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Report from the SMHI monitoring cruise with R/V Svea

Foto: Ola Kalén, SMHI

Survey period: 2020-11-12 - 2020-11-17
Principal: Swedish Meteorological and Hydrological Institute (SMHI), Swedish Agency for Marine and Water Management (SwAM)
Cooperation partners: Swedish University of Agricultural Sciences (SLU)

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SUMMARY

During the expedition, which is part of the Swedish national marine monitoring program, the Skagerrak, the Kattegat, the Sound and the Baltic Proper was visited. The weather was overcast with mostly moderate winds from the south.

The surface water (0–10 m) had only become slightly colder since October and was warmer than normal at almost all stations, the temperature was 10–12 degrees. The salinity of the surface water in the Baltic Proper was still above normal for the season and varied between 6.6–8.5 psu. In the Kattegat and Skagerrak, the salinity of the surface water was normal.

The concentrations of inorganic nutrients in the surface water had increased since October, which is normal for the autumn when phytoplankton activity decreases and the water mass mixes. The concentrations of phosphate, inorganic nitrogen and silicate were generally normal in the Skagerrak and the Kattegat but were higher than normal in parts of the Baltic Proper. In the deep water in the Western Gotland Basin, the concentration of dissolved inorganic nitrogen was far above normal.

There was no lack of oxygen in the Skagerrak's bottom water, but at the coastal station Släggö, the oxygen concentration had decreased to 2.7 ml/l. The oxygen concentration in the Kattegat's bottom water was 4–4.5 ml/l. In the Sound, the oxygen concentration in the bottom water had increased from 2 ml/l, which was measured in October, to 3.8 ml/l this November.

At this visit, there was no oxygen deficiency in the Arkona Basin, which is an improvement from October, while the oxygen situation in the other basins was largely the same. In the Bornholm Basin, there was an acute lack of oxygen (<2 ml/l) from 70 m, but no hydrogen sulphide was noted. In the Eastern Gotland Basin at station BCSIII-10 there was also no anoxia but acute oxygen deficiency from 80 m. At BY10 and BY15 Gotland Deep there was acute oxygen deficiency from 80 m down to 125–150 m where hydrogen sulphide was measured down to the bottom. In the Northern and Western Gotland Basin, there was a sharper boundary at the transition to oxygen-free status; at station BY31Landsort Deep there was acute oxygen deficiency from 80 m and hydrogen sulphide was noted just below from 90 m. At station BY38 Karlsö Deep there was acute oxygen deficiency already from 60 m and hydrogen sulphide from 70 m.

Next regular expedition is planned 3–16 December with R/V Svea at which it will be winter mapping of nutrients in the Gulf of Bothnia.

RESULT

The expedition was carried out on board R/V Svea and started in Lysekil the 12th November and ended in Kalmar the 17th November.

The weather during the expedition was overcast with mostly moderate winds from the south, during 16th November the winds increased on the Baltic Sea and the waves were relatively high. The air temperature remained around 10 °C.

All planned stations were sampled, 27 of the planned 27 stations. At some of the stations, extra sampling was performed to measure selenium for EAWAG in Switzerland (Swiss Federal Institute of Aquatic Science and Technology) as well as aquatic and phytoplankton samples at a station in the Skagerrak for Uppsala University.

Svea's instrument for measuring profiles while under way, MVP (Moving Vessel Profiler), was used several times during the expedition: along the Å-section from the coast towards station Å17, from station BY5 to station BCSIII-10, from BY10 to BY20 and between BY32 and BY39.

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

The stations BY31 Landsort Deep and BY29 are monitored by SMHI November-February and by Stockholm university the rest of the months. The seasonal plots and the vertical profiles for these two stations also include data from Stockholm university. These data are however also only initially quality controlled and will be available at the data host during 2021.

Data can be downloaded from SHARKweb here:
http://www.smhi.se/klimatdata/oceanografi/havsmiljodata

Skagerrak

The surface water (0–10 m) had not cooled down as much as it normally does and the temperature in the Skagerrak was 11-12 °C. It was warmest along the Å-section where it was warmer than normal and some degree colder at the coast where it was normal for the season. The salinity of the surface water was normal throughout the Skagerrak and varied from 26 psu closest to the coast to 33 psu at the far end of the Å-section. At the stations along the Å-section, thermocline and halocline coincided around 15 m. Below this stratification, the water was warmer down to 60 m where there was a second thermocline. The deep water was around 8 °C and with the salinity 35 psu. The temperature in the Å-section was above normal all the way down to 60 meters. Along the coast, at station Släggö, and at the border between Skagerrak and Kattegat, at station P2, the thermocline and halocline coincided at 5 m and there was then a deeper thermocline at 45 m and a second halocline around 20 m.

The concentration of nutrients in the surface water has increased since October at almost all stations in the Skagerrak. The exception was Å13 where the content of DIN (dissolved inorganic nitrogen) was unchanged and silicate had decreased. The concentration of phosphate in the surface water varied between 0.19–0.35 µmol/l, the variation of DIN was 0.60–3.35 µmol/l and for silicate the variation was between 1.40–6.23 µmol/l. The levels of nutrients were normal except at Å13 where it was lower

than normal. The lowest concentrations were at the outermost station, Å17, and the highest closest to the coast. The nutrient concentrations were generally normal in the deep water, but slightly elevated below 40 m at station P2.

There was no clear peak in chlorophyll fluorescence at any station.

The oxygen concentration in the bottom water was mostly the same as in October or lower, as was noted at the coastal station Släggö where the concentration had decreased from 4.1 ml/l in October to 2.7 ml/l at the time of the measurement in November.

Kattegat and the Sound

The temperature in the surface water (0–10 m) had only dropped with about one degree since October and was now in November around 11 °C at all stations in the Kattegat and the Sound, which was warmer than normal for the month. The salinity of the surface water was normal and varied between 22–25 psu in the Kattegat and was about 10 psu at the station W Landskrona in the Sound. At Anholt E and N14 Falkenberg, the water was well mixed down to 15 m where the thermocline and halocline coincided. Temperature and salinity then increased down to 20 m and below that the temperature decreased again to 35 m. At the Kattegatt's northernmost station, Fladen, which is also deeper, the stratification was not as clear. In the Sound, the water mass was stratified around 15–20 m. The temperature was slightly higher than normal in the deep water and the salinity was normal.

The concentration of nutrients had increased at most stations since the last measurement and was mostly normal. The concentration of phosphate varied between 0.17–0.25 µmol/l in the Kattegat. At the stations Anholt E and N14 Falkenberg, the content of DIN was around the reporting limit, 0.10 µmol/l, and at Fladen it was 0.77 µmol/l. The silicate content varied between 2.9 - 4.2 µmol/l. The highest levels of nutrients in the surface water were in the Sound; 0.60 µmol/l phosphate, 2.51 µmol/l DIN and 14.6 µmol/l Si. In the deep water there was no general pattern but the concentration of nutrients varied between being slightly below normal to slightly above normal.

The oxygen concentration in the bottom water of Kattegat was 4-4.5 ml/l. In the Sound, the oxygen concentration had increased from 2 ml/l, which was measured in October, to 3.8 ml/l now in November.

Measurements of chlorophyll fluorescence showed low levels and no clear peak in the measurements occurred in the Kattegat.

The Baltic Proper

The temperature in the surface water was above normal at all stations in the Baltic Sea and was between 10–12 °C. It was coldest in the Western Gotland Basin and warmest in Arkona. The surface salinity varied between 6.6 psu in the Northern Gotland Basin to 8.5 psu in Arkona. At most stations, the surface salinity was above normal except in the North and parts of the Western Gotland Basin where the salinity was normal. The surface water was well mixed down to 30–40 m where there was a sharp thermocline and below that the temperature decreased to about 6 °C and then increased again below the halocline. At most stations, there was also a stratification in salinity at the same depth as the thermocline. Then there was a deeper and sharper halocline around 30–60 m. The

halocline was most shallow in Arkona and the Bornholm Basin and was deeper in other areas. At the station Ref M1V1 in Kalmarsund, where the bottom depth is only 20 m, there were no stratification. In the Arkona Basin at station BY2, there was a thin layer near the bottom with saltier and warmer water. In the deep water, salinity and temperature were above normal in the Eastern, Western and Northern Gotland Basins.

The concentration of phosphate in the surface water had increased since October and was normal for the season except in the Eastern Gotland Basin where it was above normal, the variation was between 0.3 µmol/l in the northern parts and 0.6 µmol/l in the south. The concentration of dissolved inorganic nitrogen had also increased since October and varied from 0.8 µmol/l in Arkona to 2.3 µmol/l in the Northern Gotland Basin, concentrations were normal in the Arkona and Bornholm Basins but above normal in the Eastern, Northern and parts of the Western Gotland Basins. Silicate levels had increased since October at some stations but decreased at others, the variation was between 11–16 µmol/l with decreasing concentrations to the north. The levels of silicate were above normal at all stations except in the Western Gotland Basin. Below the halocline, nutrient levels were generally normal. It was mainly DIN that was above normal at the stations BY15, BY29, BY32 and BY38. The coastal station Ref M1V1 had the highest levels of nutrients; phosphate 0.8 µmol/l, DIN 2.4 µmol/l and silicate 19 µmol/l.

At this visit, there was no oxygen deficiency in the Arkona Basin, which is an improvement from October, while the oxygen situation in the other basins was largely the same. In the Bornholm Basin, there was an acute lack of oxygen (<2 ml/l) from 70 m, but no hydrogen sulphide was noted. In the Eastern Gotland Basin at station BCSIII-10 there was also no anoxia but acute oxygen deficiency from 80 m. At BY10 and BY15 Gotland Deep there was acute oxygen deficiency from 80 m down to 125–150 m where hydrogen sulphide was measured down to the bottom. In the Northern and Western Gotland Basin, there was a sharper boundary at the transition to oxygen-free status; at station BY31Landsort Deep there was acute oxygen deficiency from 80 m and hydrogen sulphide was noted just below from 90 m. At station BY38 Karlsö Deep there was acute oxygen deficiency already from 60 m and hydrogen sulphide from 70 m.

Measurements of chlorophyll fluorescence showed a low activity at all stations except from in the Arkona Basin where it was a little higher.

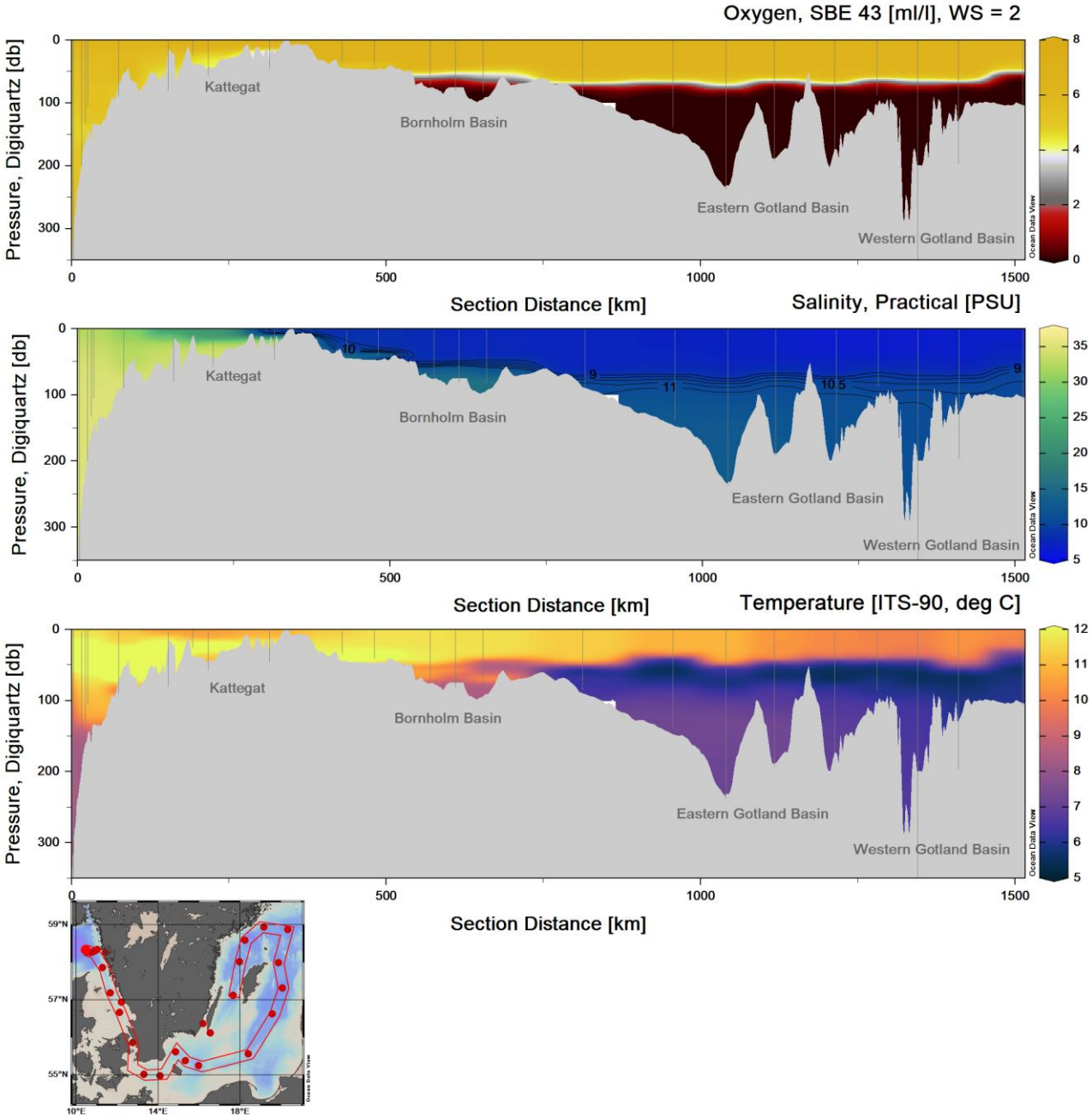


Figure 1. Transect showing dissolved oxygen, salinity and temperature from the Skagerrak, through the Sound and the Eastern Gotland Basin to the Western Gotland Basin.

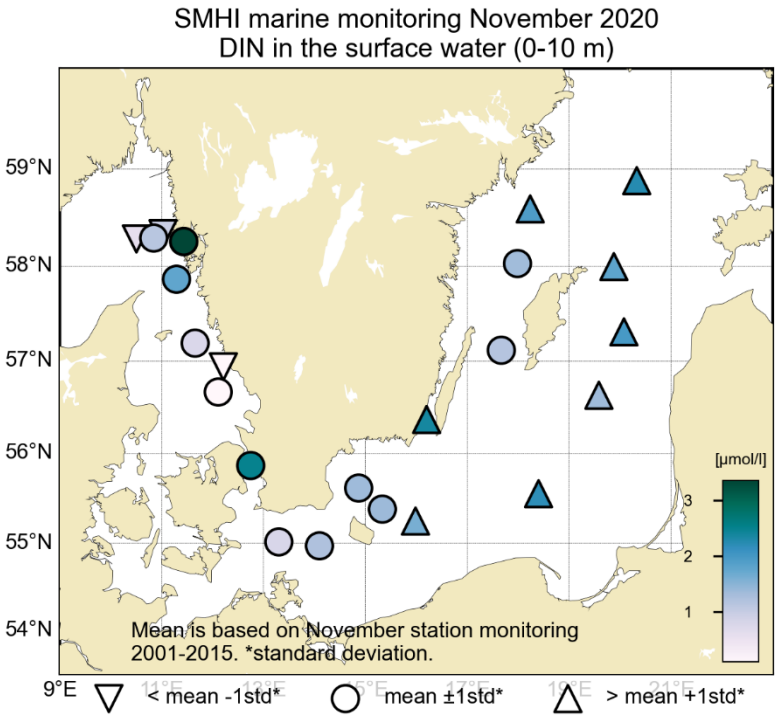


Figure 2. Concentration of dissolved inorganic nitrogen in the surface water (0-10m).

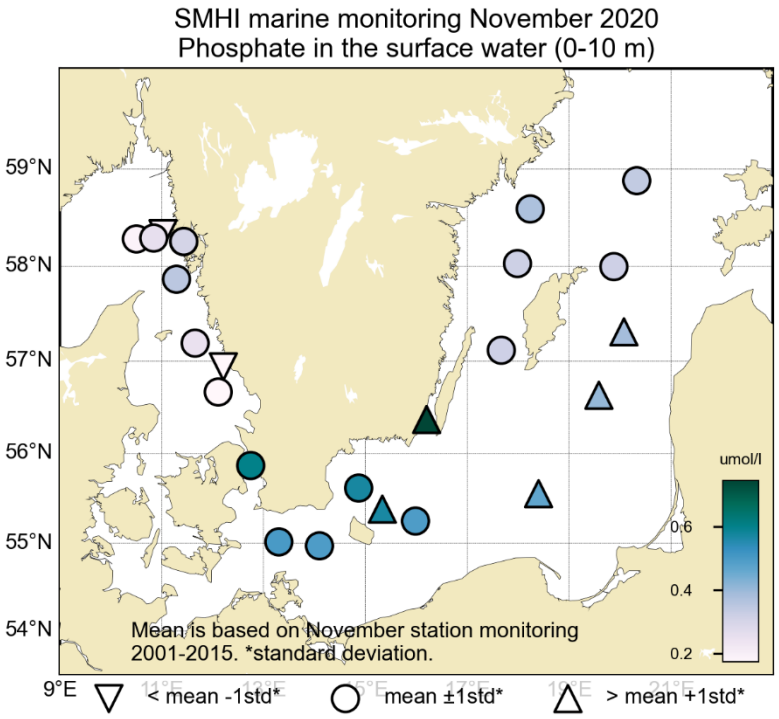


Figure 3. Concentration of phosphate in the surface water (0-10m).

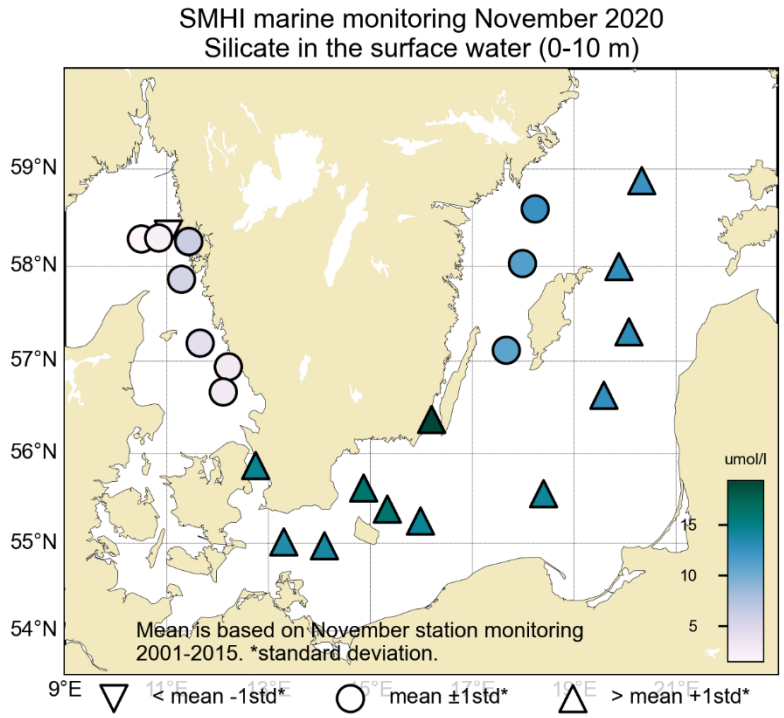


Figure 4 Concentration of silicate in the surface water (0-10m).

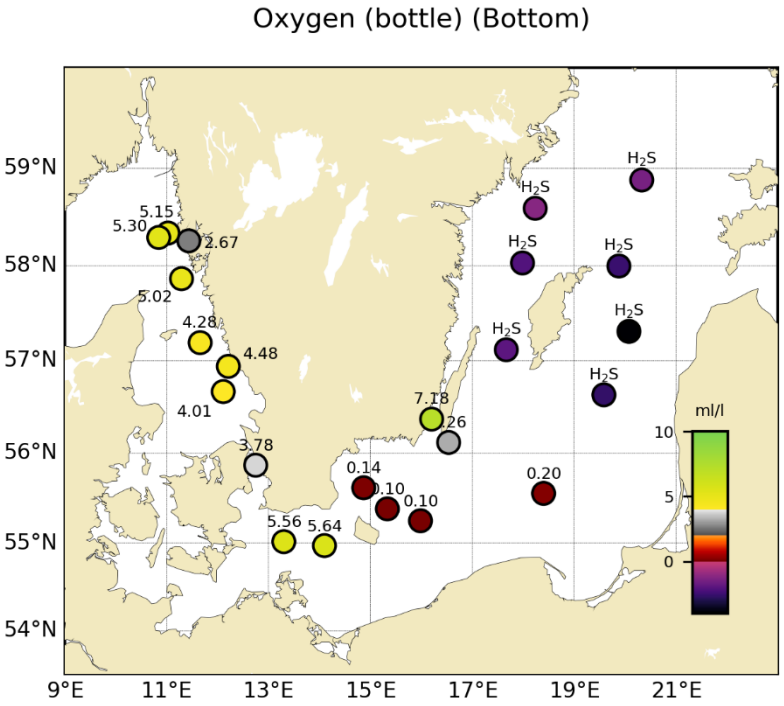


Figure 5. Concentration of oxygen and hydrogen sulphide (as negative oxygen) in the bottom water, ca 1 m above the bottom.

PARTICPANTS

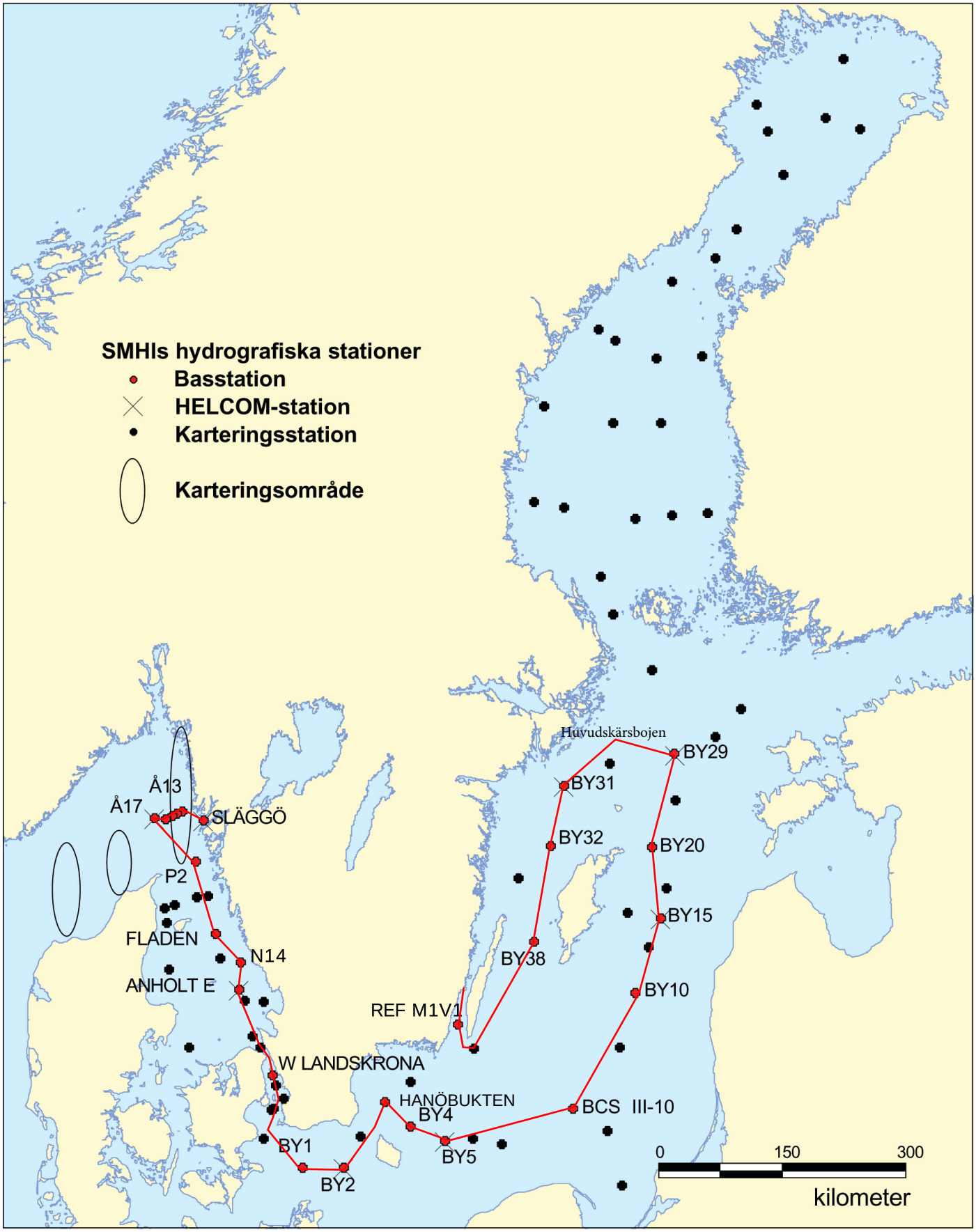
Name		From
Sara Johansson	Chief scientist	SMHI
Sari Sipilä	Chief scientist	SMHI
Kristin Andreasson		SMHI
Daniel Bergman-Sjöstrand		SMHI
Ann-Turi Skjevik		SMHI

