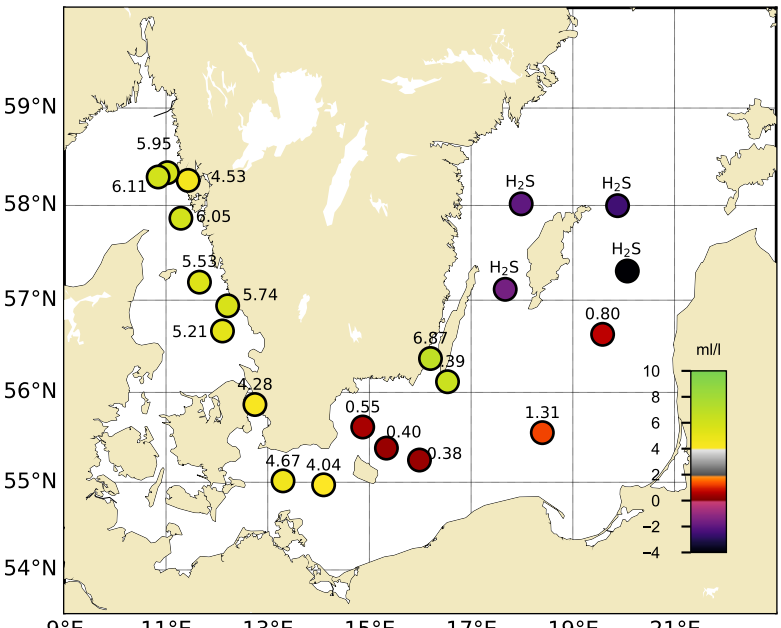
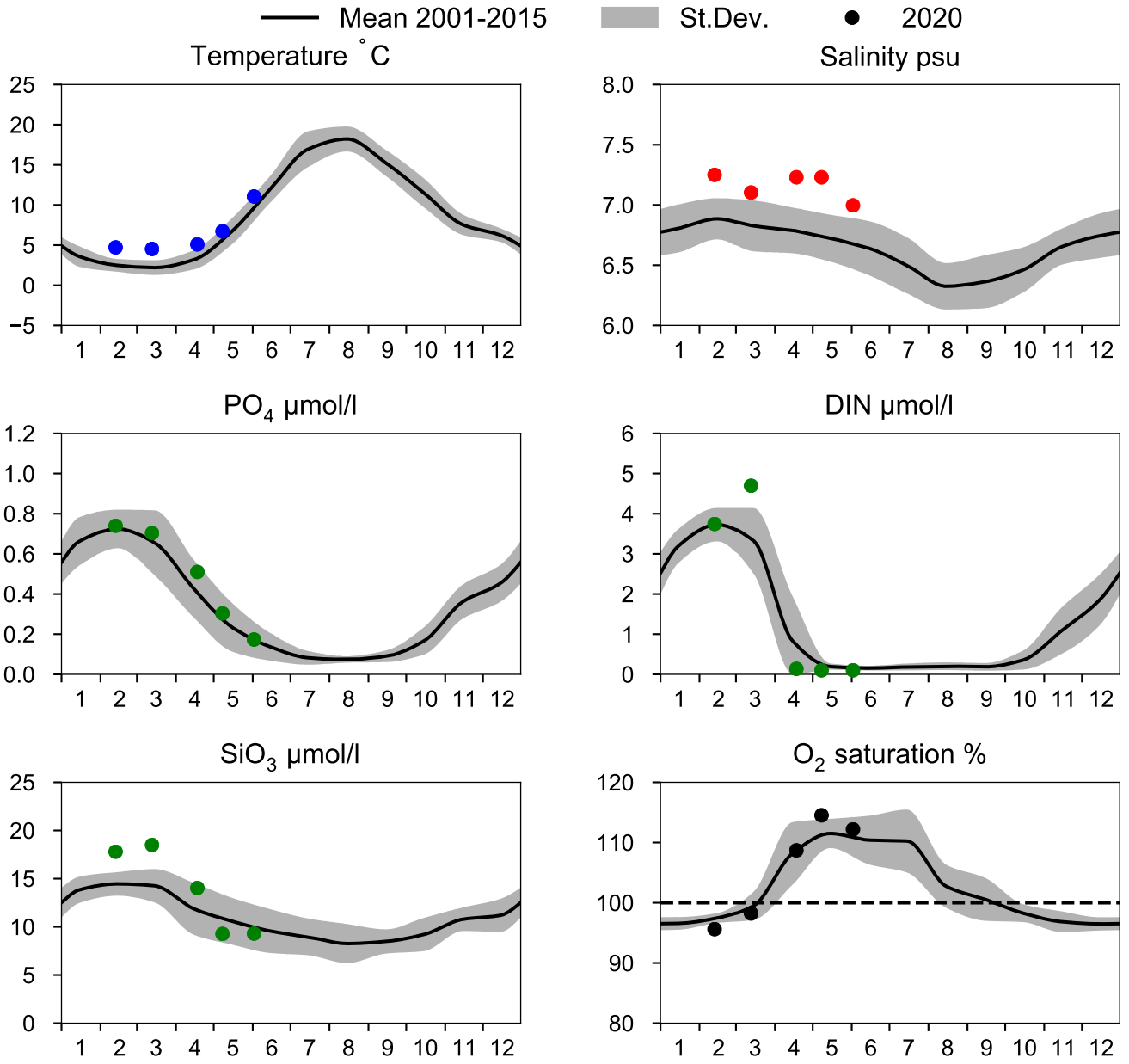
Date: 20200602-20200607
Series: 0439-0464

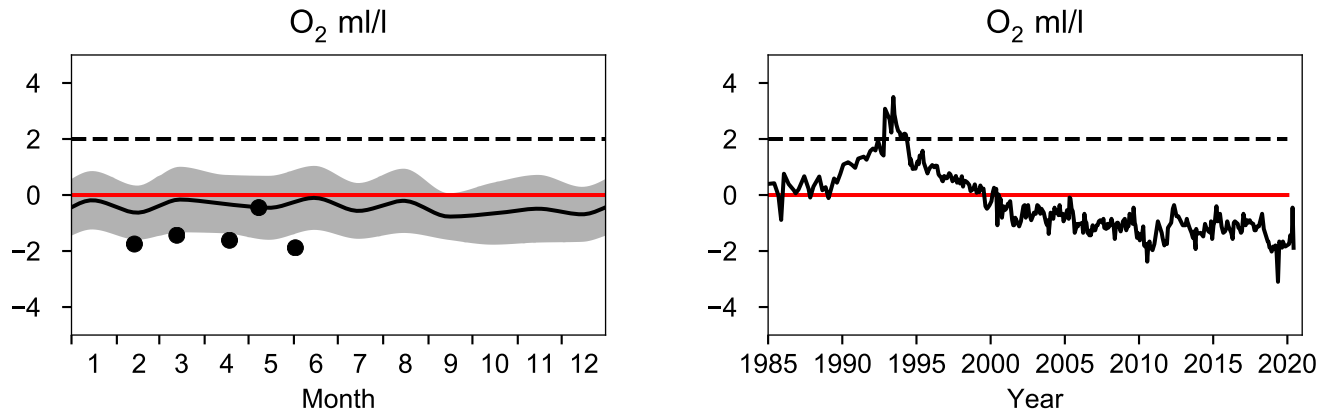


STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

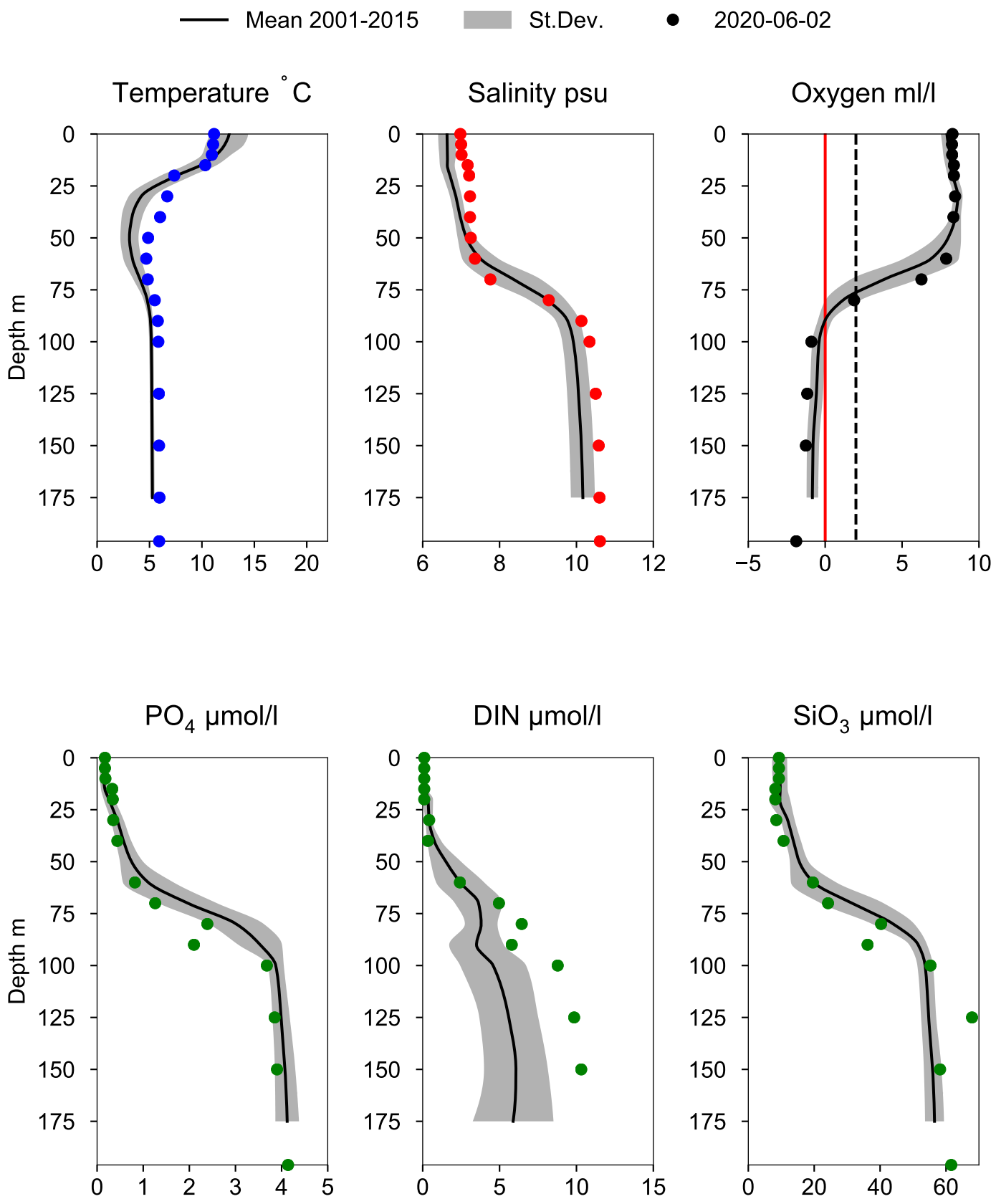
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

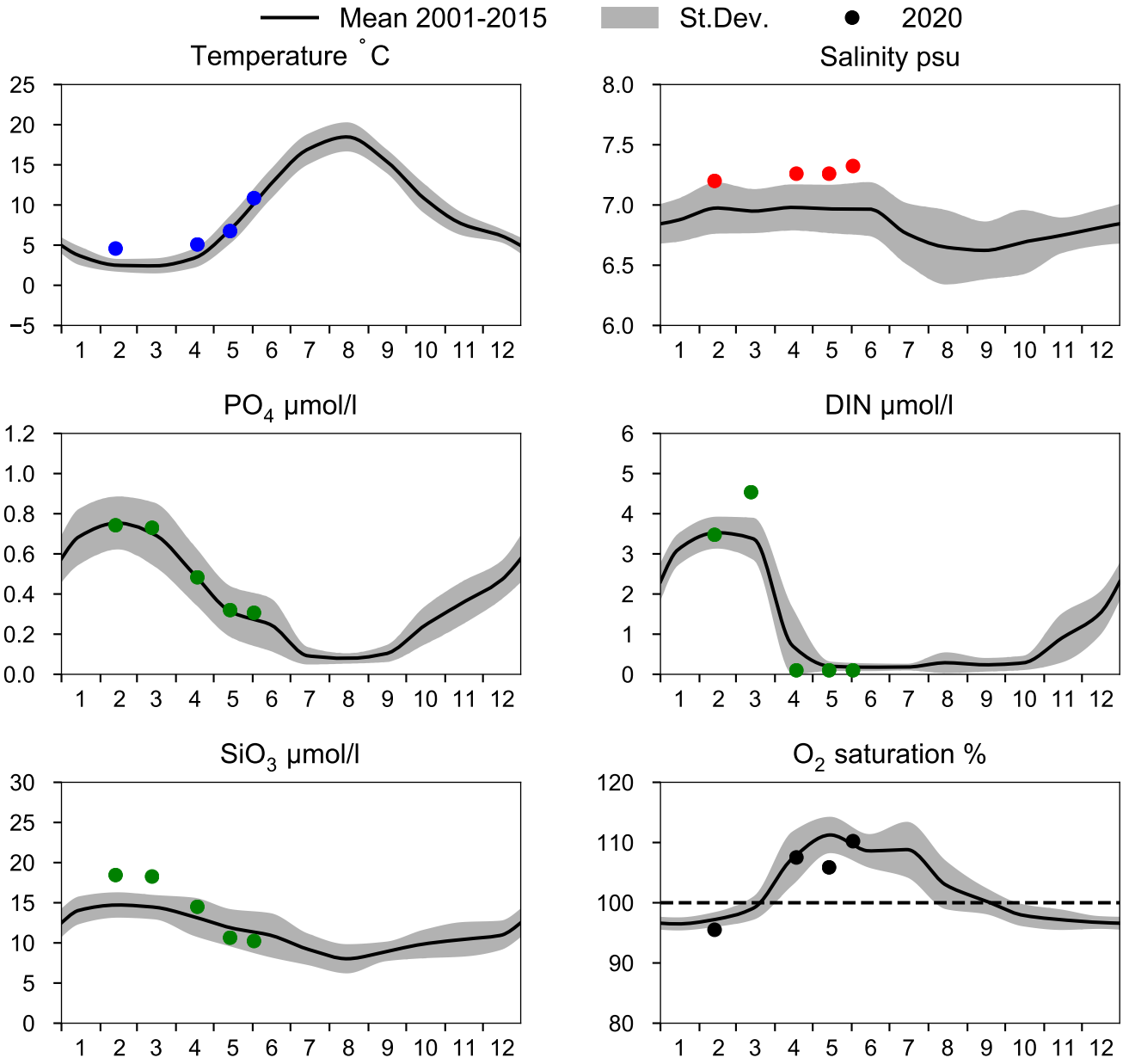


Vertical profiles BY32 NORRKÖPINGSDJ
June

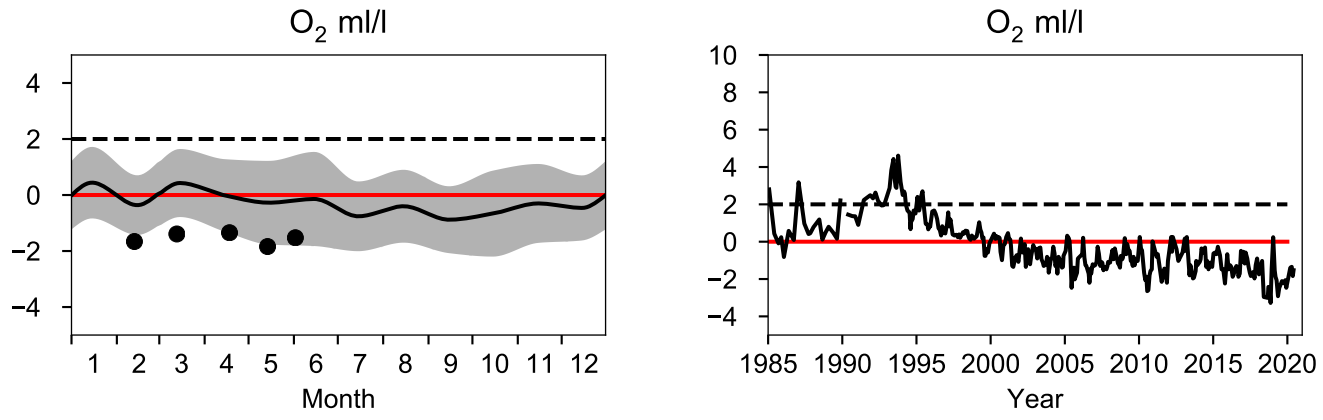


STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

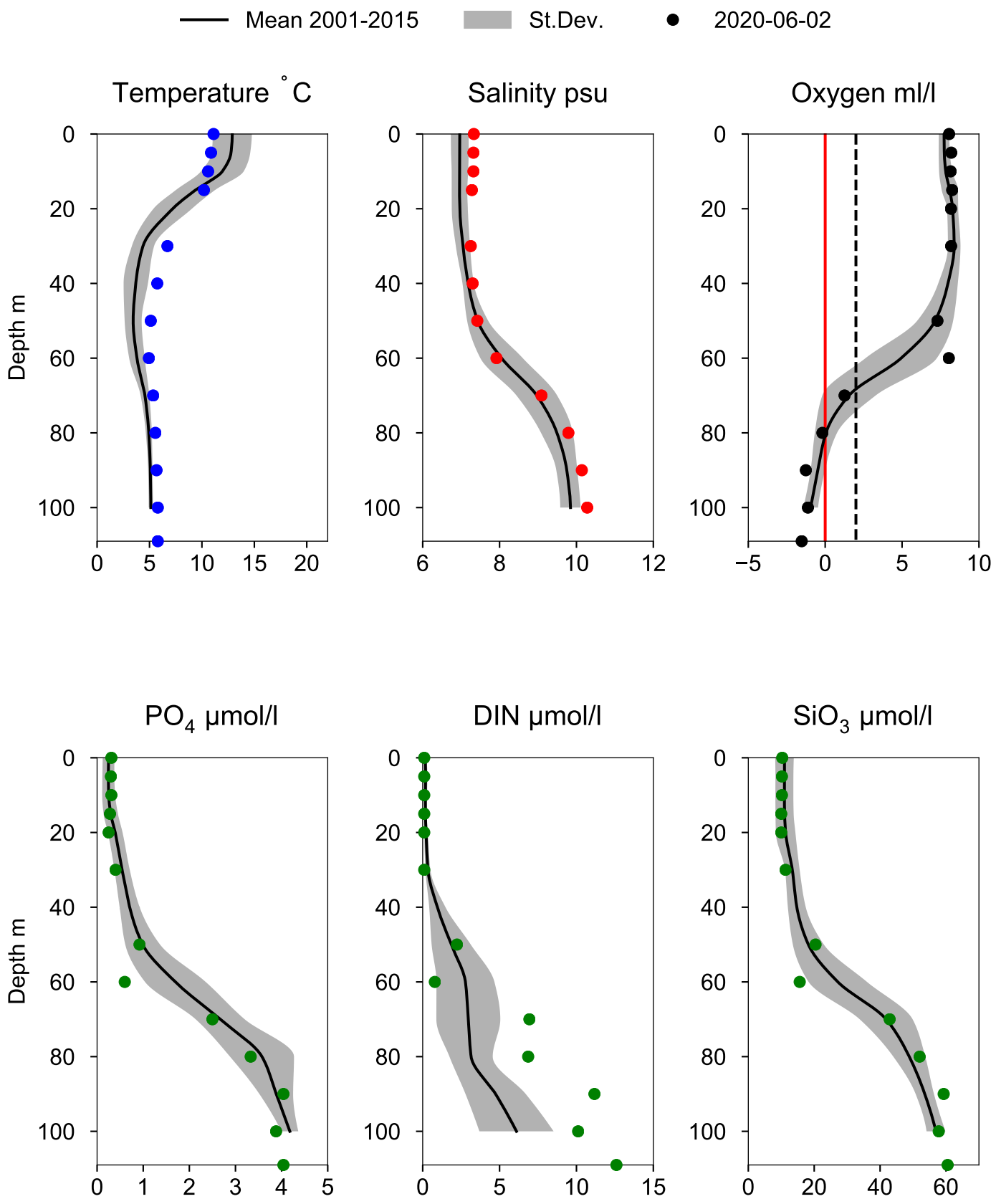
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

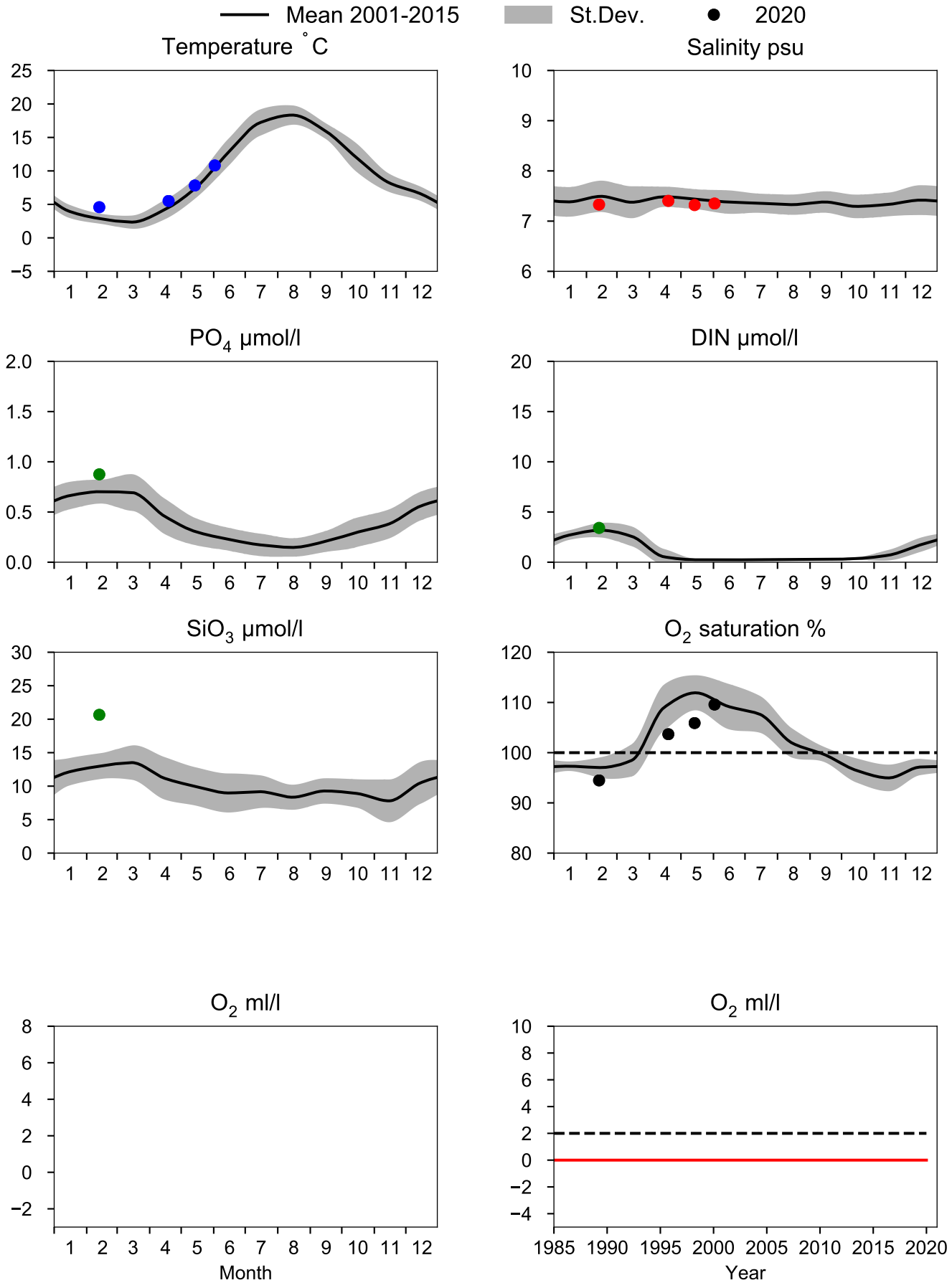


Vertical profiles BY38 KARLSÖDJ
June

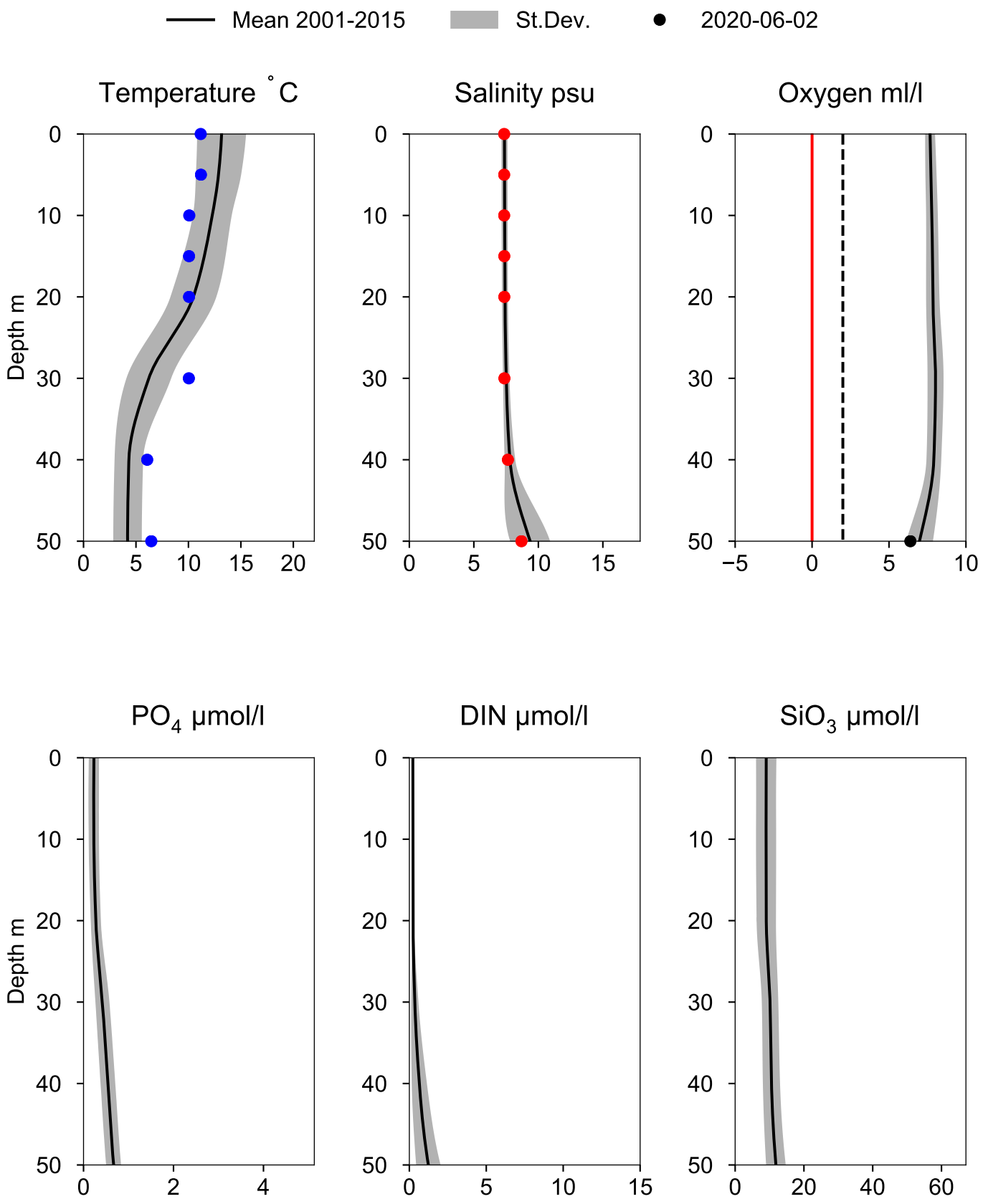


STATION BY39 ÖLANDS S UDDE SURFACE WATER (0-10 m)