APPENDICES

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

SMHI
Havs
och Vatten
myndigheten

Rutt november 2020
Lysekil-Kalmar



Date: 2020-11-20
Time: 08:46

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	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
0676	21	FIBG27	BAS...	SLÄGGÖ	5815.58	01126.12	20201112	1022	78	6	11	7	6.1	1017	2810	xxx-	9	9	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	x
0677	21	SKEX14	BAS...	Å13	5820.37	01101.65	20201112	1300	109	7	12	7	7	1016	2830	x---	10	10	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0678	21	SKEX18	BAS...	Å17	5817.12	01030.31	20201112	1612	350		11	8	7.7	1016	9990	xxx-	15	14	-	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	x	x
0679	21	SKEX17	BAS...	Å16	5816.03	01043.46	20201112	1930	201		13	7	7.5	1015	9990	----	13	0	-	x	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0680	21	SKEX16	BAS...	Å15	5817.66	01050.70	20201112	2045	136		12	6	7.4	1016	9990	x---	12	12	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0681	21	SKEX15	BAS...	Å14	5818.92	01056.53	20201112	2200	108		12	7	7.4	1016	9990	----	11	0	-	x	x	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-
0682	21	SKEX23	BAS...	P2	5752	01117.51	20201113	0020	95		10	7	6.8	1015	9990	x---	10	10	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	x	-
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0685	21	KAEX29	BAS...	ANHOLT E	5640.11	01206.72	20201113	1240	64	12	19	4	9.8	1013	1720	xxxx	10	10	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x
0686	21	SOCX39	BAS...	W LANDSKRONA	5552.00	01244.90	20201113	1845	52		20	8	9.3	1013	9990	x---	9	9	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	-	-
0687	21	BPSA02	BAS...	BY1	5500.94	01318.04	20201114	0305	46		22	7	9.8	1013	9990	x---	7	8	x	x	x	x	-	x	x	-	x	x	x	x	x	x	x	-	x	-	x	-
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0689	21	BPSH05	BAS...	HANÖBUKTEN	5537.04	01452.08	20201114	1150	79		29	3	10.3	1014	2720	x---	11	11	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x	-	-	-
0690	21	BPSB06	BAS...	BY4 CHRISTIANSÖ	5522.97	01519.98	20201114	1510	92	8	26	5	11.2	1014	1620	x--x	12	12	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	x	-	x	-
0691	21	BPSB07	BAS...	BY5 BORNHOLMSDJ	5515.00	01559.05	20201114	1830	91		21	5	11.1	1015	9990	xxx-	12	12	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	x	-
0692	21	BPSE11	BAS...	BCS III-10	5533.32	01824.01	20201115	0515	90		16	6	10.7	1014	9990	x-x-	12	12	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x	x	-	-
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0698	21	BPNX37	BAS...	BY31 LANDSORTSDJ	5835.62	01814.17	20201116	1710	448		18	8	10.0	1007	9990	xxx-	23	23	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	-	-
0699	21	BPWX38	BAS...	BY32 NORRKÖPINGSDJ	5801.83	01759.14	20201116	2240	203		21	8	10.4	1009	9990	x---	17	17	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x	-	-	-
0700	21	BPWX45	BAS...	BY38 KARLSÖDJ	5707.02	01740.12	20201117	0445	110		22	6	10.2	1011	9990	x-x-	14	14	x	x	x	x	-	x	x	x	x	x	x	x	x	x	x	-	x	x	x	-
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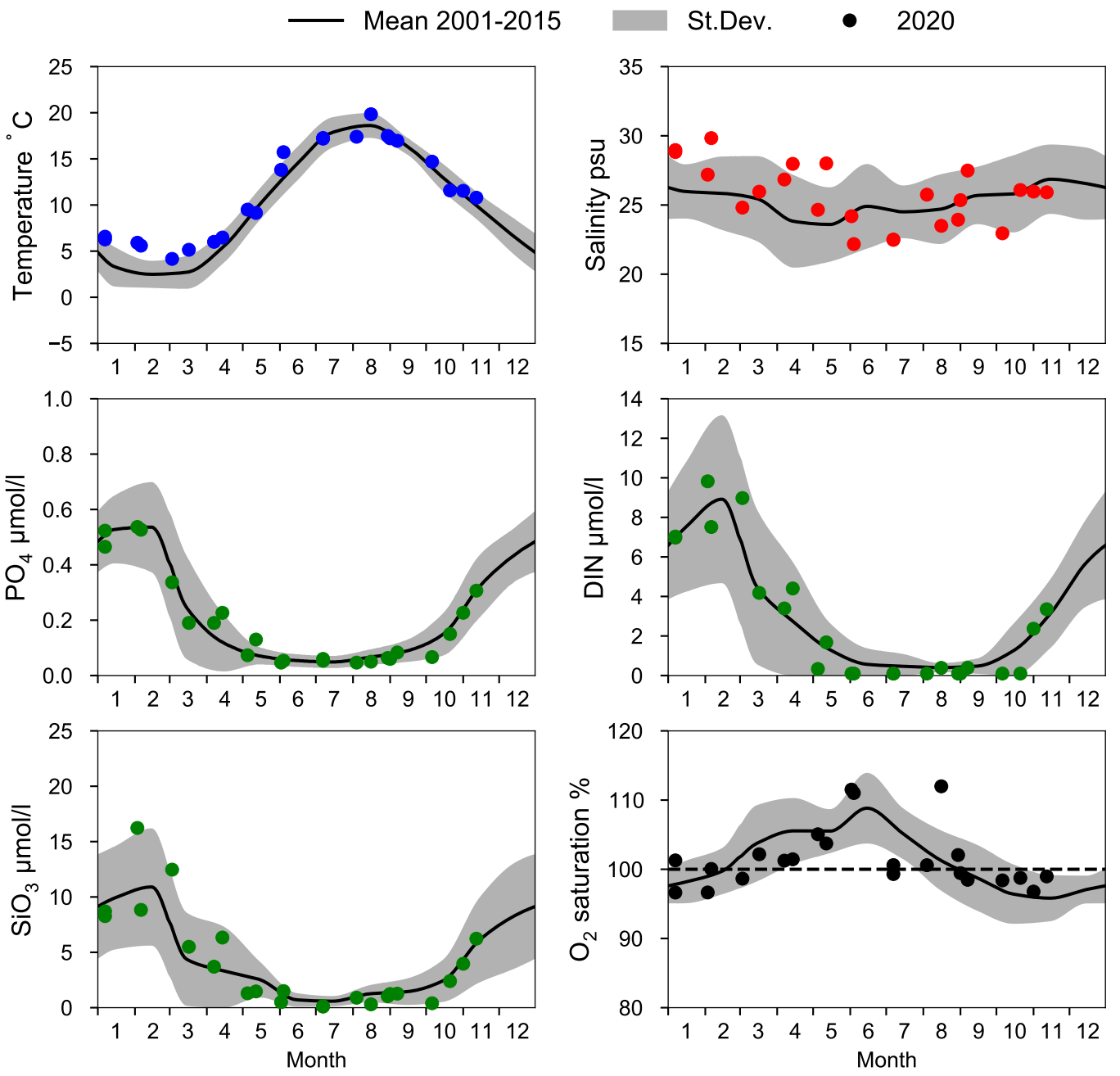
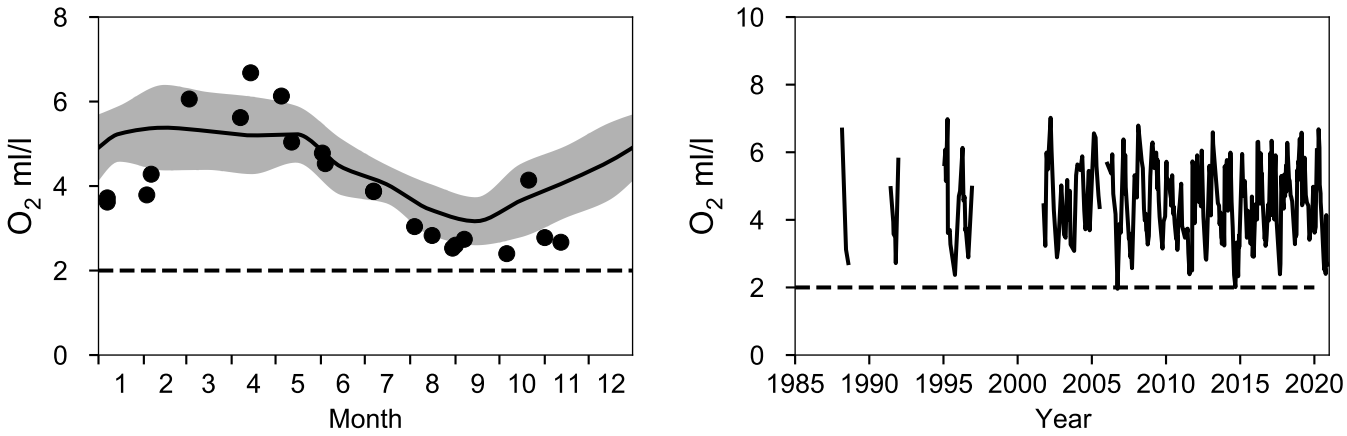
0702	21	BPWK01	BAS...	REF M1V1	5622.26	01612.15	20201117	1740	21		21	9	10.1	1012	9990	xxx-	5	5	x	x	x	x	x	x	x	-	x	x	x	x	x	x	x	x	x	-	-	-

STATION SLÄGGÖ SURFACE WATER (0-10 m)

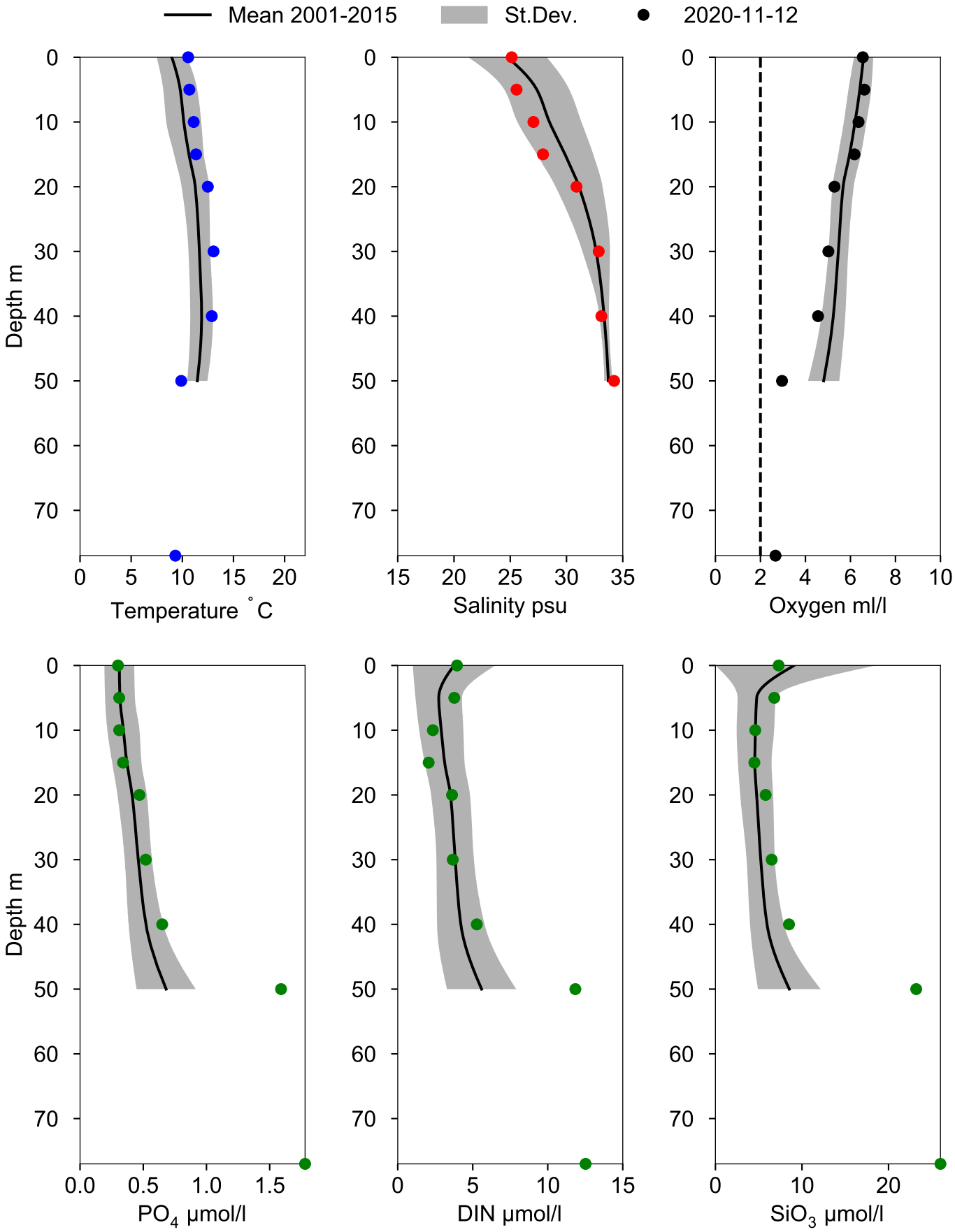
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 64 m)

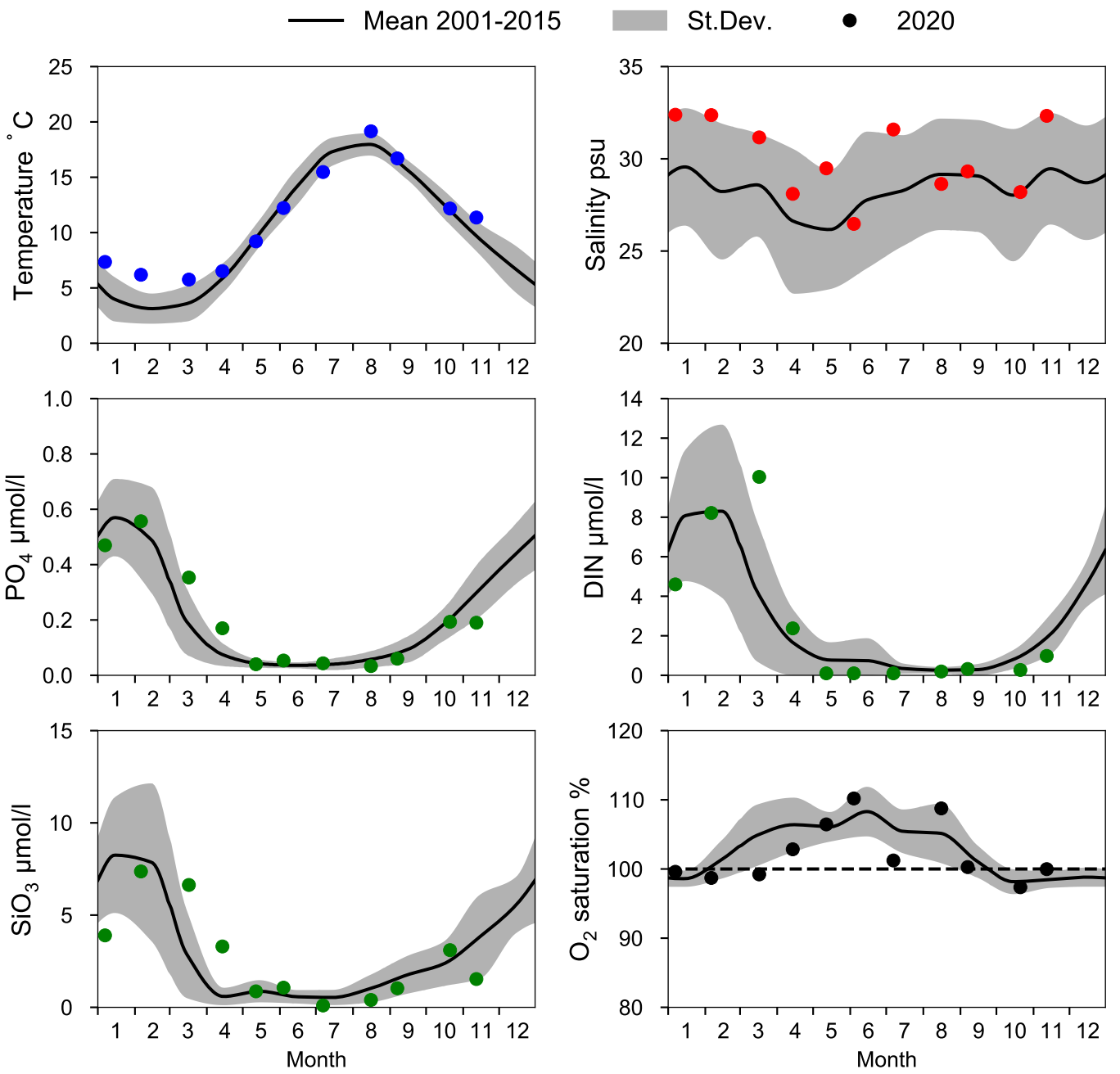


Vertical profiles SLÄGGÖ
November

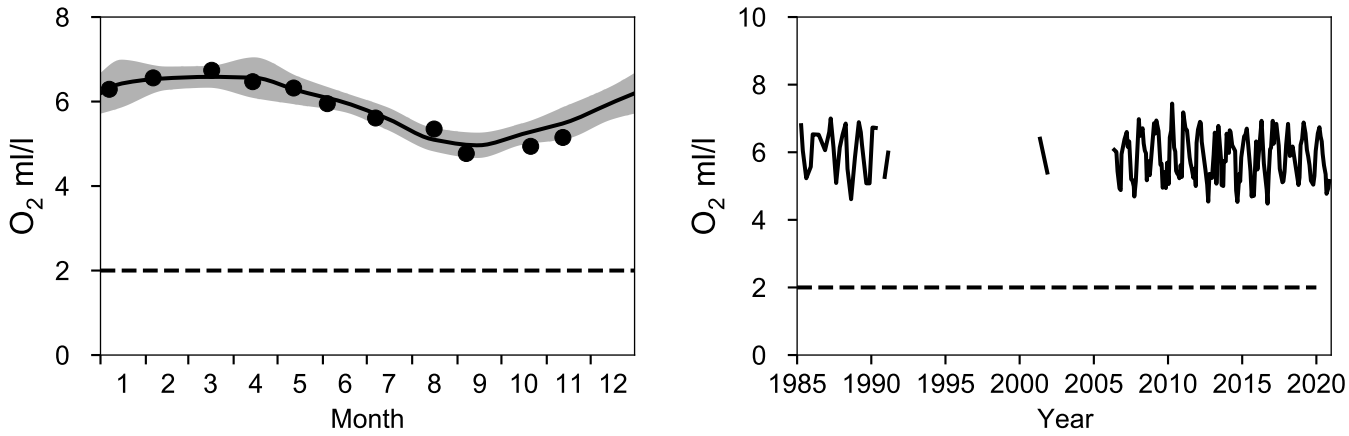


STATION Å13 SURFACE WATER (0-10 m)

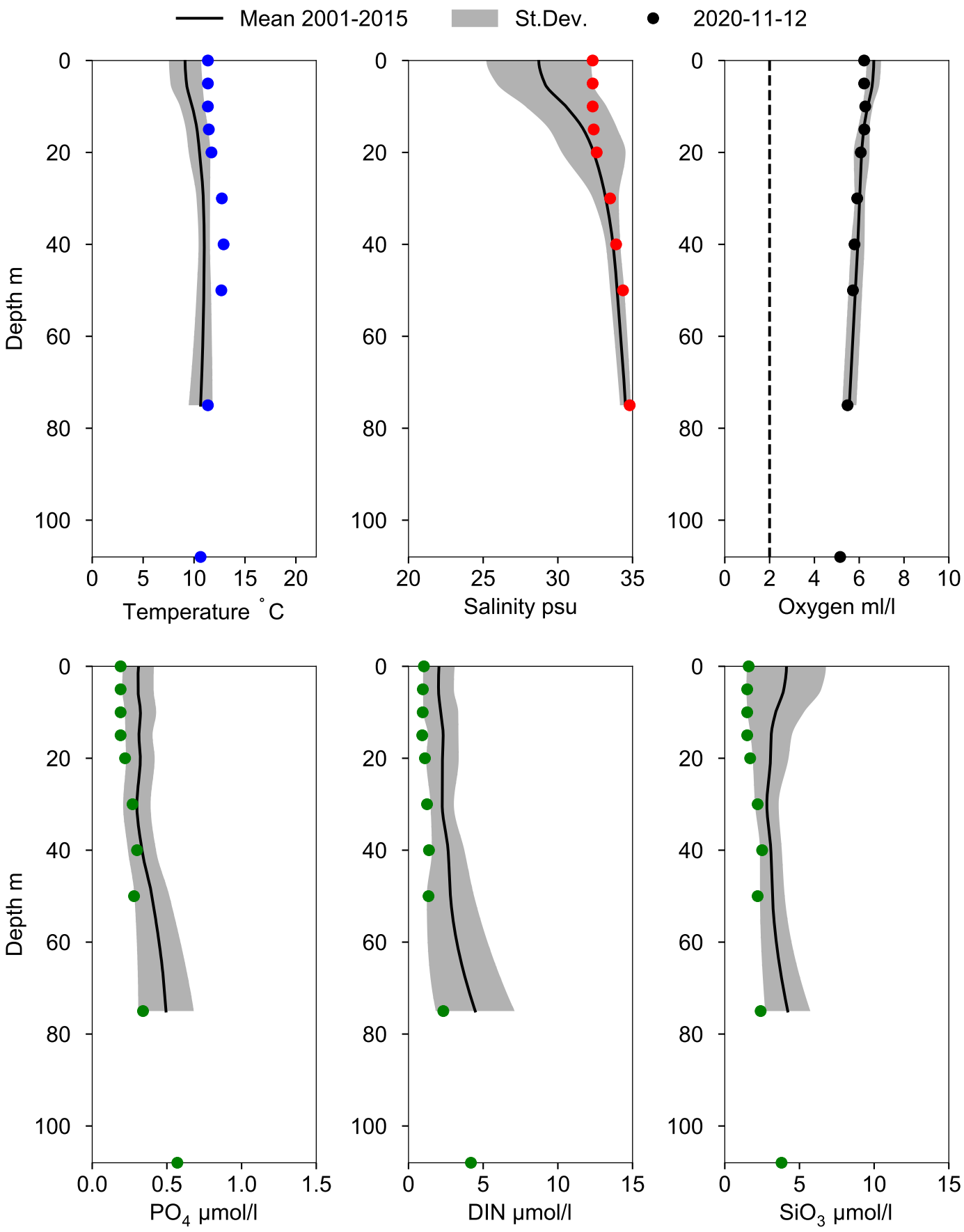
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

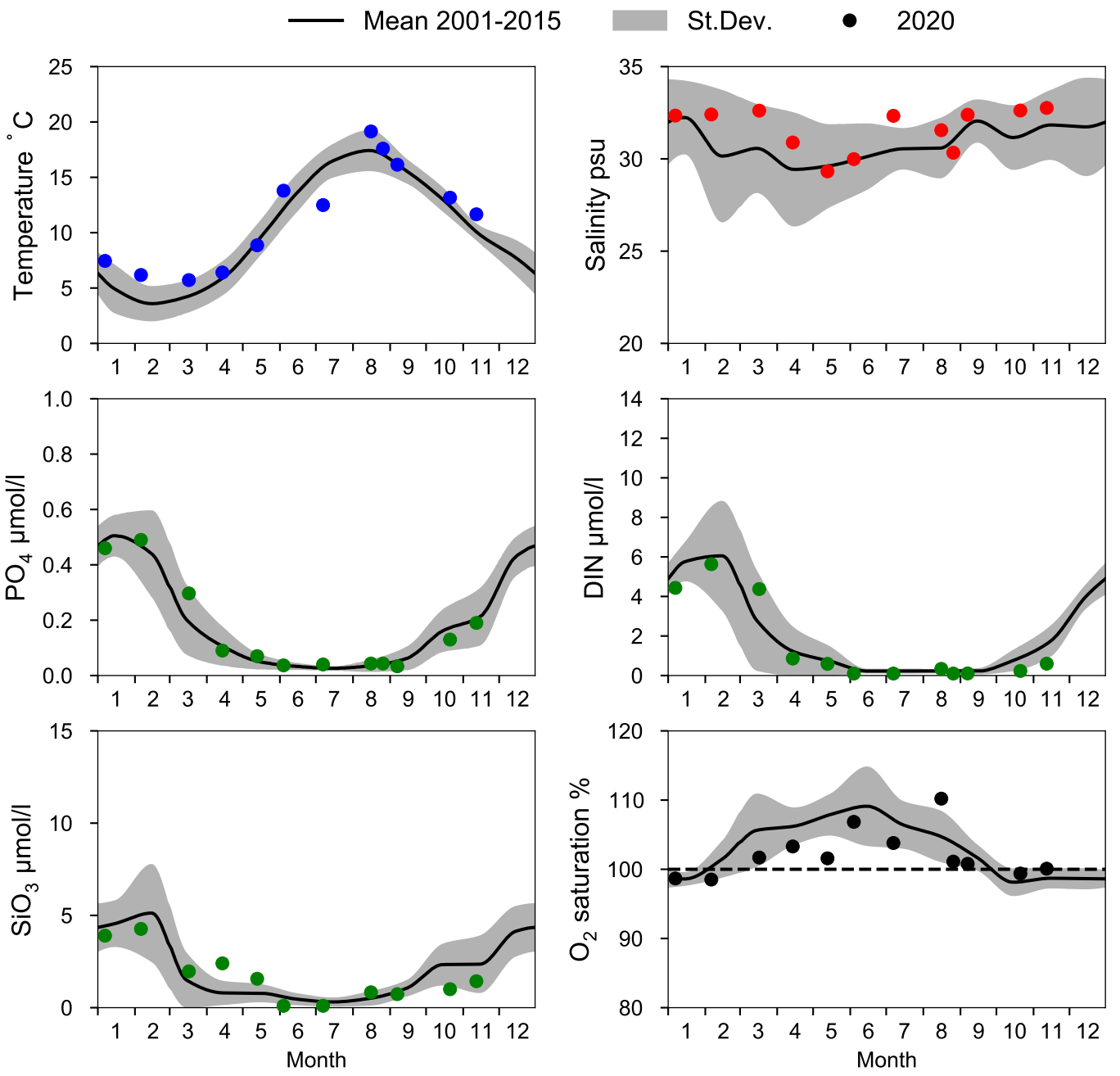


Vertical profiles Å13
November

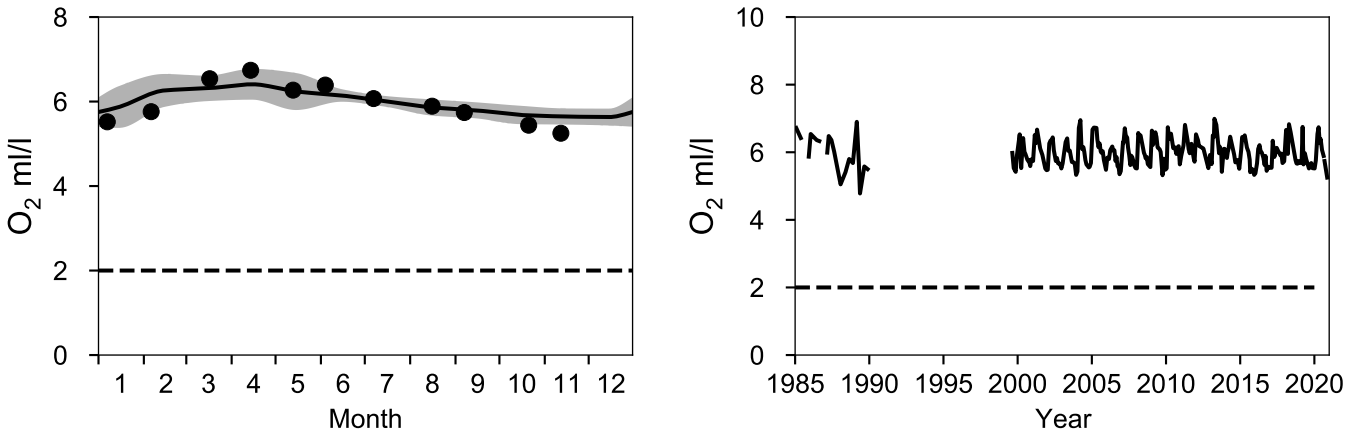


STATION Å17 SURFACE WATER (0-10 m)

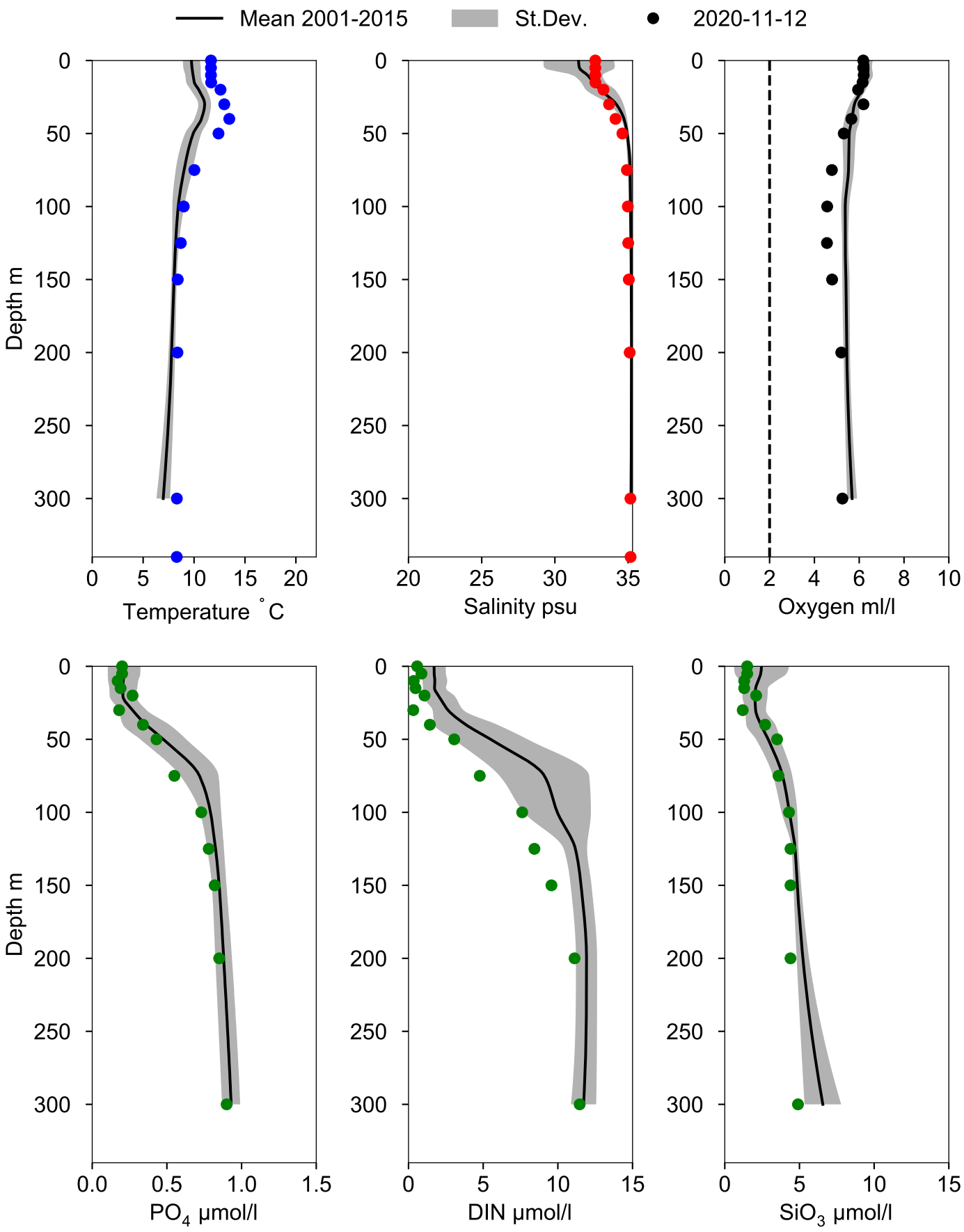
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 300 m)

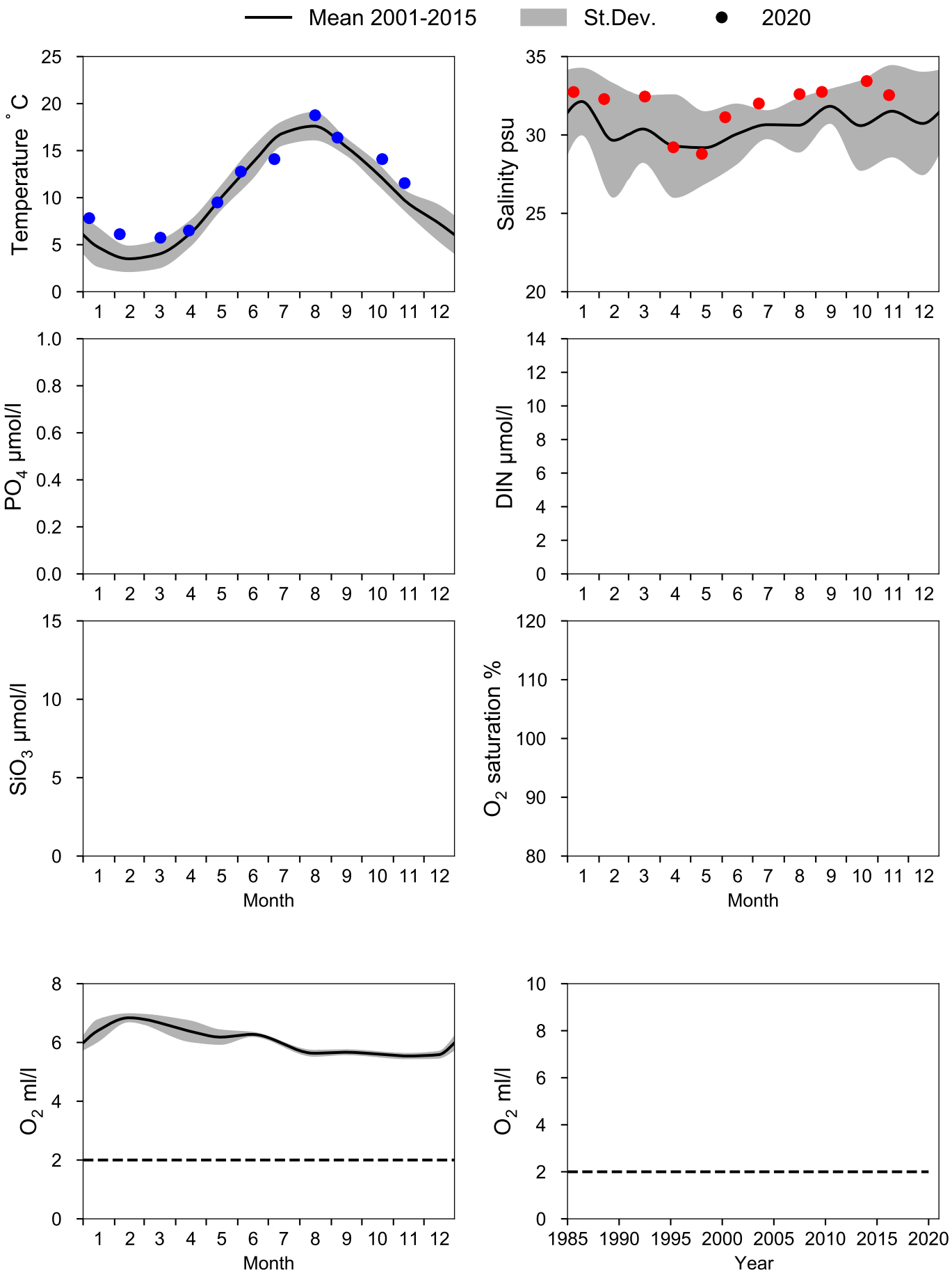


Vertical profiles Å17
November

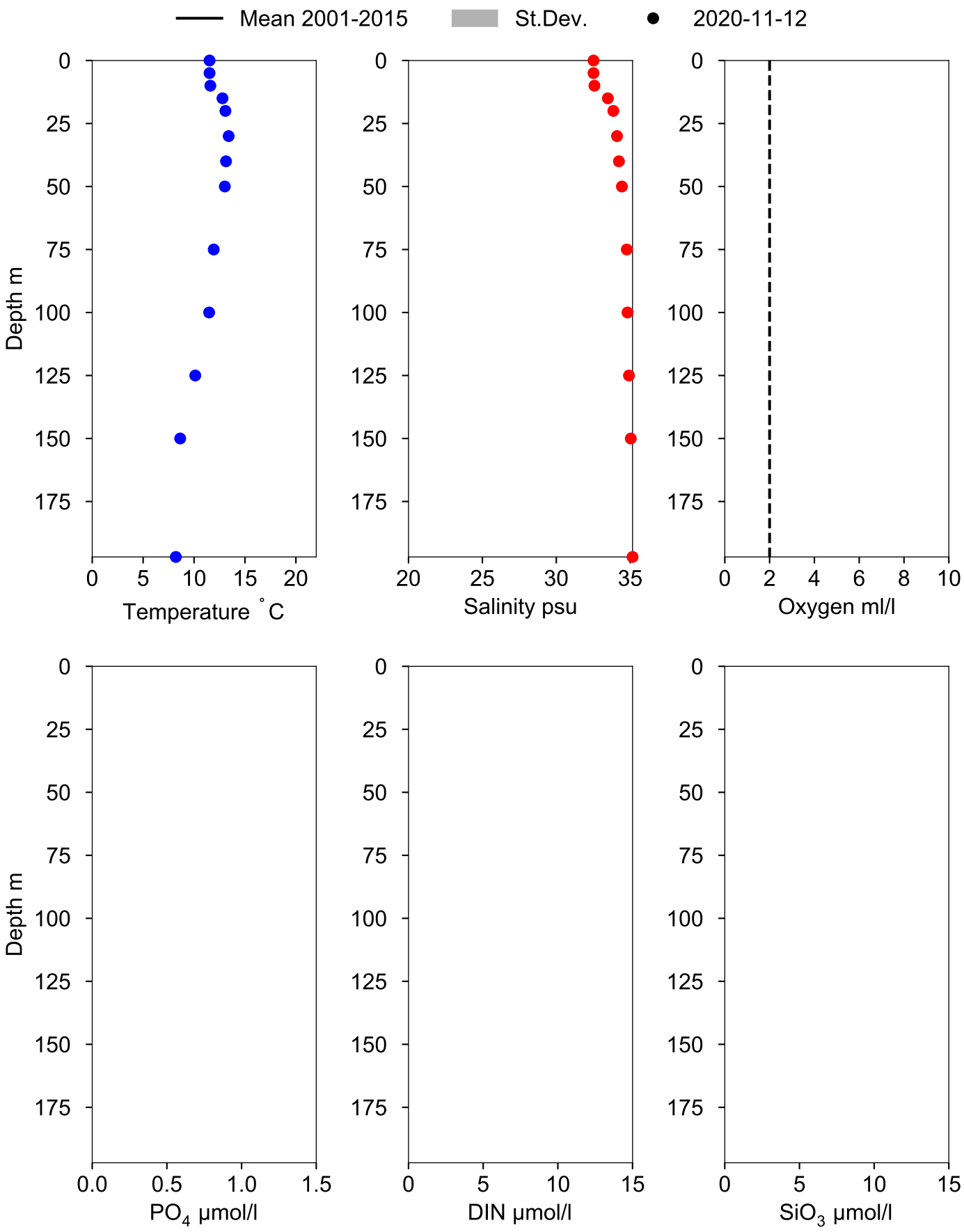


STATION Å16 SURFACE WATER (0-10 m)

Annual Cycles

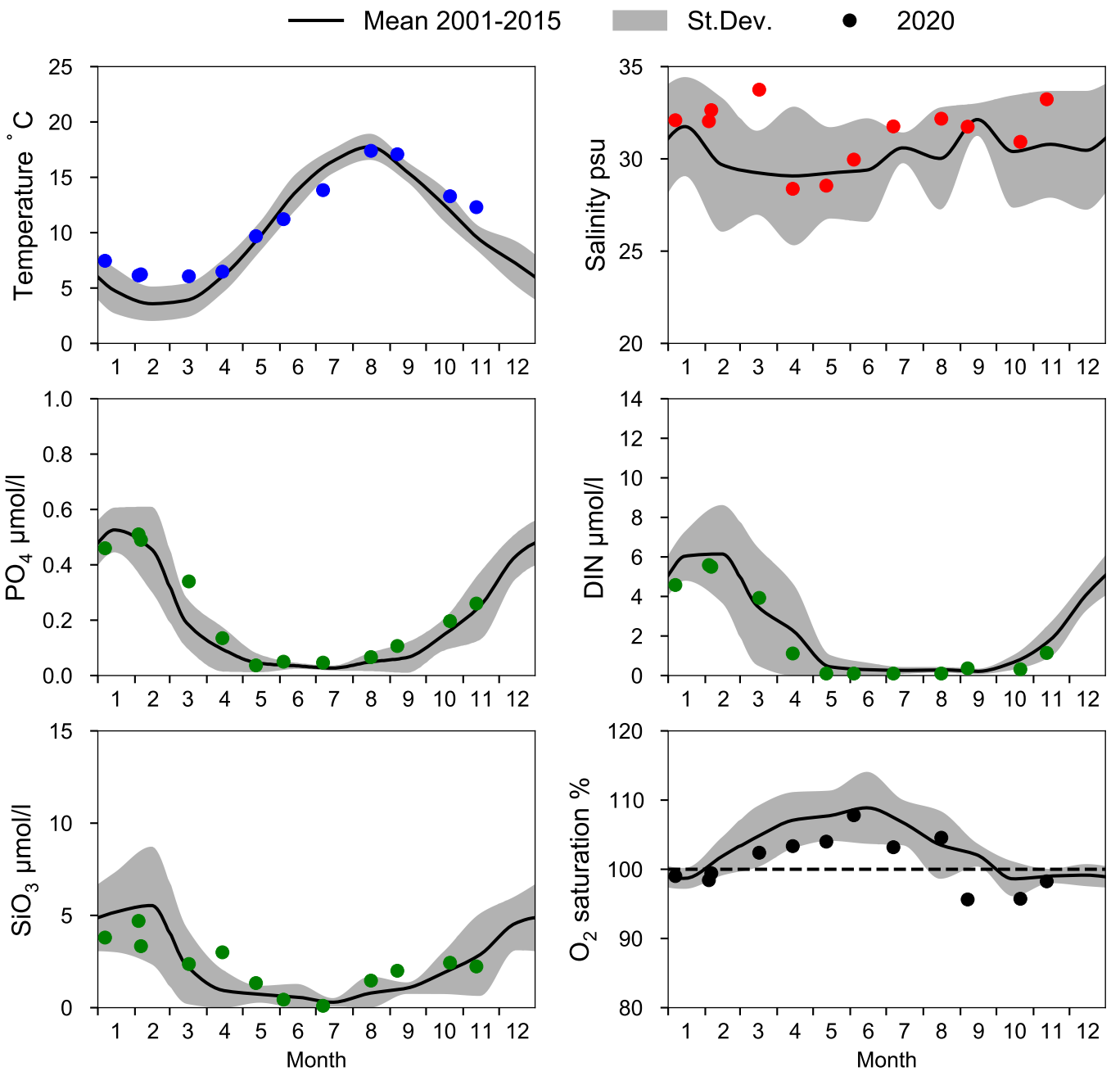


Vertical profiles Å16
November

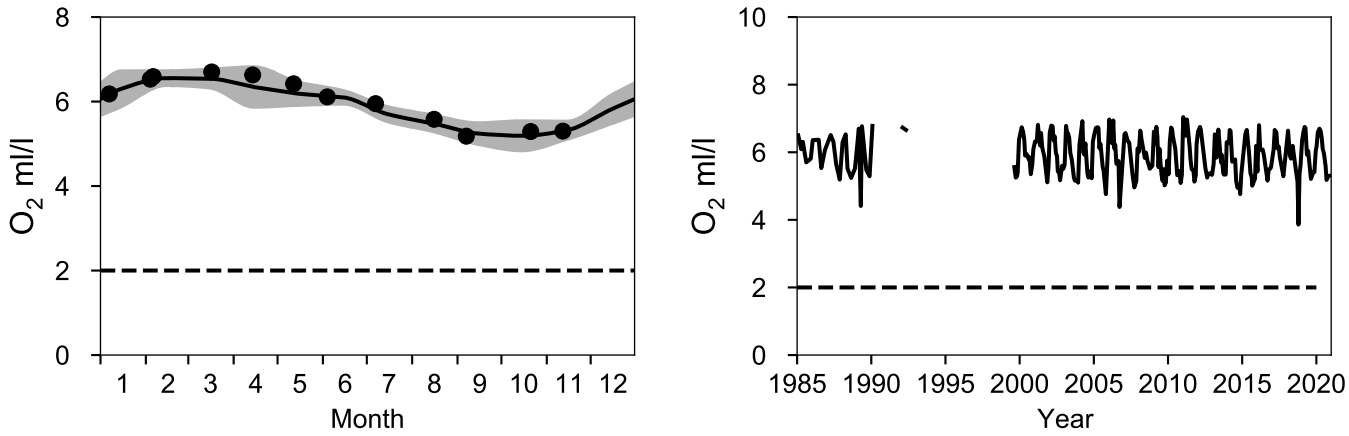


STATION Å15 SURFACE WATER (0-10 m)

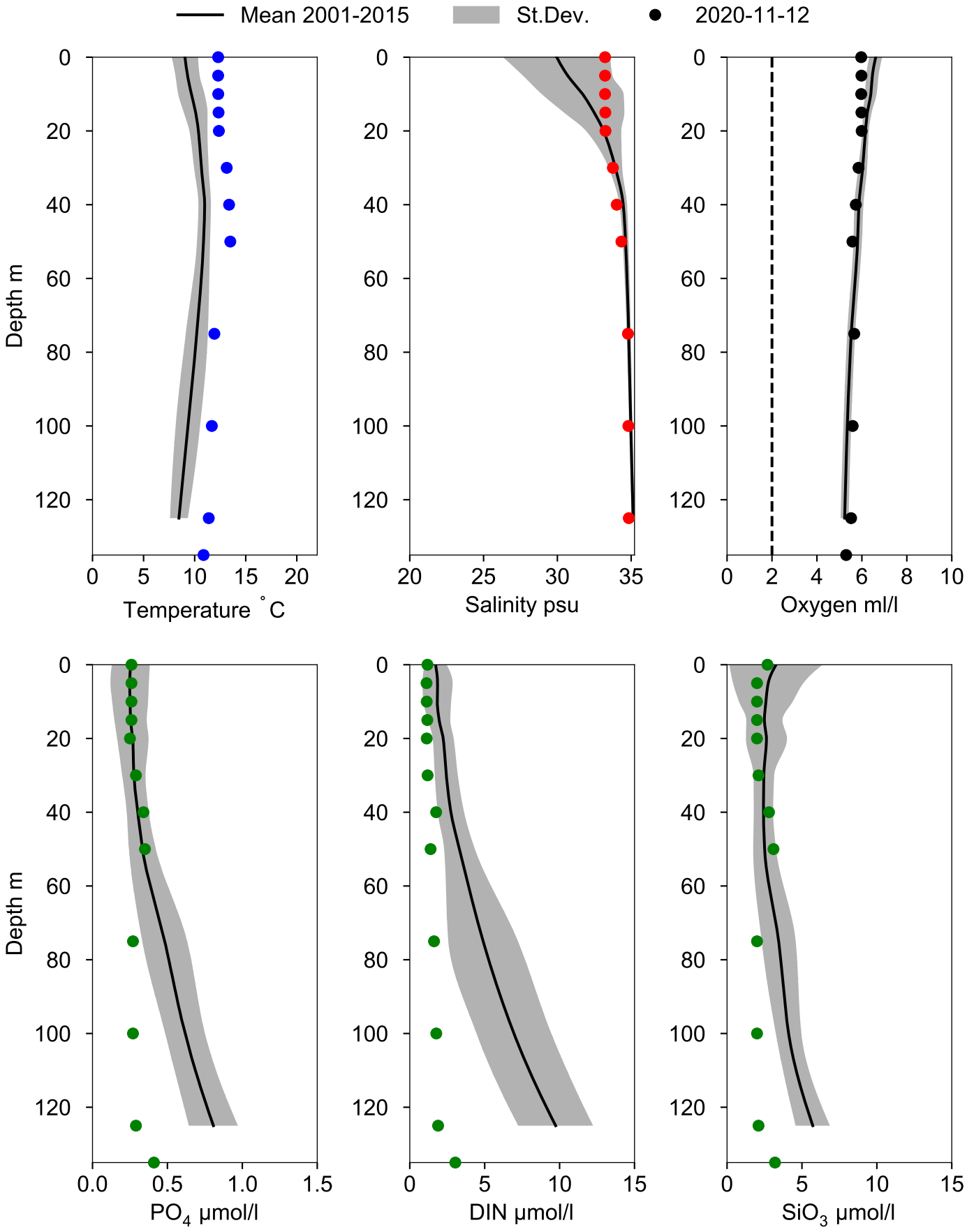
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

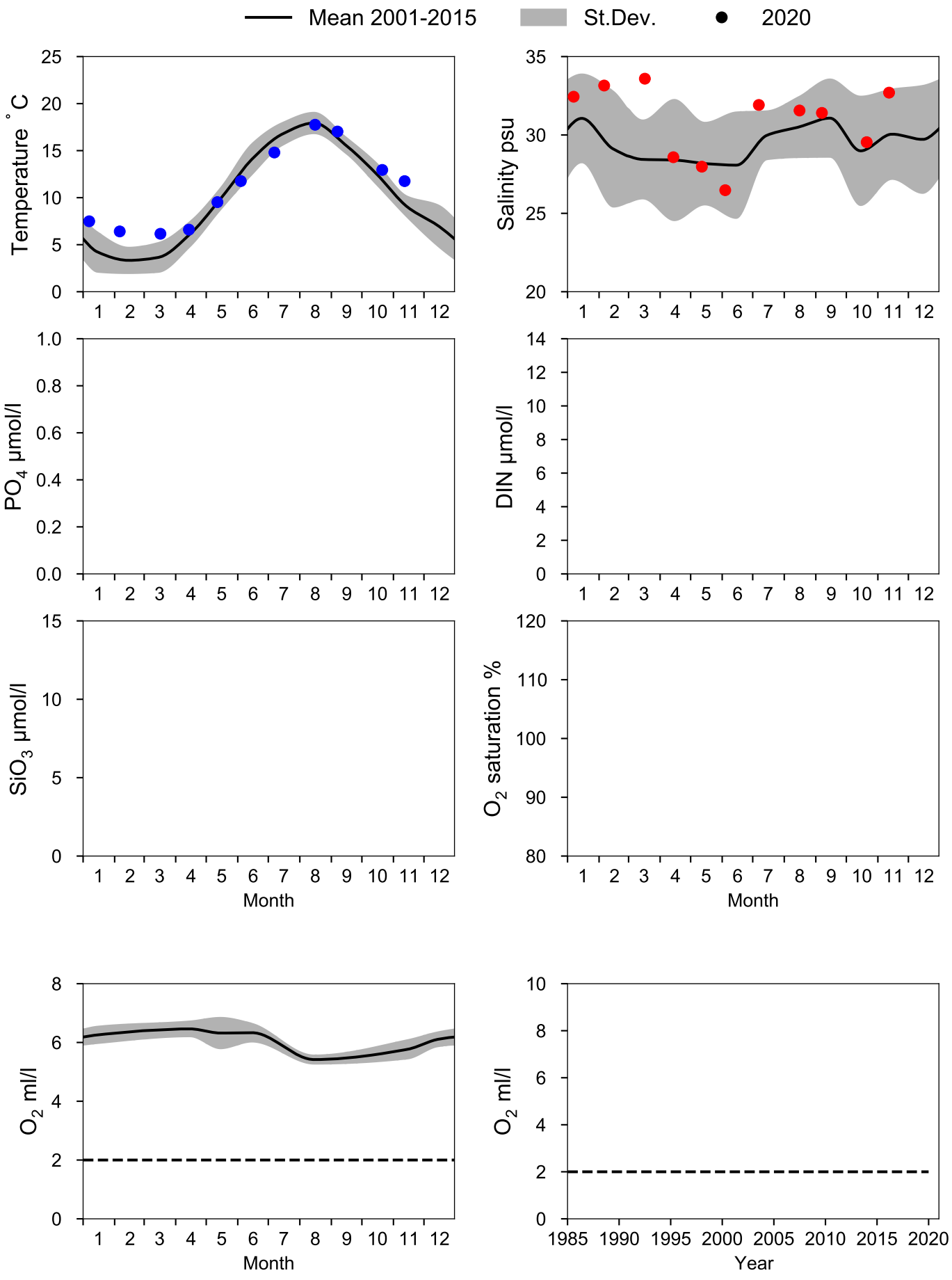


Vertical profiles Å15
November

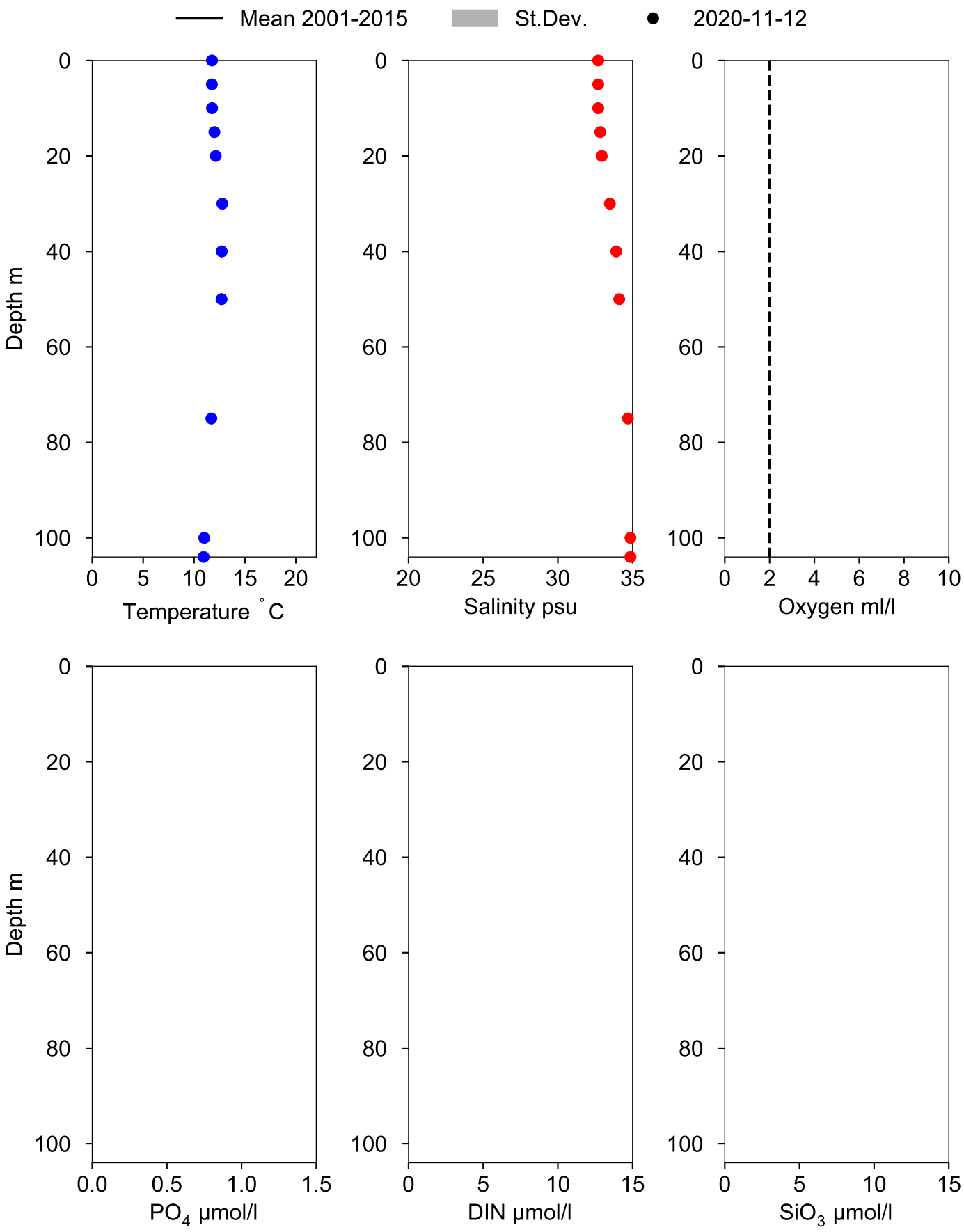


STATION Å14 SURFACE WATER (0-10 m)

Annual Cycles

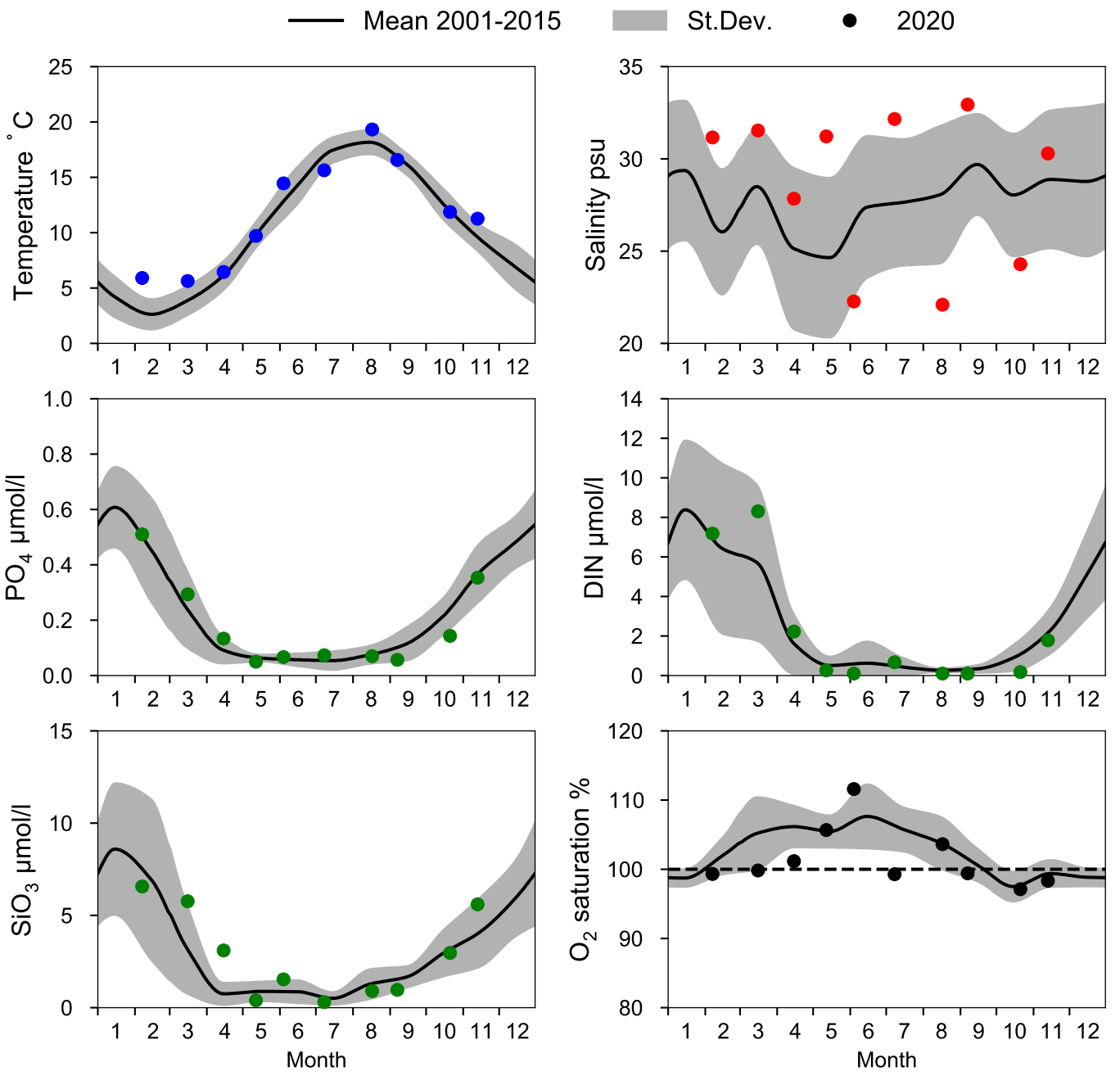


Vertical profiles Å14
November

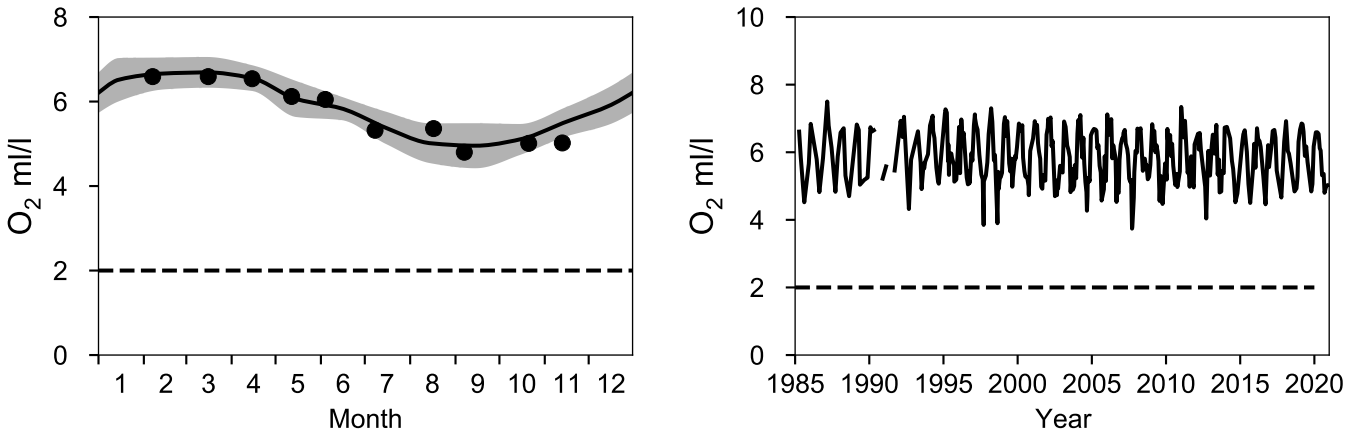


STATION P2 SURFACE WATER (0-10 m)

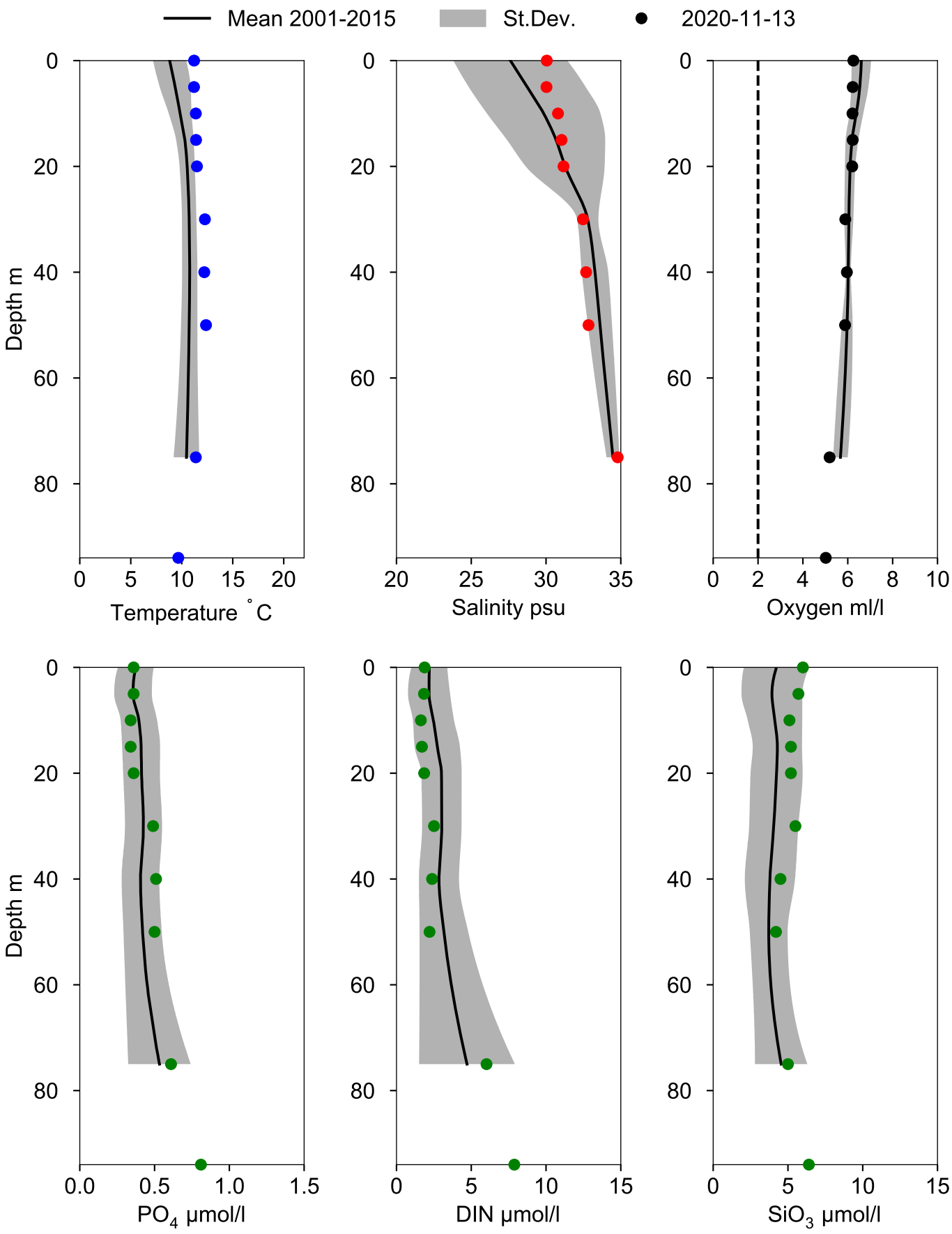
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 75 m)