Annual Cycles

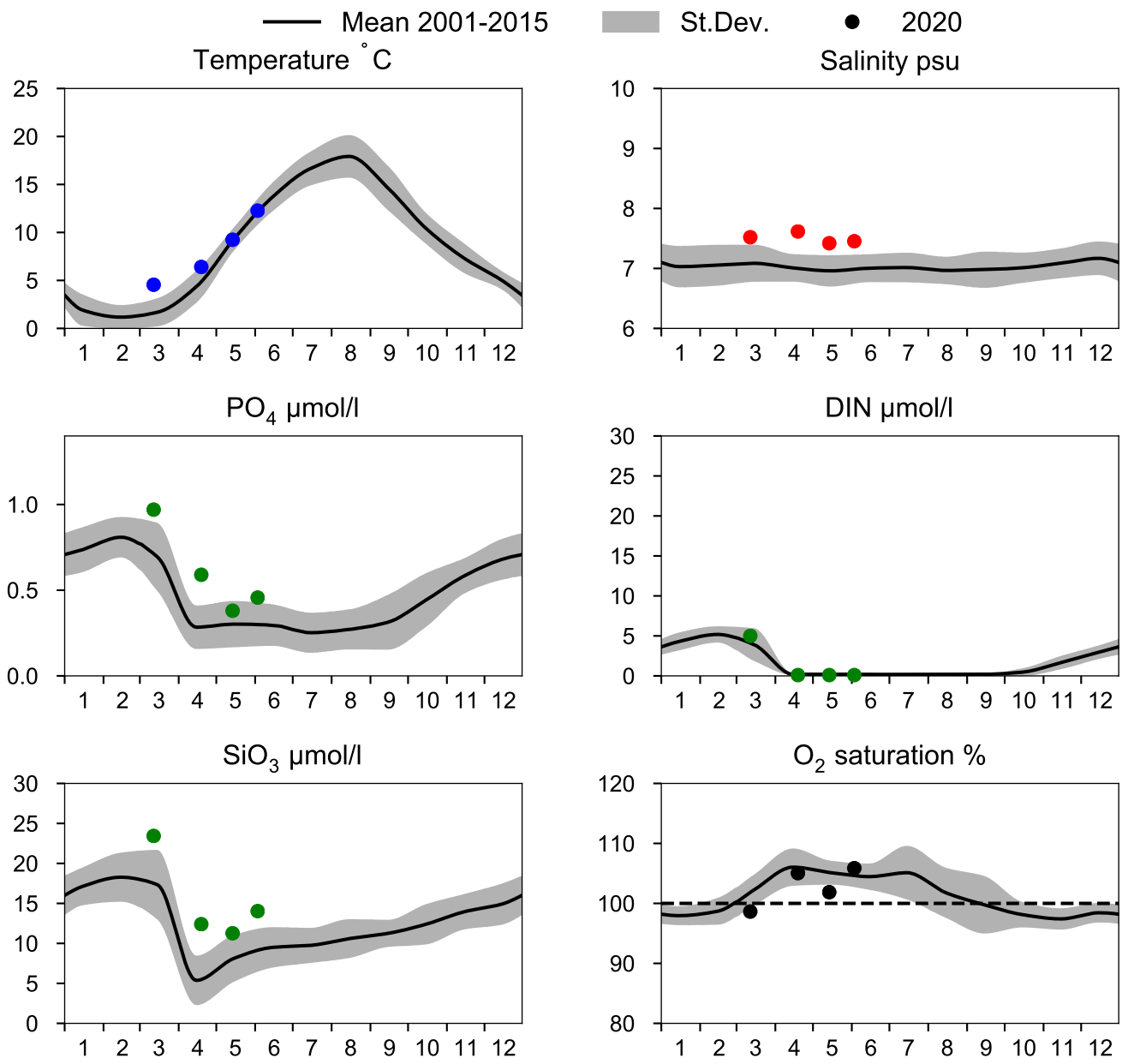


Vertical profiles BY39 ÖLANDS S UDDE
June

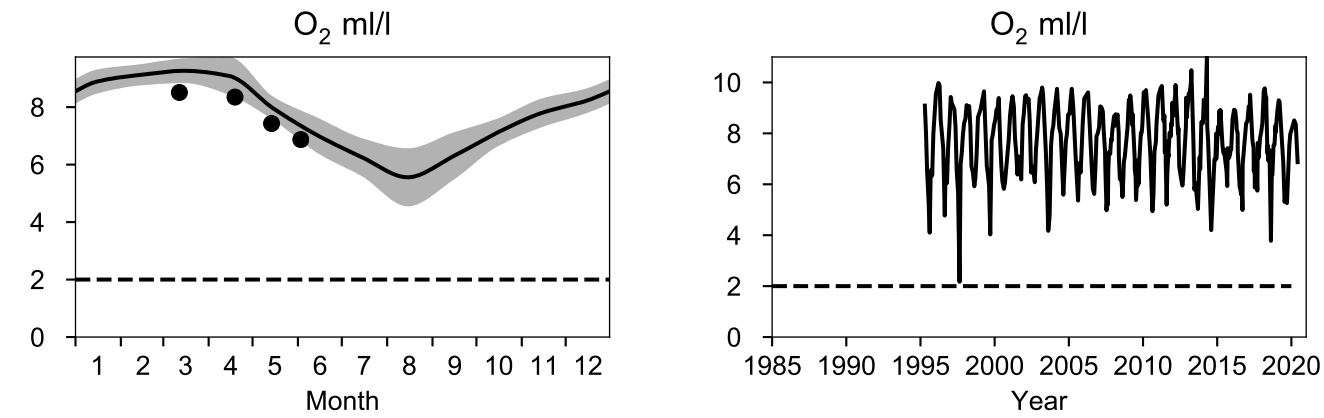


STATION REF M1V1 SURFACE WATER (0-10 m)

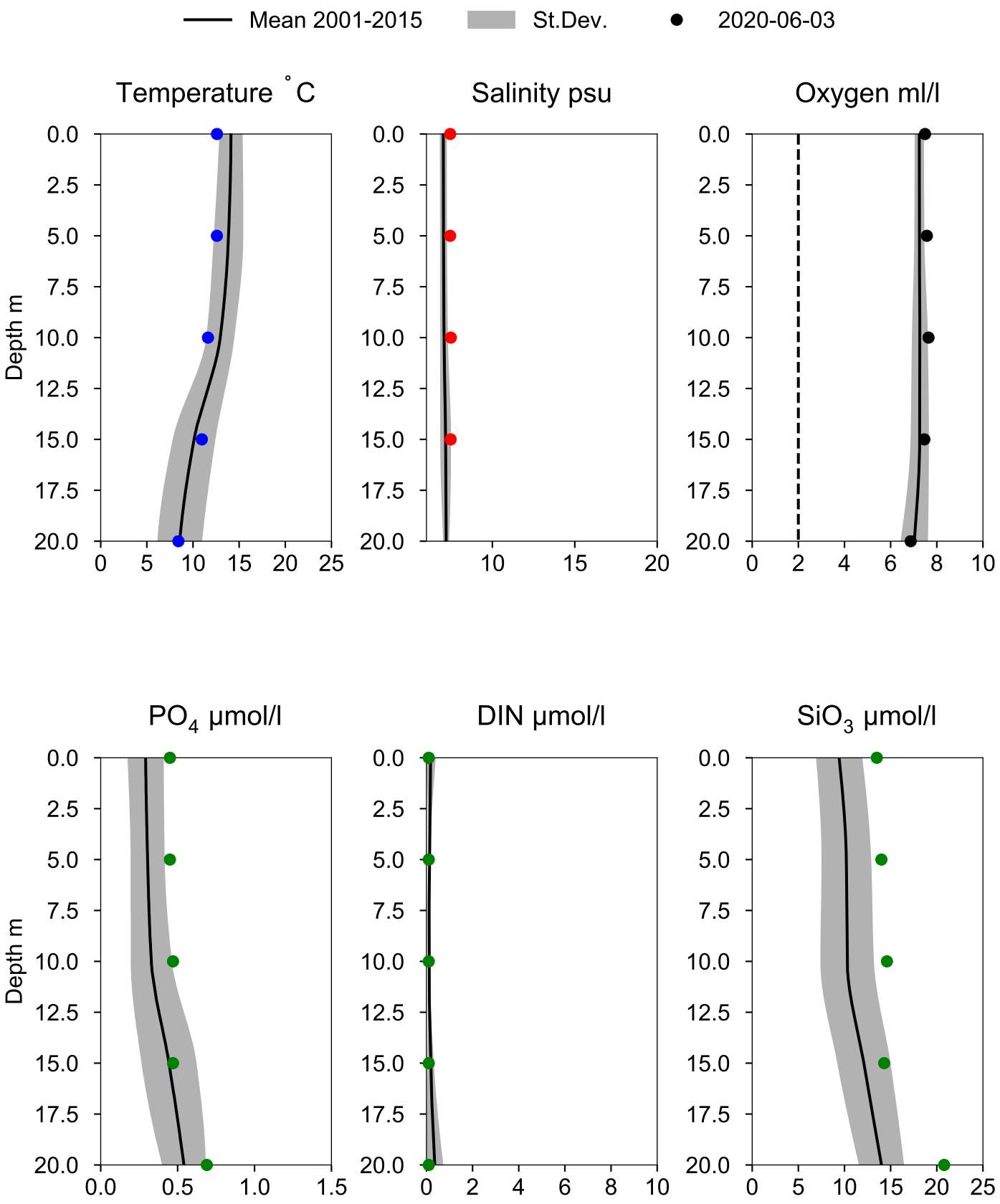
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 15 m)

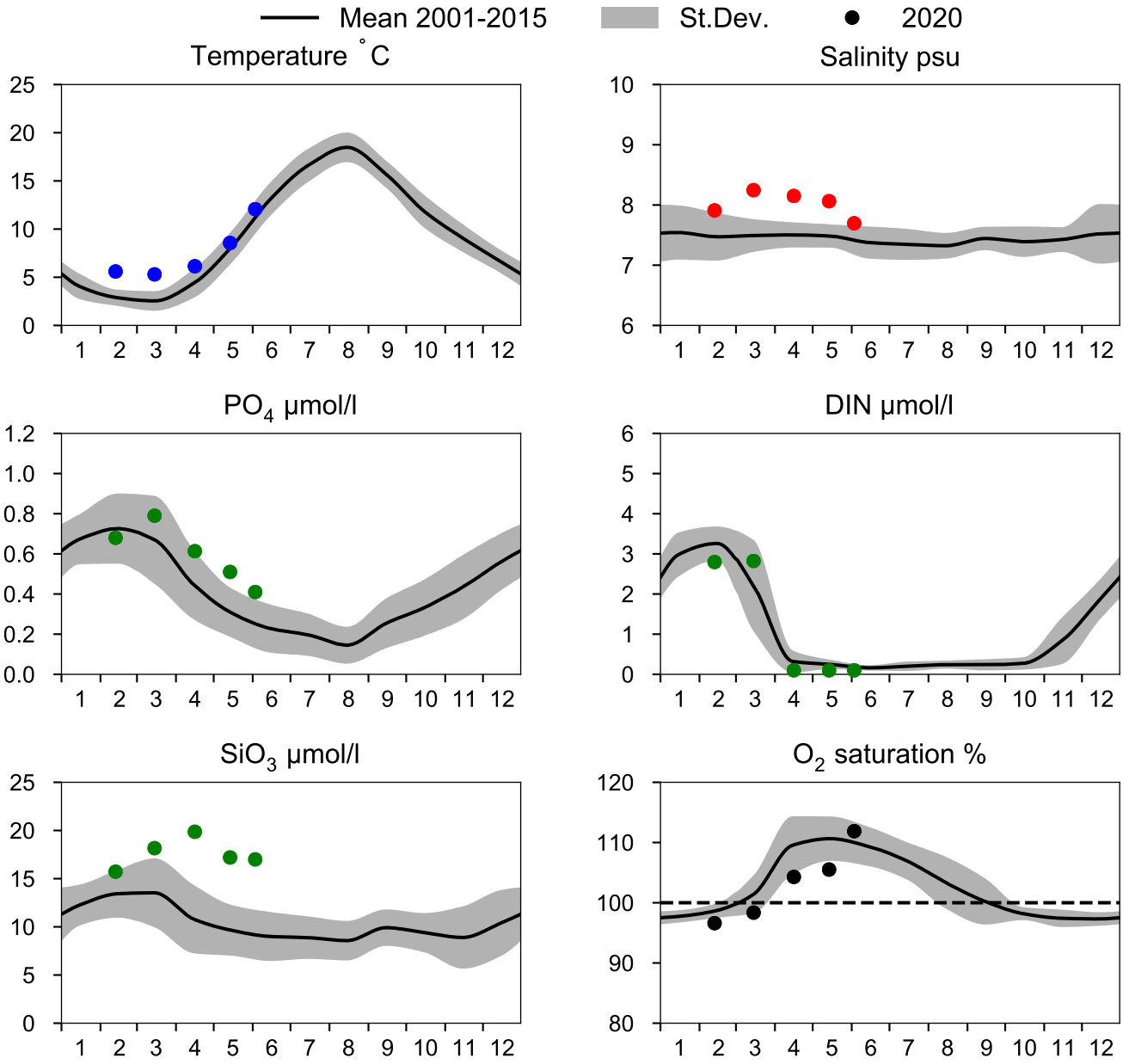


Vertical profiles REF M1V1
June

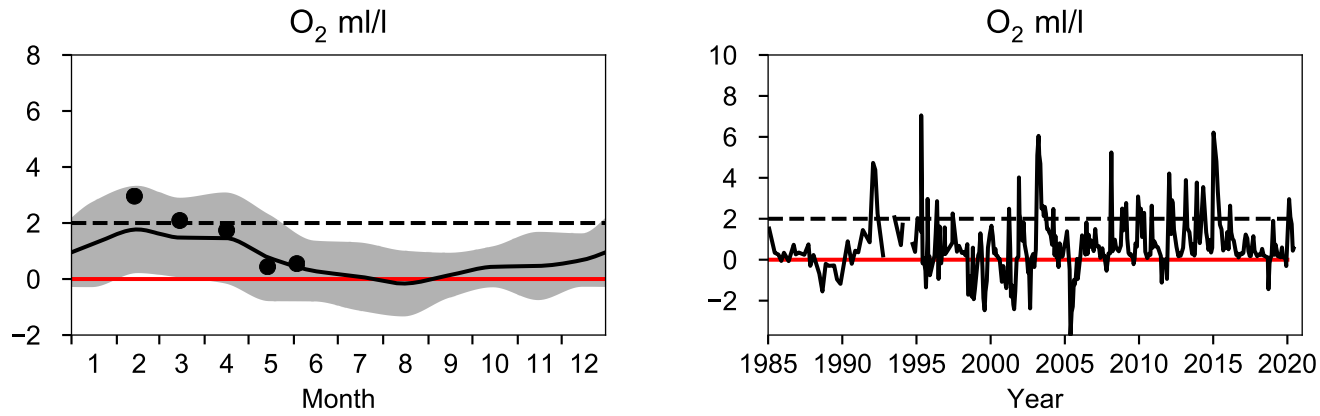


STATION HANÖBUKTEN SURFACE WATER (0-10 m)

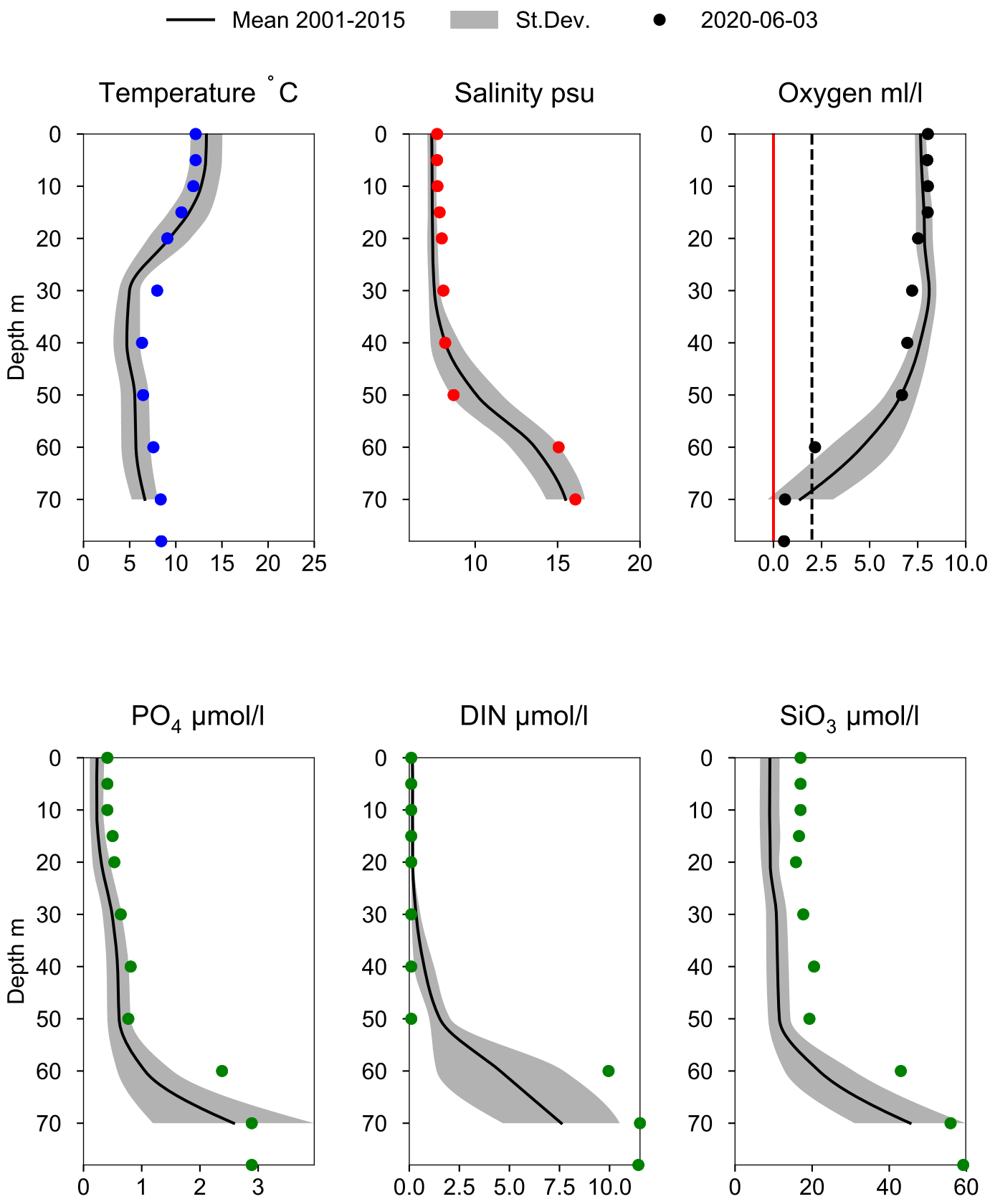
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)

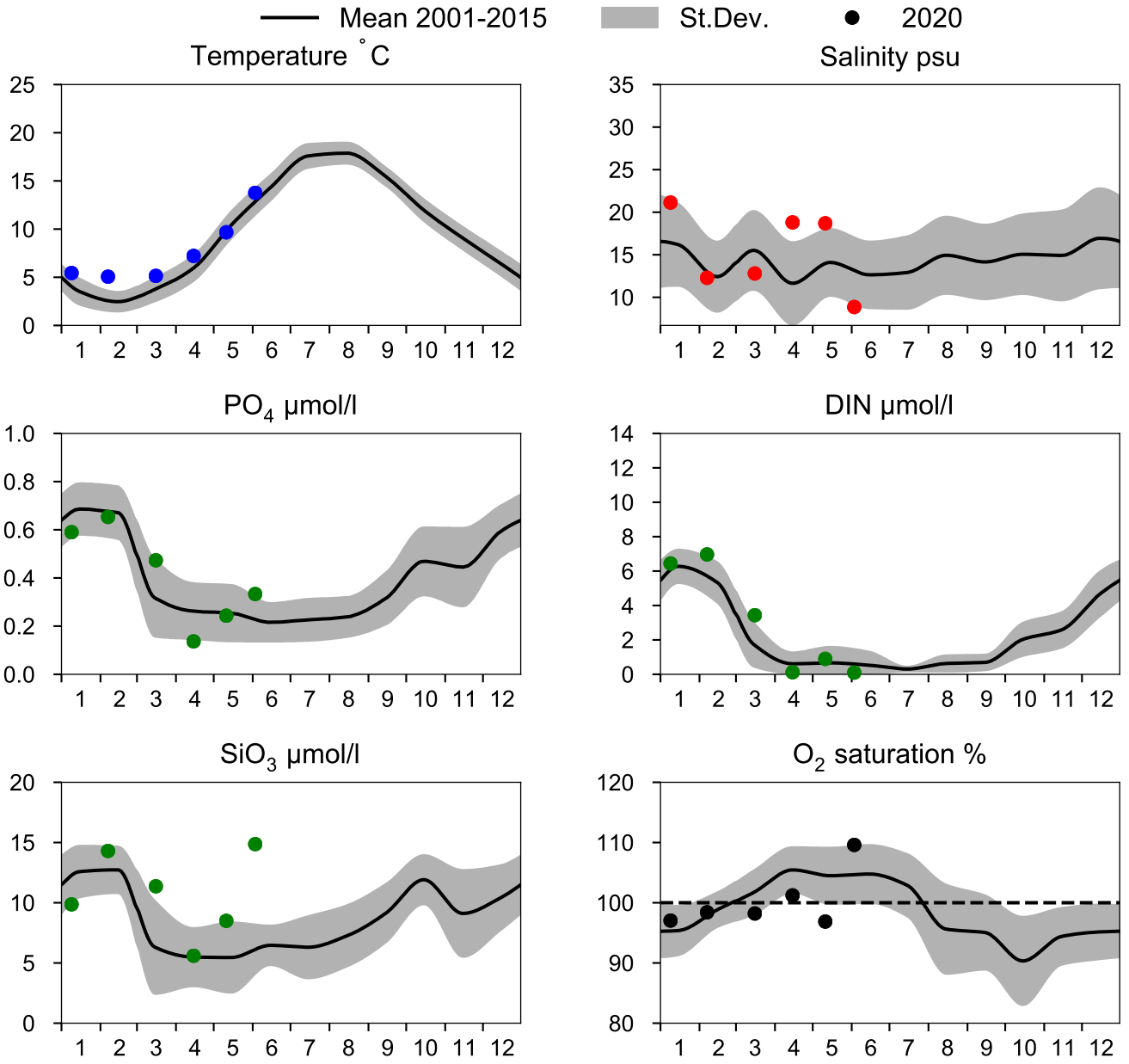


Vertical profiles HANÖBUKTEN
June

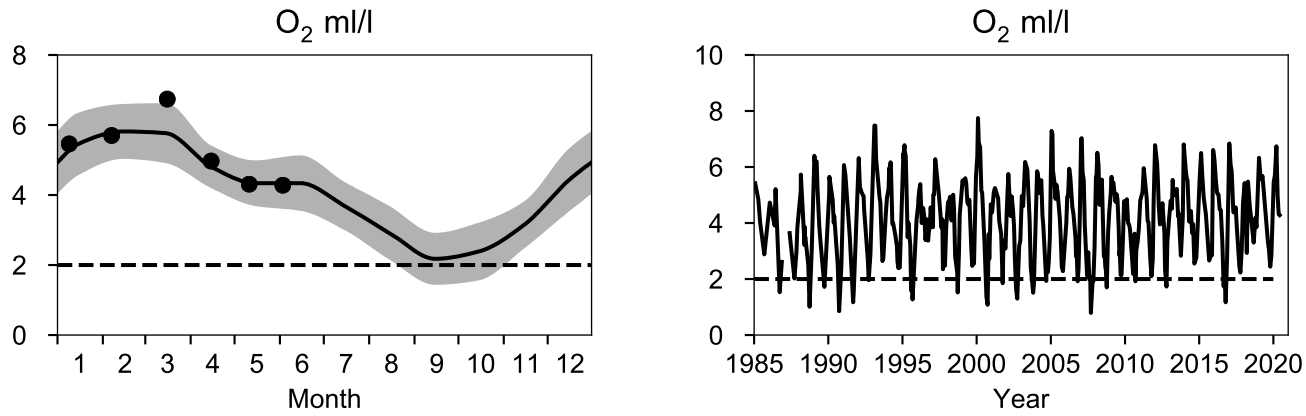


STATION W LANDSKRONA SURFACE WATER (0-10 m)

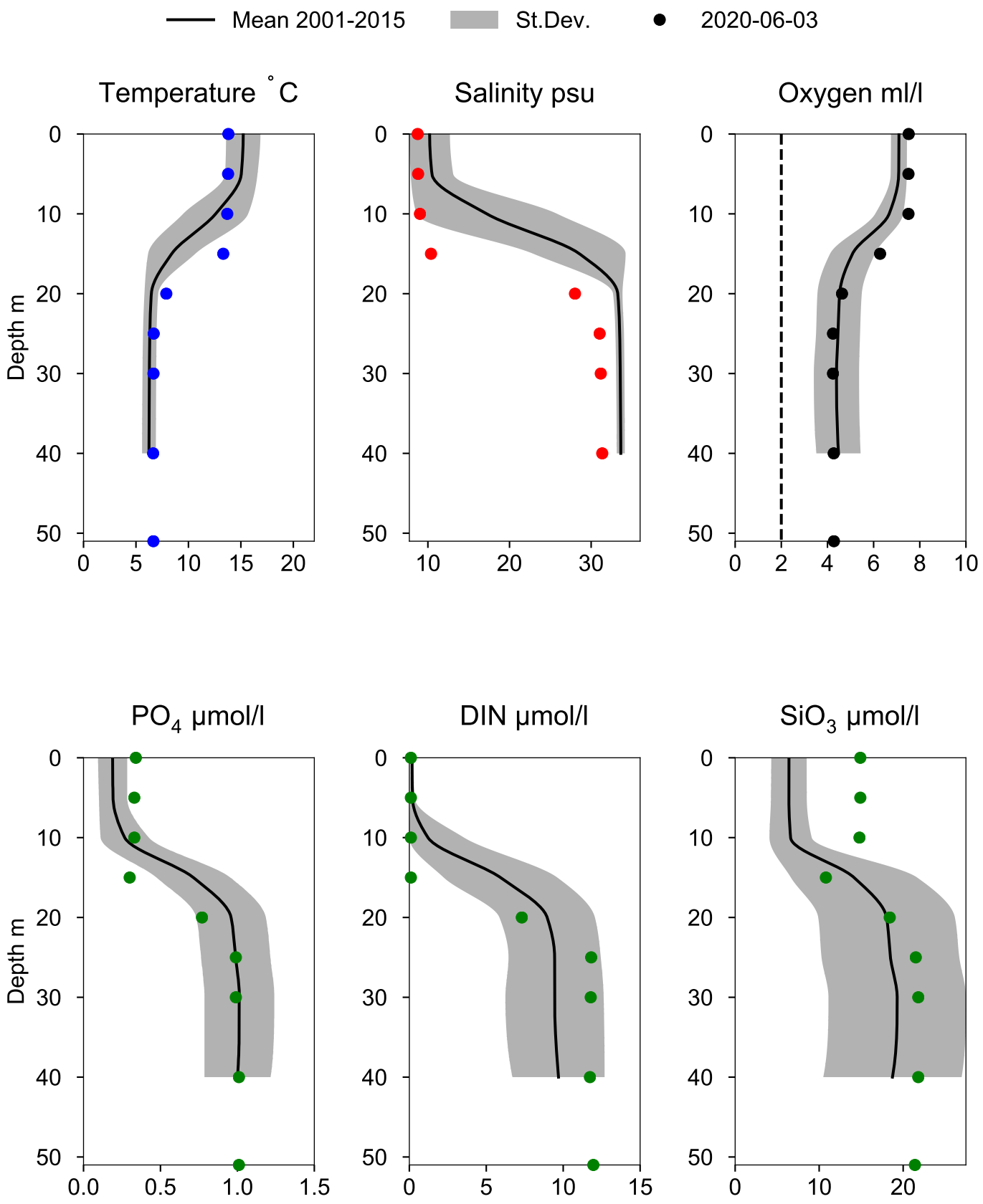
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