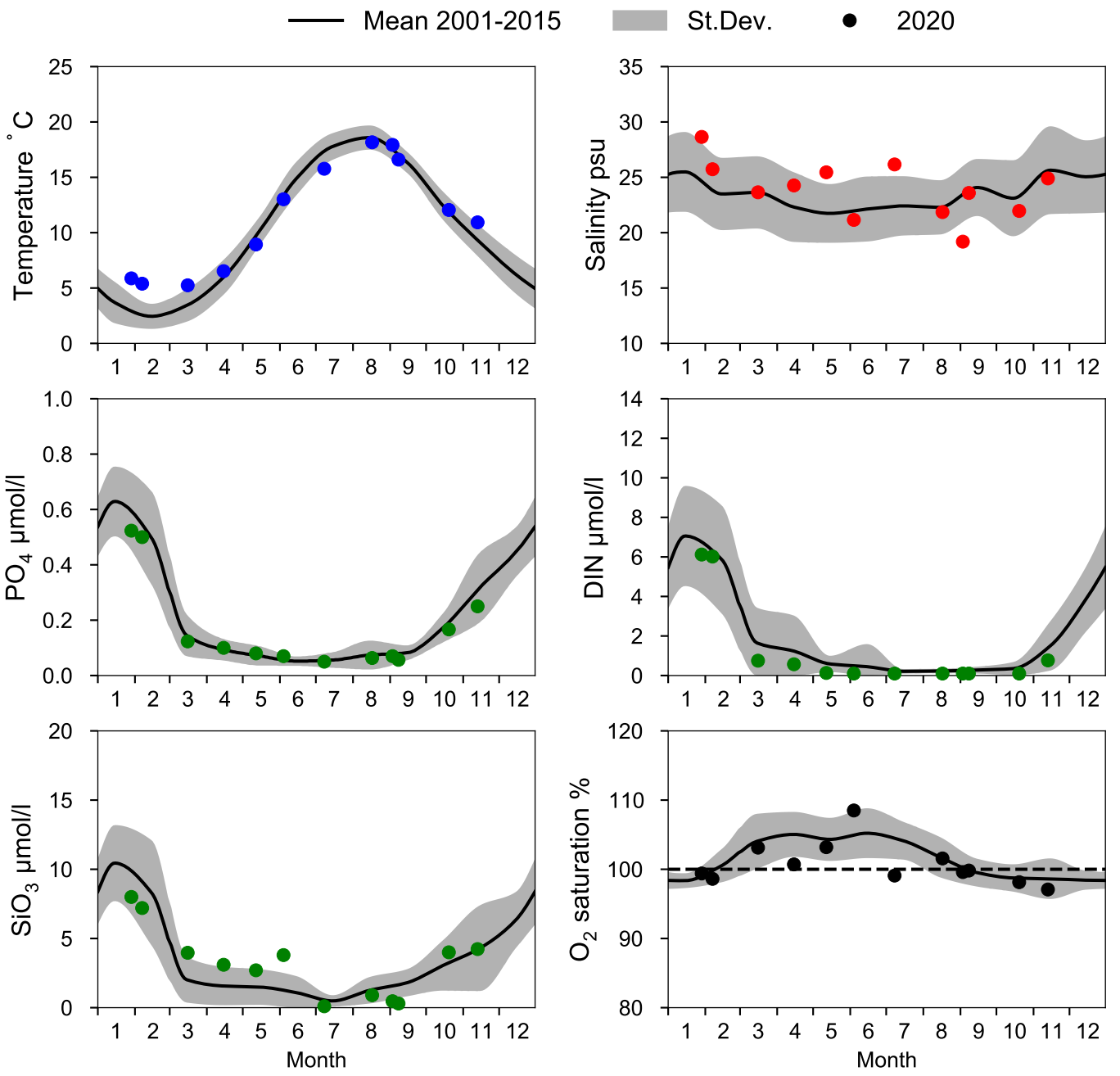


Vertical profiles P2
November

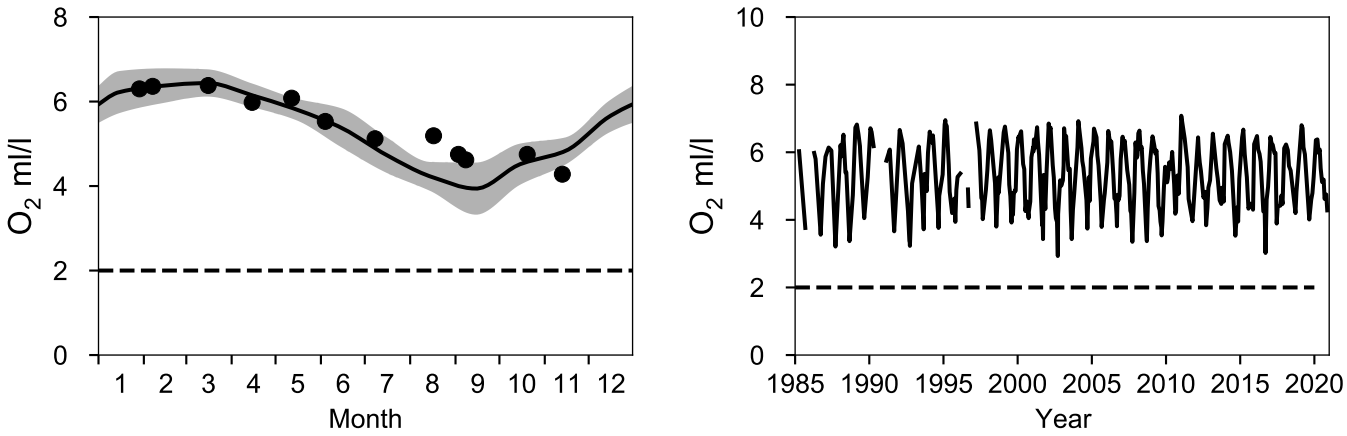


STATION FLADEN SURFACE WATER (0-10 m)

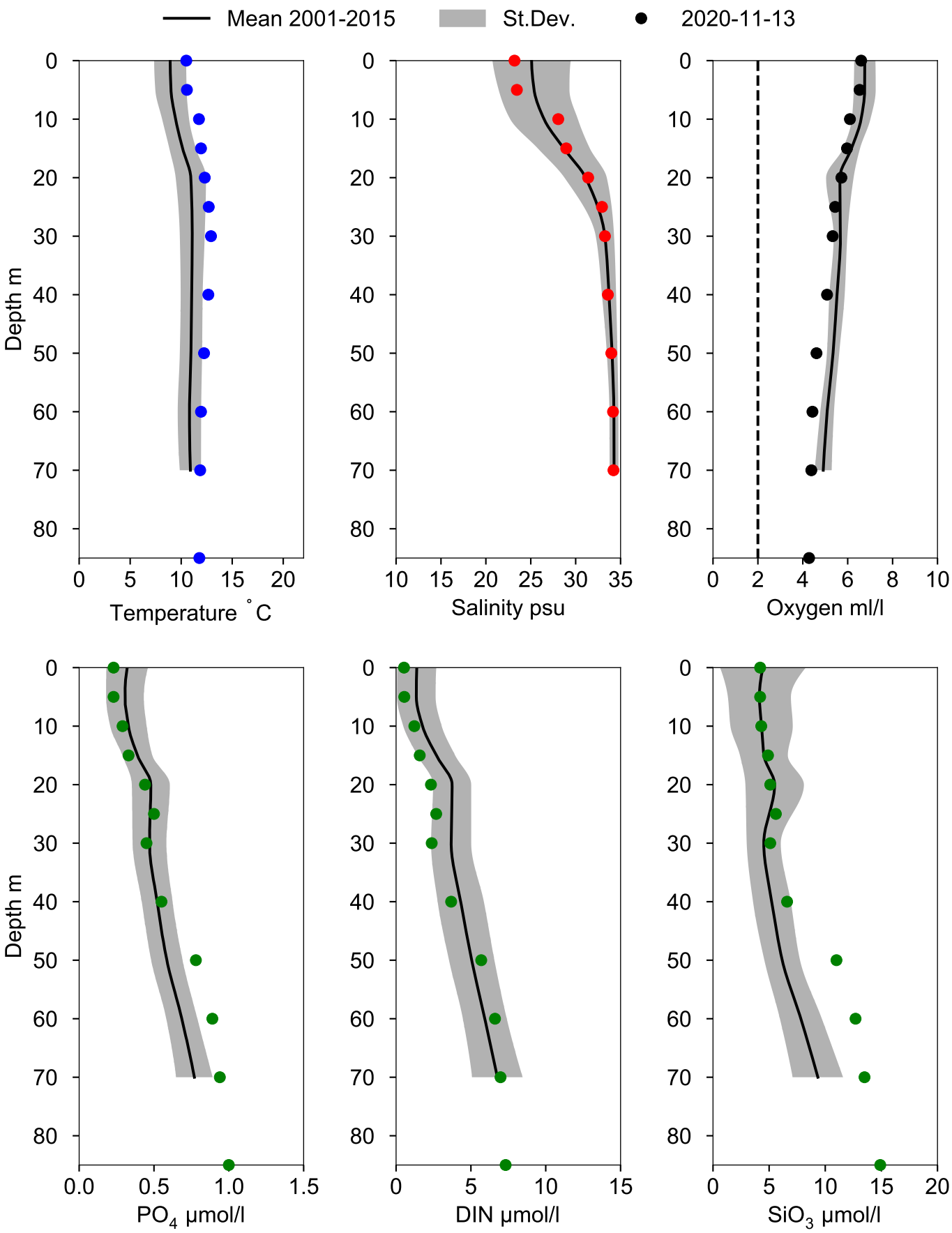
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 74 m)

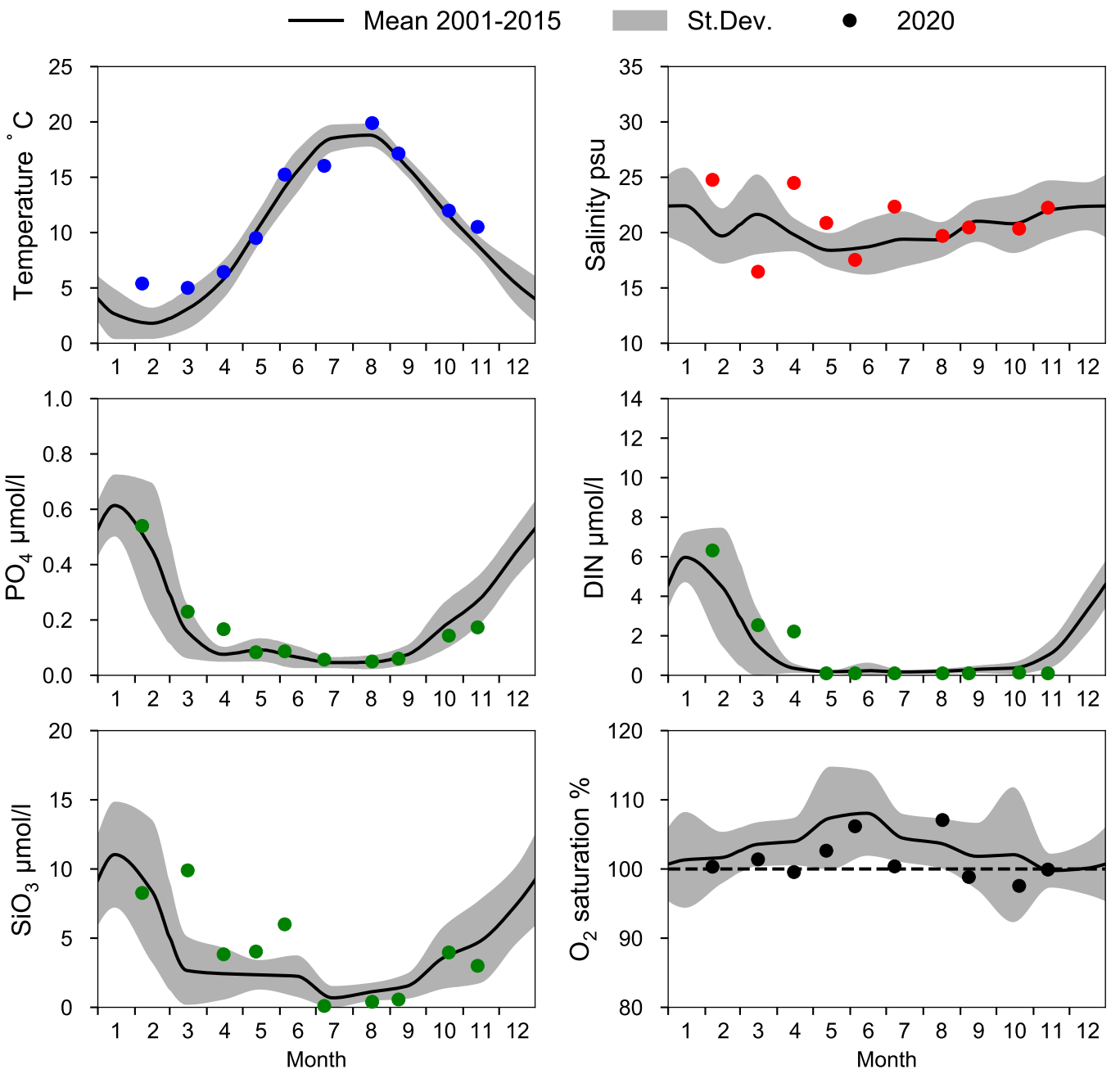


Vertical profiles FLADEN
November

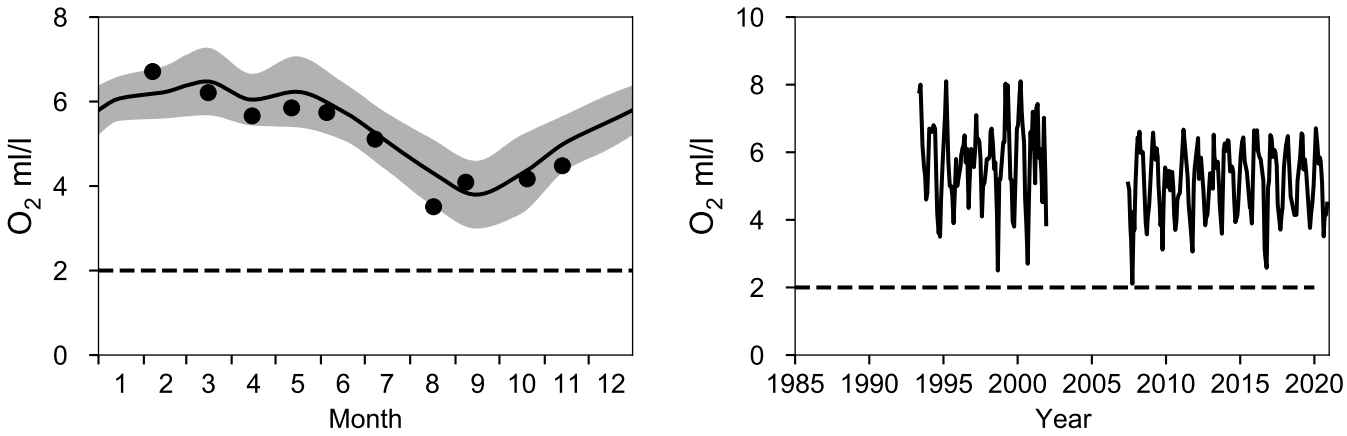


STATION N14 FALKENBERG SURFACE WATER (0-10 m)

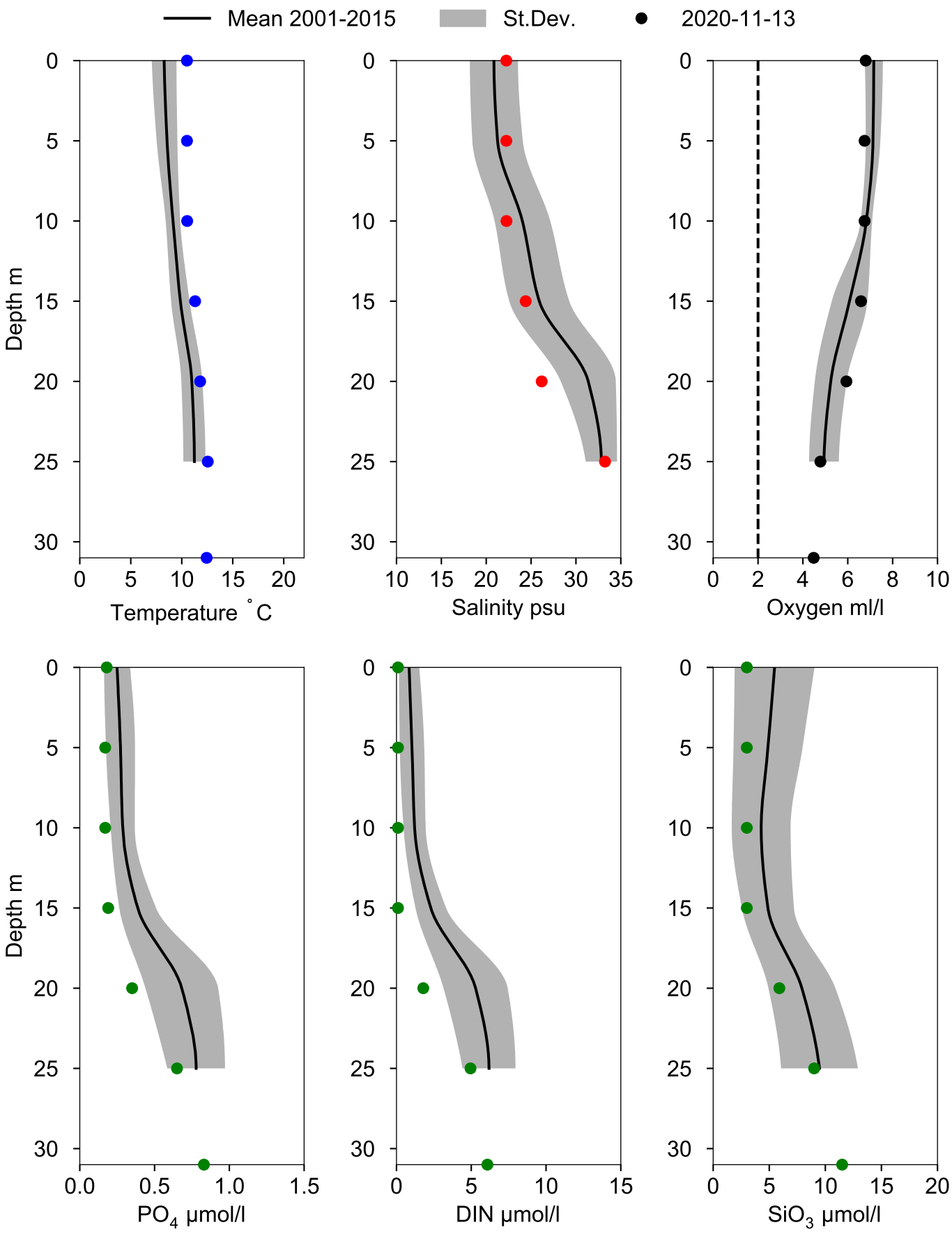
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 20 m)

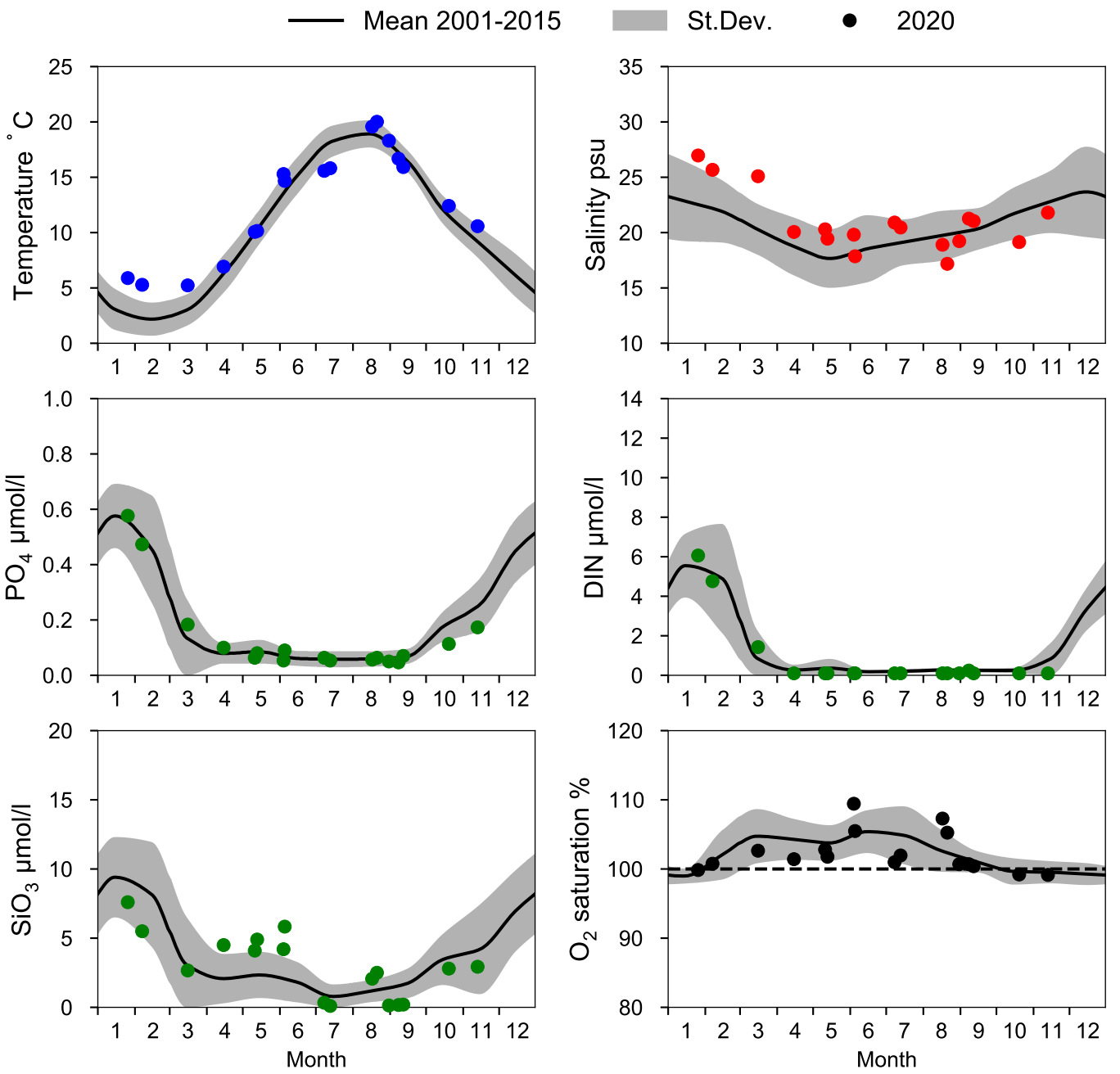


Vertical profiles N14 FALKENBERG
November

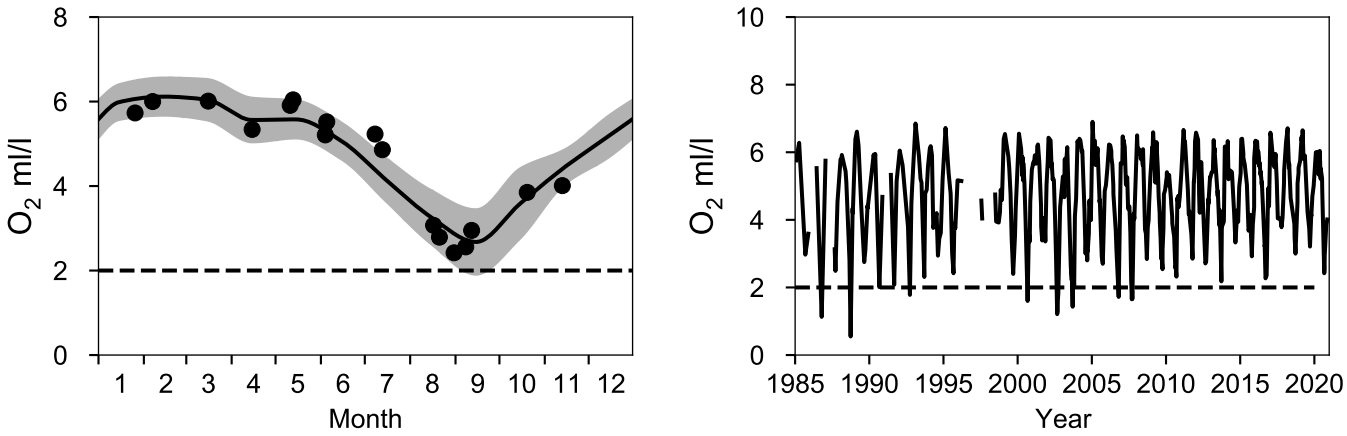


STATION ANHOLT E SURFACE WATER (0-10 m)

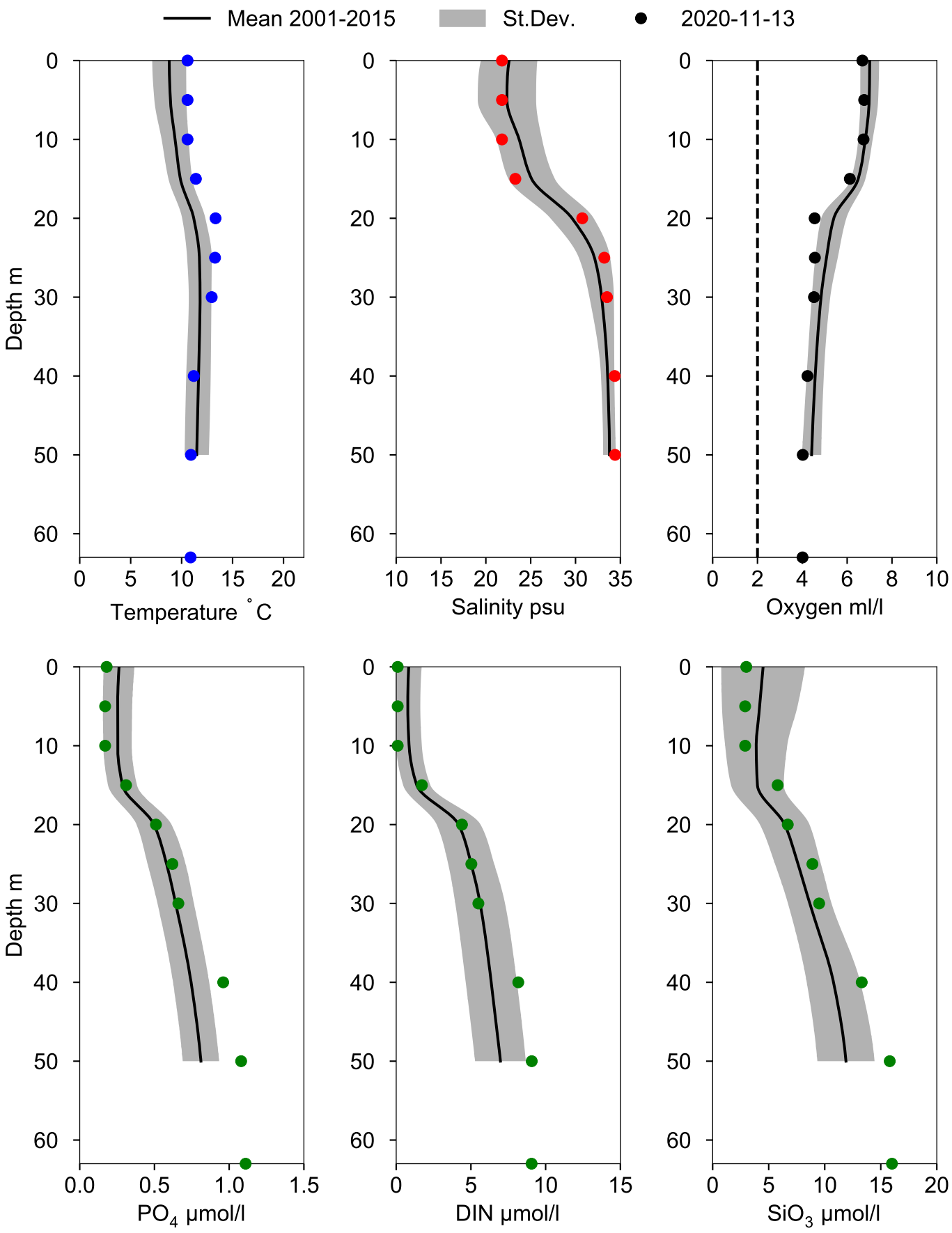
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 52 m)