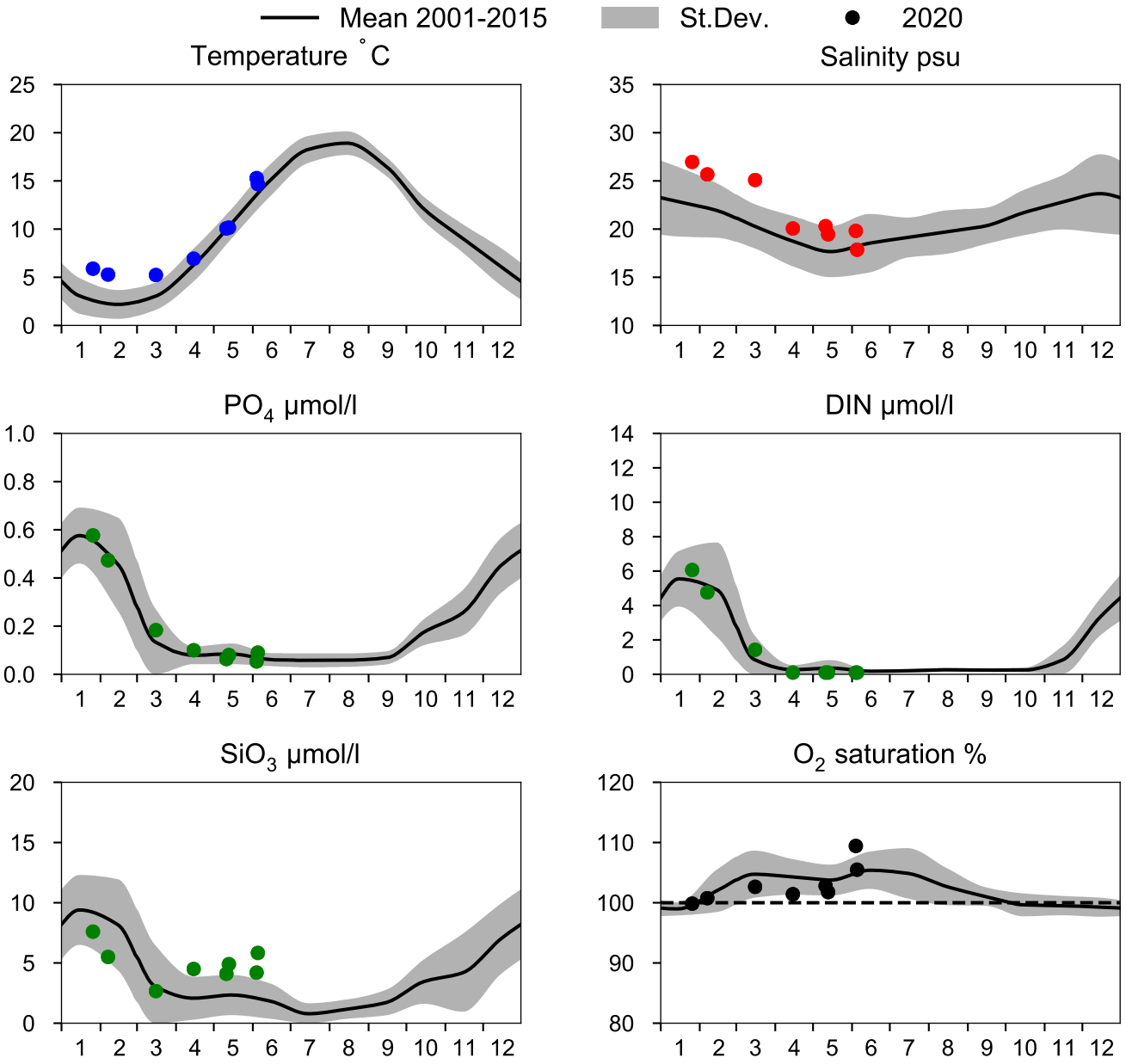


Vertical profiles W LANDSKRONA
June

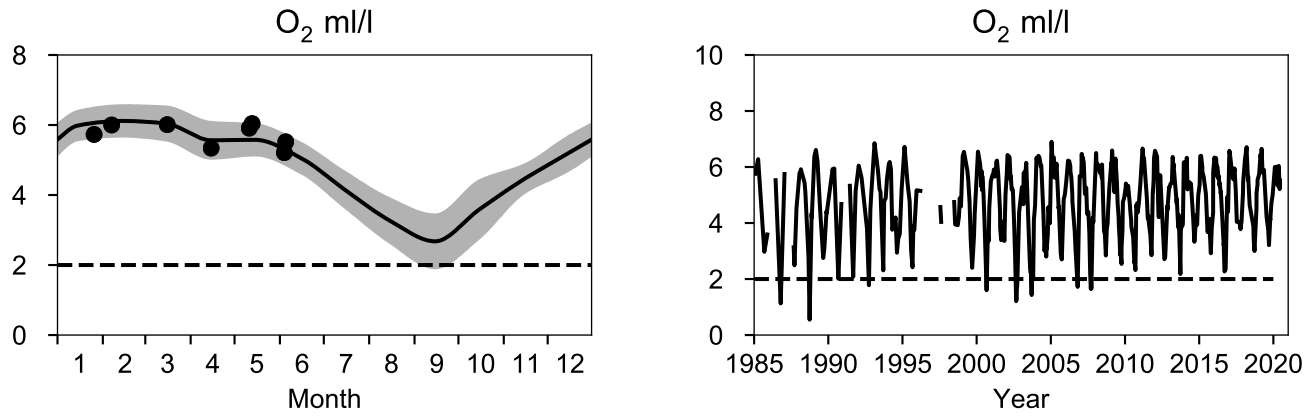


STATION ANHOLT E SURFACE WATER (0-10 m)

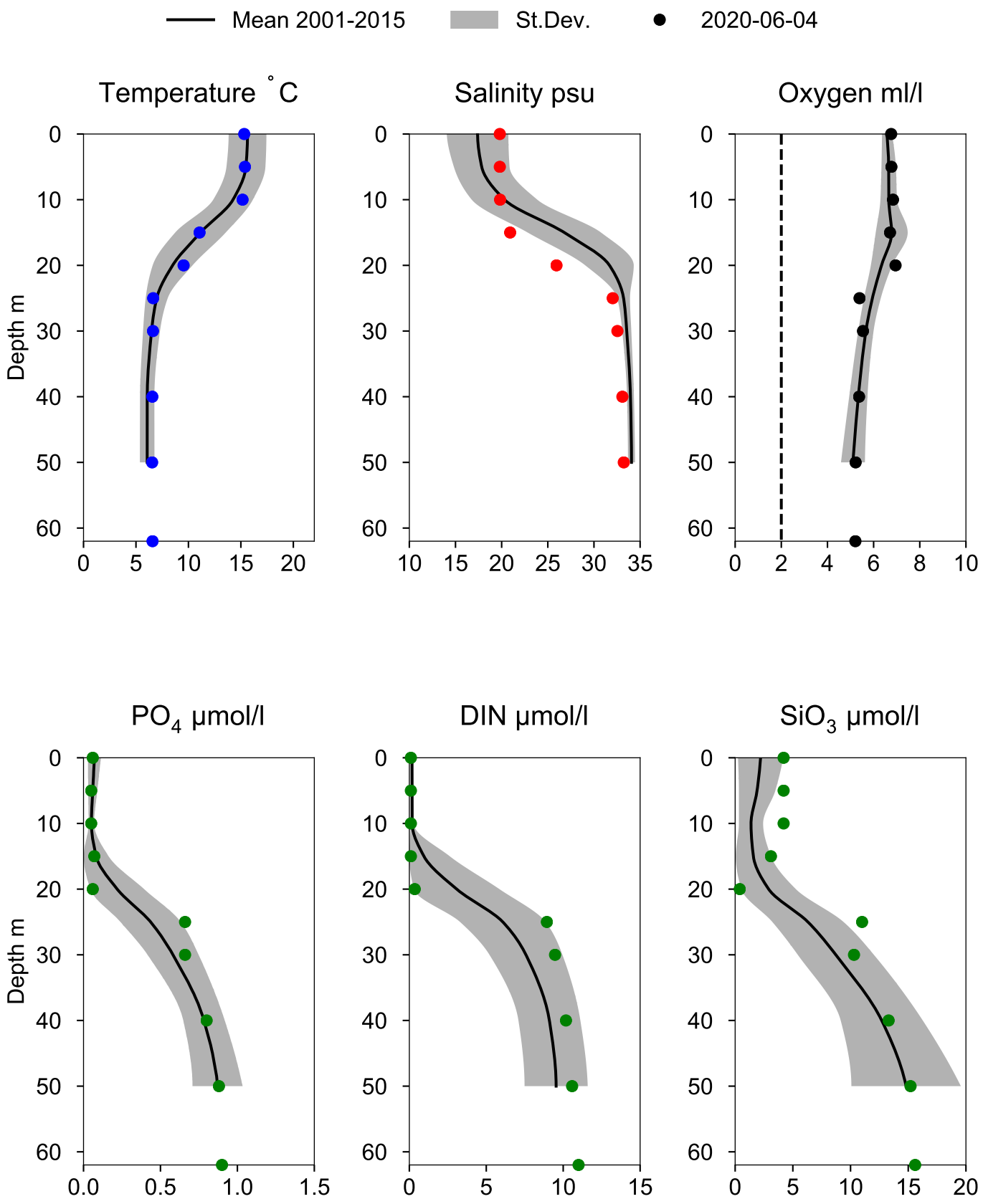
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

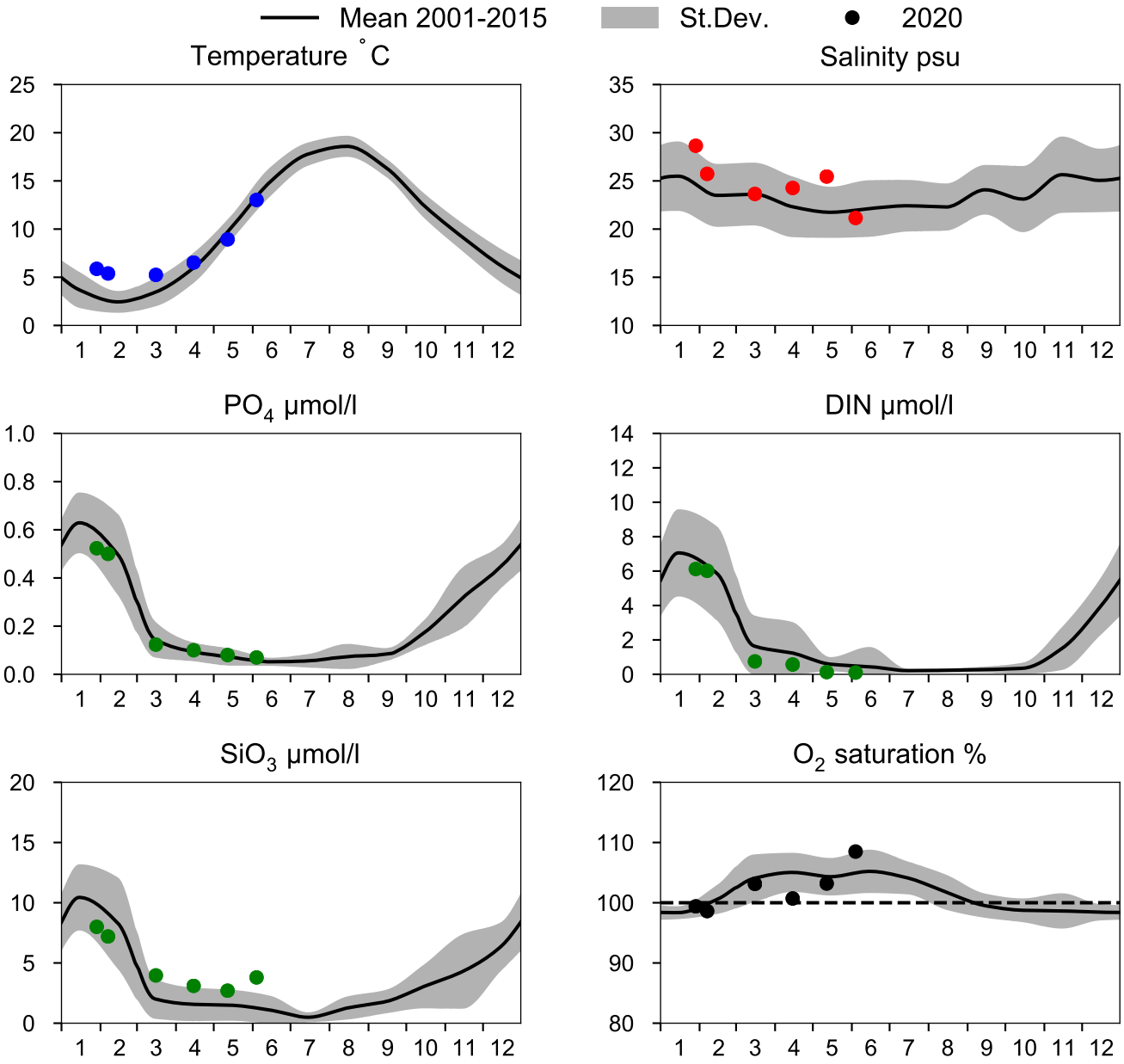


Vertical profiles ANHOLT E
June

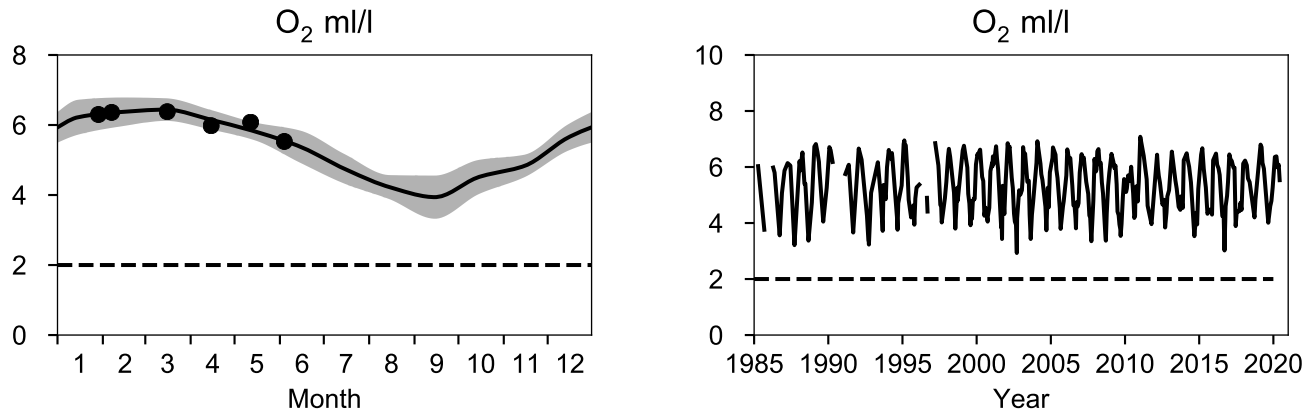


STATION FLADEN SURFACE WATER (0-10 m)

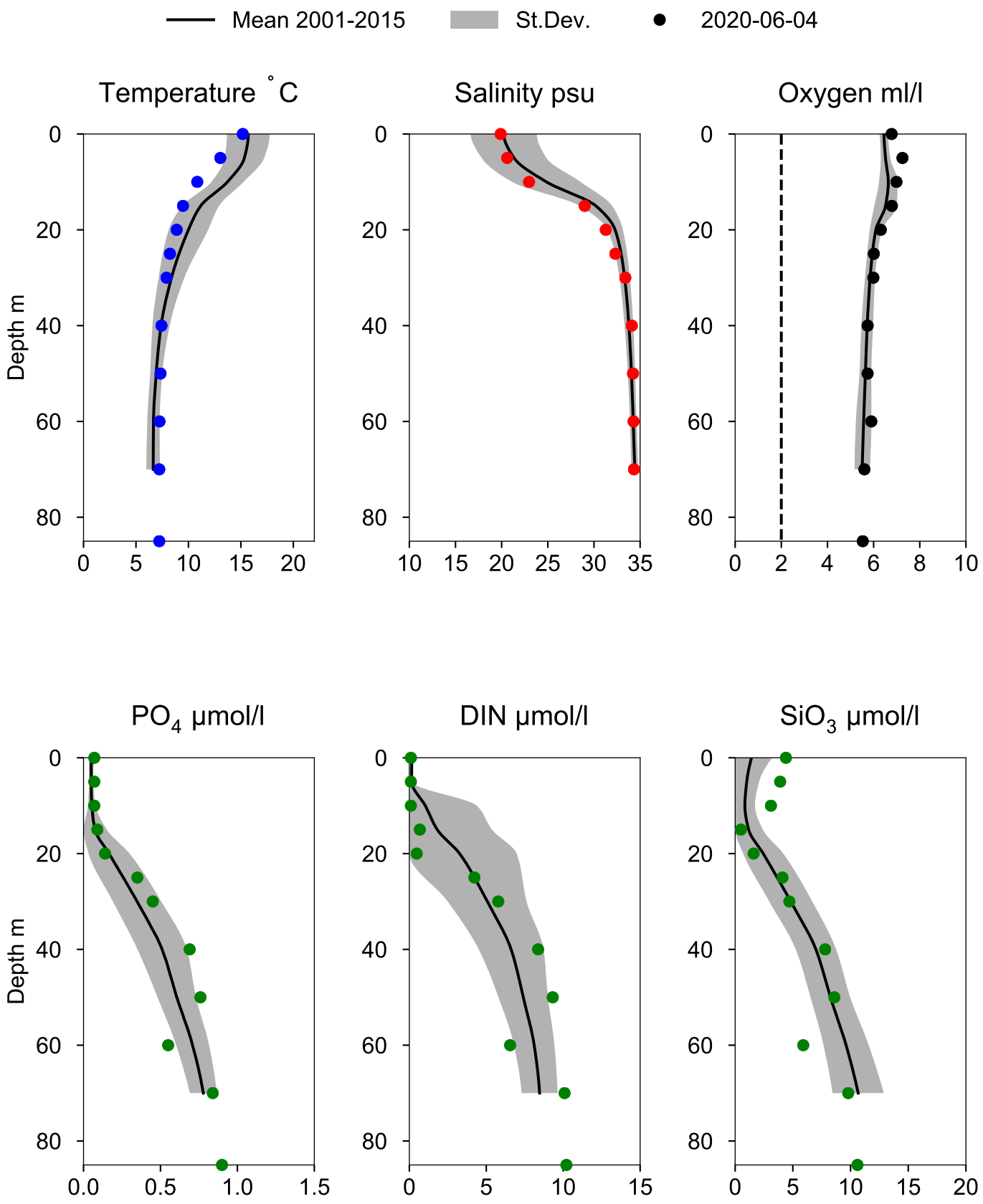
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 74 m)

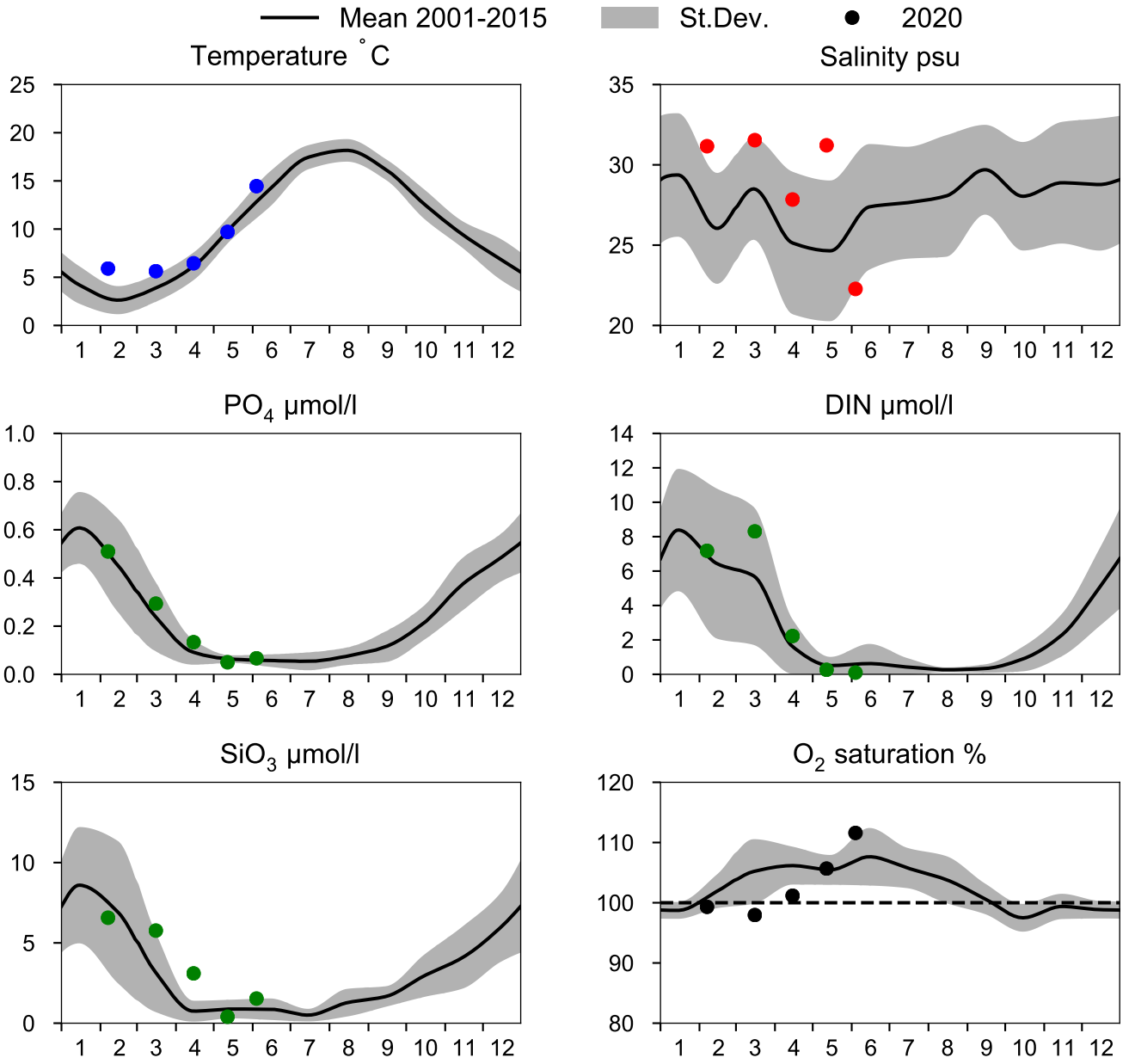


Vertical profiles FLADEN
June

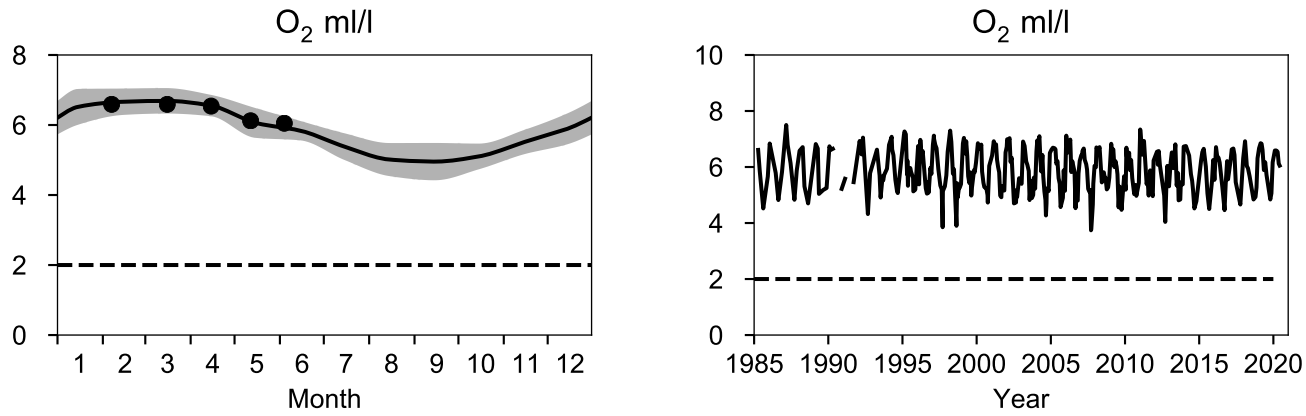


STATION P2 SURFACE WATER (0-10 m)

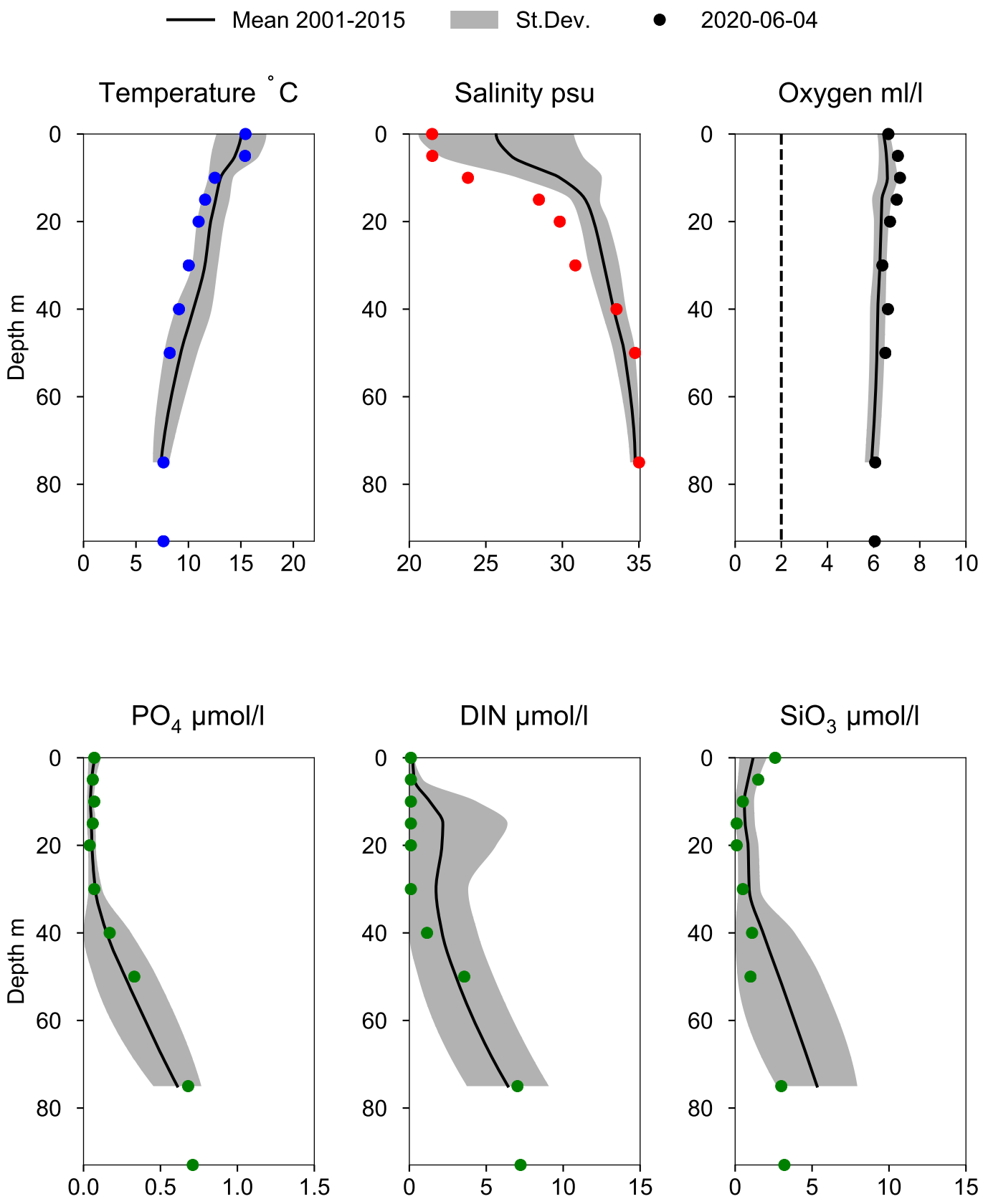
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 75 m)