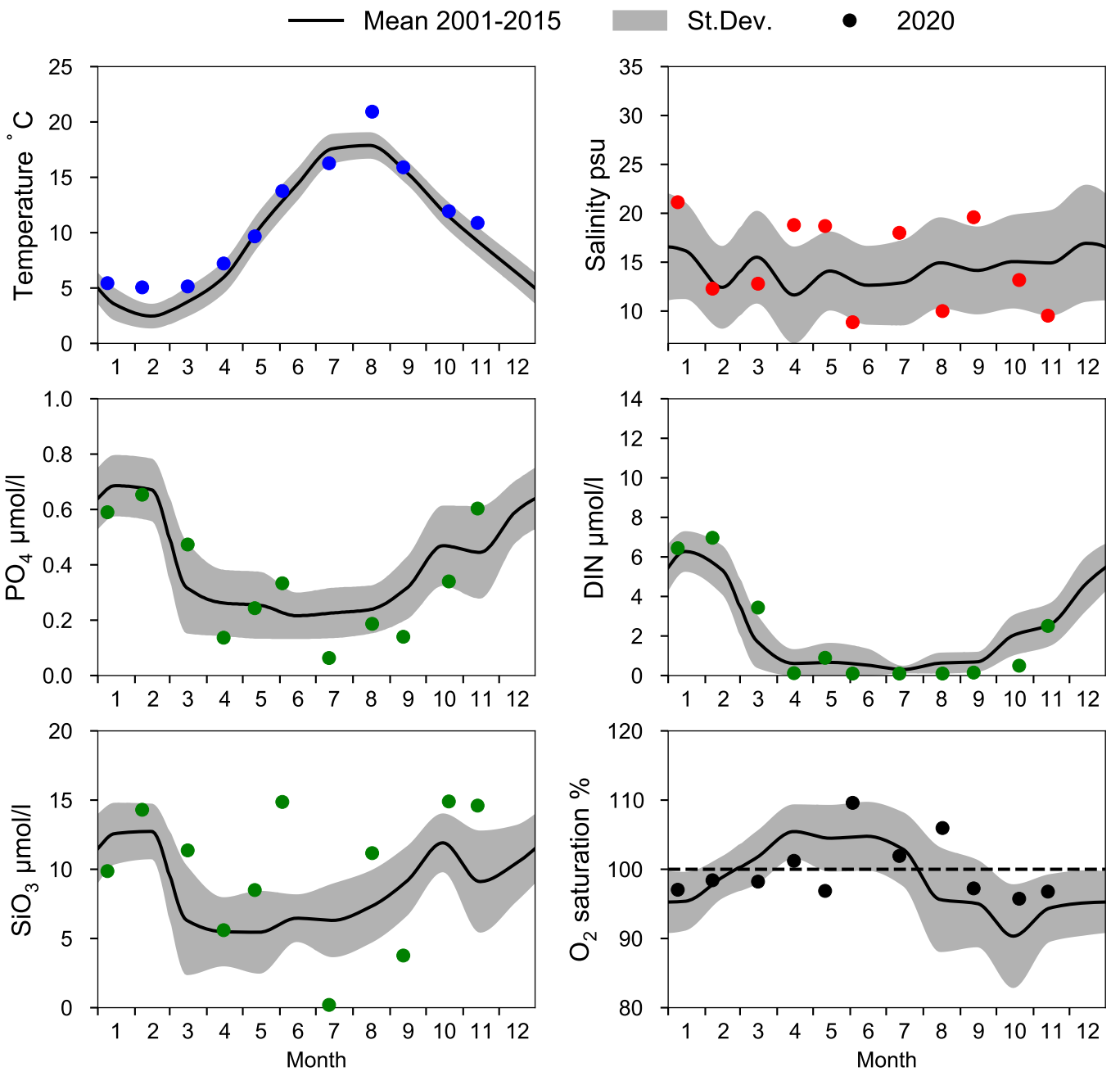


Vertical profiles ANHOLT E
November

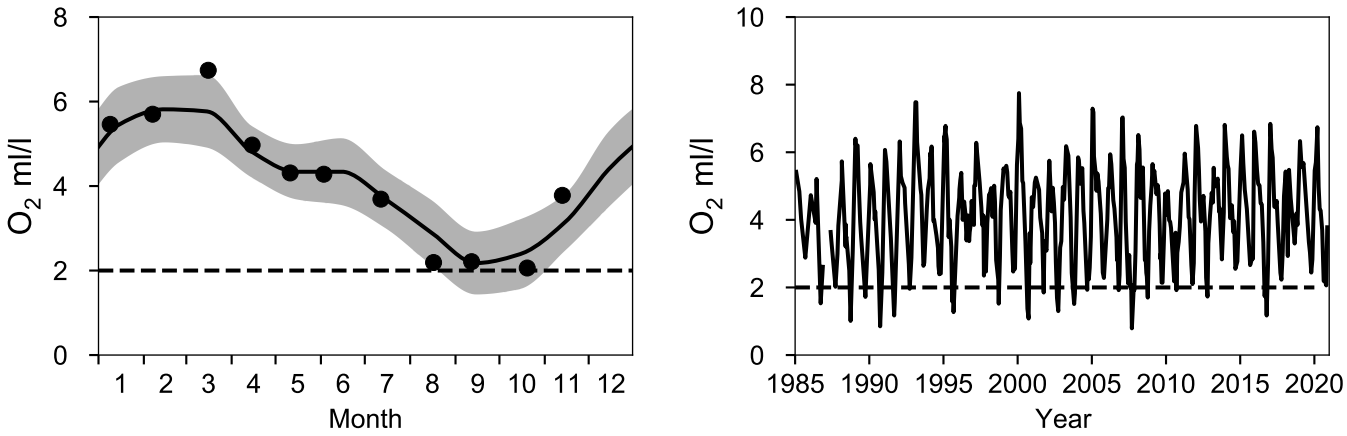


STATION W LANDSKRONA SURFACE WATER (0-10 m)

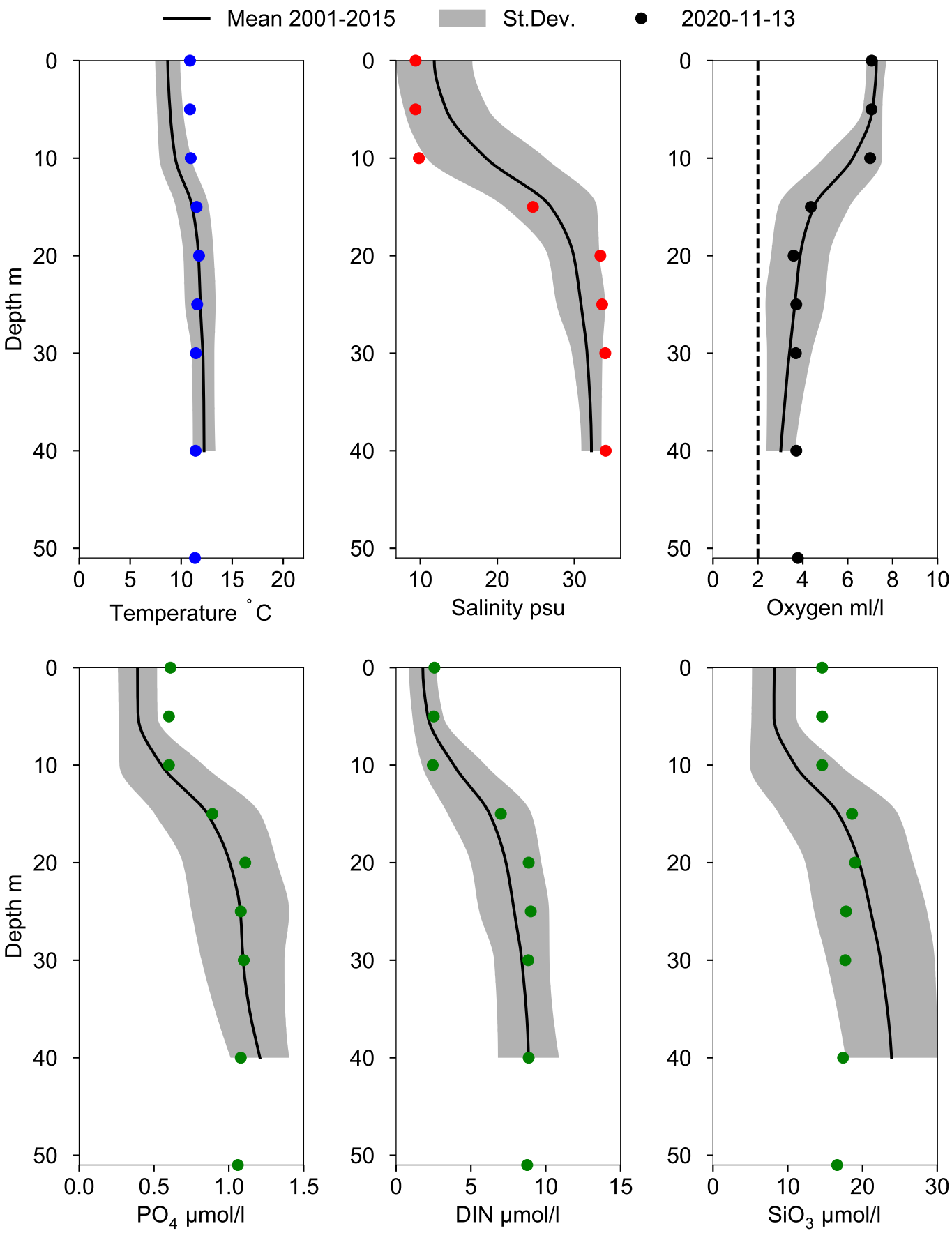
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

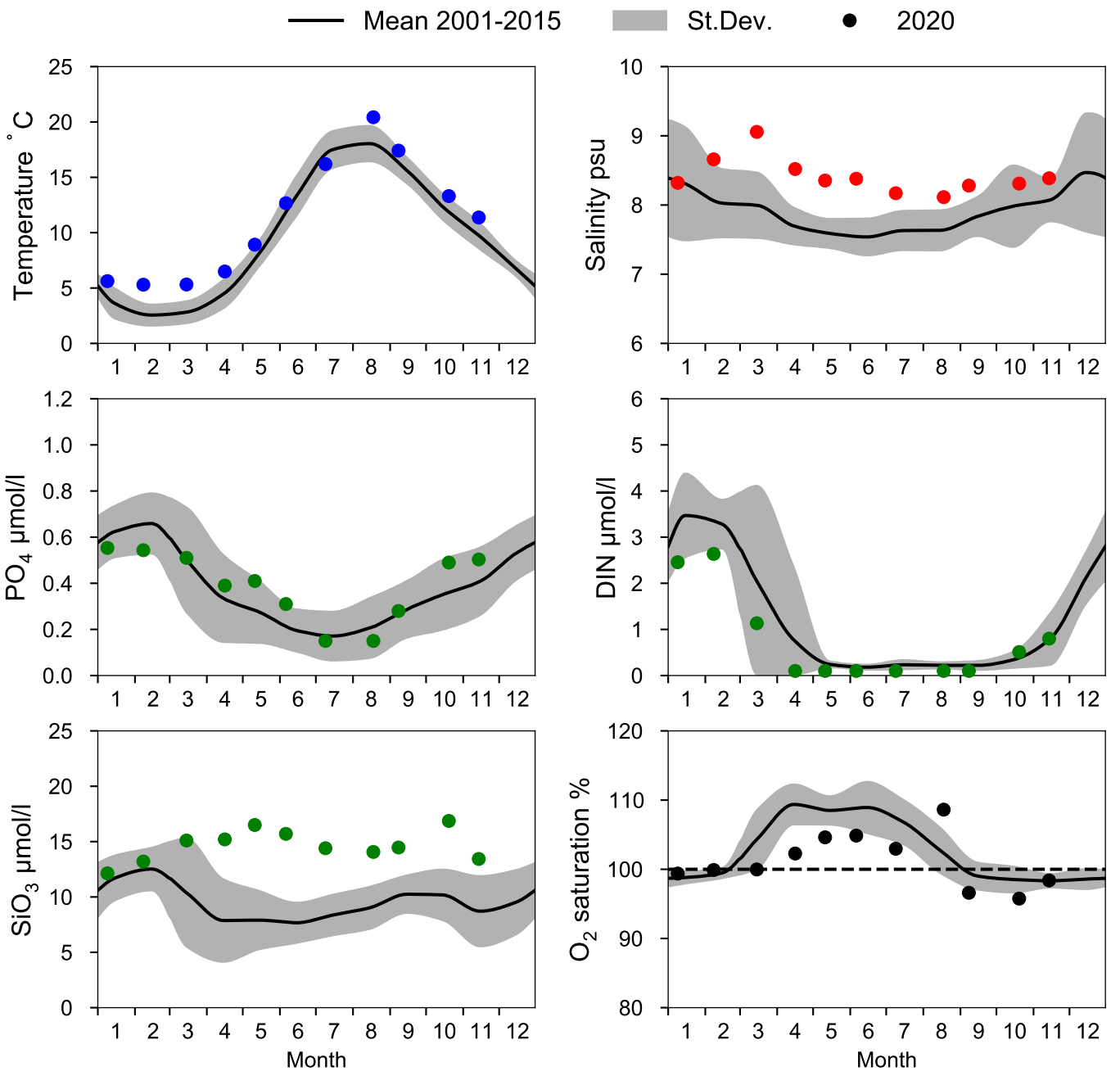


Vertical profiles W LANDSKRONA
November

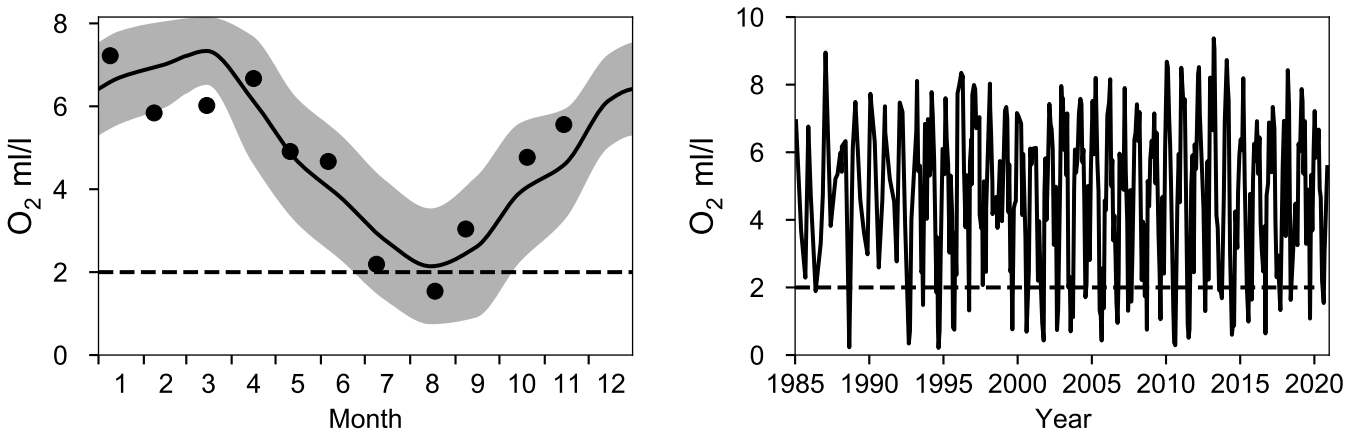


STATION BY1 SURFACE WATER (0-10 m)

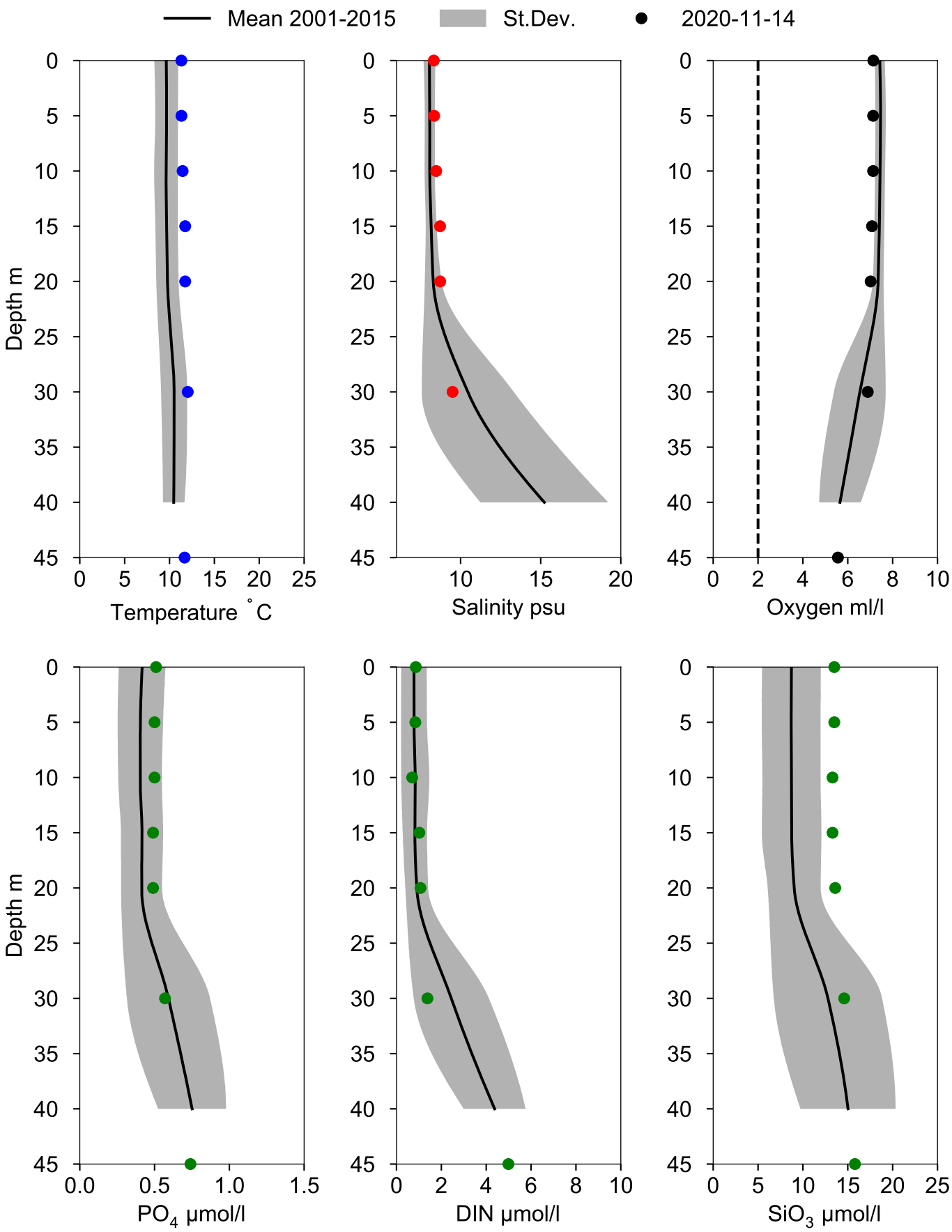
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

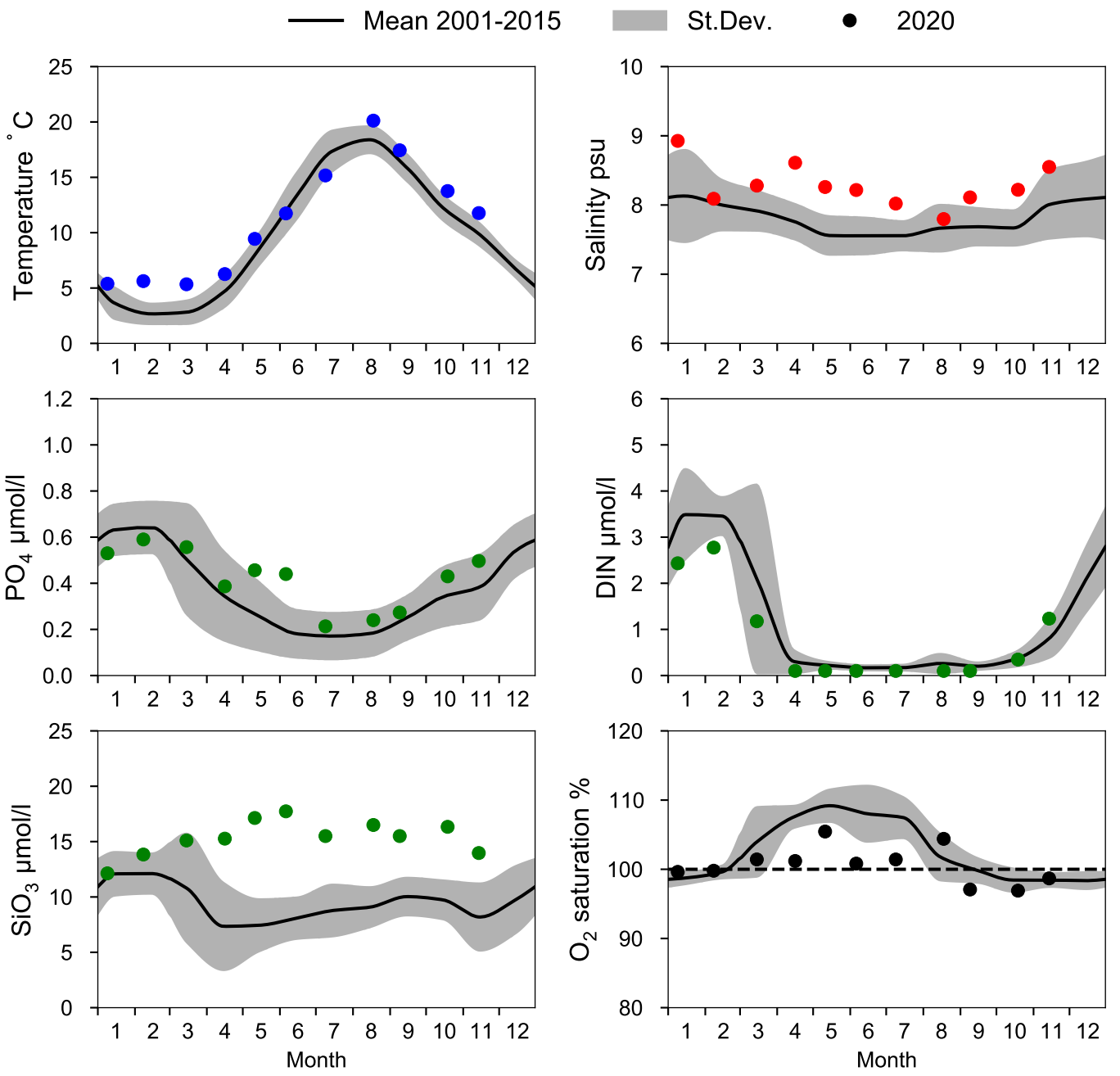


Vertical profiles BY1
November

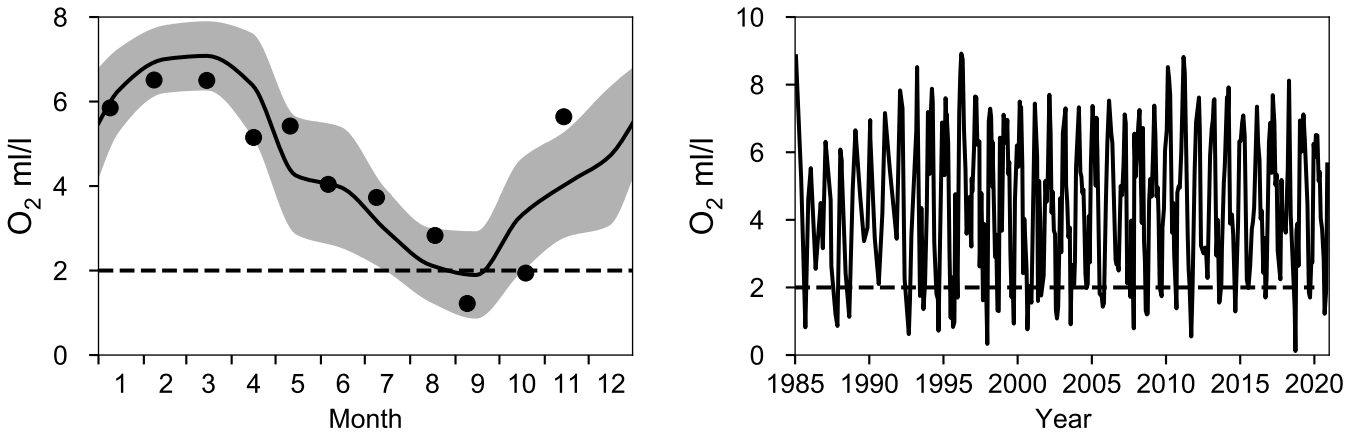


STATION BY2 ARKONA SURFACE WATER (0-10 m)

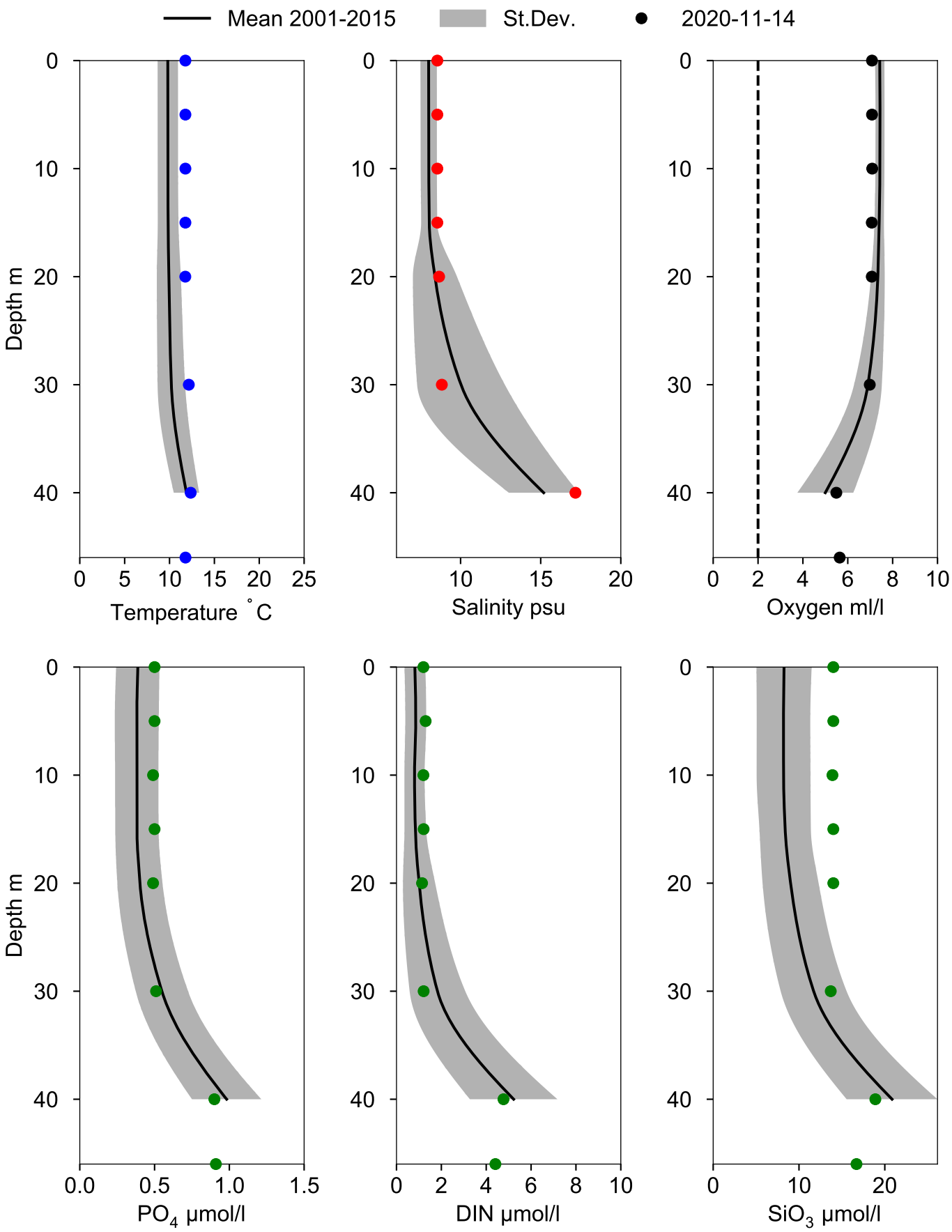
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 40 m)