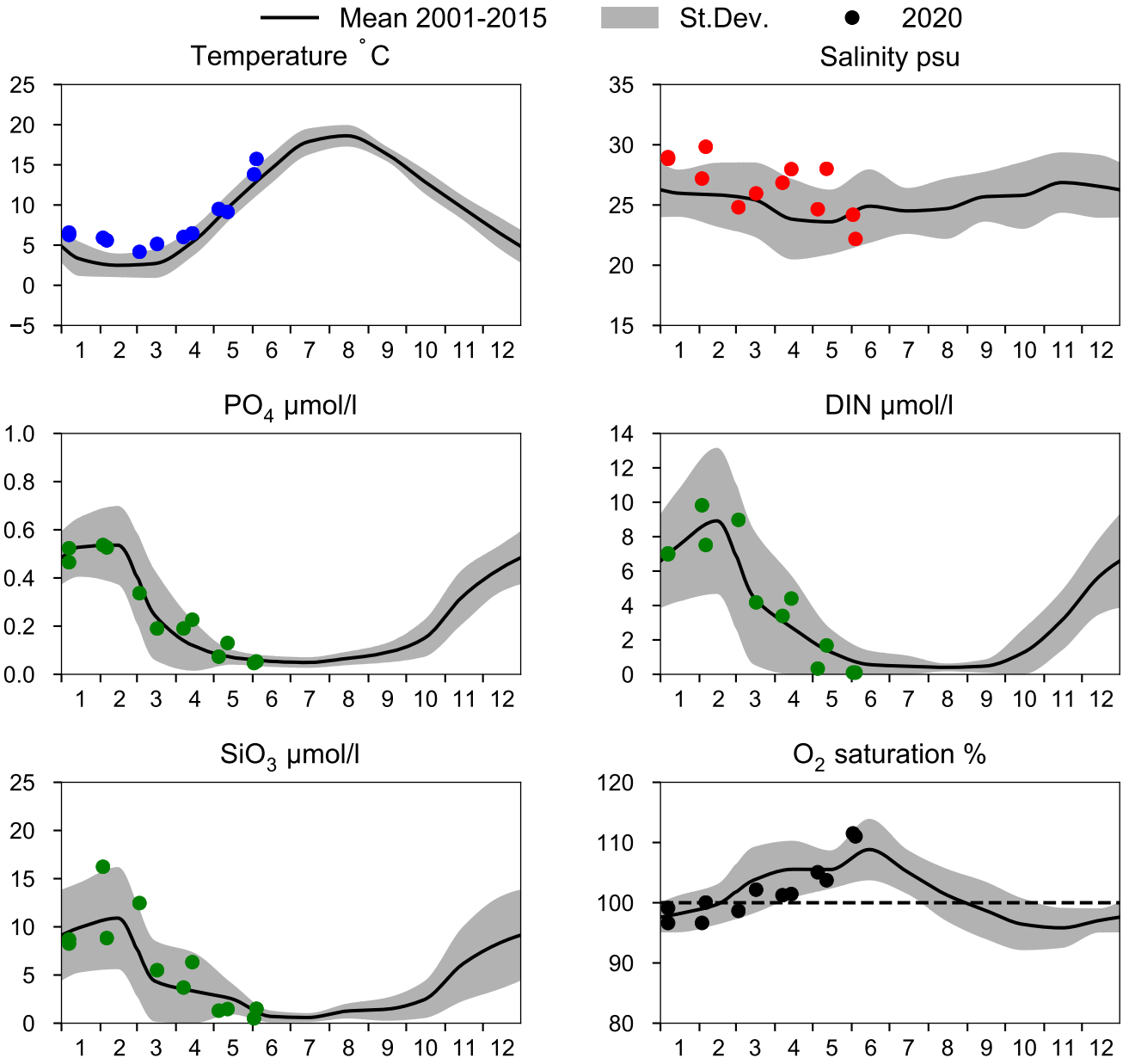


Vertical profiles P2
June

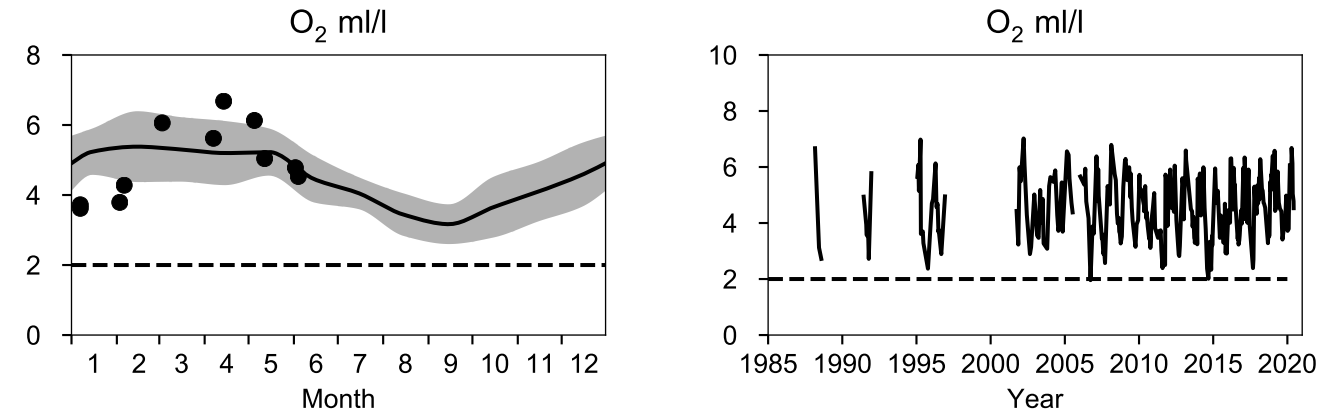


STATION SLÄGGÖ SURFACE WATER (0-10 m)

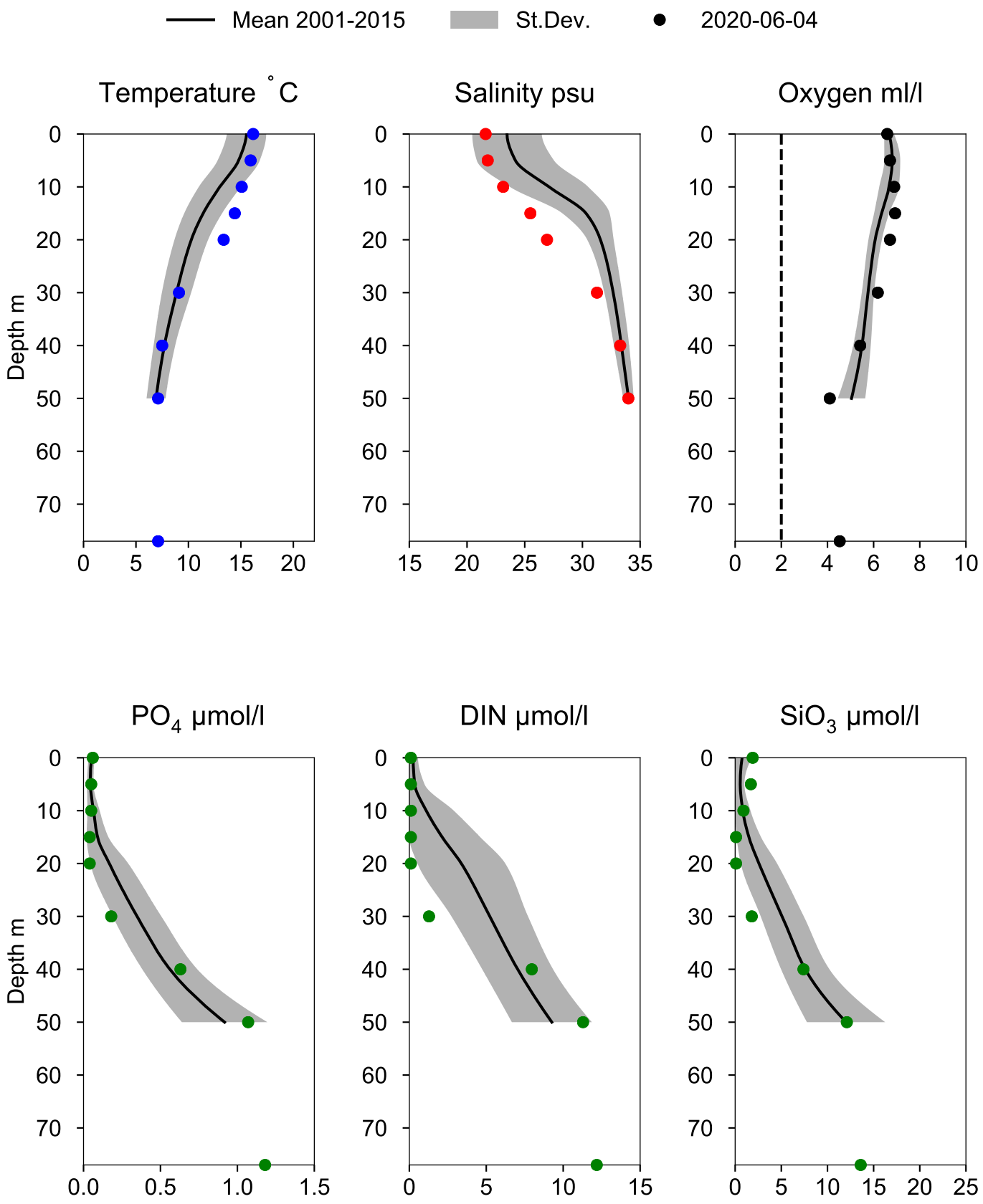
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)

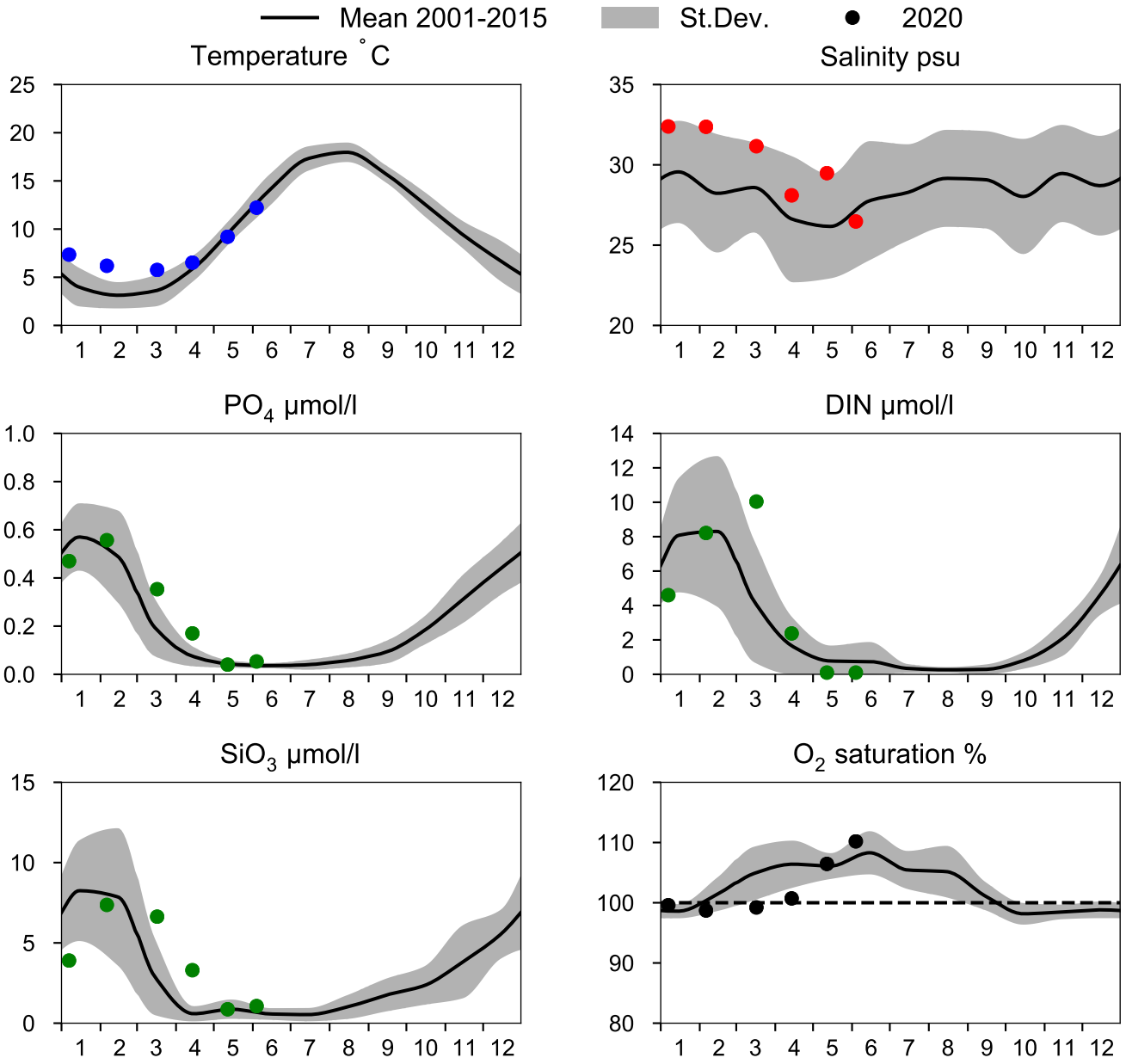


Vertical profiles SLÄGGÖ
June

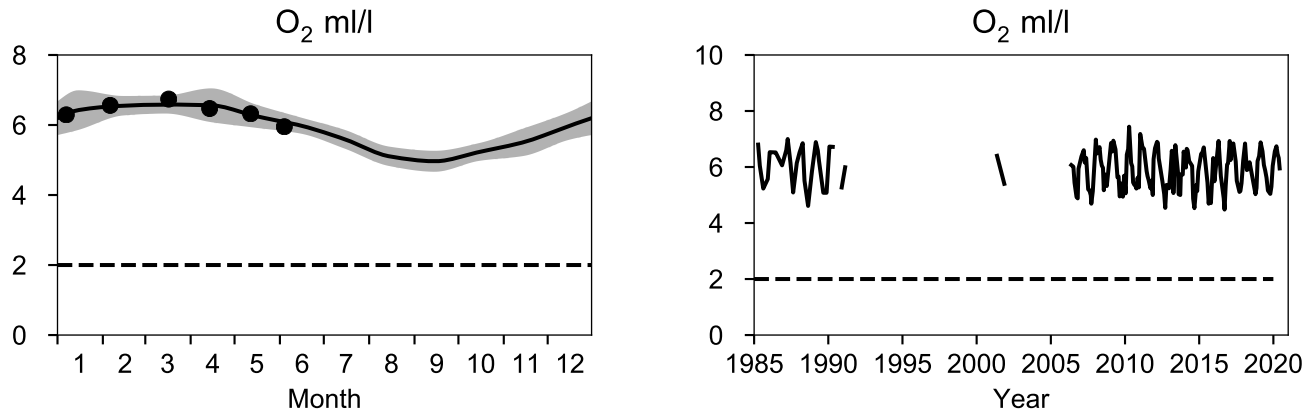


STATION Å13 SURFACE WATER (0-10 m)

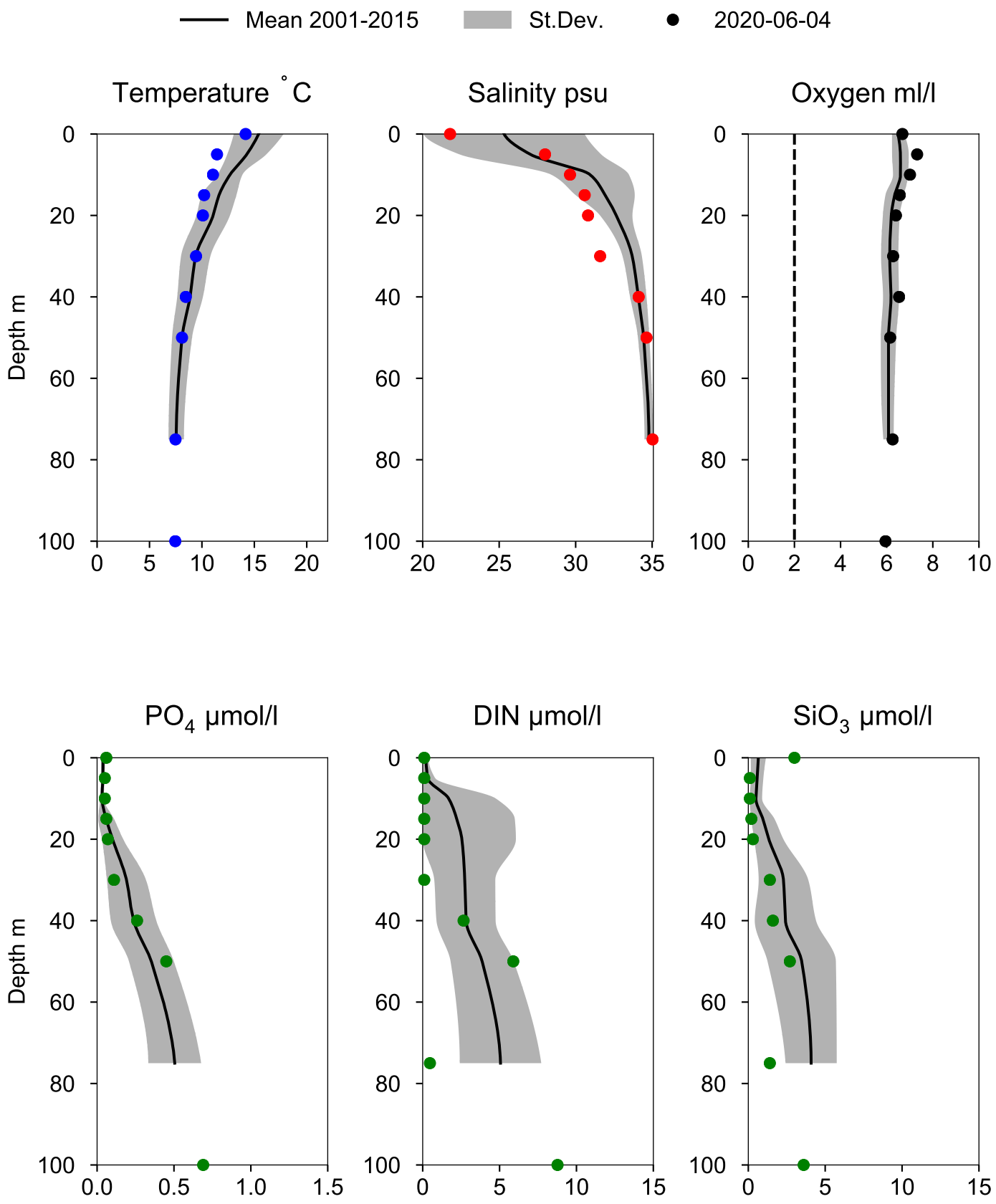
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

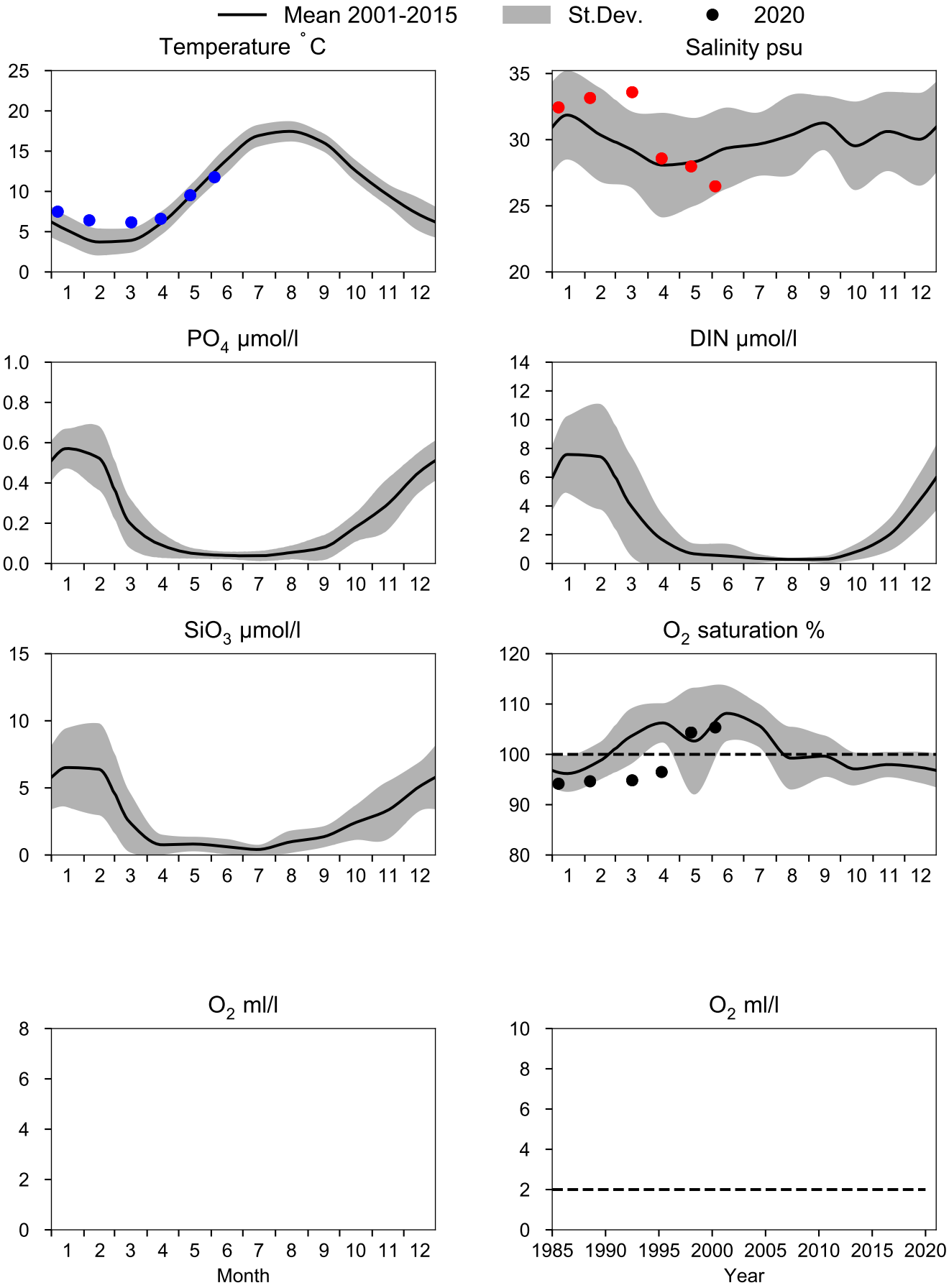


Vertical profiles Å13
June

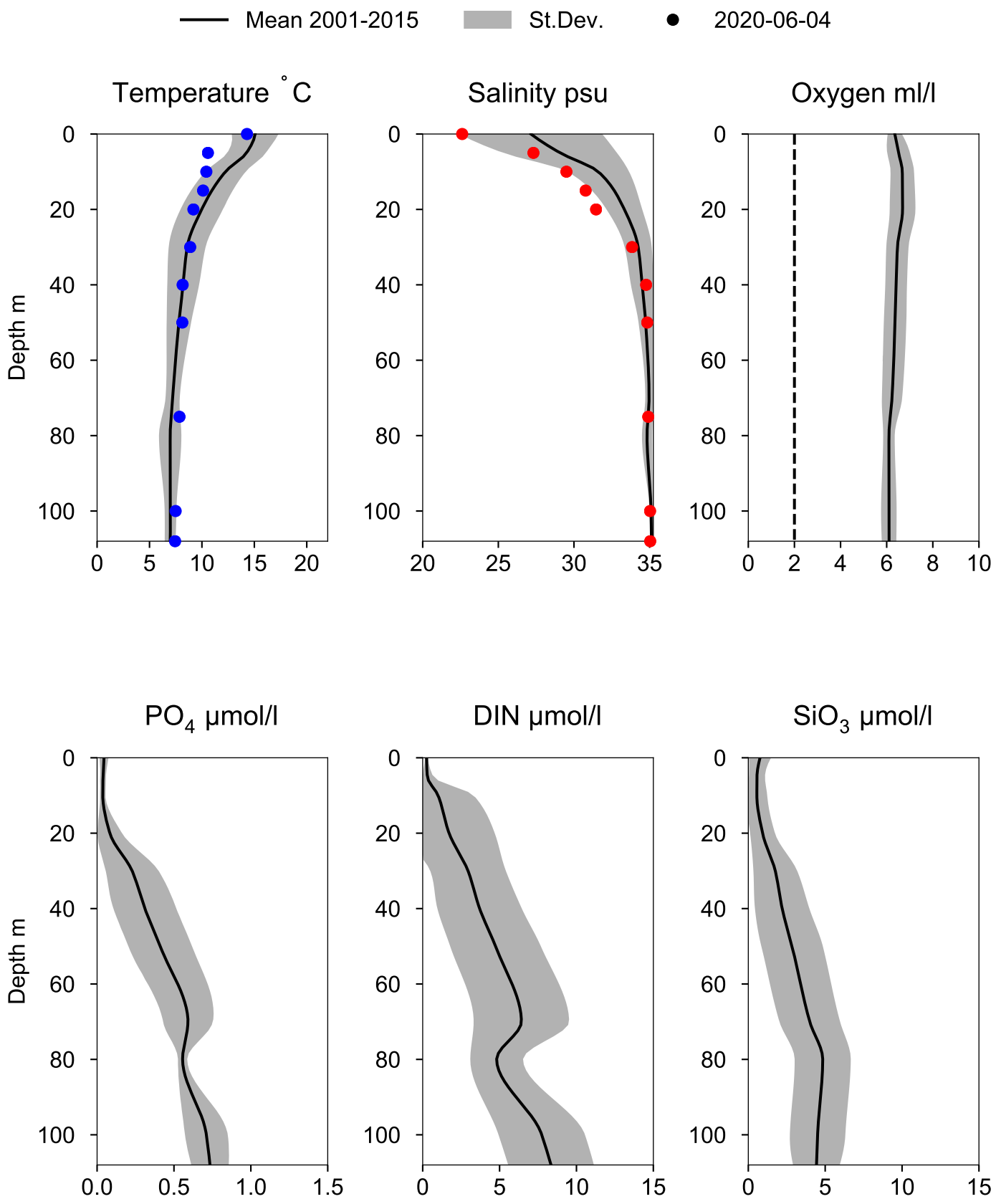


STATION Å14 SURFACE WATER (0-10 m)

Annual Cycles

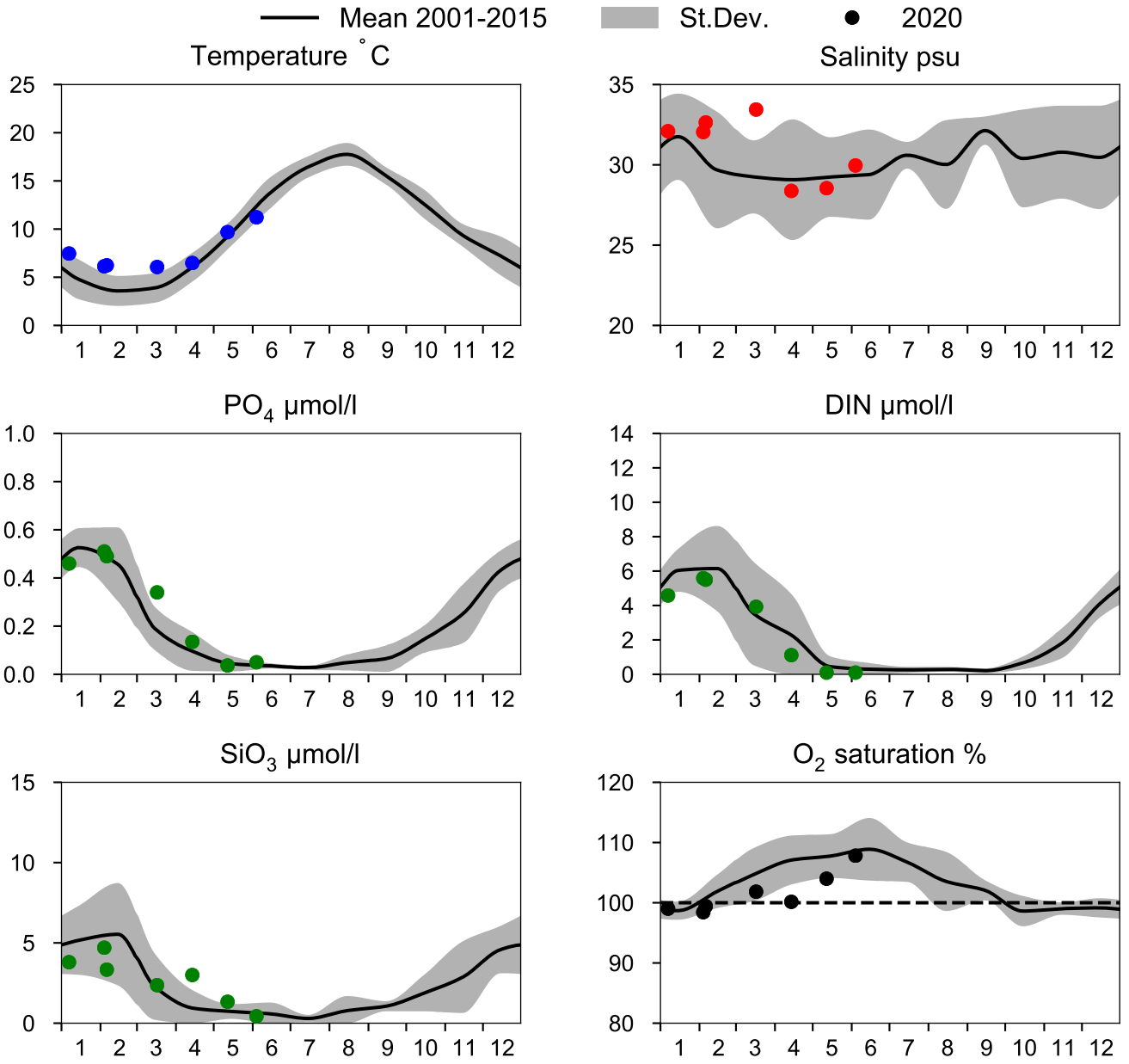


Vertical profiles Å14
June

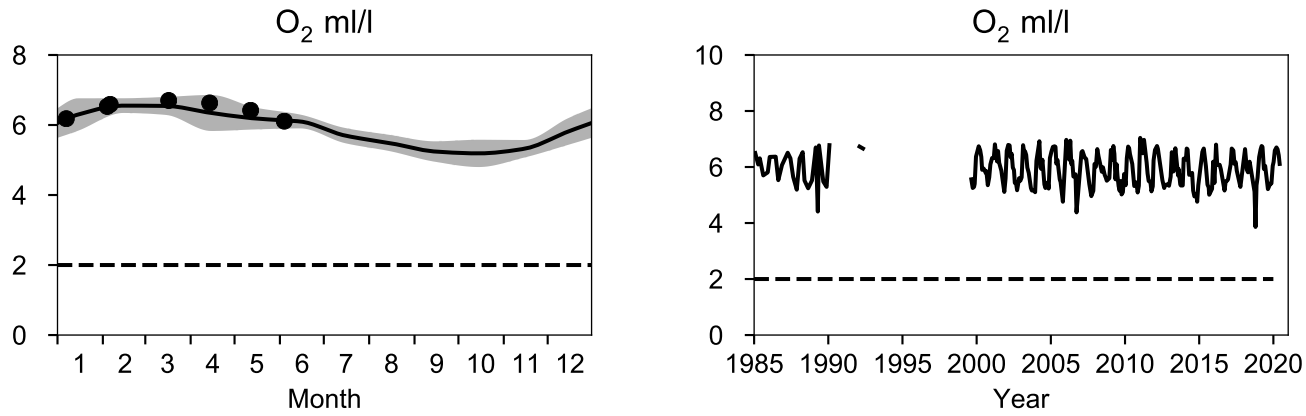


STATION Å15 SURFACE WATER (0-10 m)