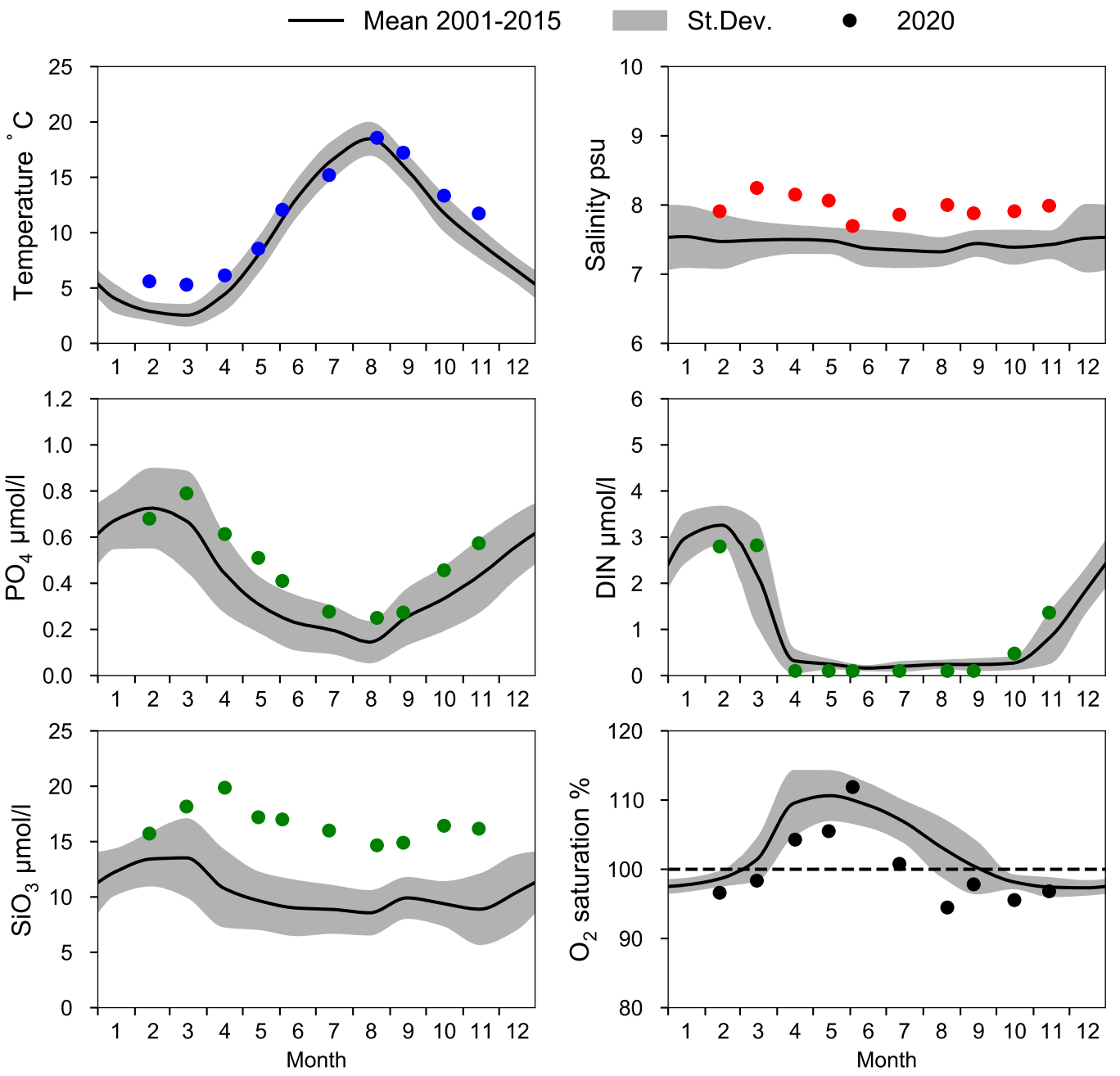


Vertical profiles BY2 ARKONA
November

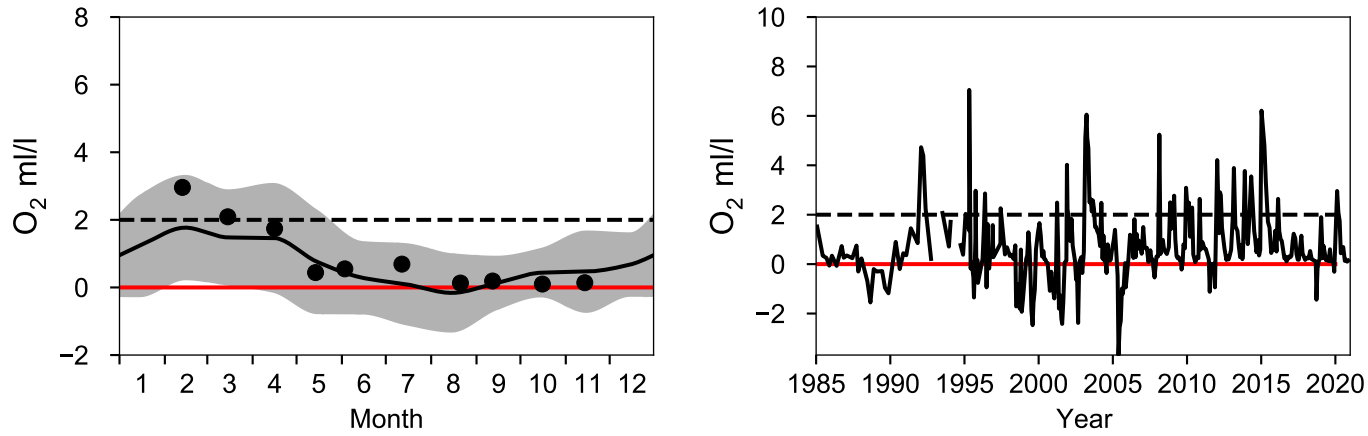


STATION HANÖBUKTEN SURFACE WATER (0-10 m)

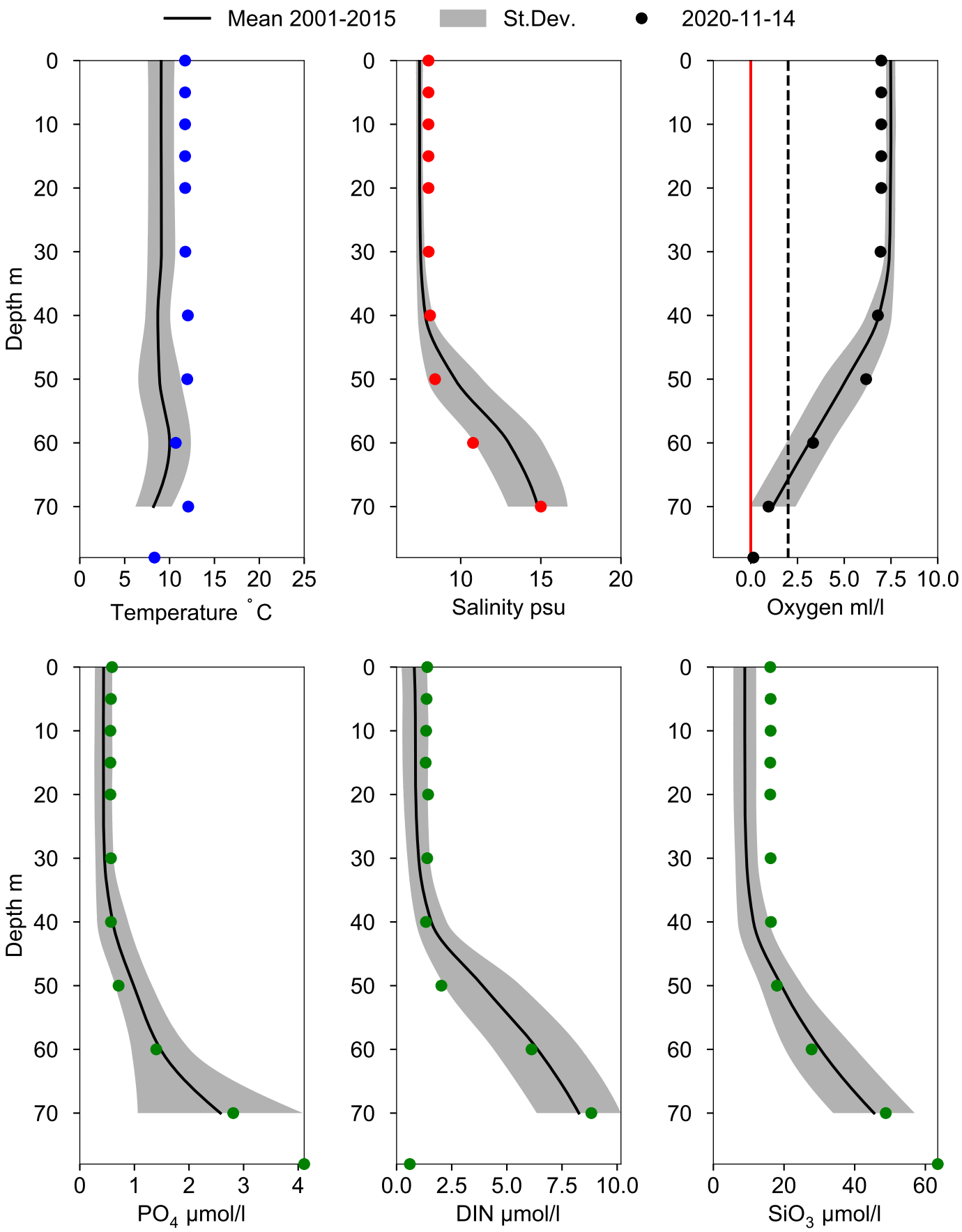
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 70 m)

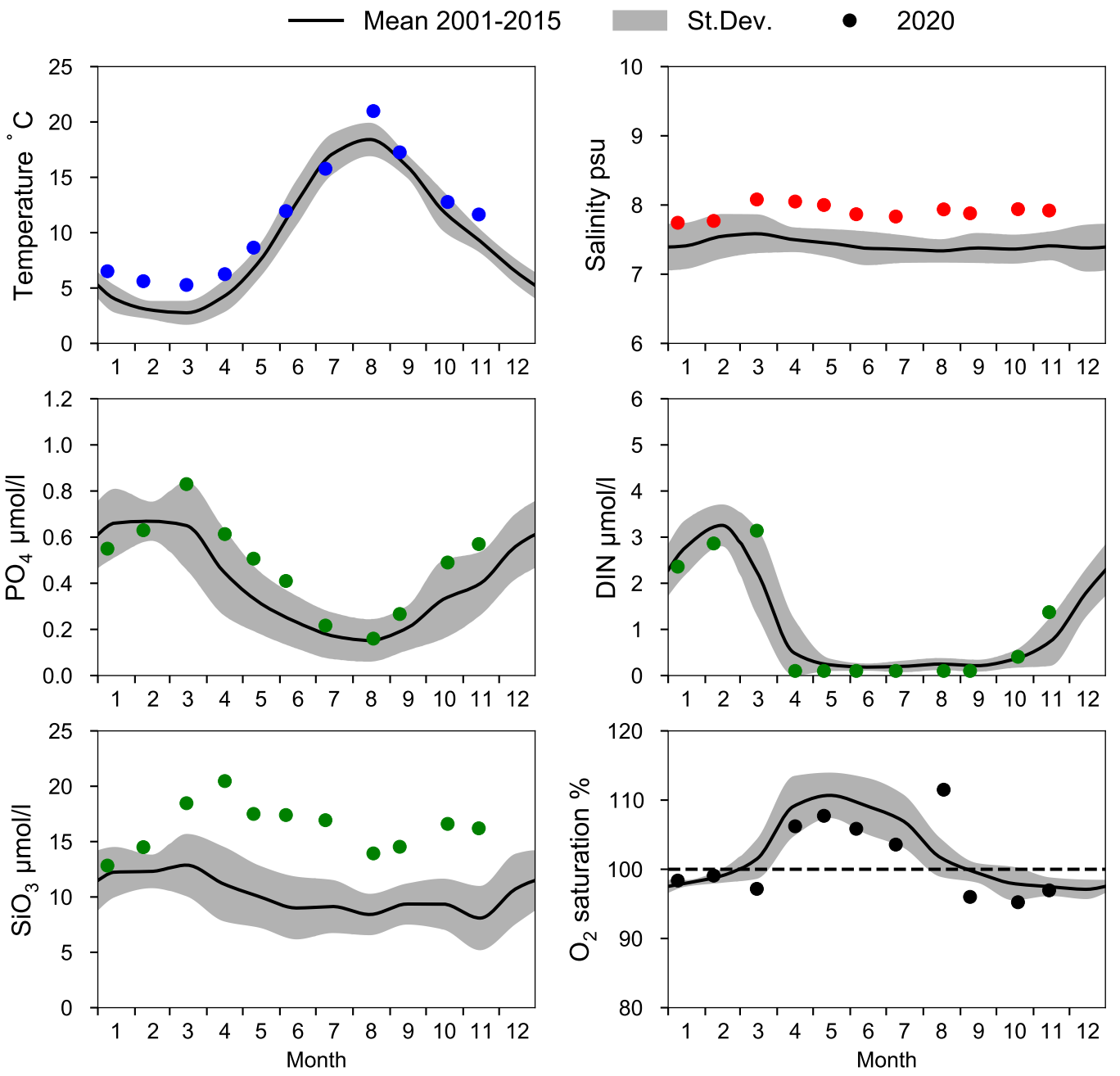


Vertical profiles HANÖBUKTEN
November

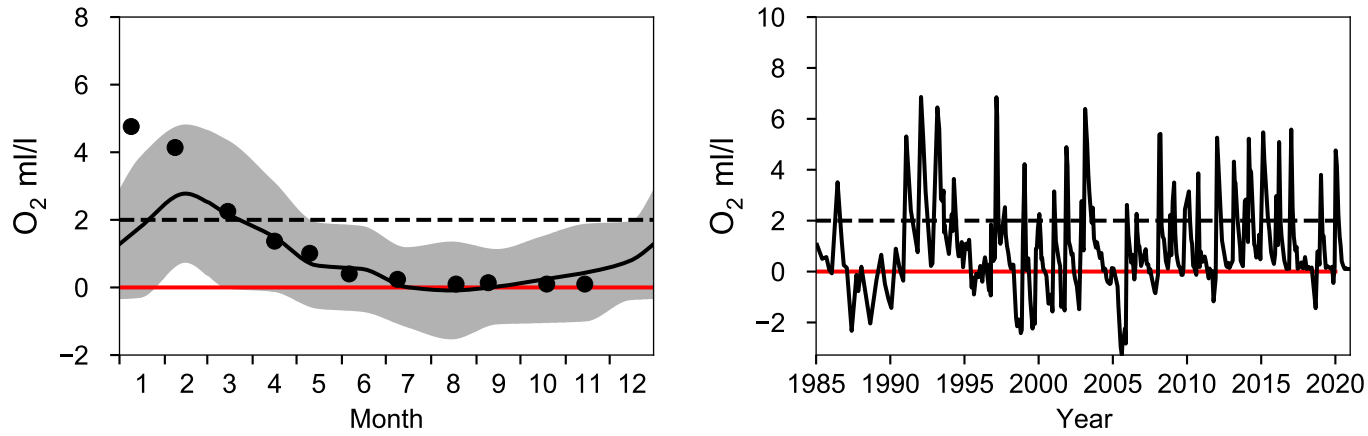


STATION BY4 CHRISTIANSÖ SURFACE WATER (0-10 m)

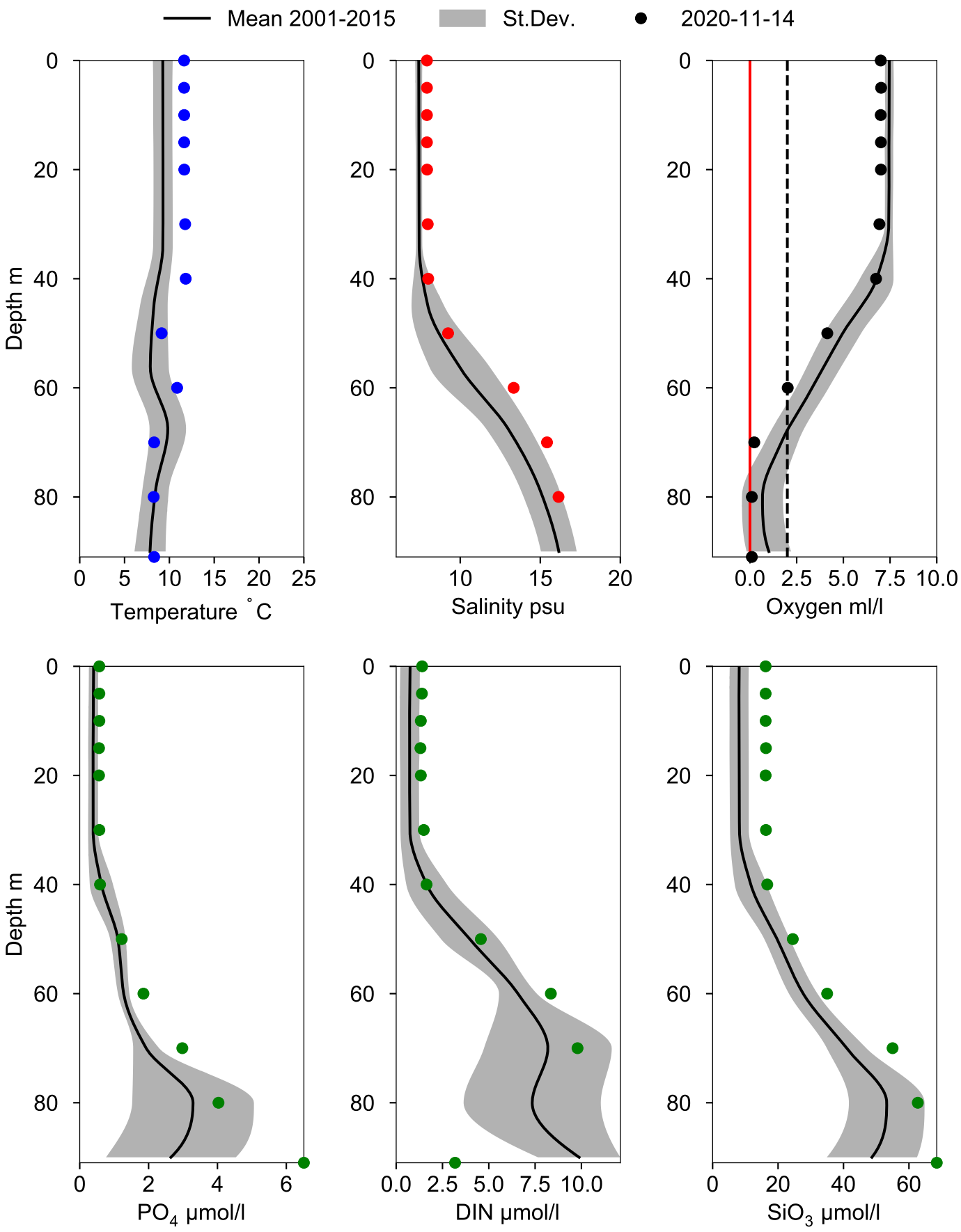
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

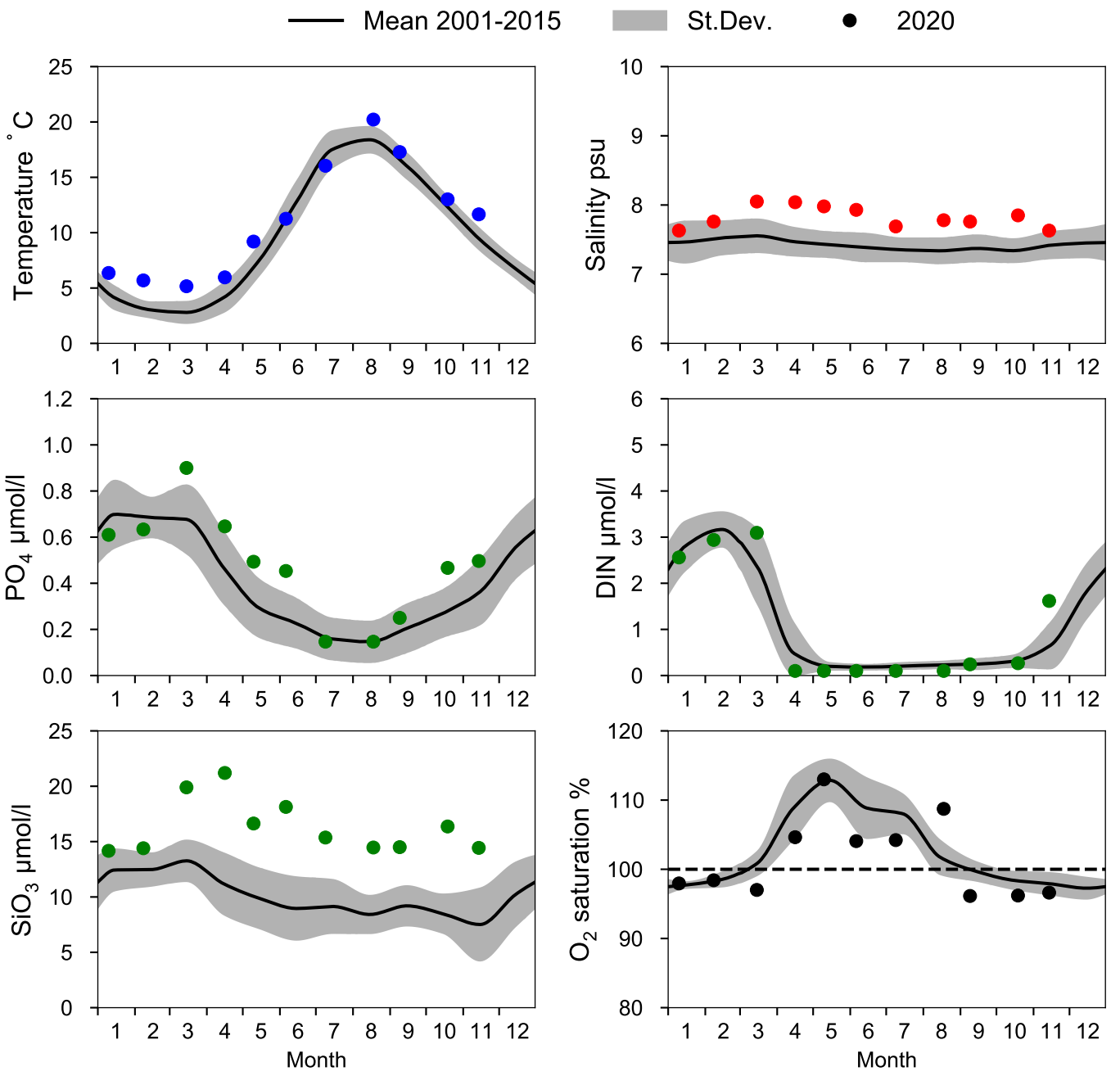


Vertical profiles BY4 CHRISTIANSÖ
November

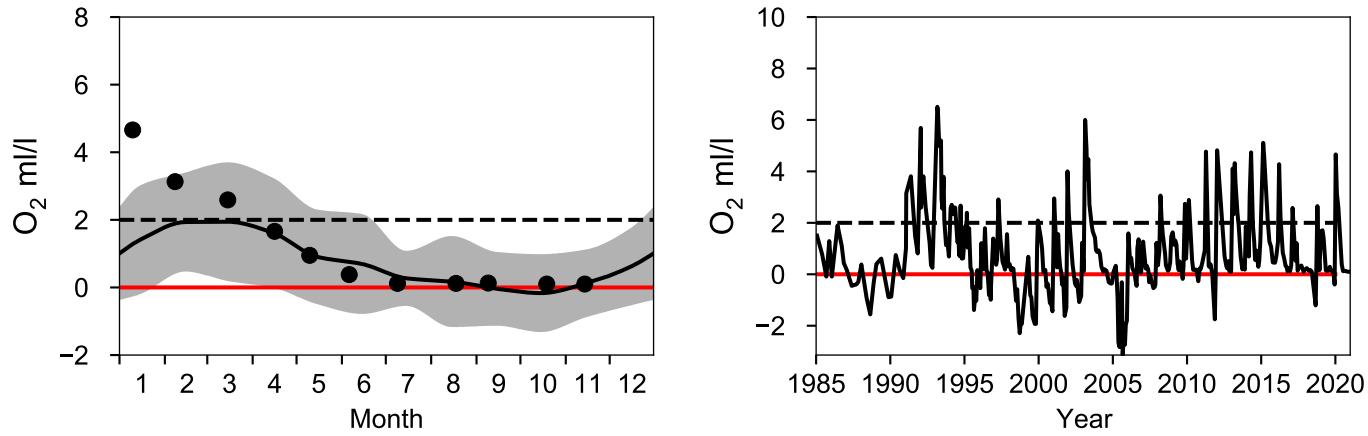


STATION BY5 BORNHOLMSDJ SURFACE WATER (0-10 m)

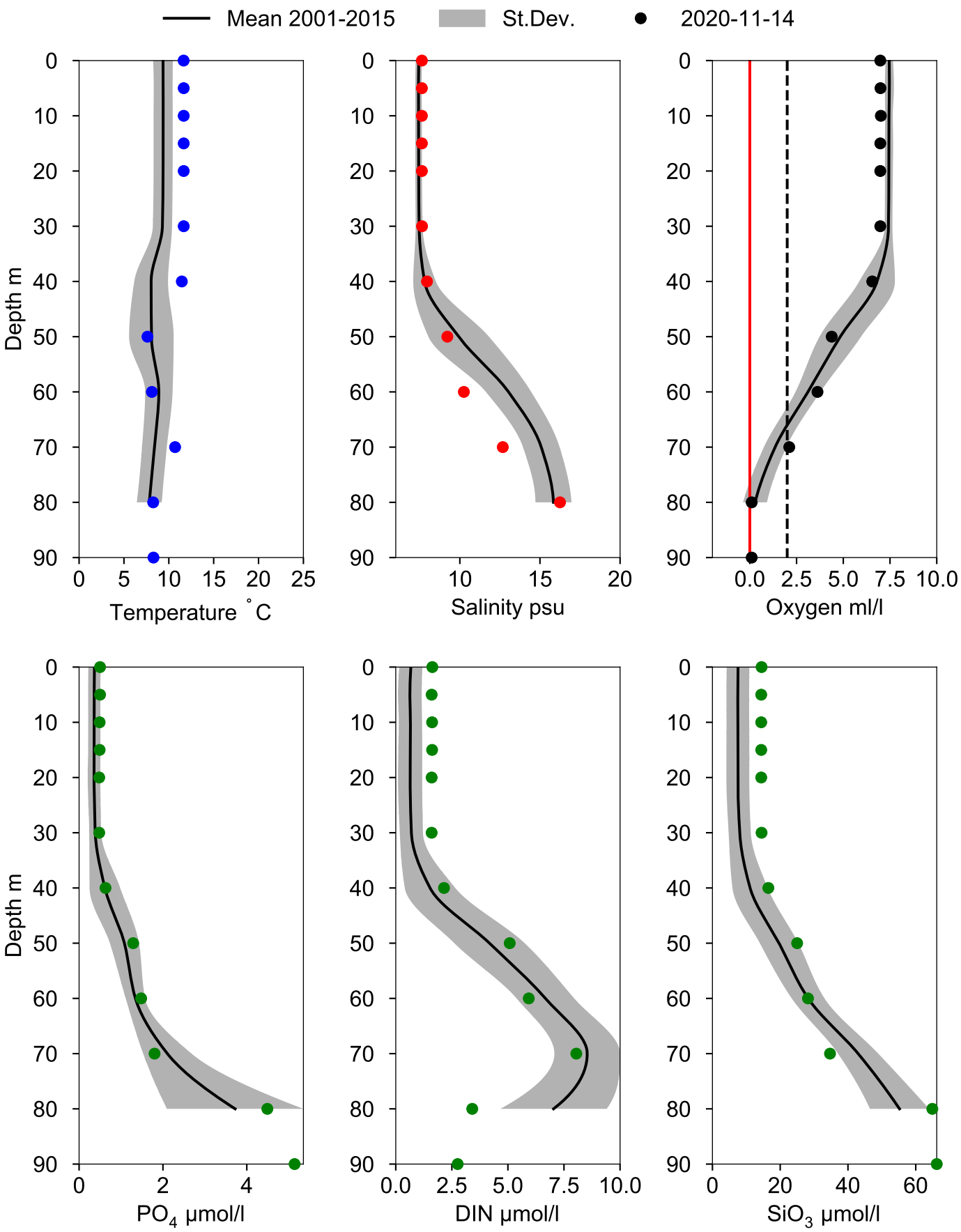
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

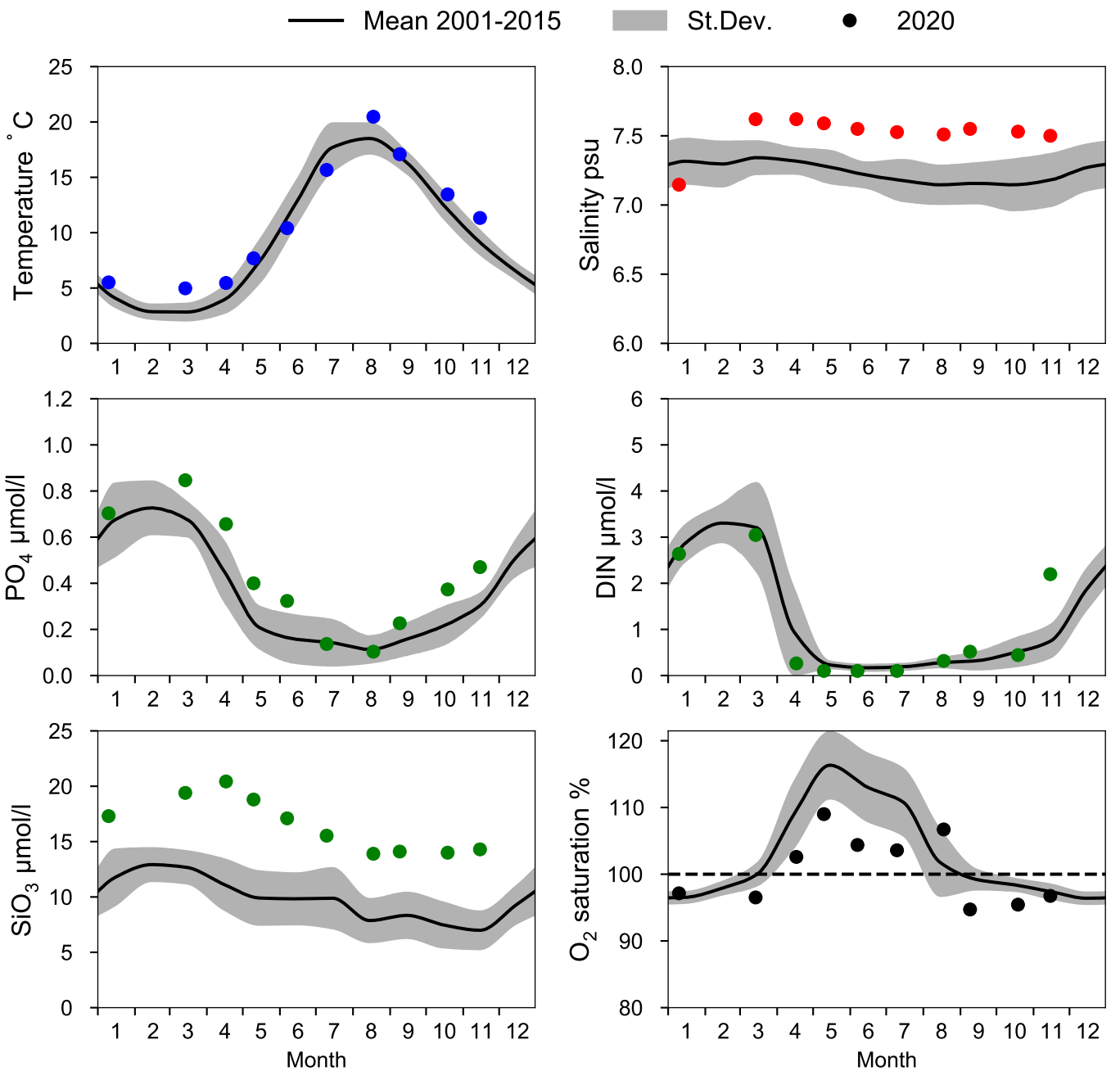


Vertical profiles BY5 BORNHOLMSDJ
November

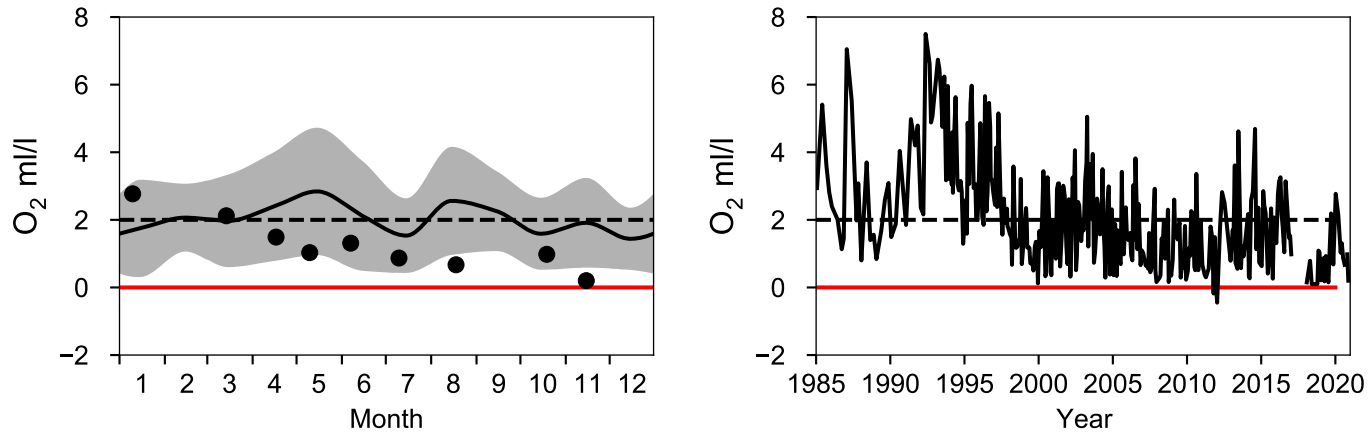


STATION BCS III-10 SURFACE WATER (0-10 m)