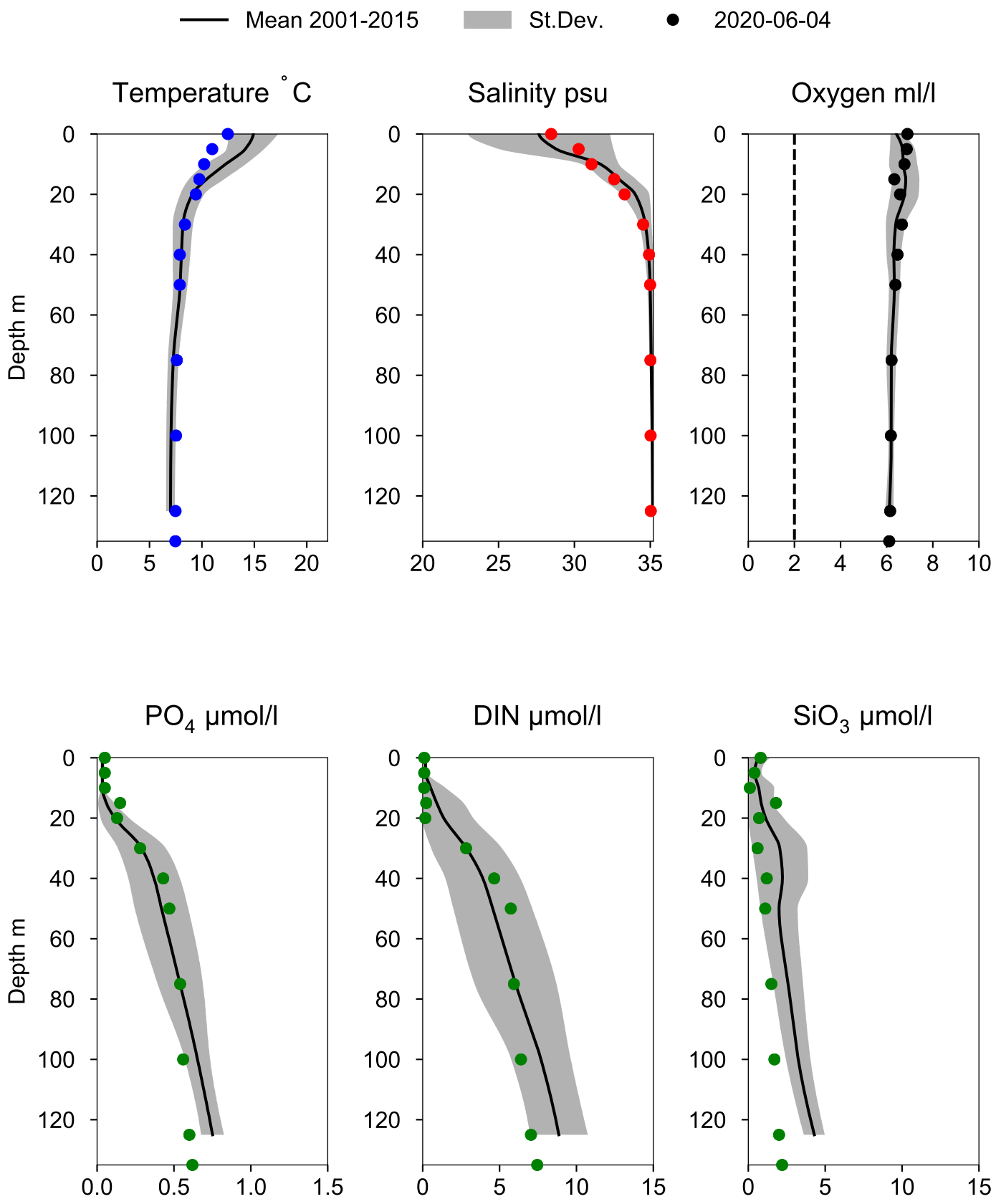
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

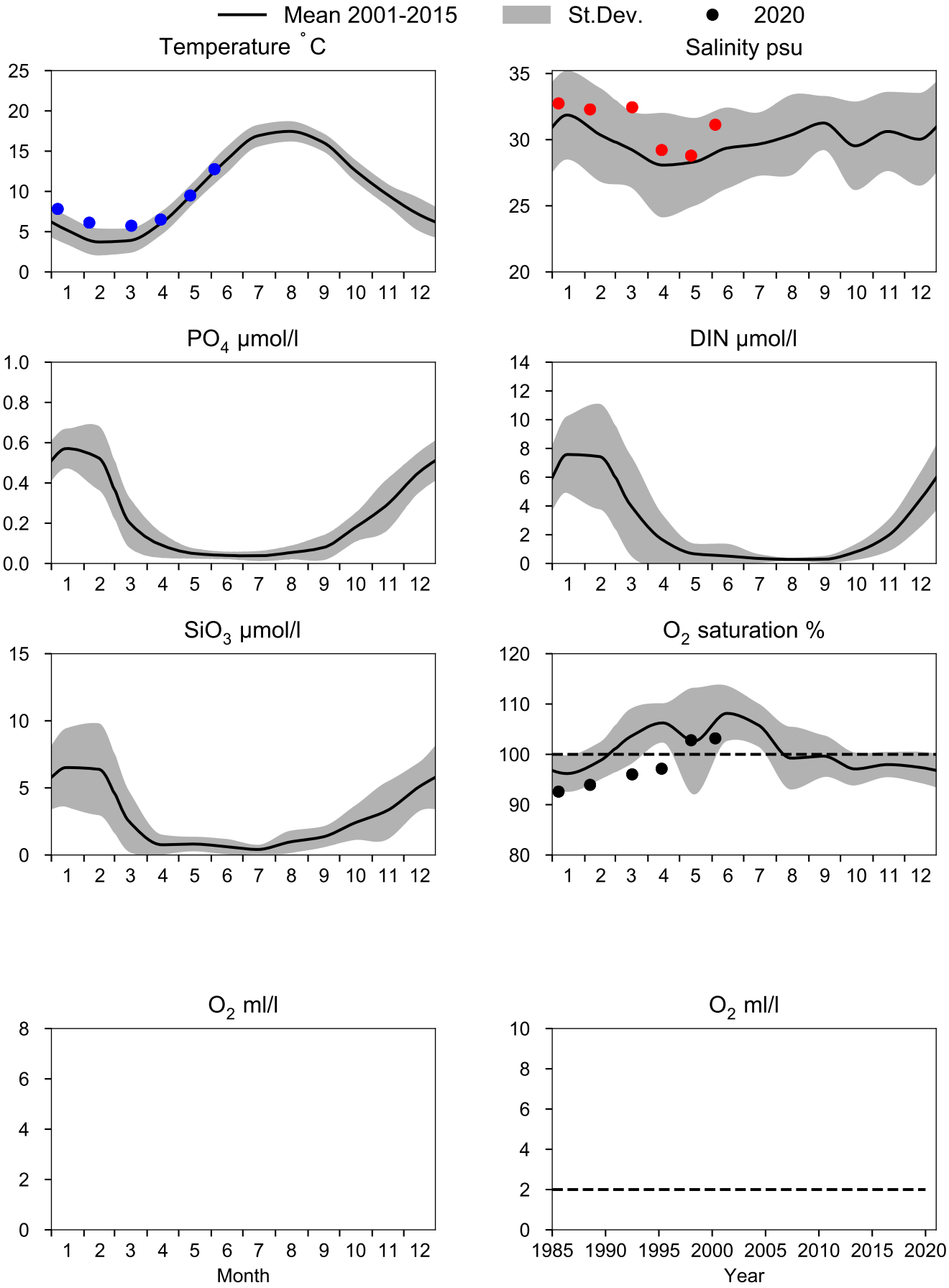


Vertical profiles Å15
June

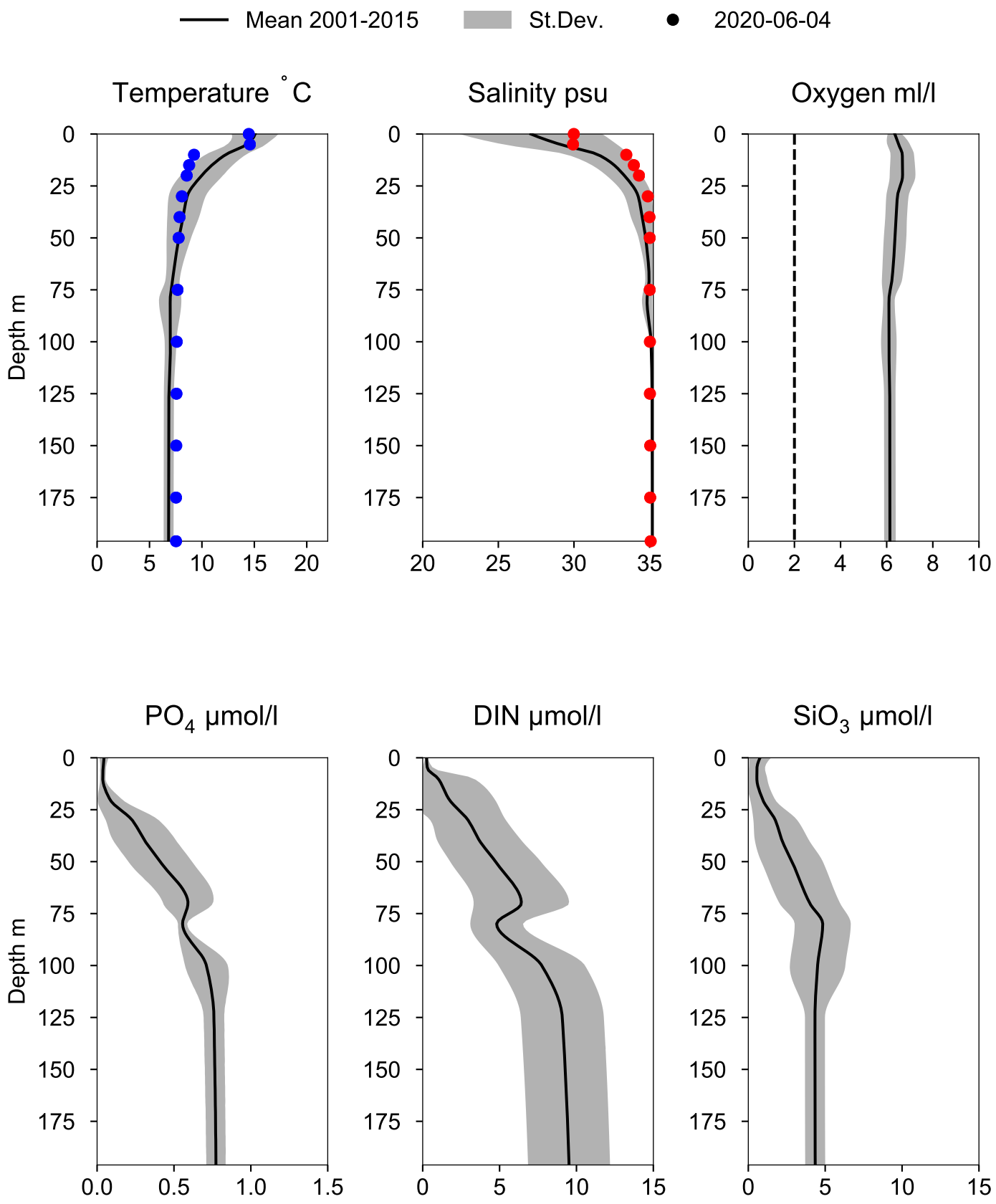


STATION Å16 SURFACE WATER (0-10 m)

Annual Cycles

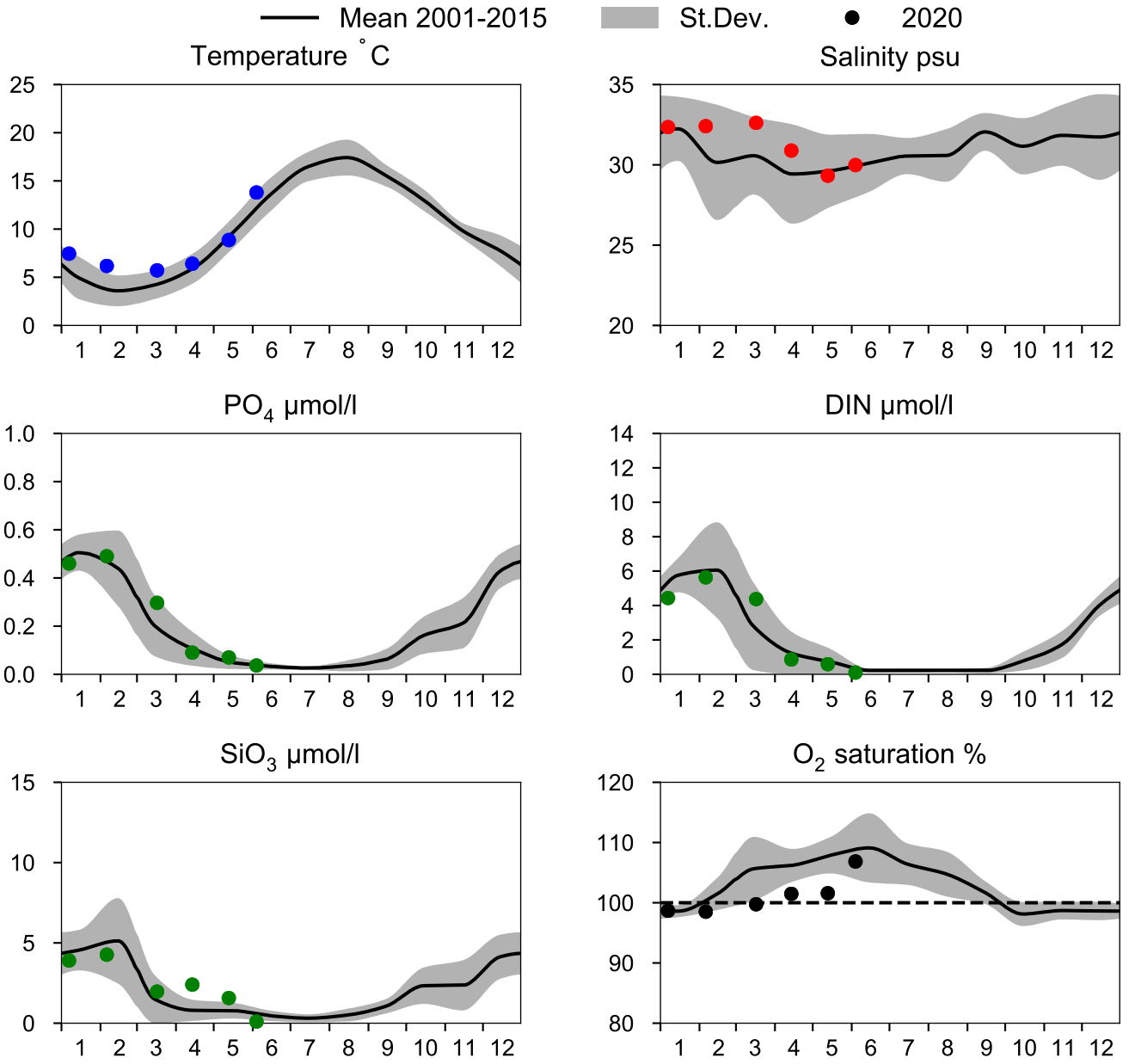


Vertical profiles Å16
June

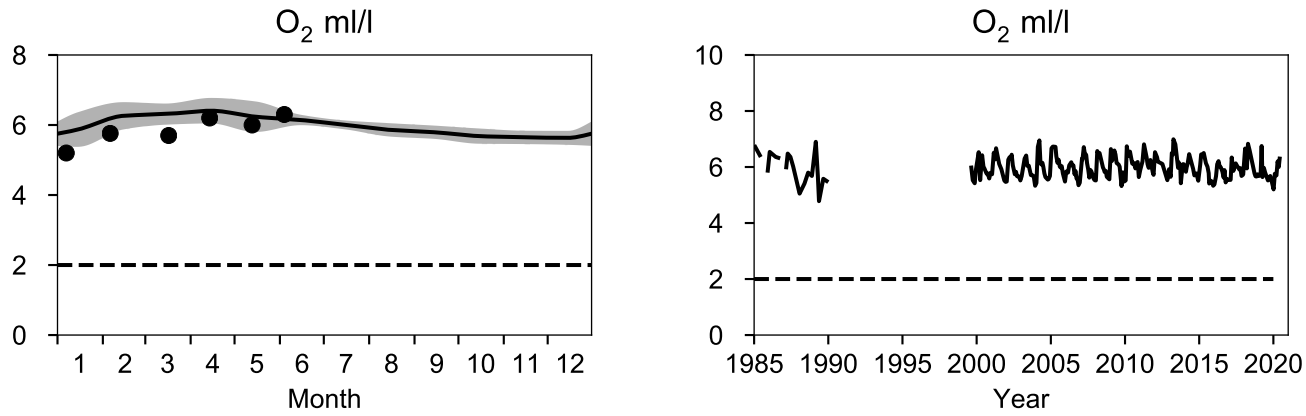


STATION Å17 SURFACE WATER (0-10 m)

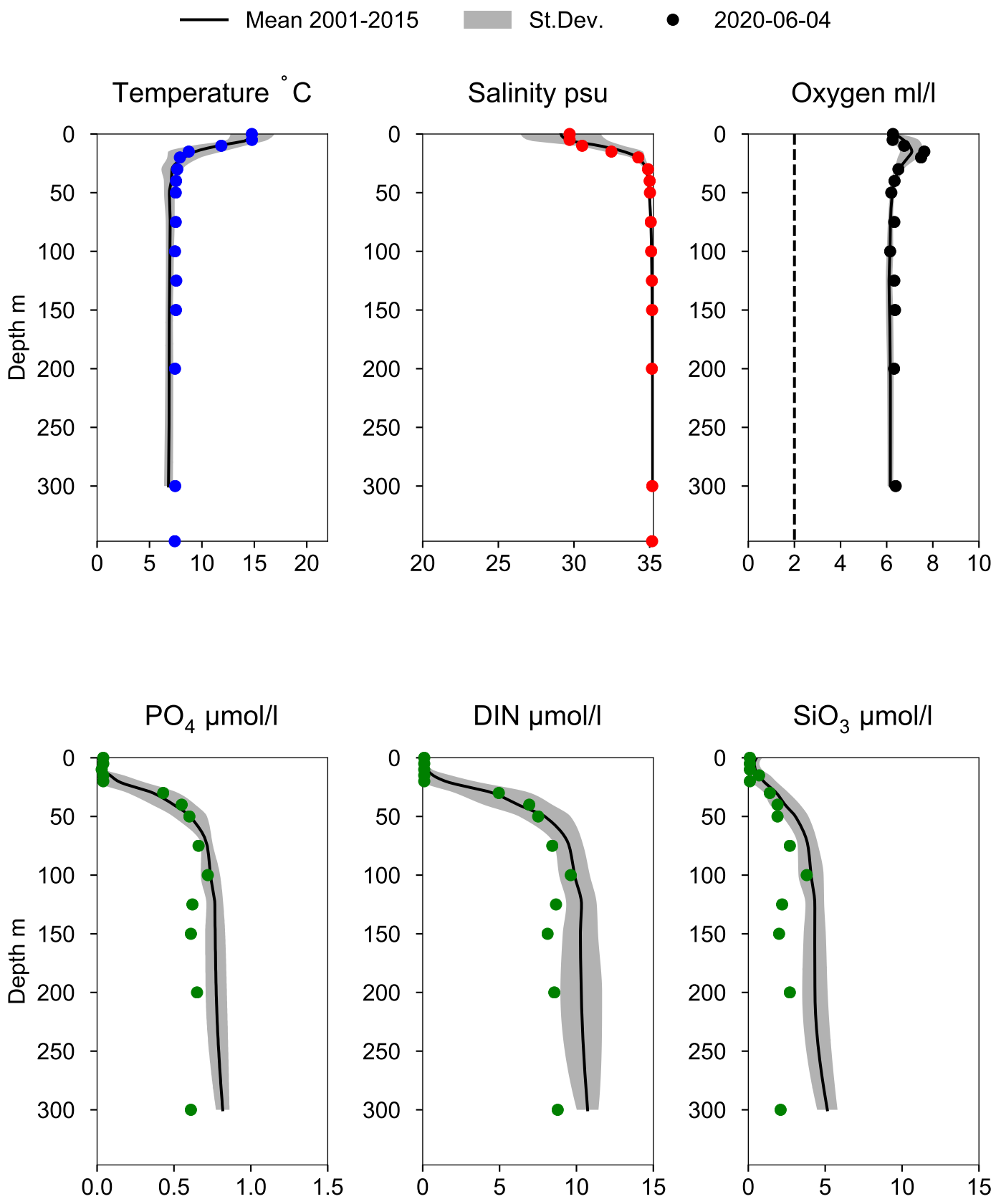
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 300 m)

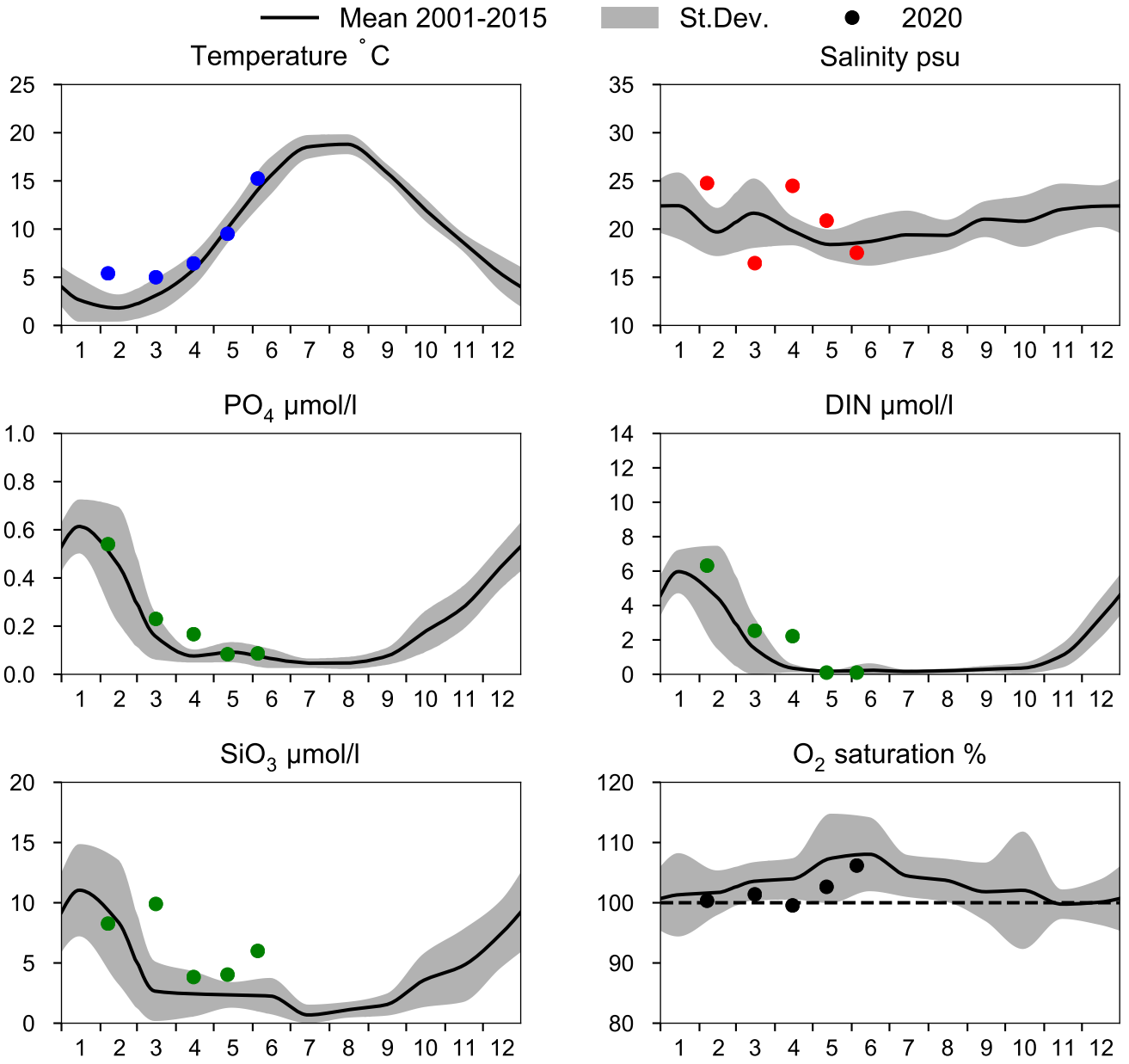


Vertical profiles Å17
June

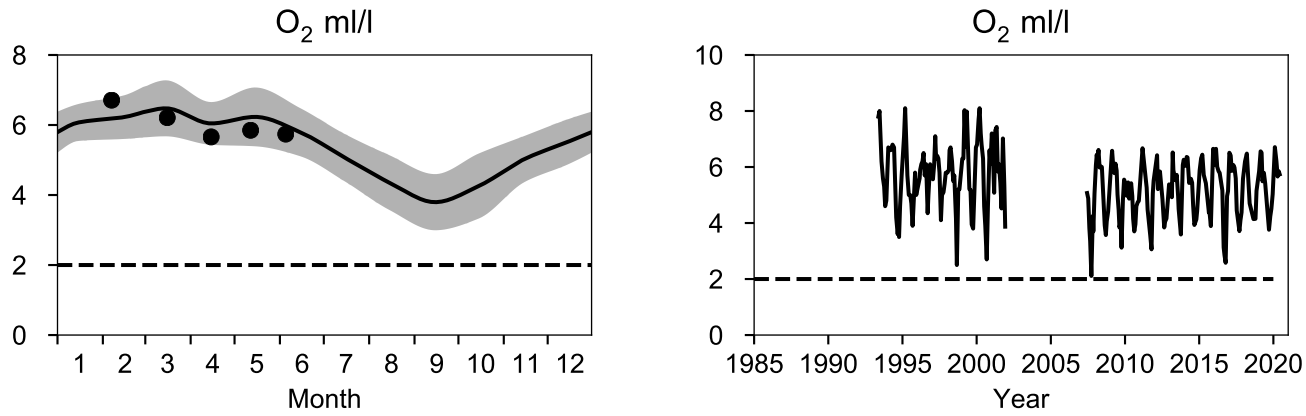


STATION N14 FALKENBERG SURFACE WATER (0-10 m)

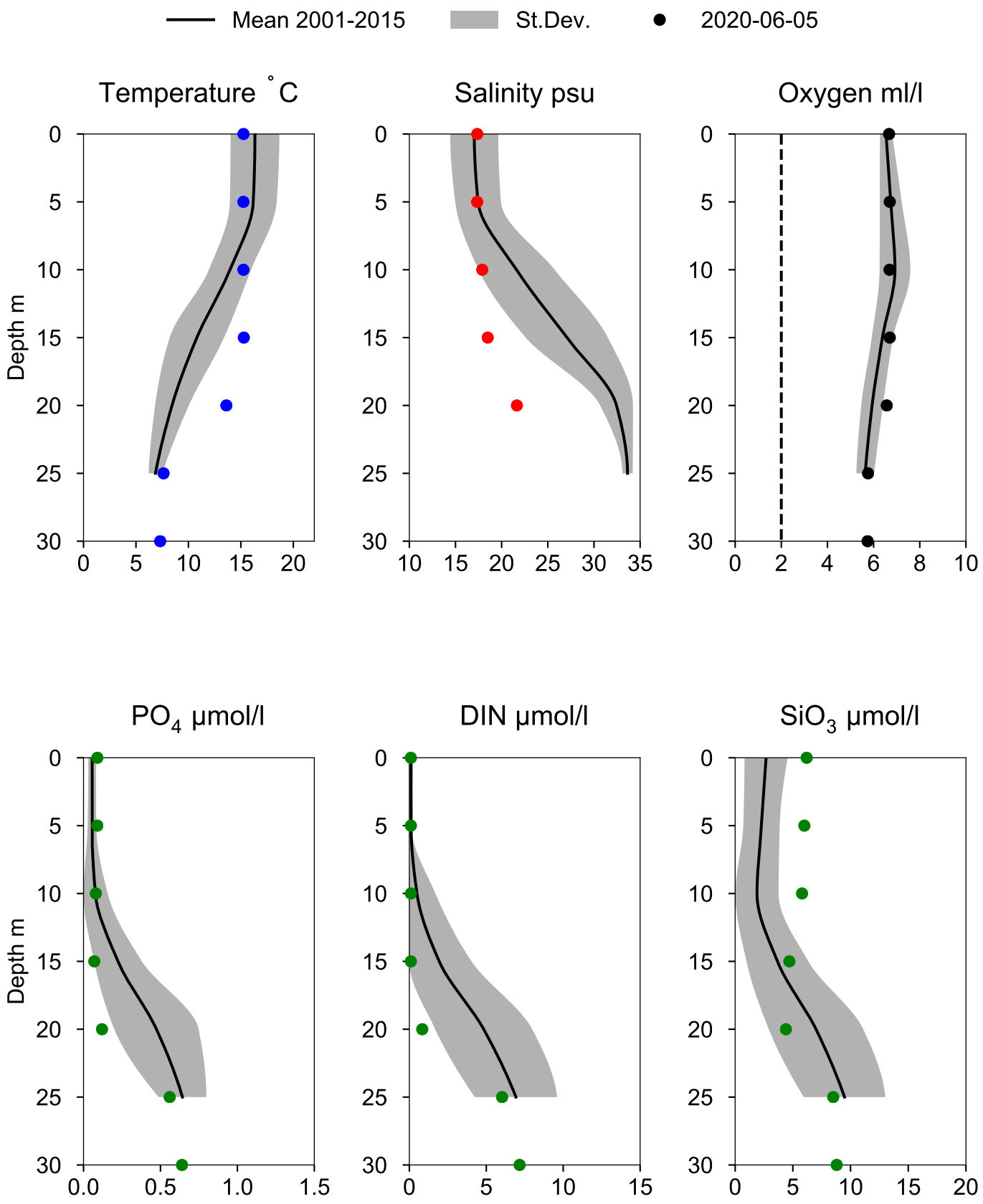
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 20 m)

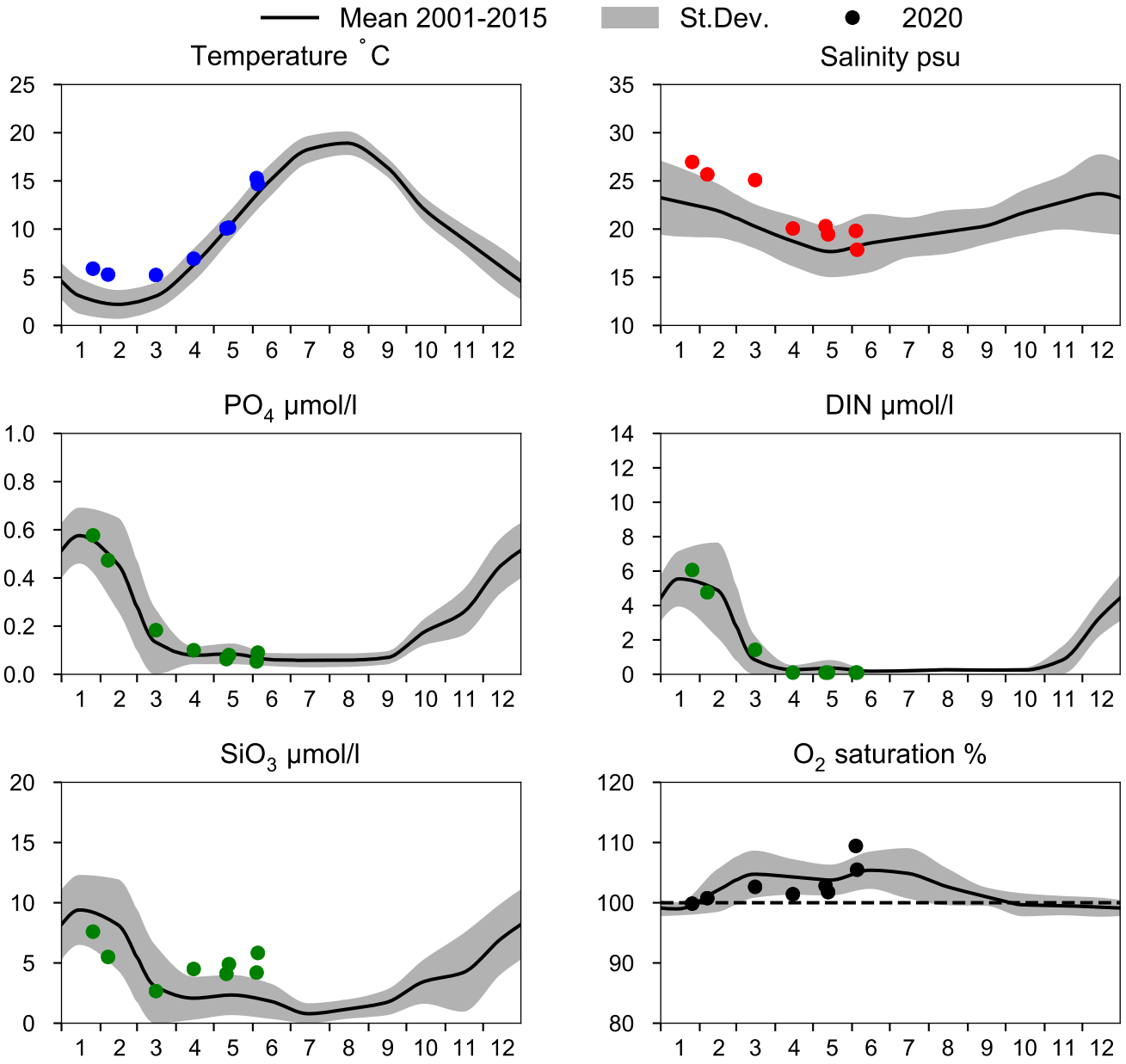


Vertical profiles N14 FALKENBERG
June

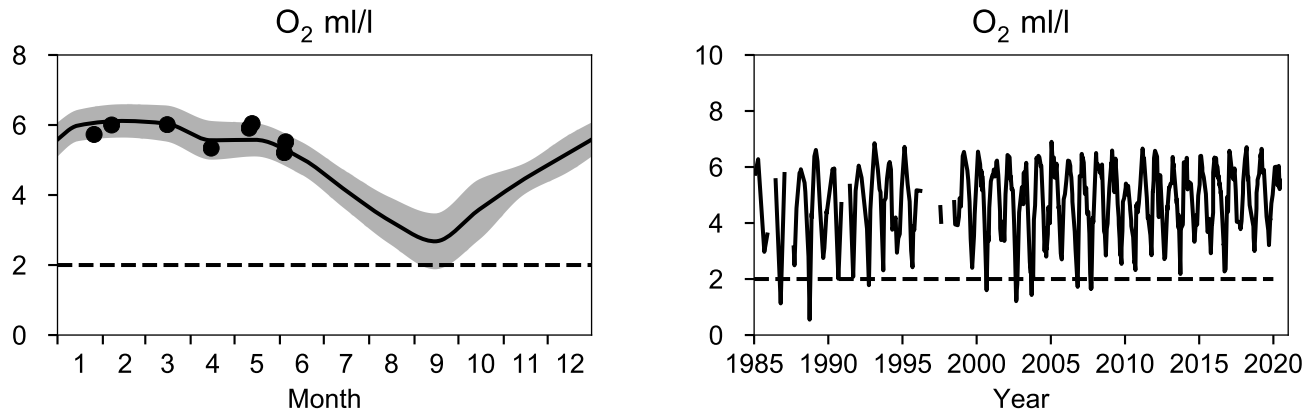


STATION ANHOLT E SURFACE WATER (0-10 m)

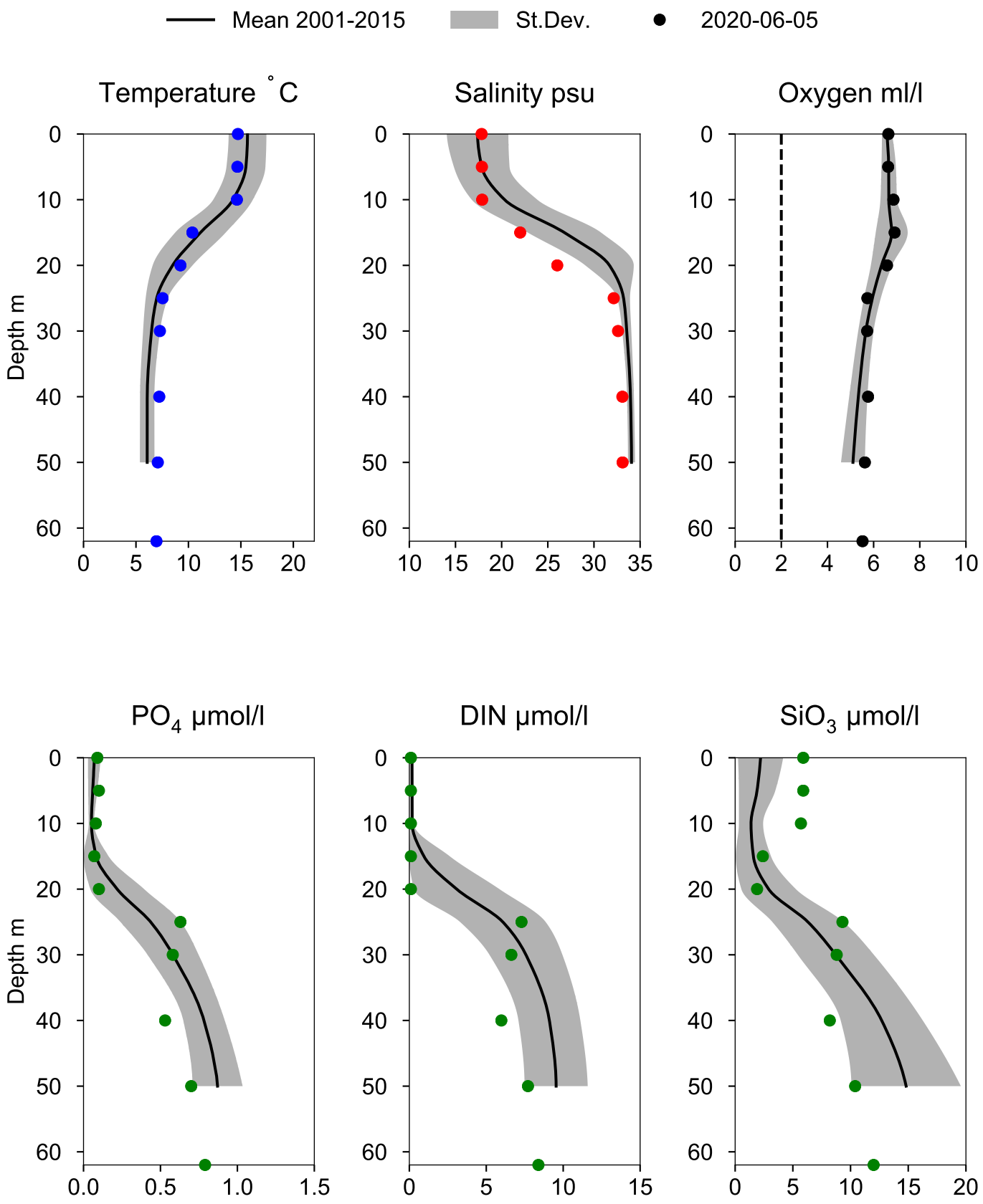
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

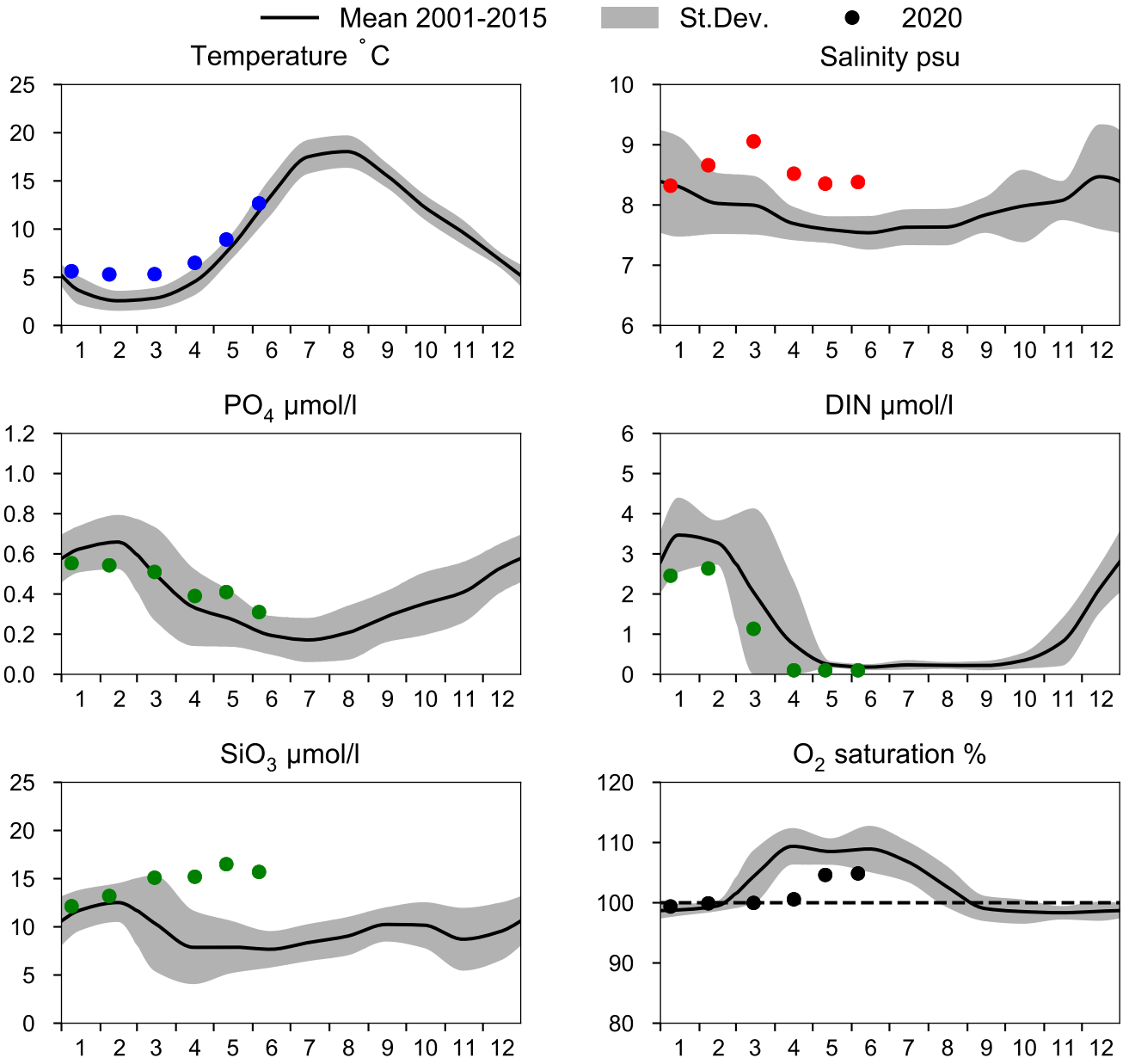


Vertical profiles ANHOLT E
June

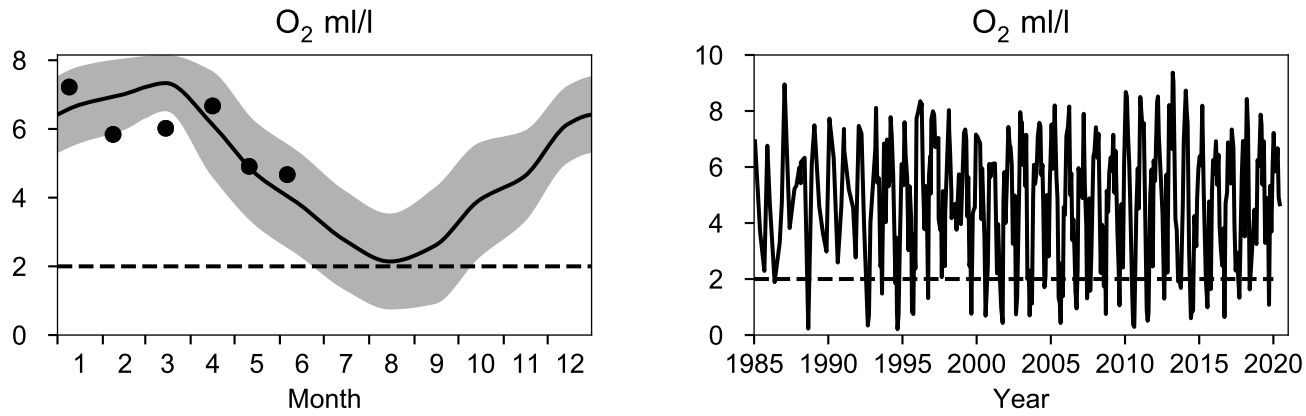


STATION BY1 SURFACE WATER (0-10 m)

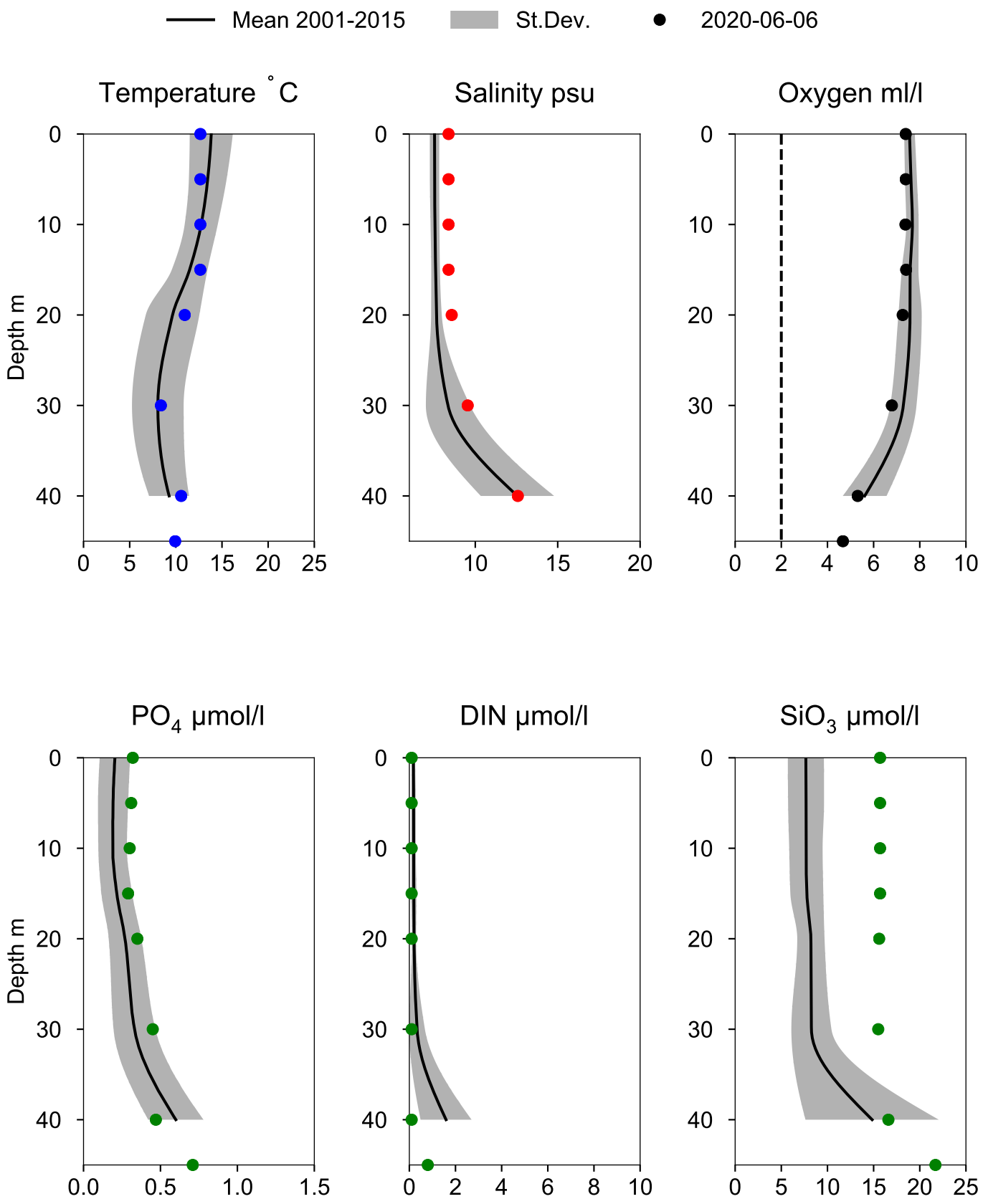
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

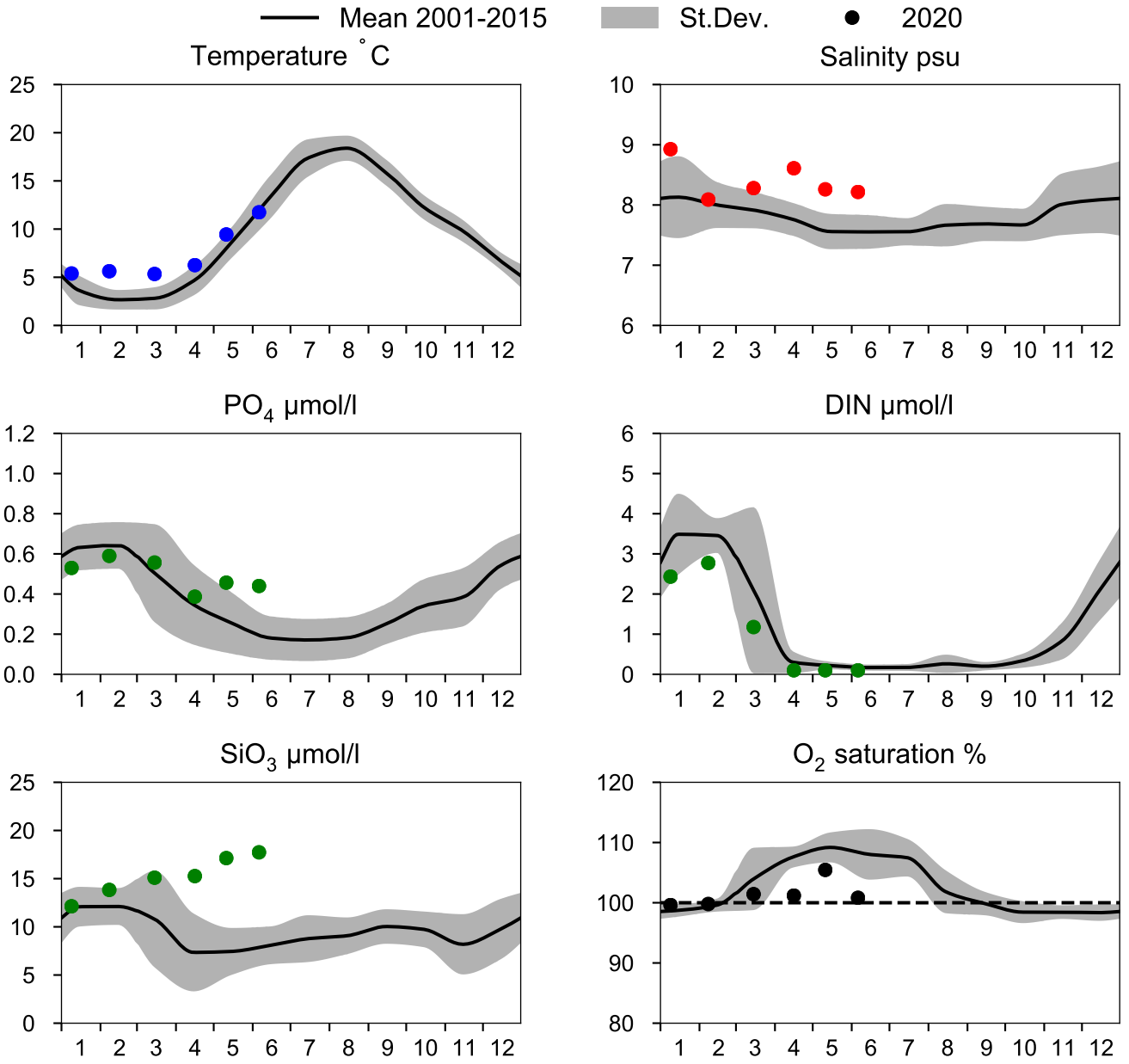


Vertical profiles BY1
June

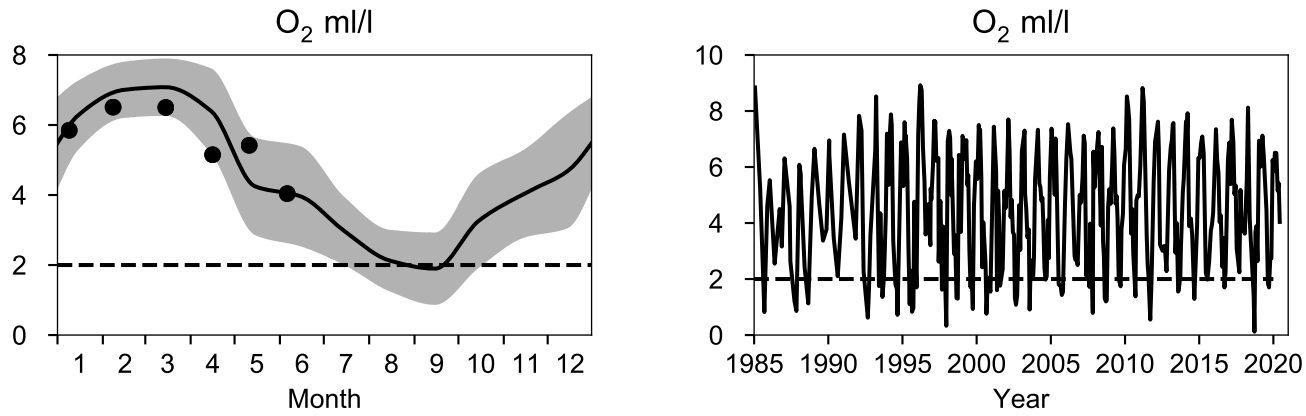


STATION BY2 ARKONA SURFACE WATER (0-10 m)