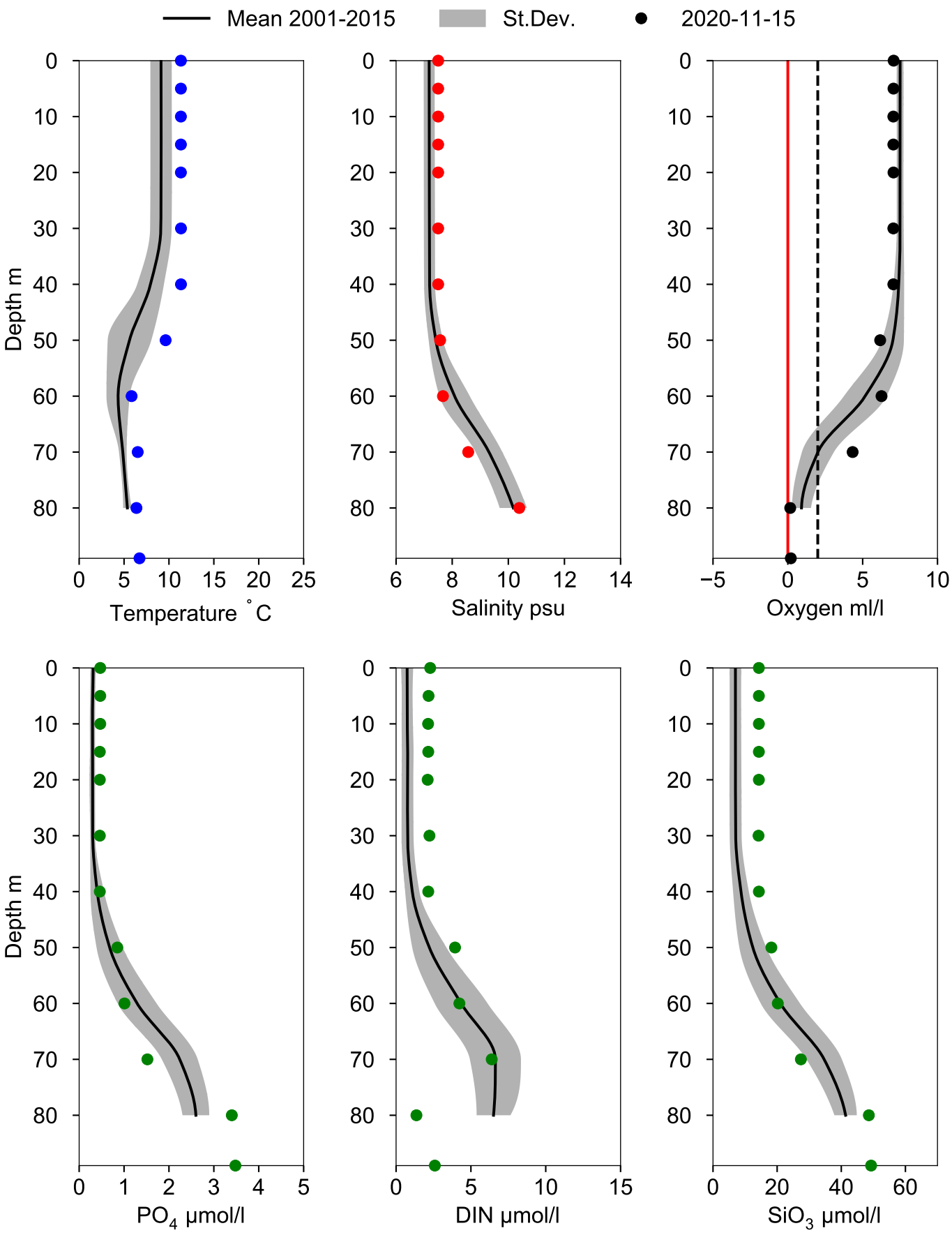
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 80 m)

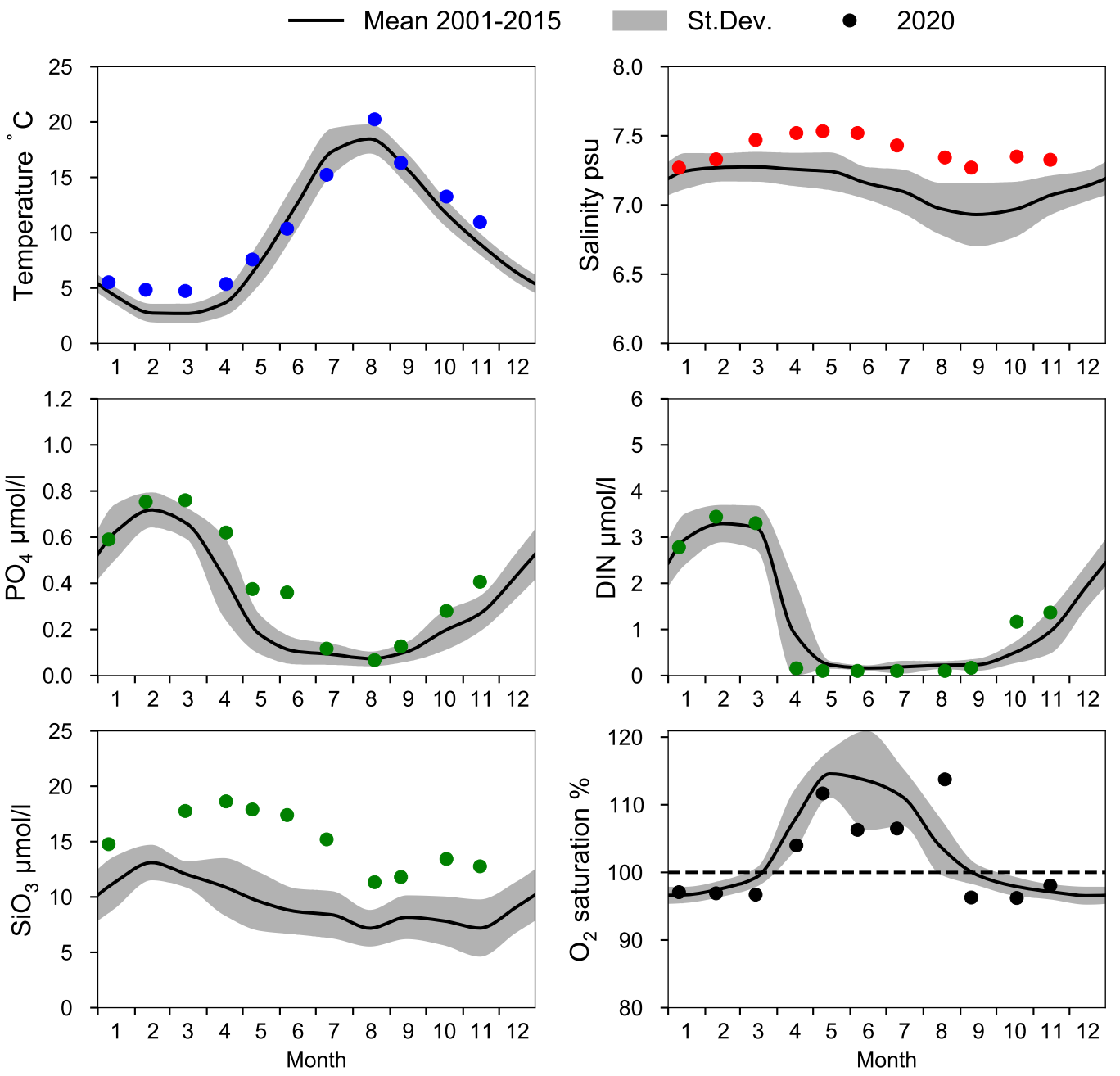


Vertical profiles BCS III-10
November

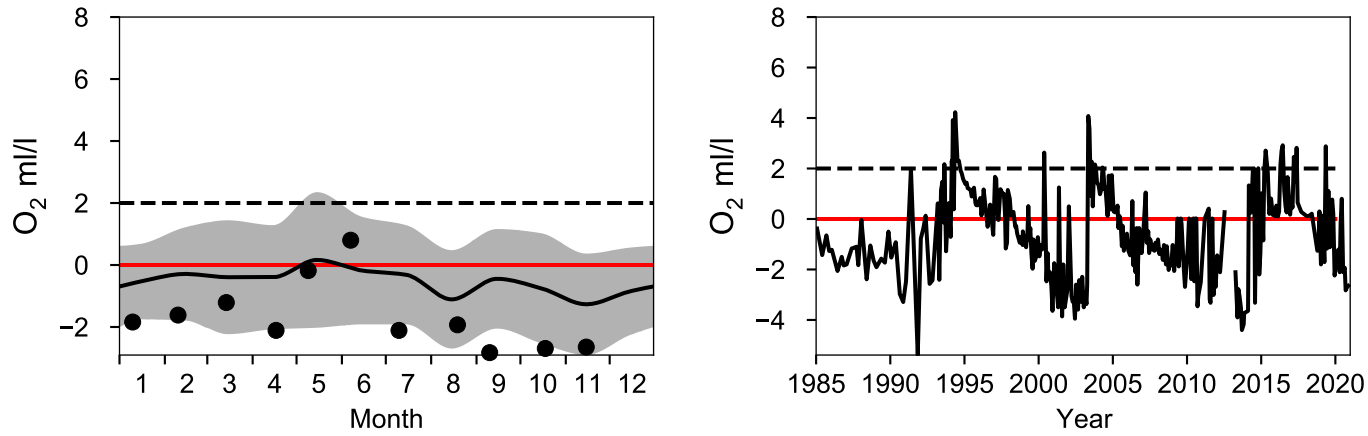


STATION BY10 SURFACE WATER (0-10 m)

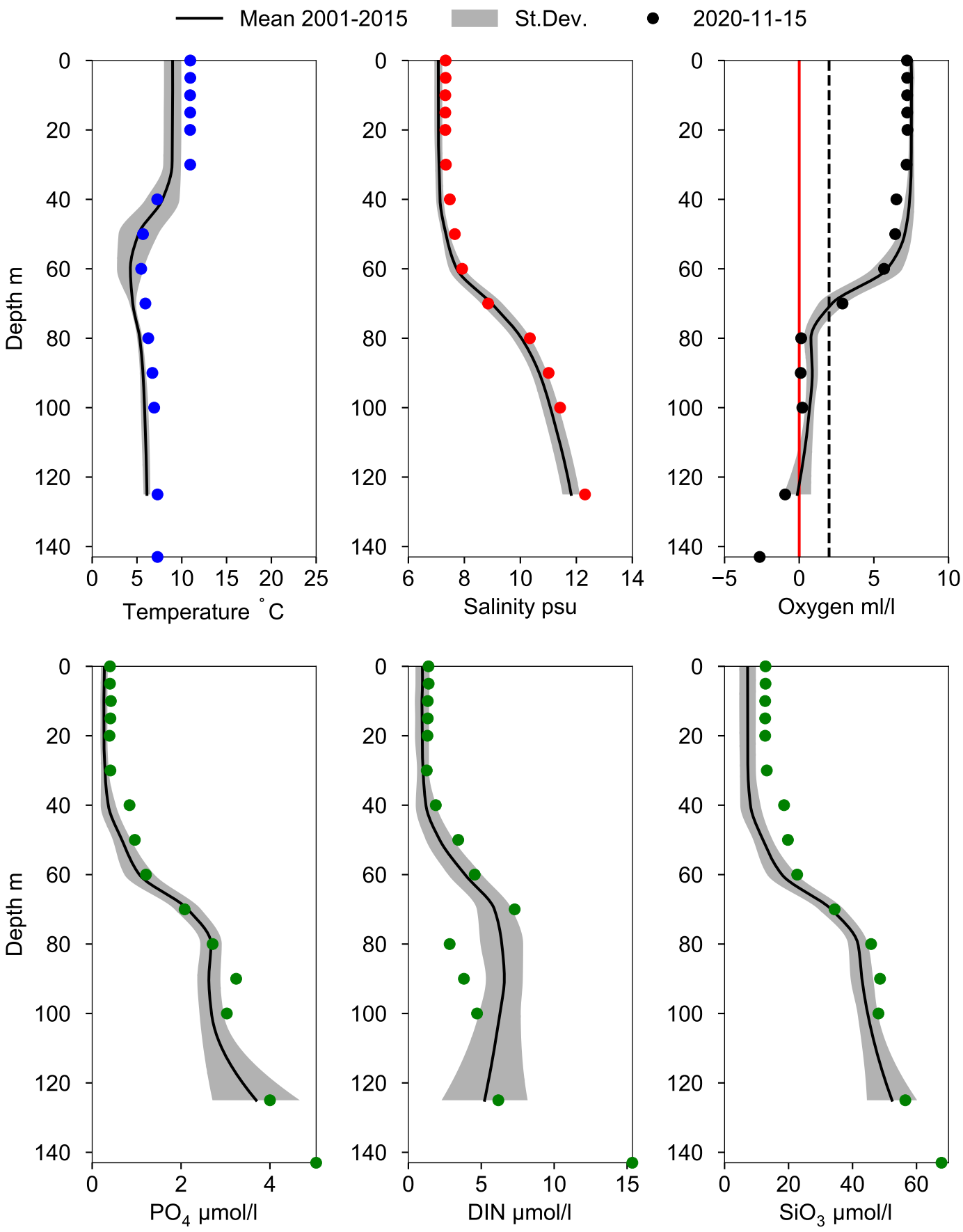
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 125 m)

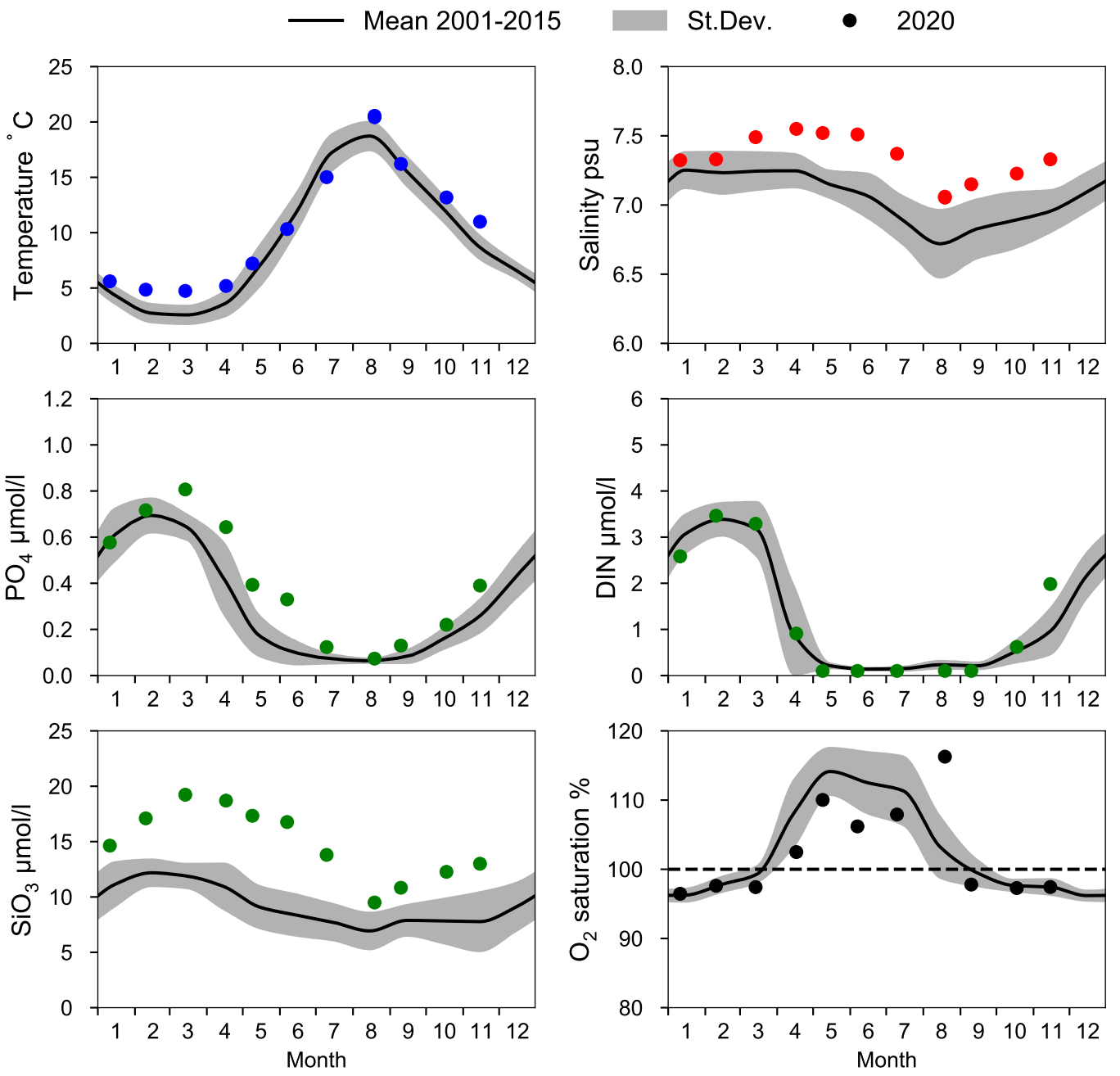


Vertical profiles BY10
November

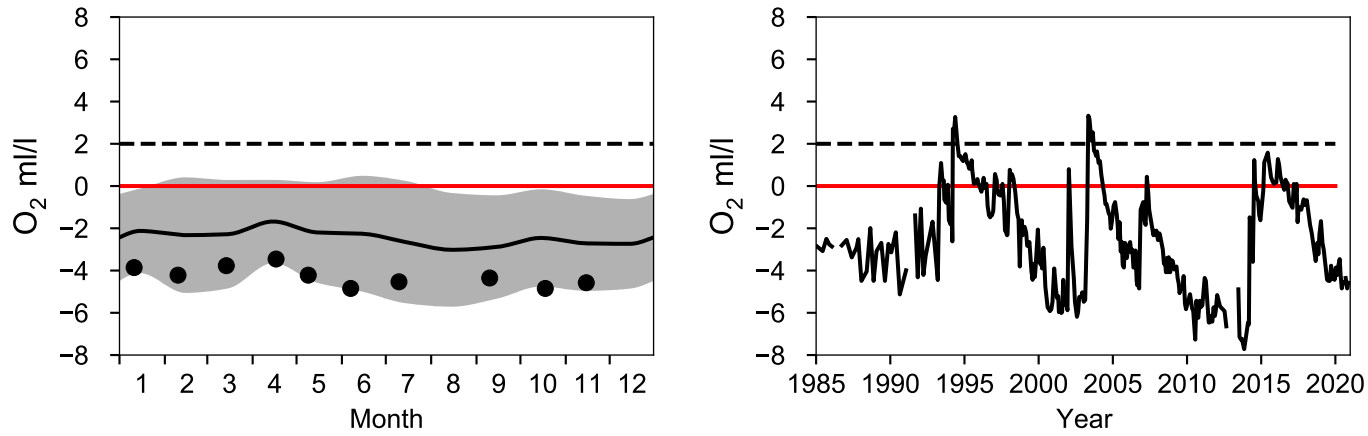


STATION BY15 GOTLANDSDJ SURFACE WATER (0-10 m)

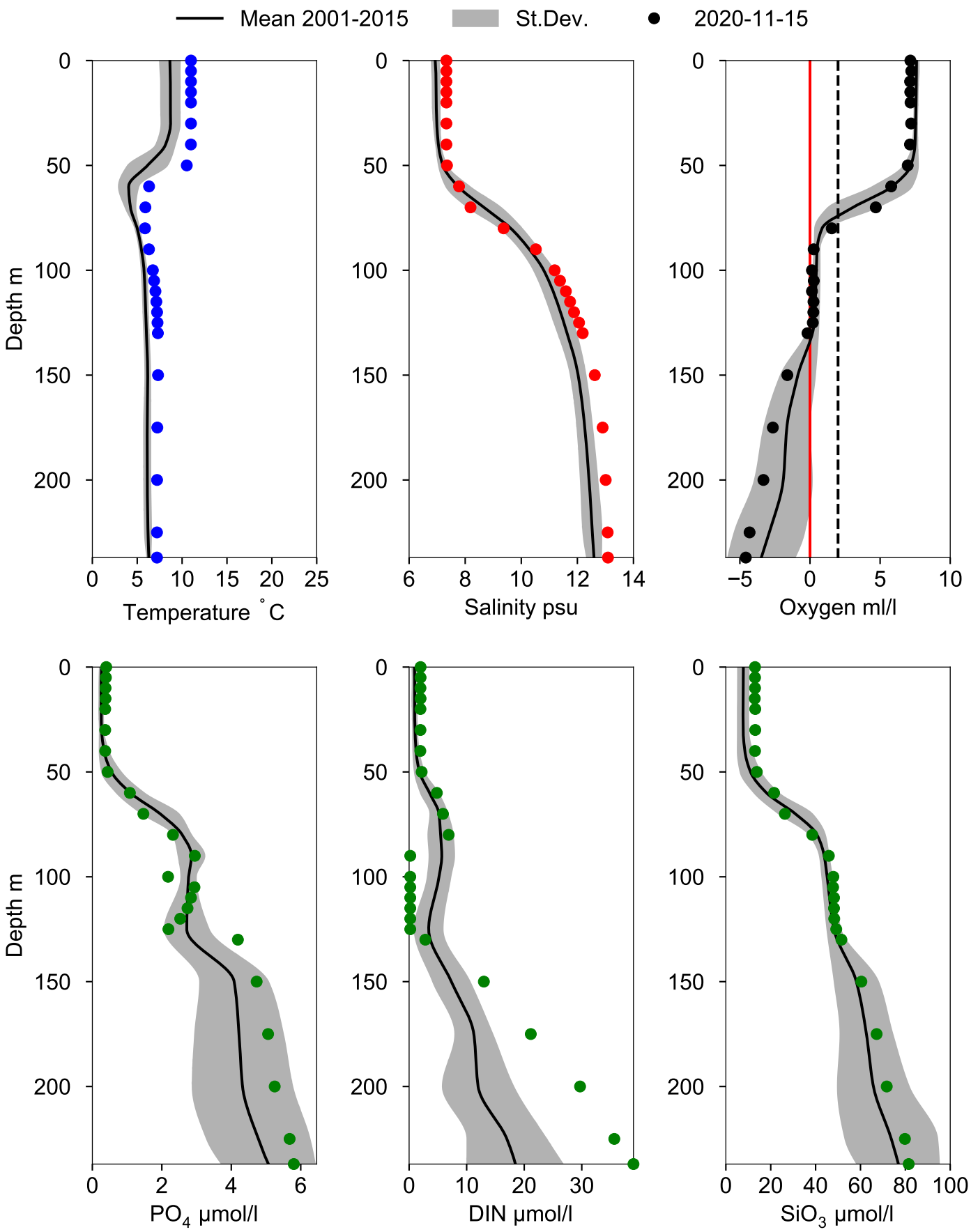
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 225 m)

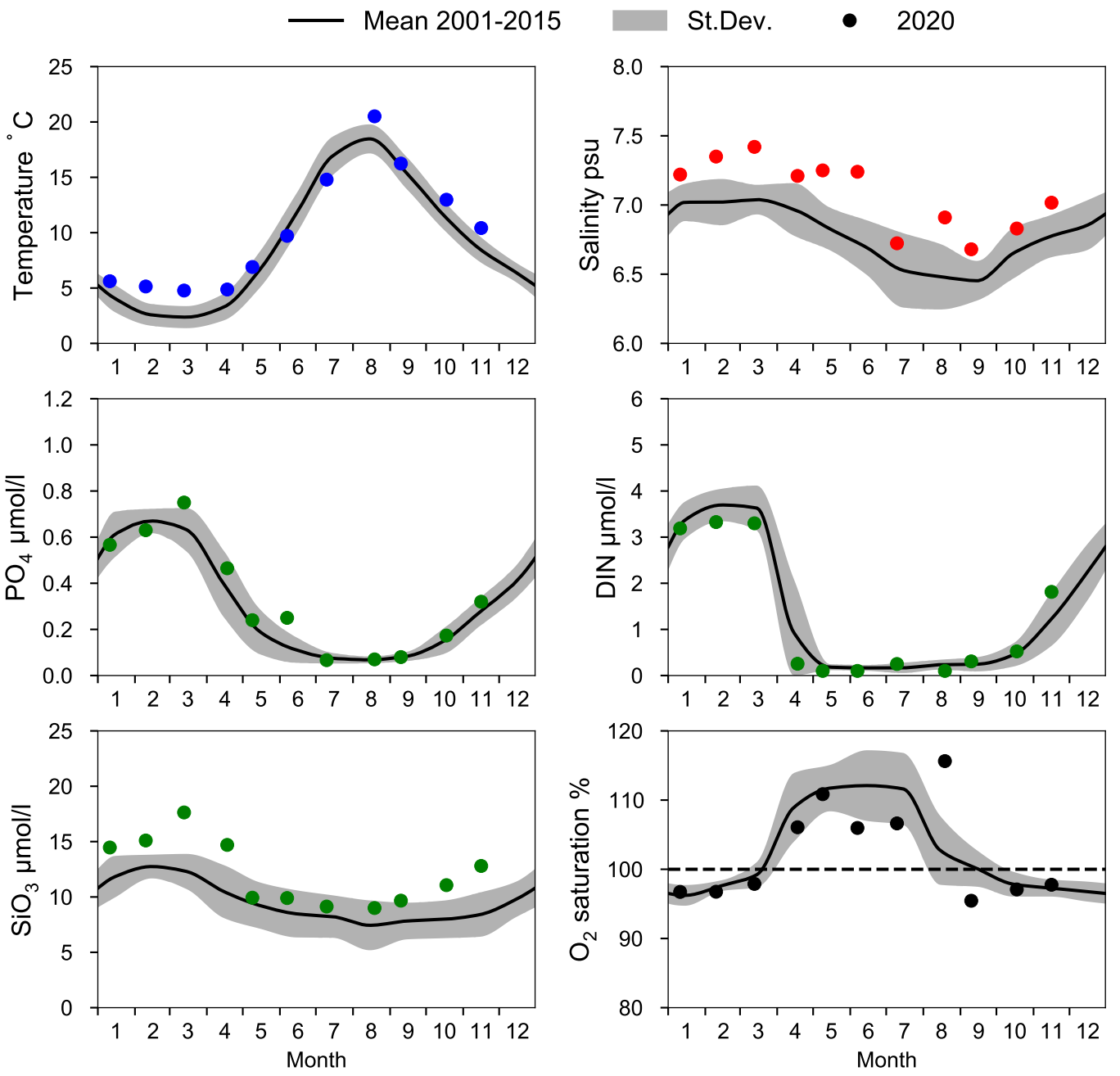


Vertical profiles BY15 GOTLANDSDJ
November

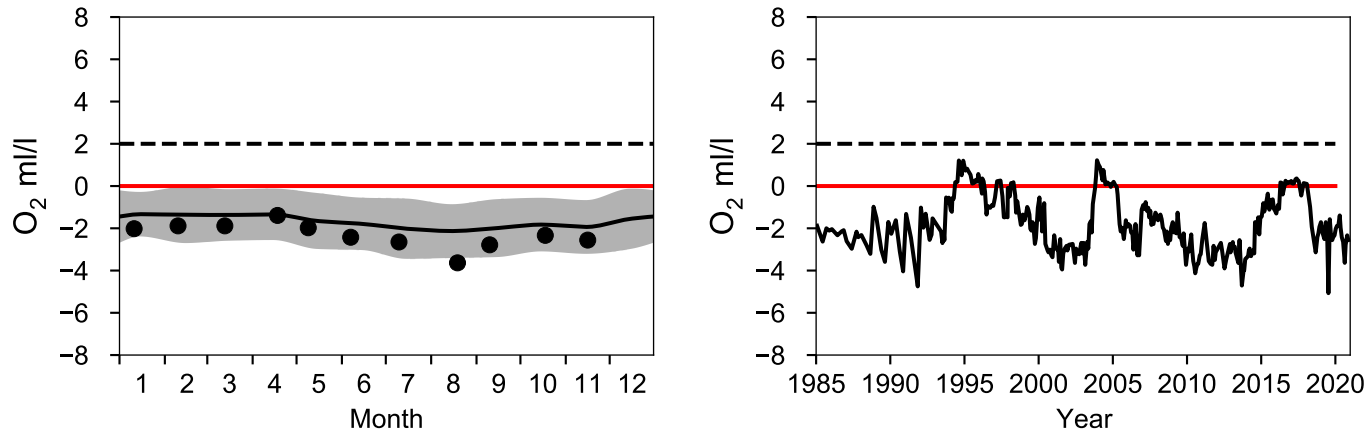


STATION BY20 FÅRÖDJ SURFACE WATER (0-10 m)