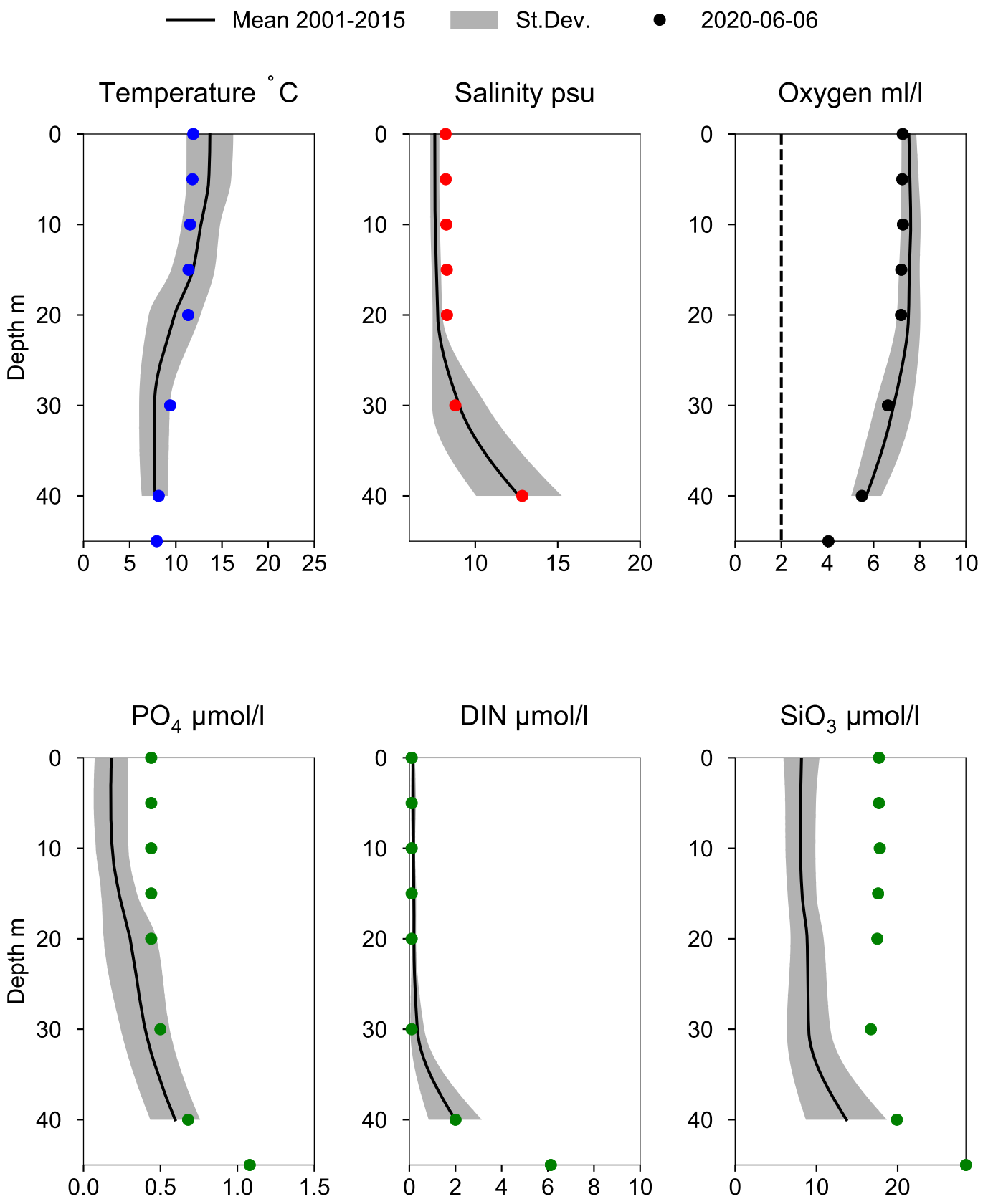
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

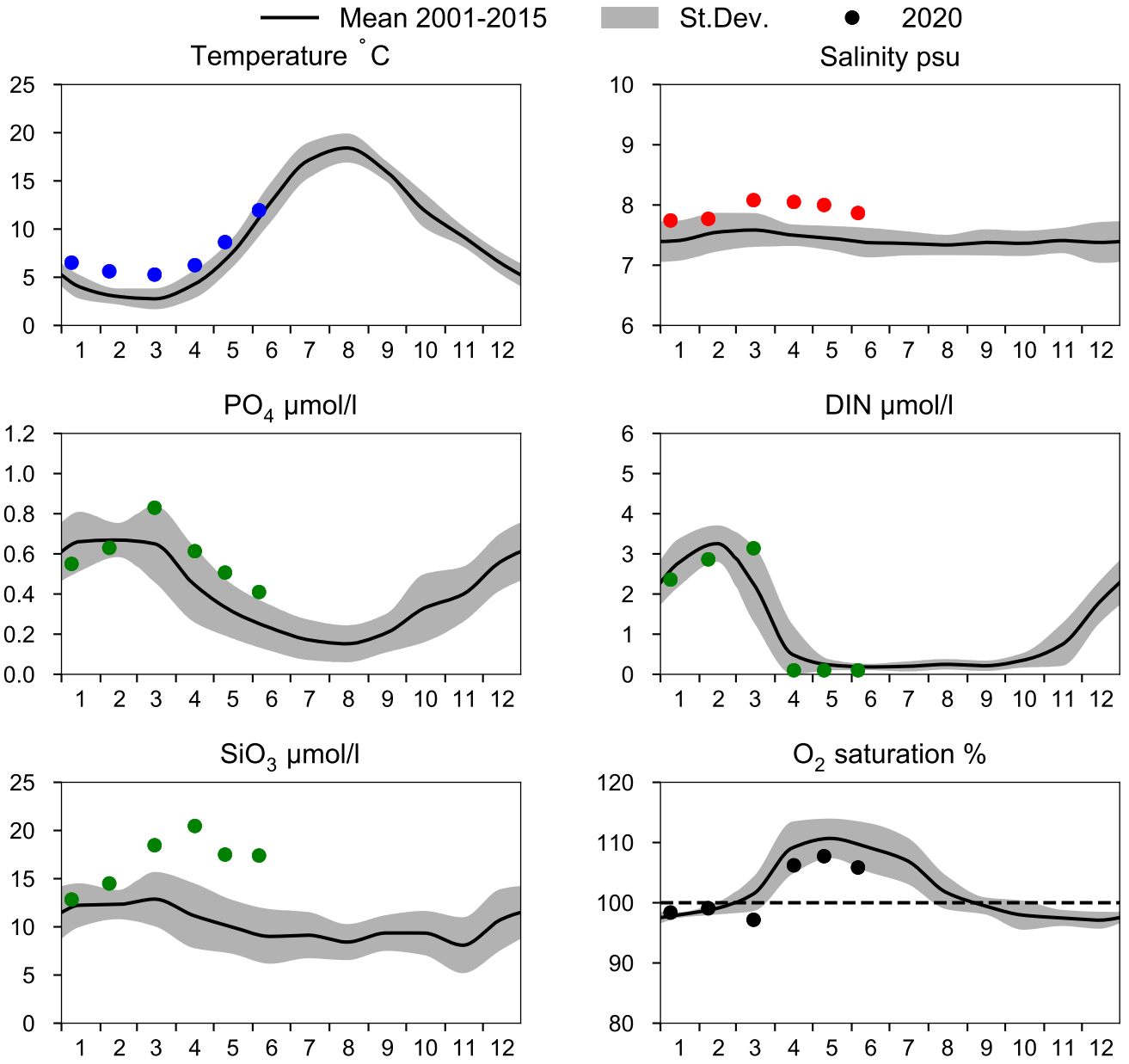


Vertical profiles BY2 ARKONA
June

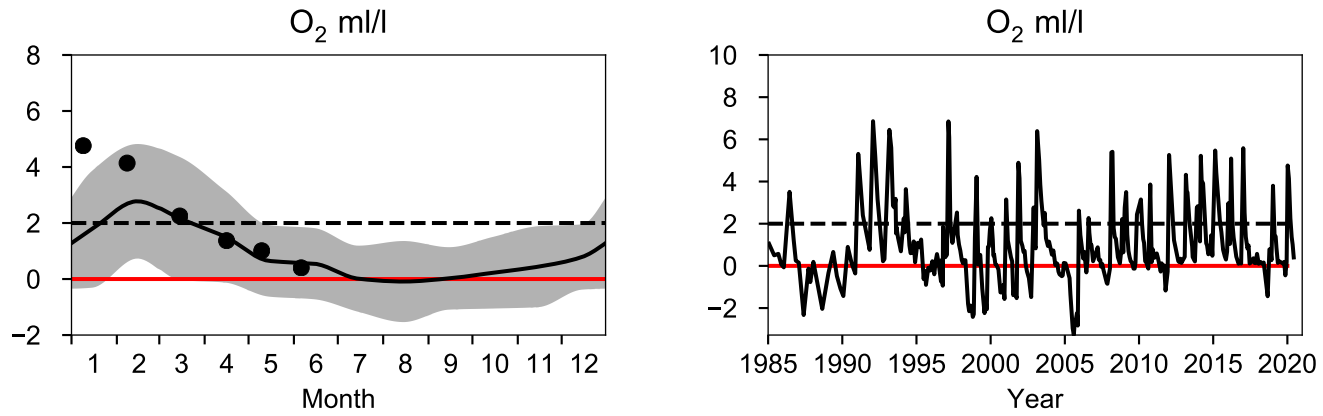


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

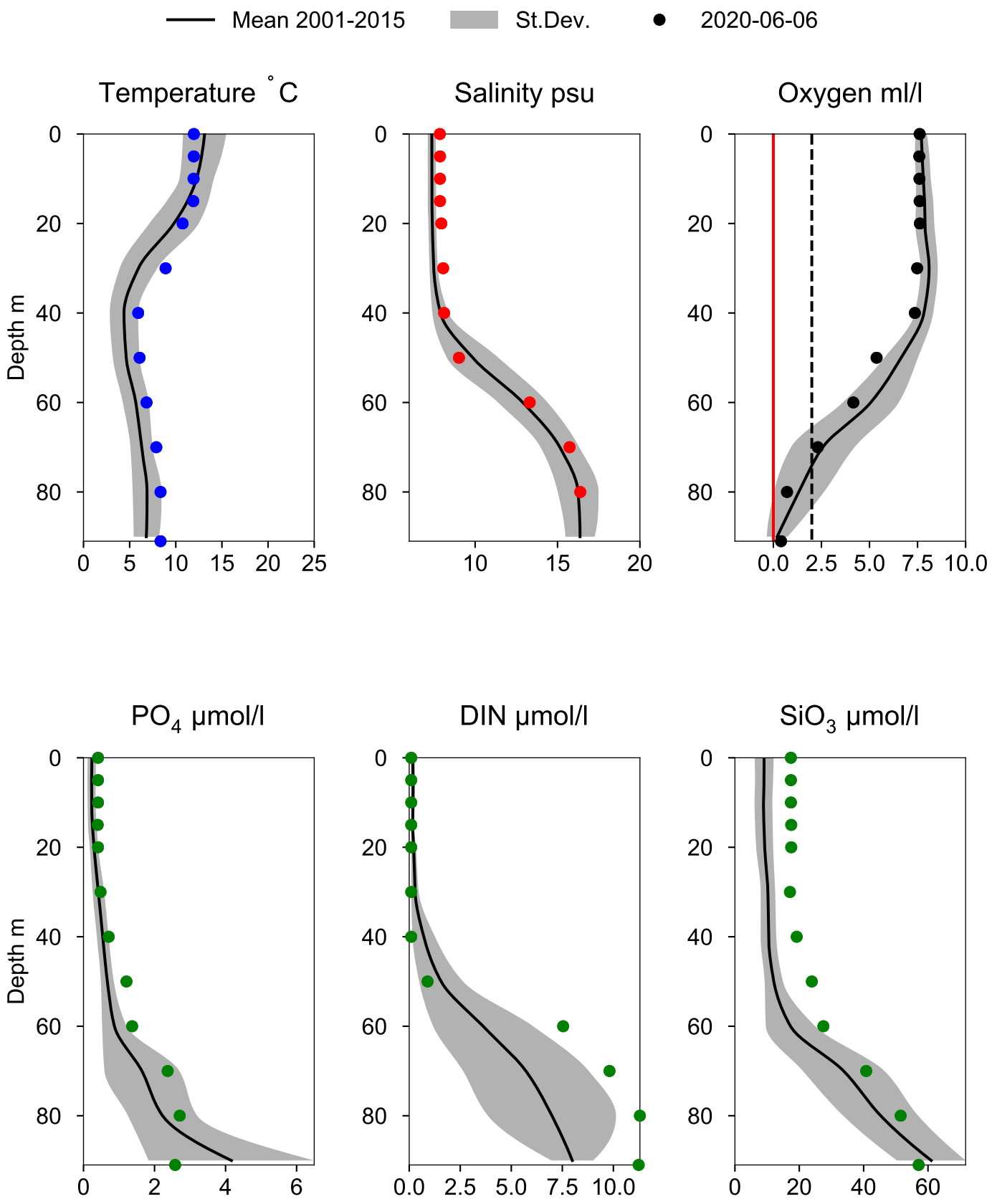
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

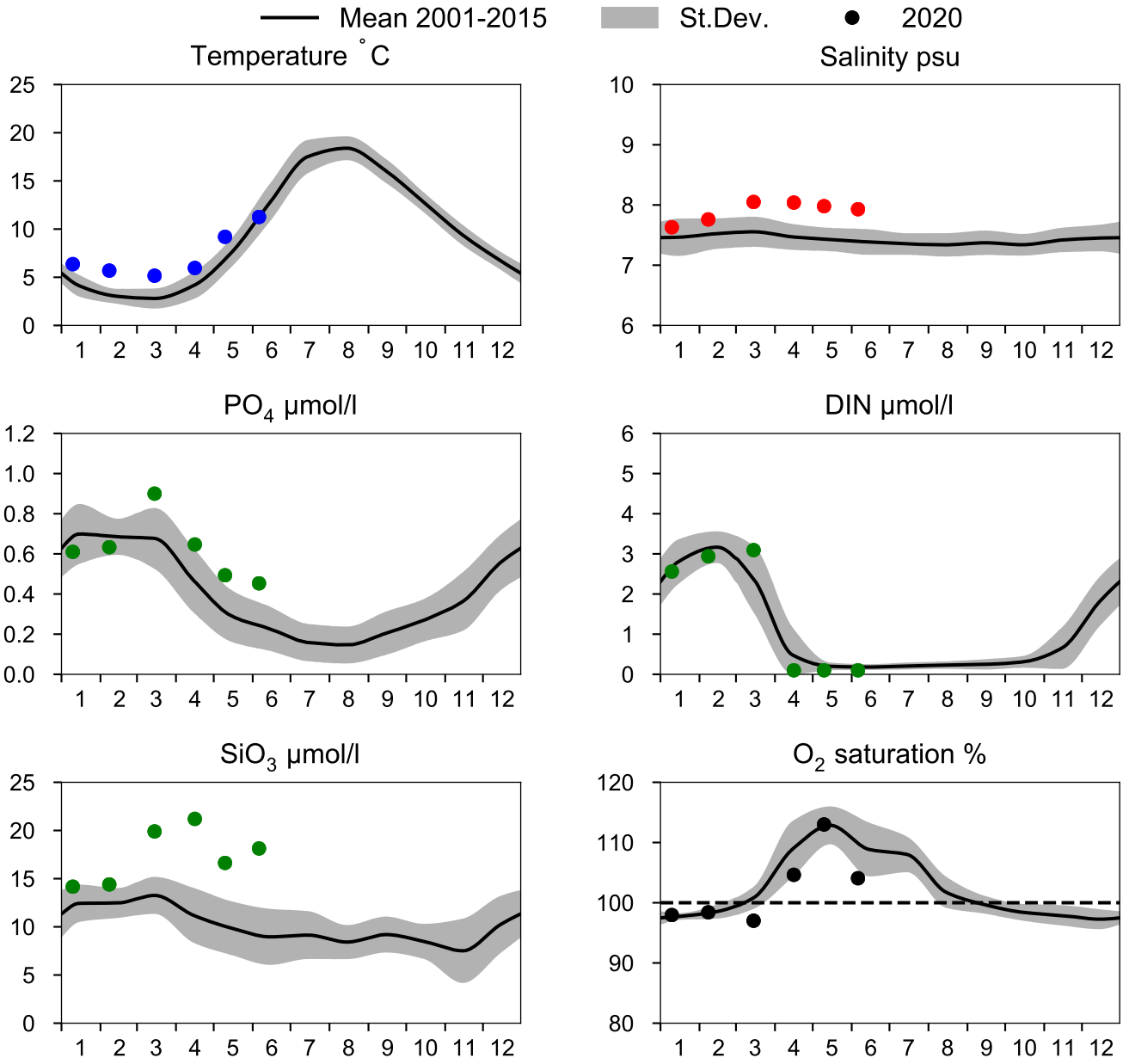


Vertical profiles BY4 CHRISTIANSÖ
June

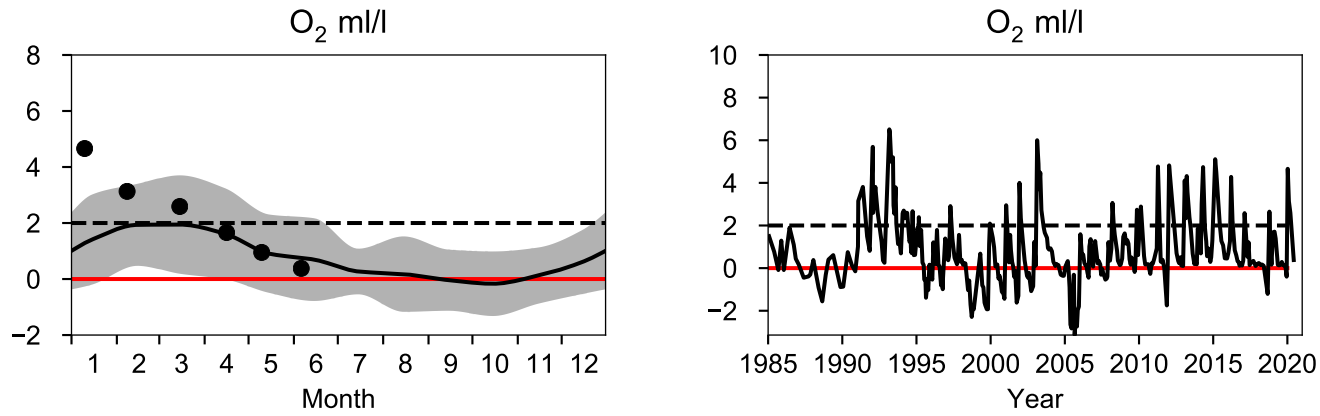


STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

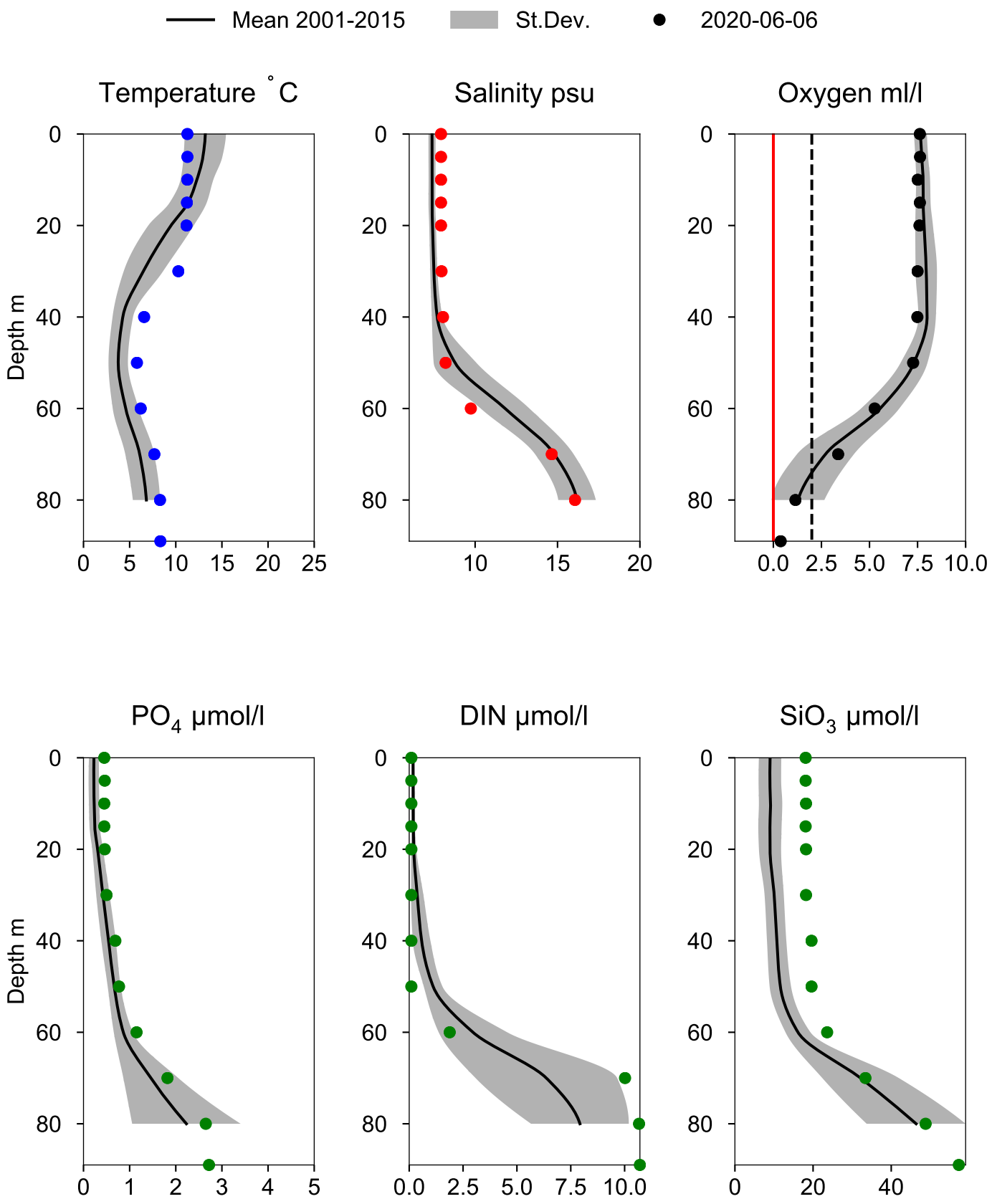
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

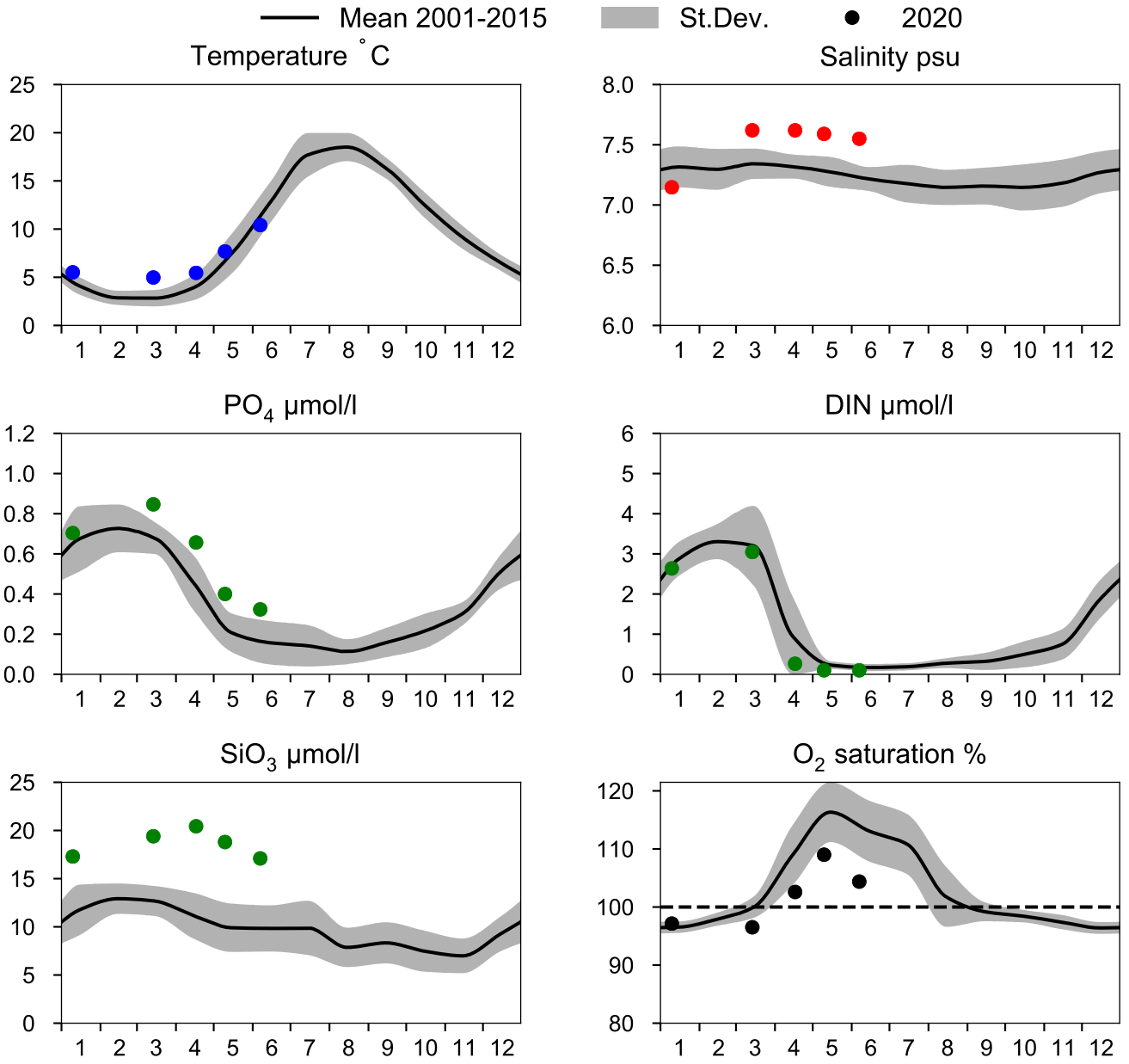


Vertical profiles BY5 BORNHOLMSDJ
June

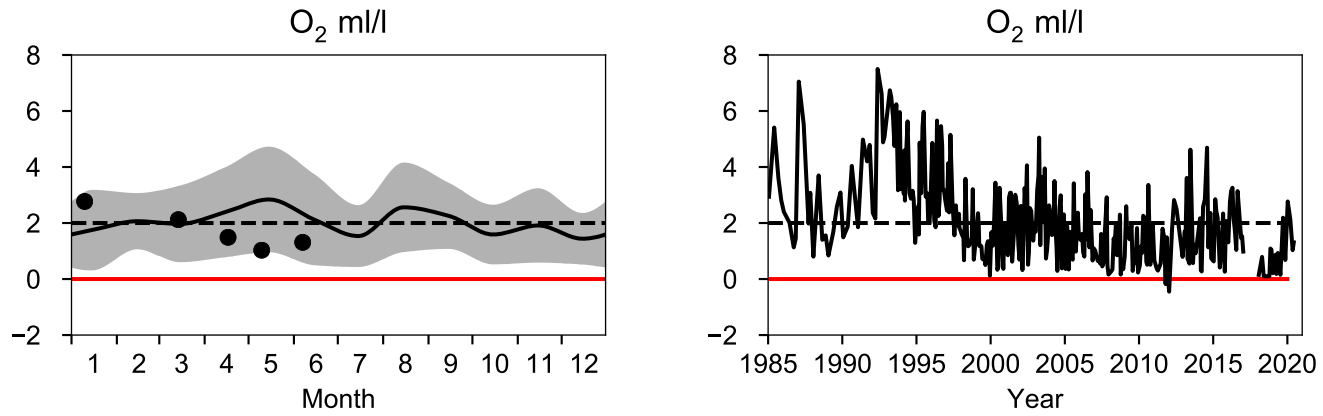


STATION BCS III-10 SURFACE WATER (0-10 m)

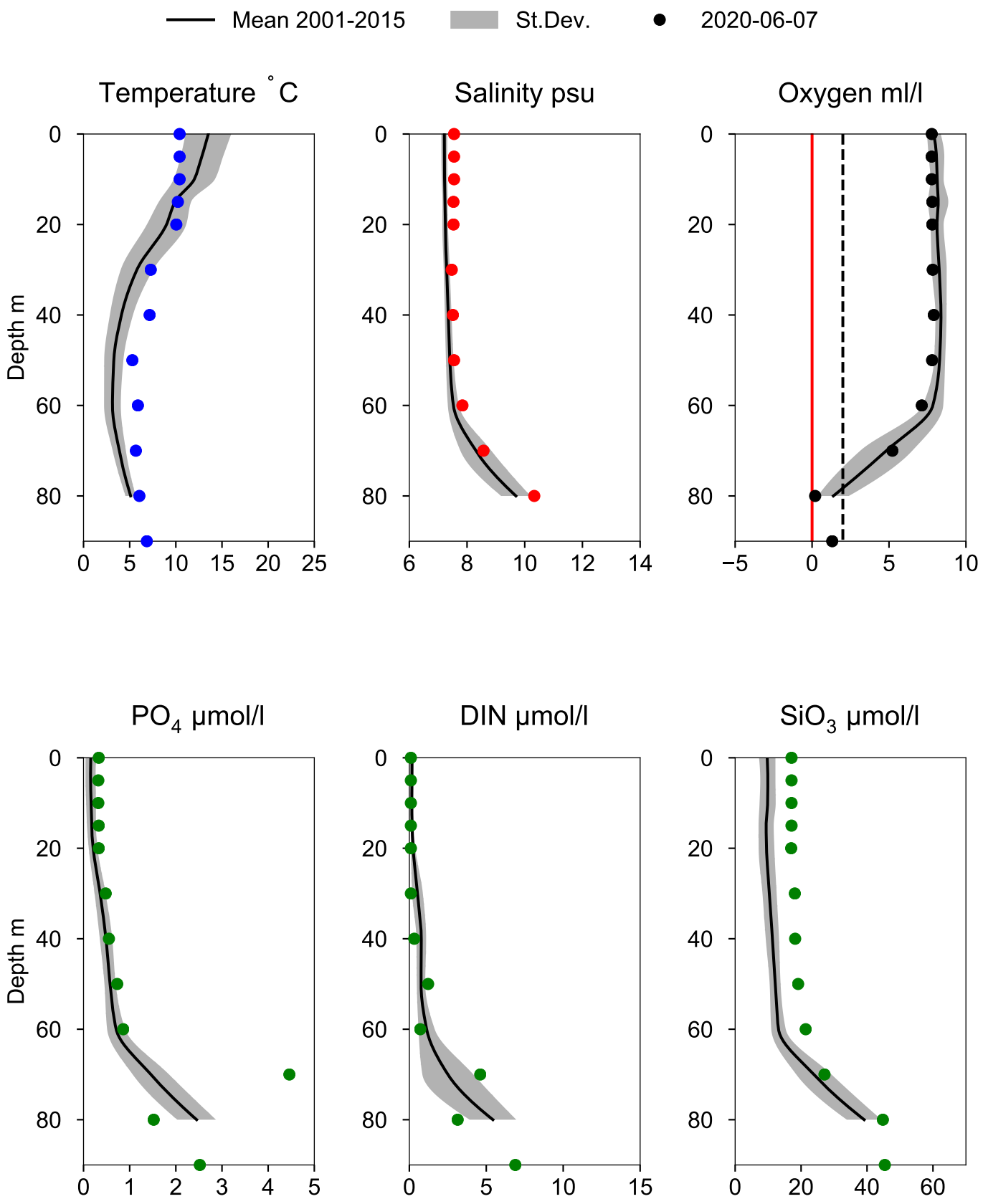
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

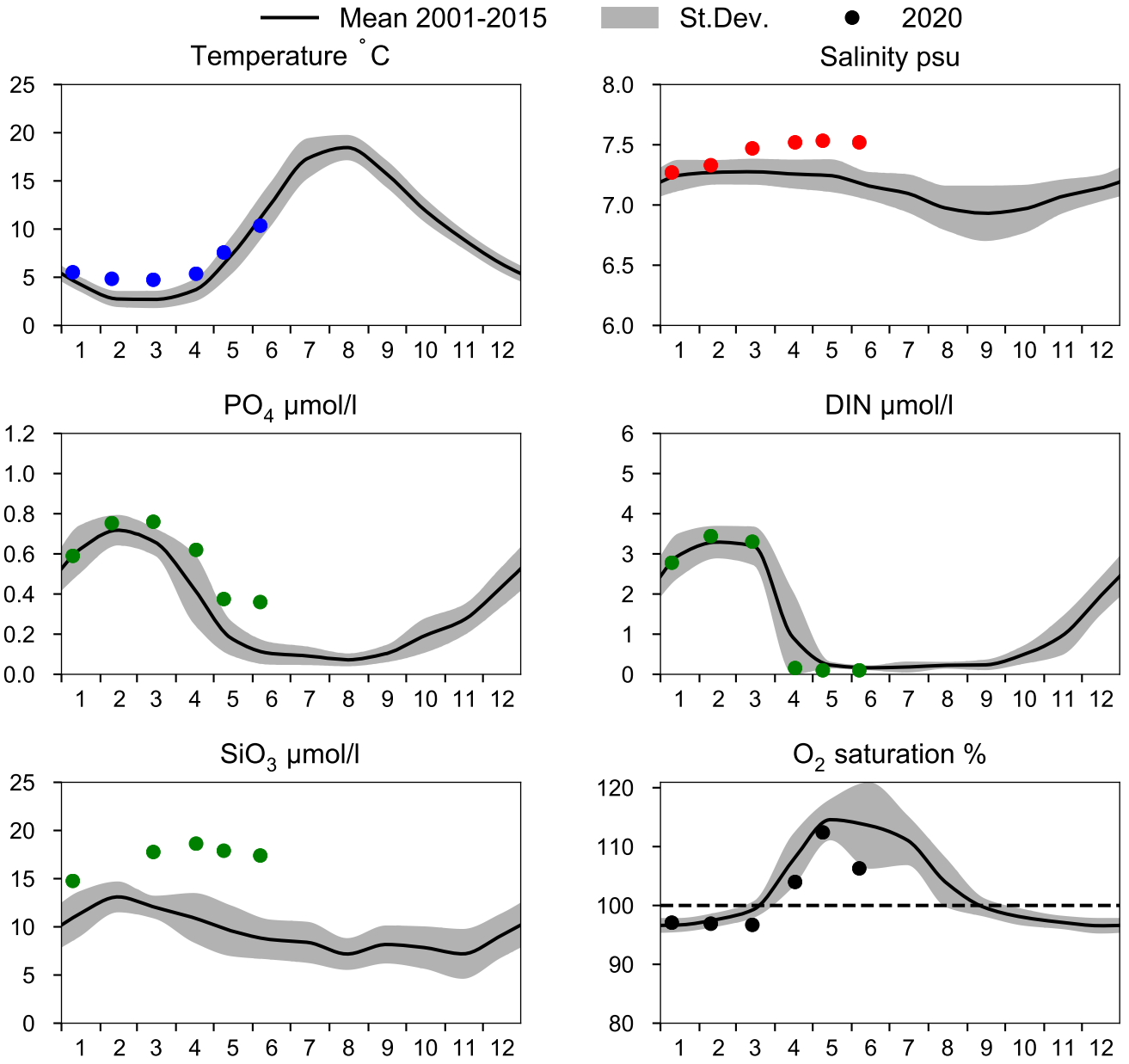


Vertical profiles BCS III-10
June

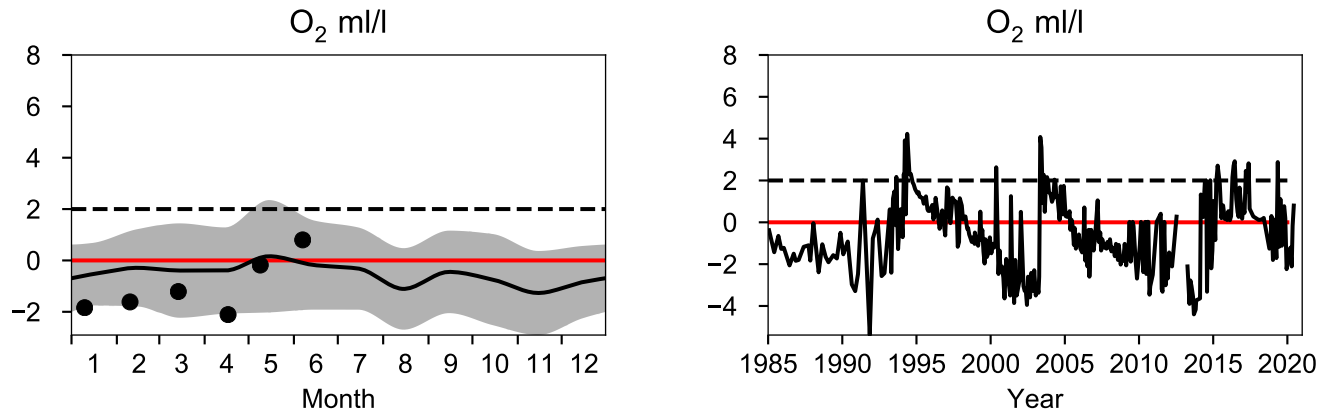


STATION BY10 SURFACE WATER (0-10 m)

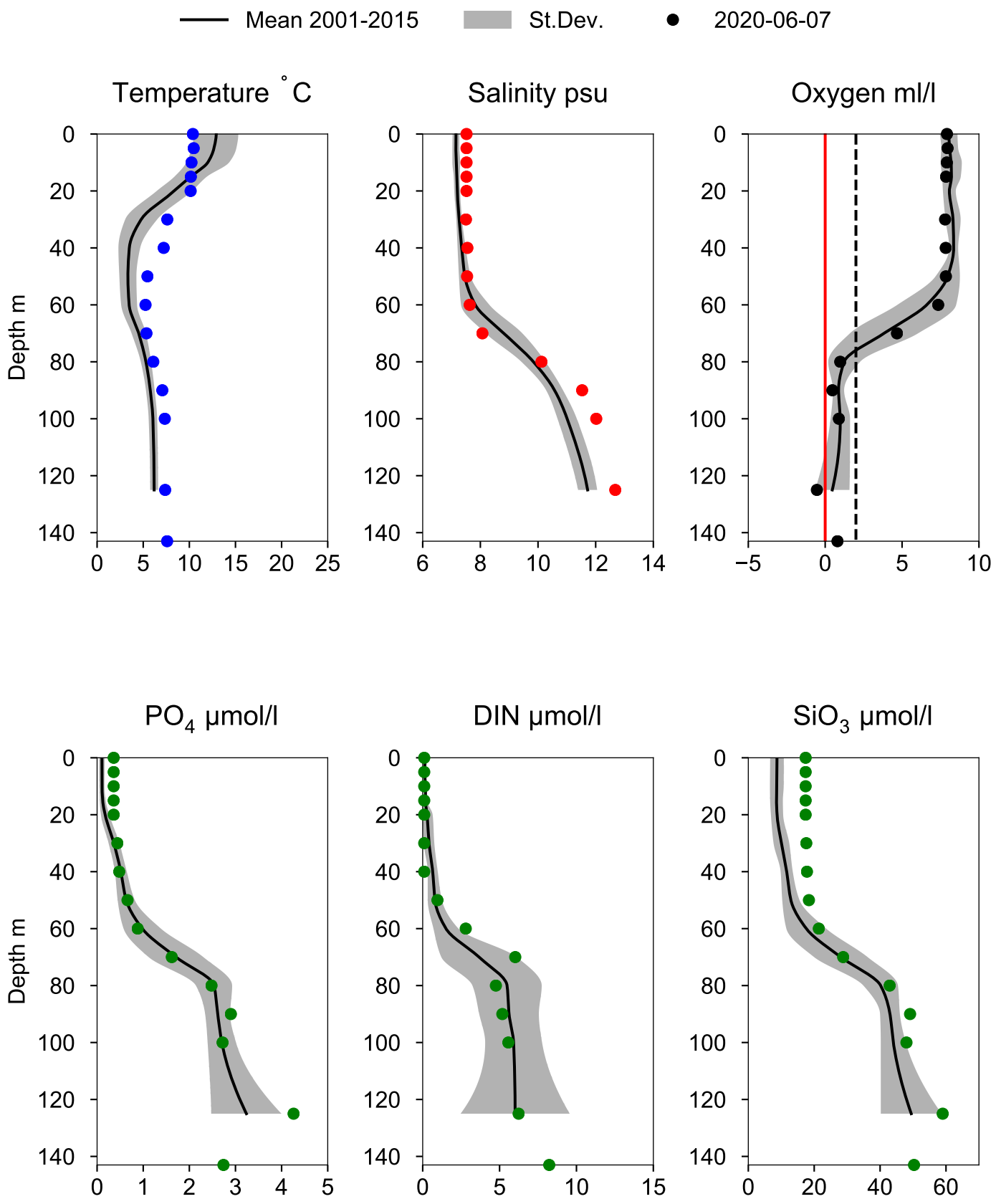
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

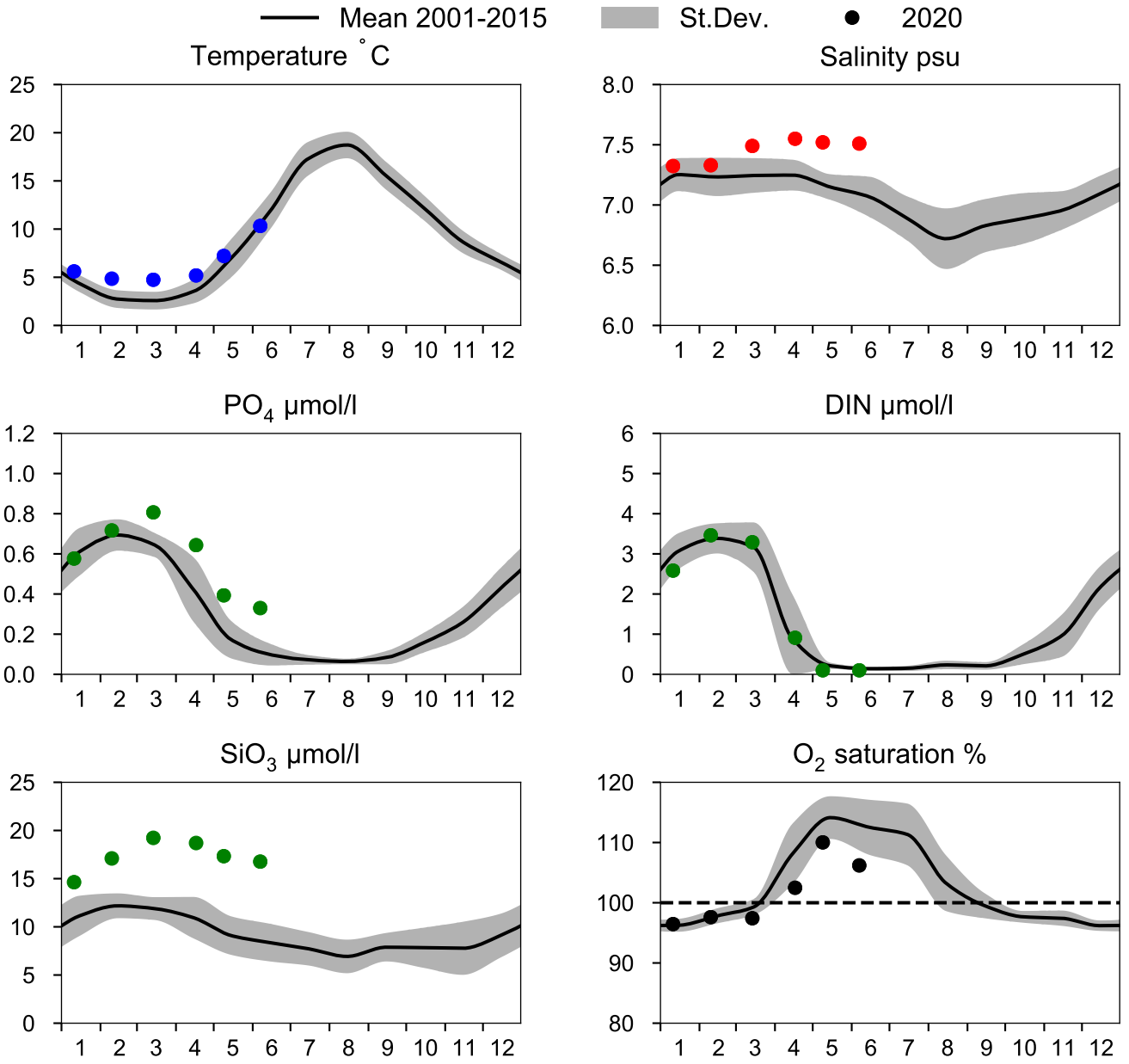


Vertical profiles BY10
June

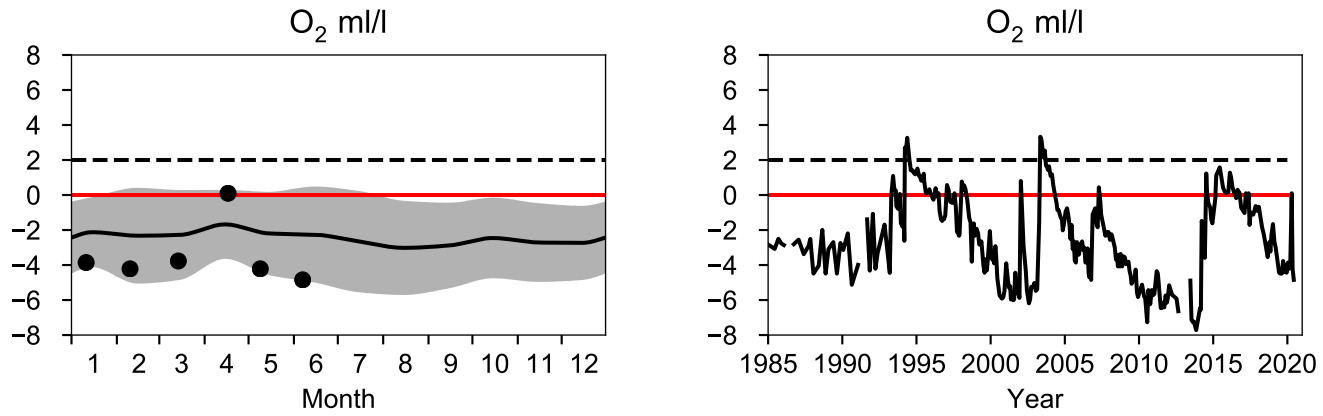


STATION BY15 GOTLANDSDJ SURFACE WATER (0-10 m)

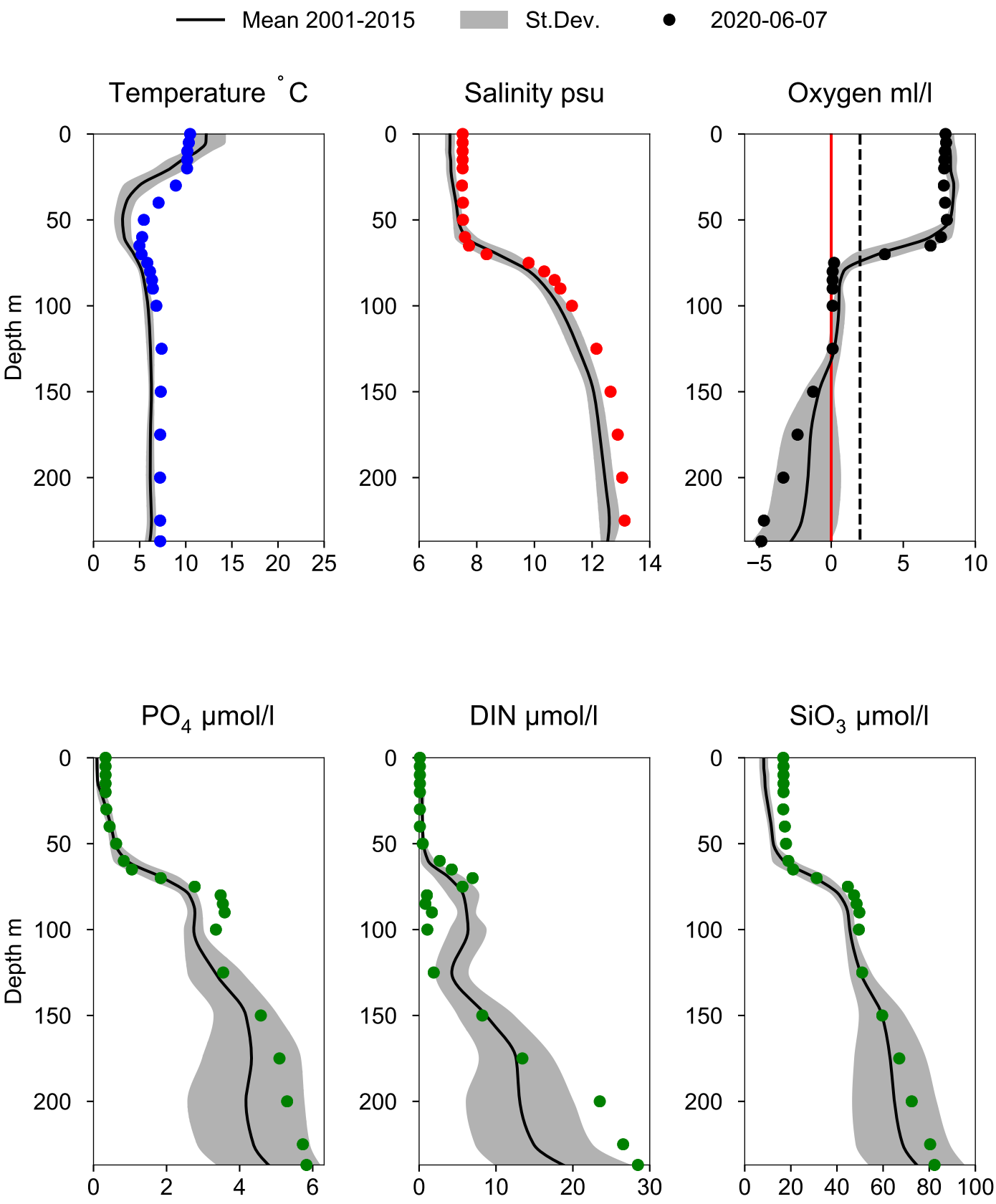
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 225 m)

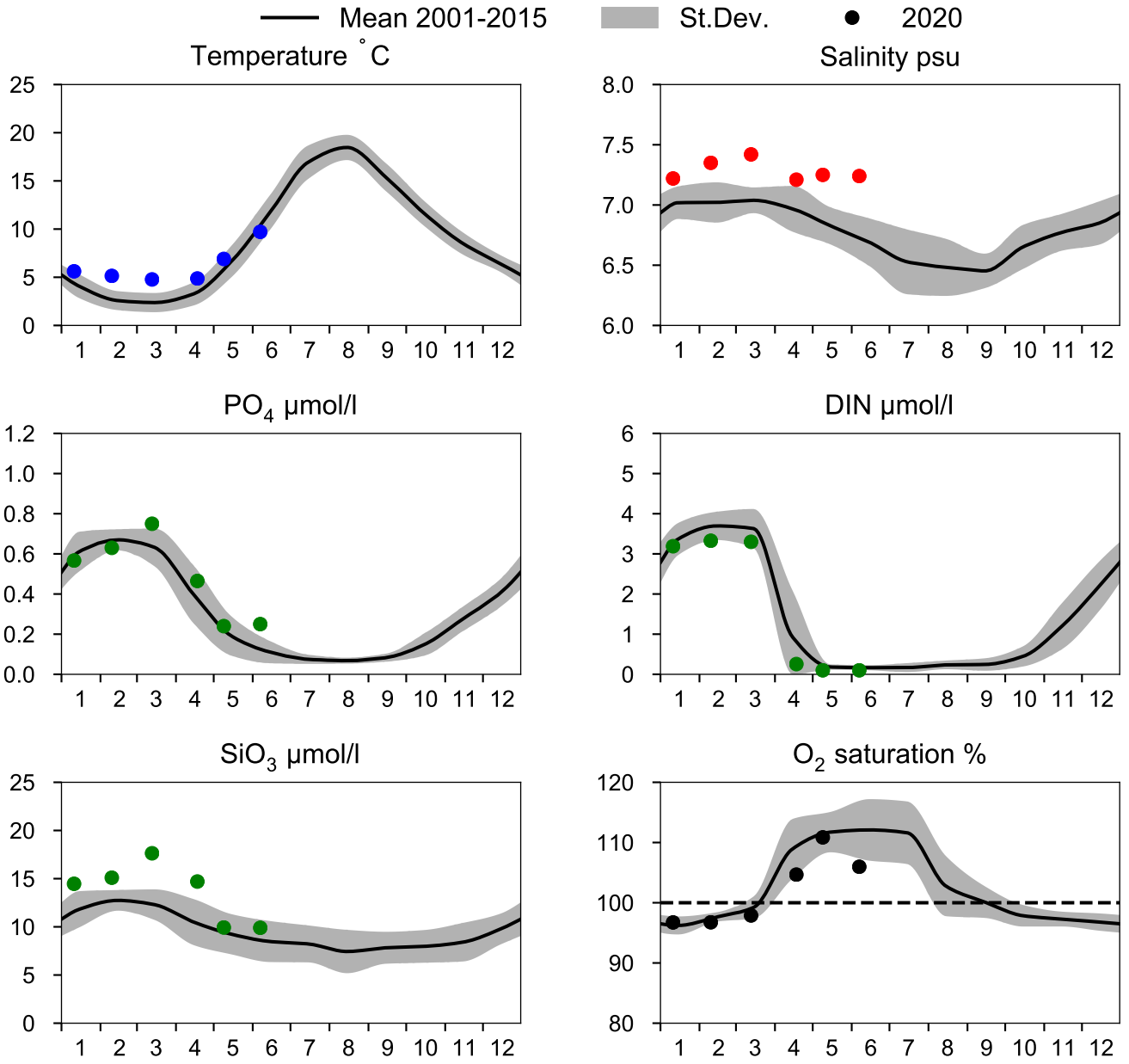


Vertical profiles BY15 GOTLANDSDJ
June

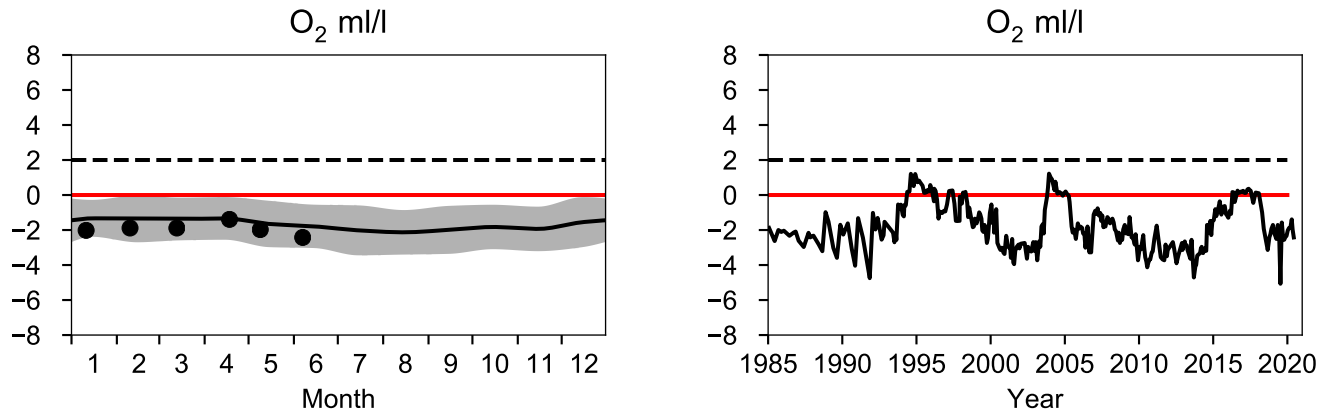


STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)



Vertical profiles BY20 FÅRÖDJ
June