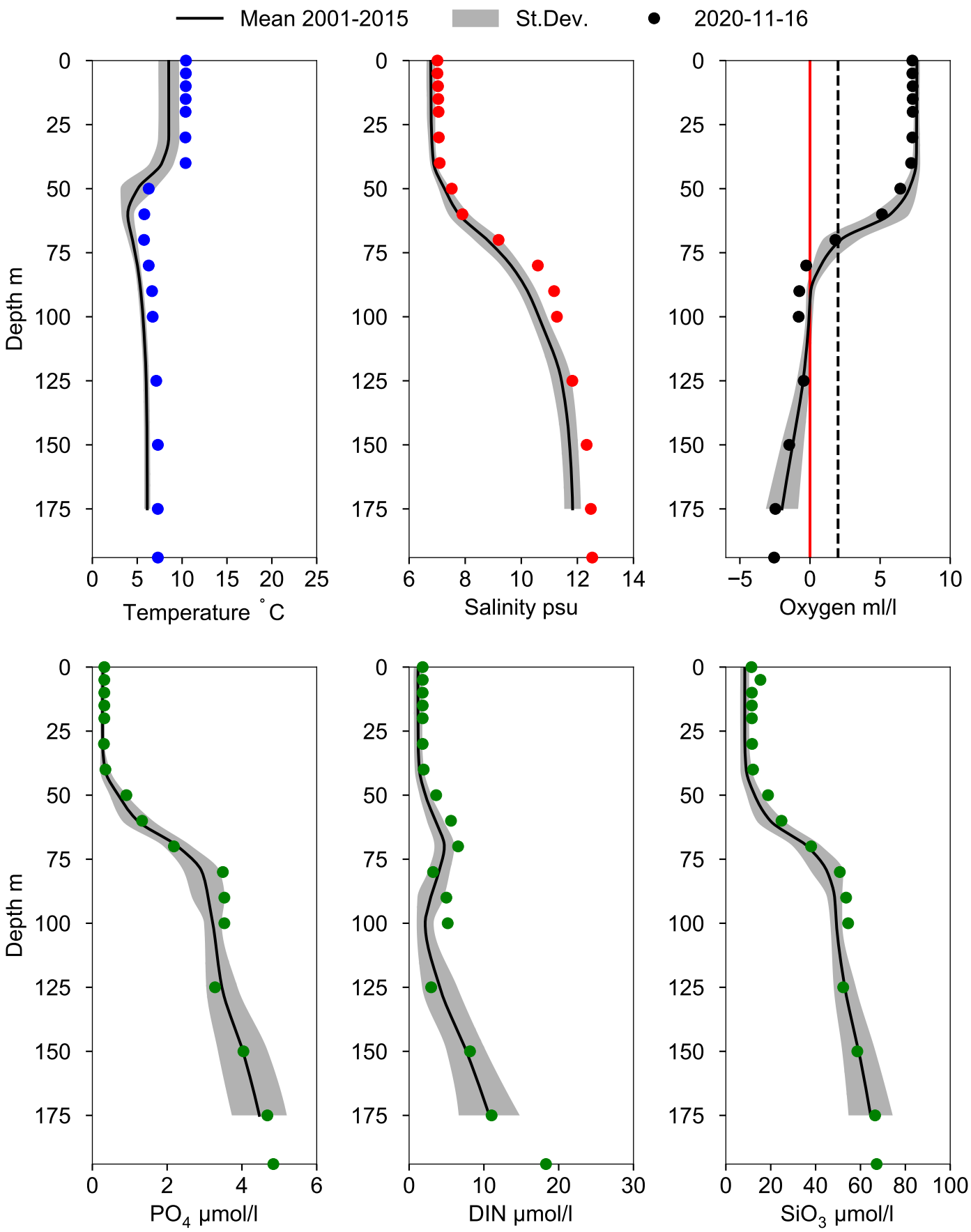
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

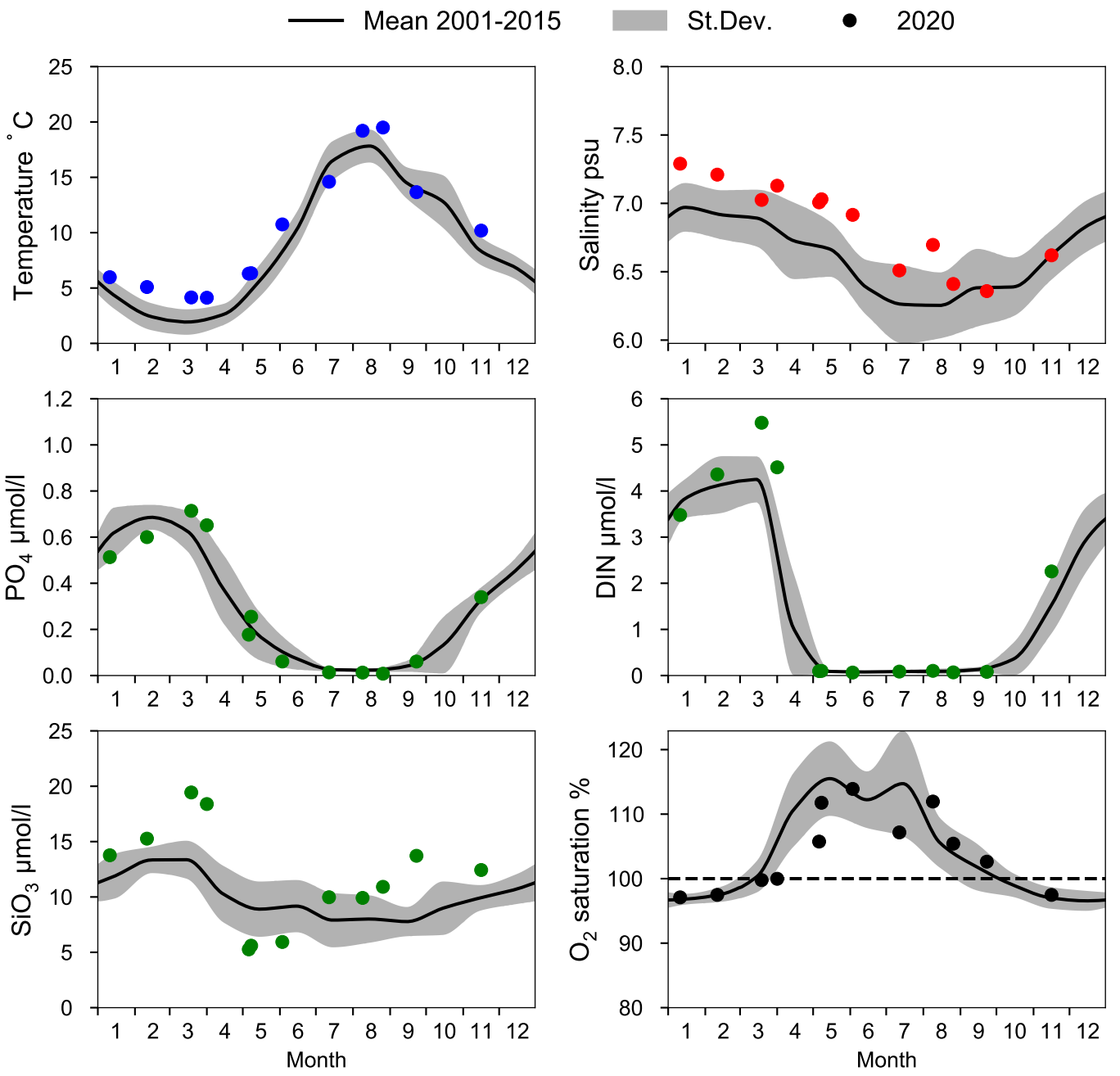


Vertical profiles BY20 FÅRÖDJ
November

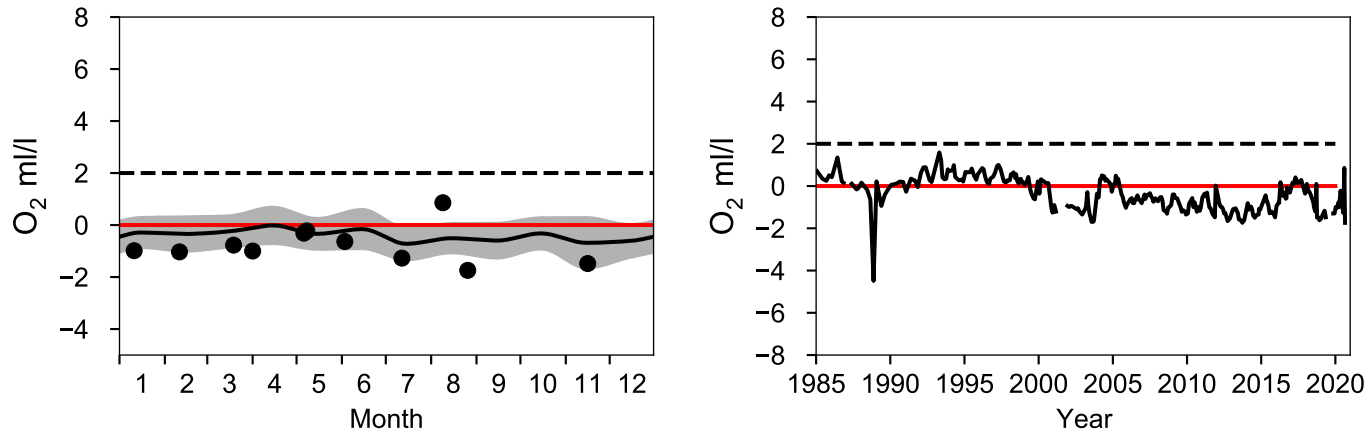


STATION BY29 / LL19 SURFACE WATER (0-10 m)

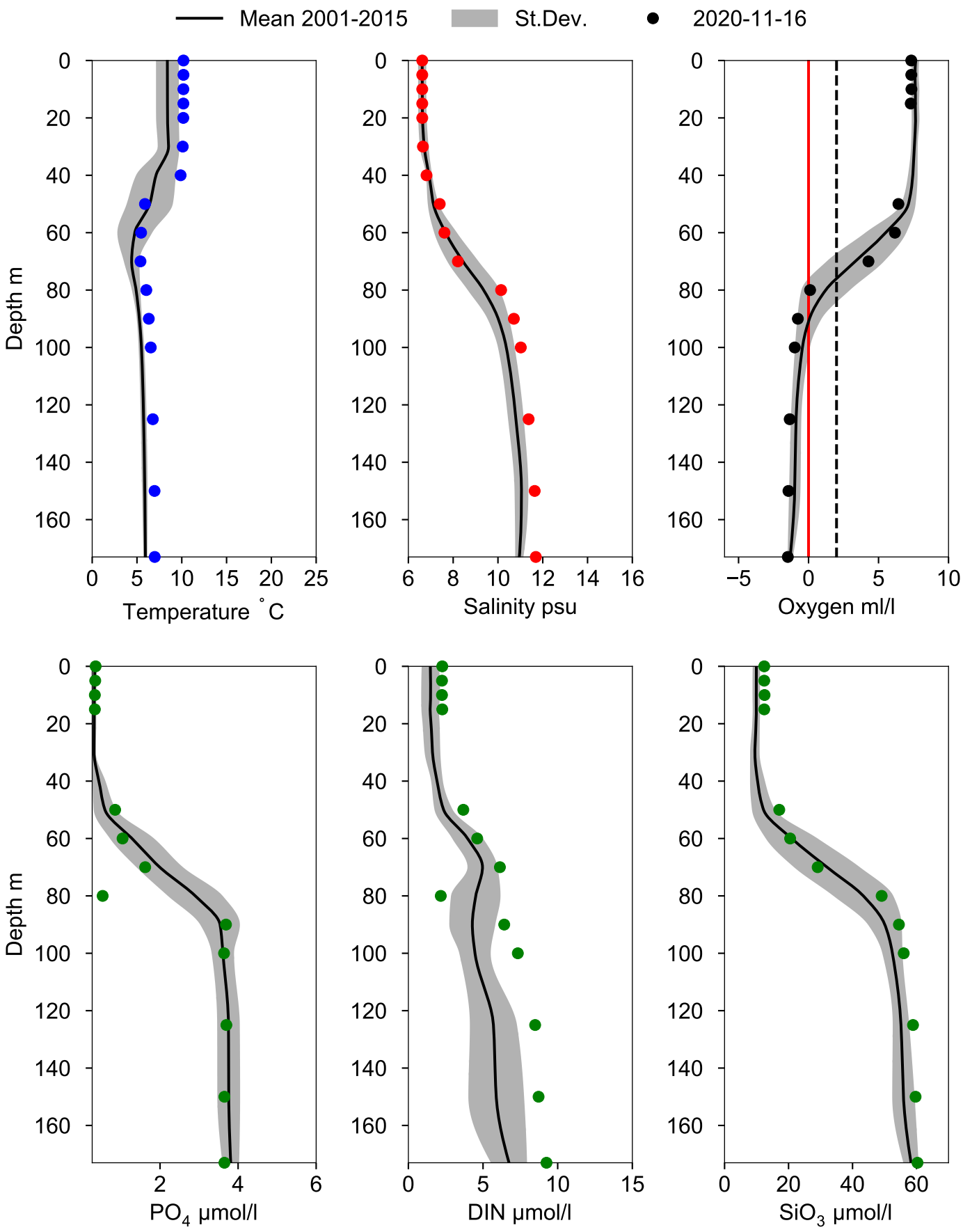
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 150 m)

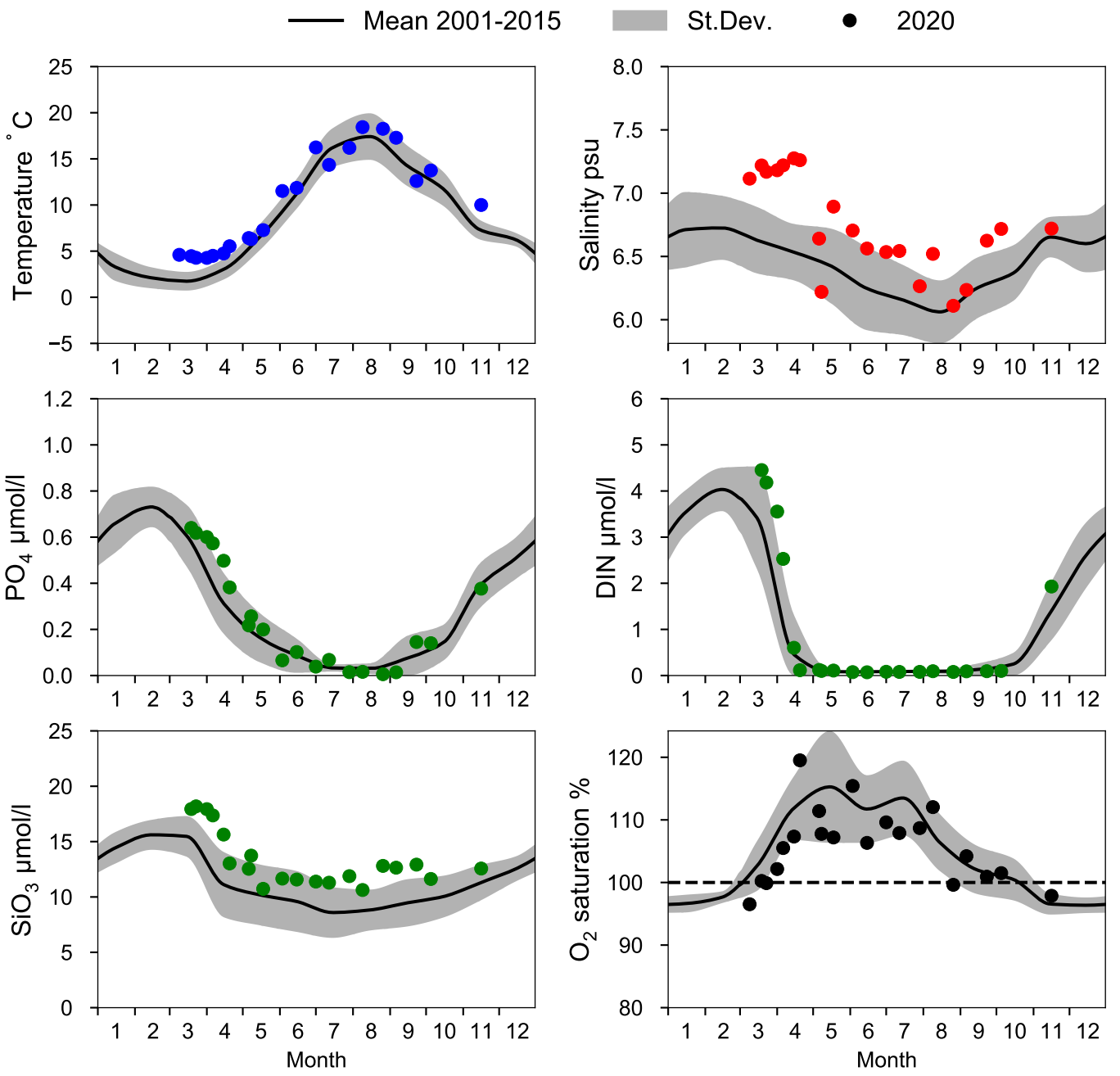


Vertical profiles BY29 / LL19
November

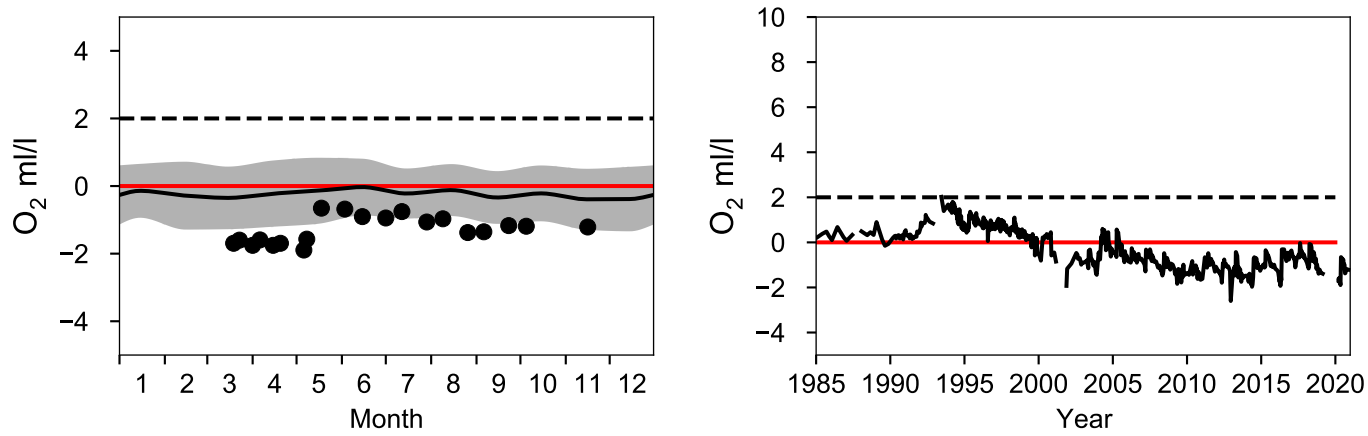


STATION BY31 LANDSORTSDJ SURFACE WATER (0-10 m)

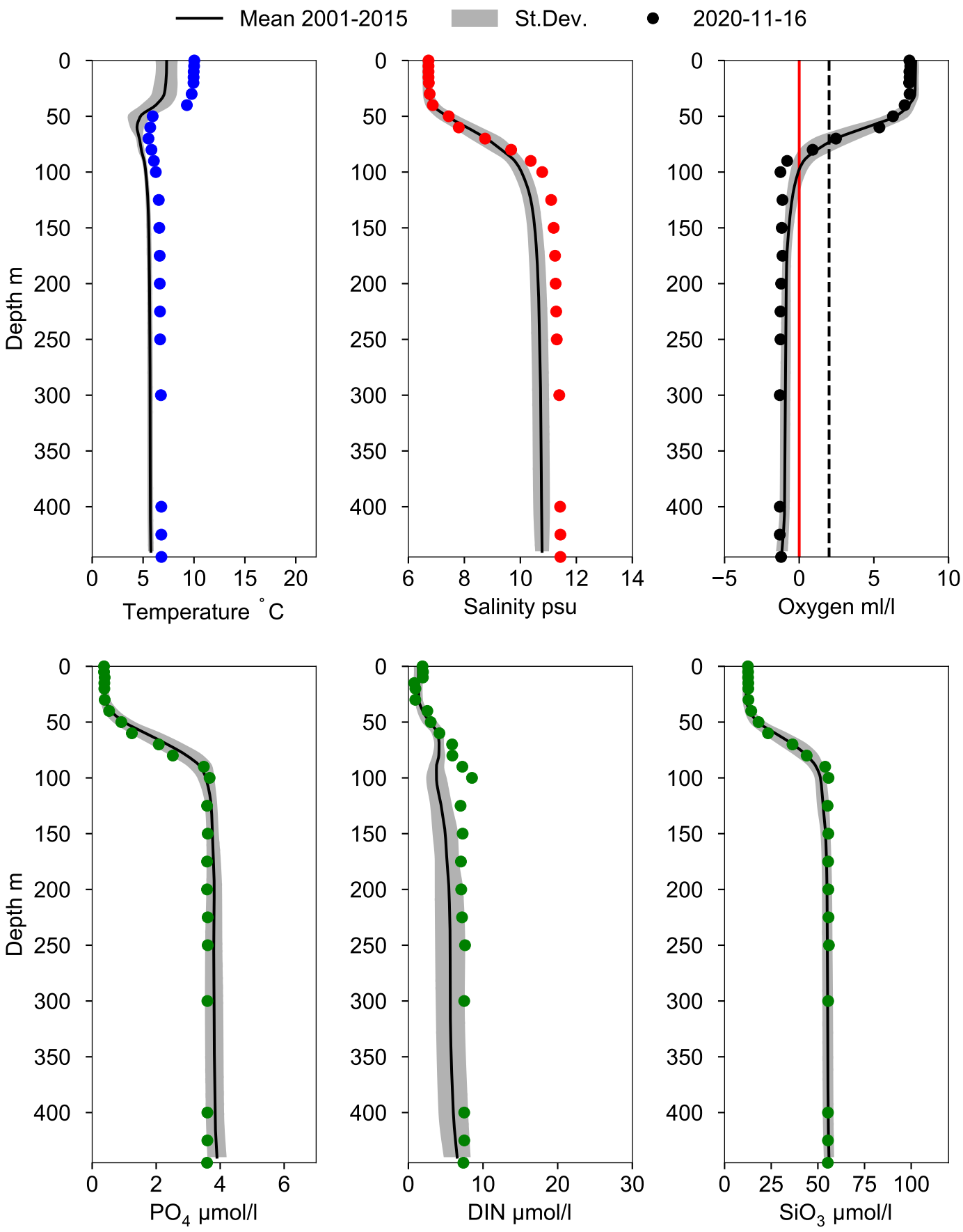
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 419 m)

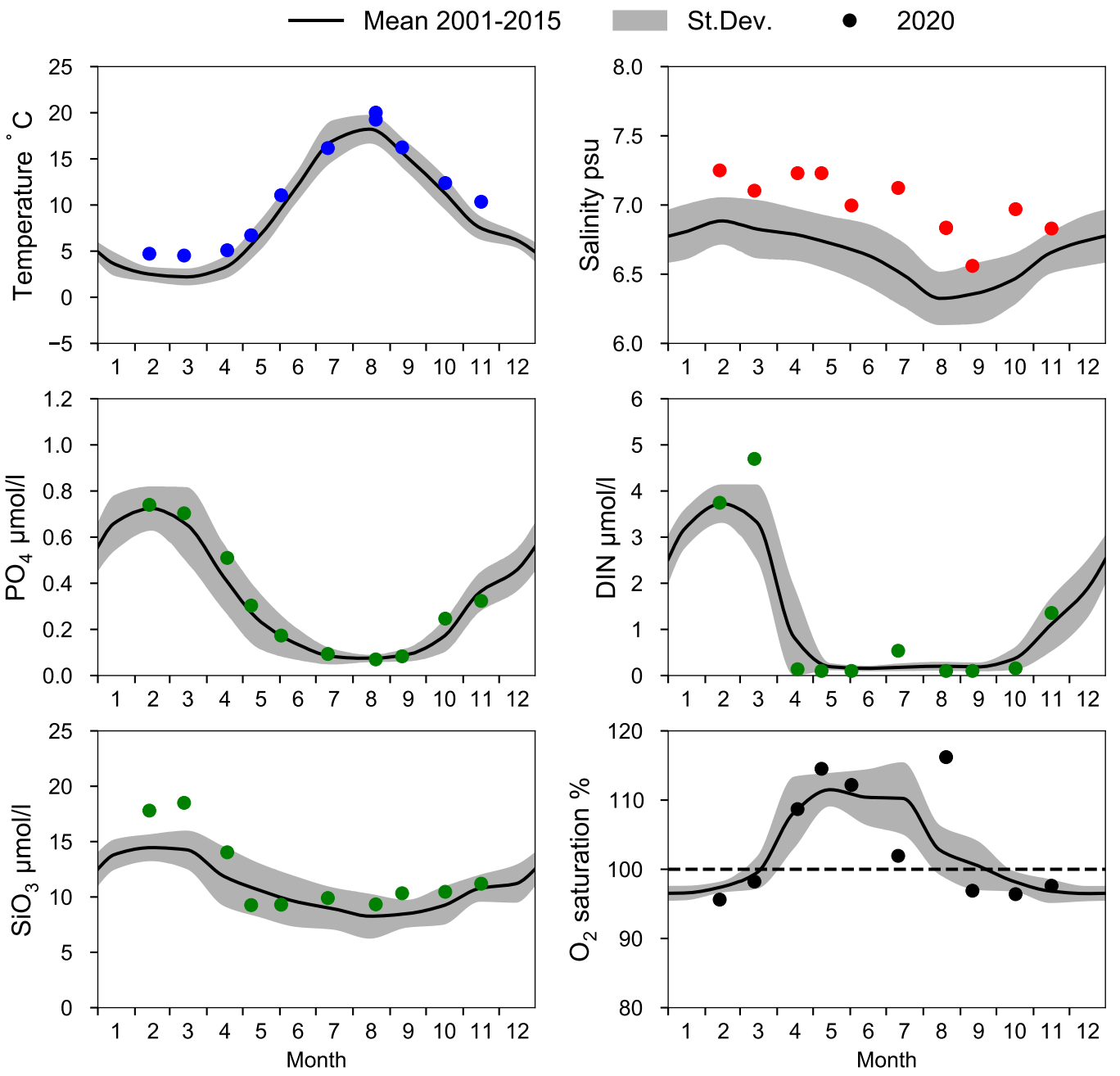


Vertical profiles BY31 LANDSORTSDJ
November

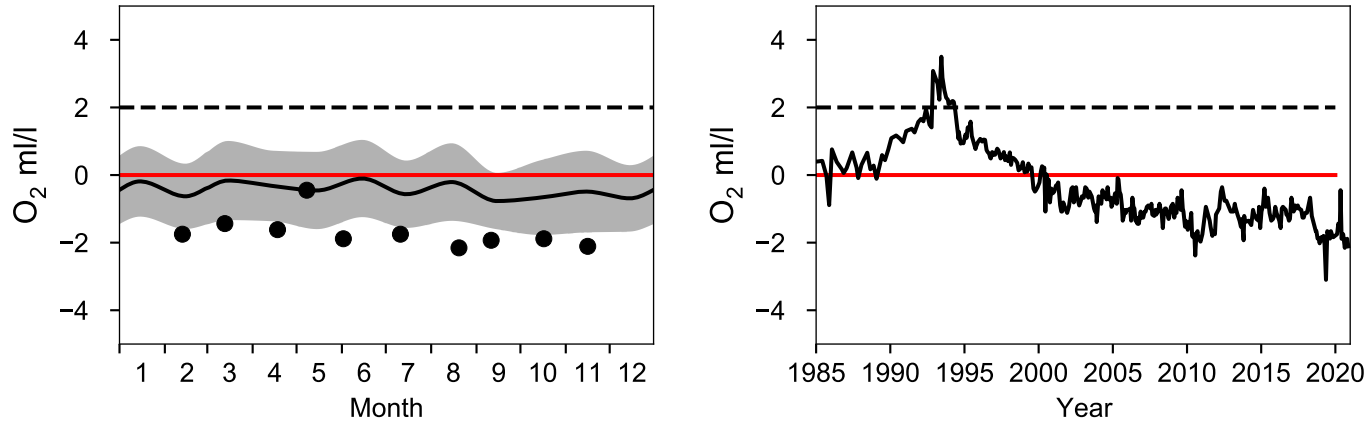


STATION BY32 NORRKÖPINGSDJ SURFACE WATER (0-10 m)

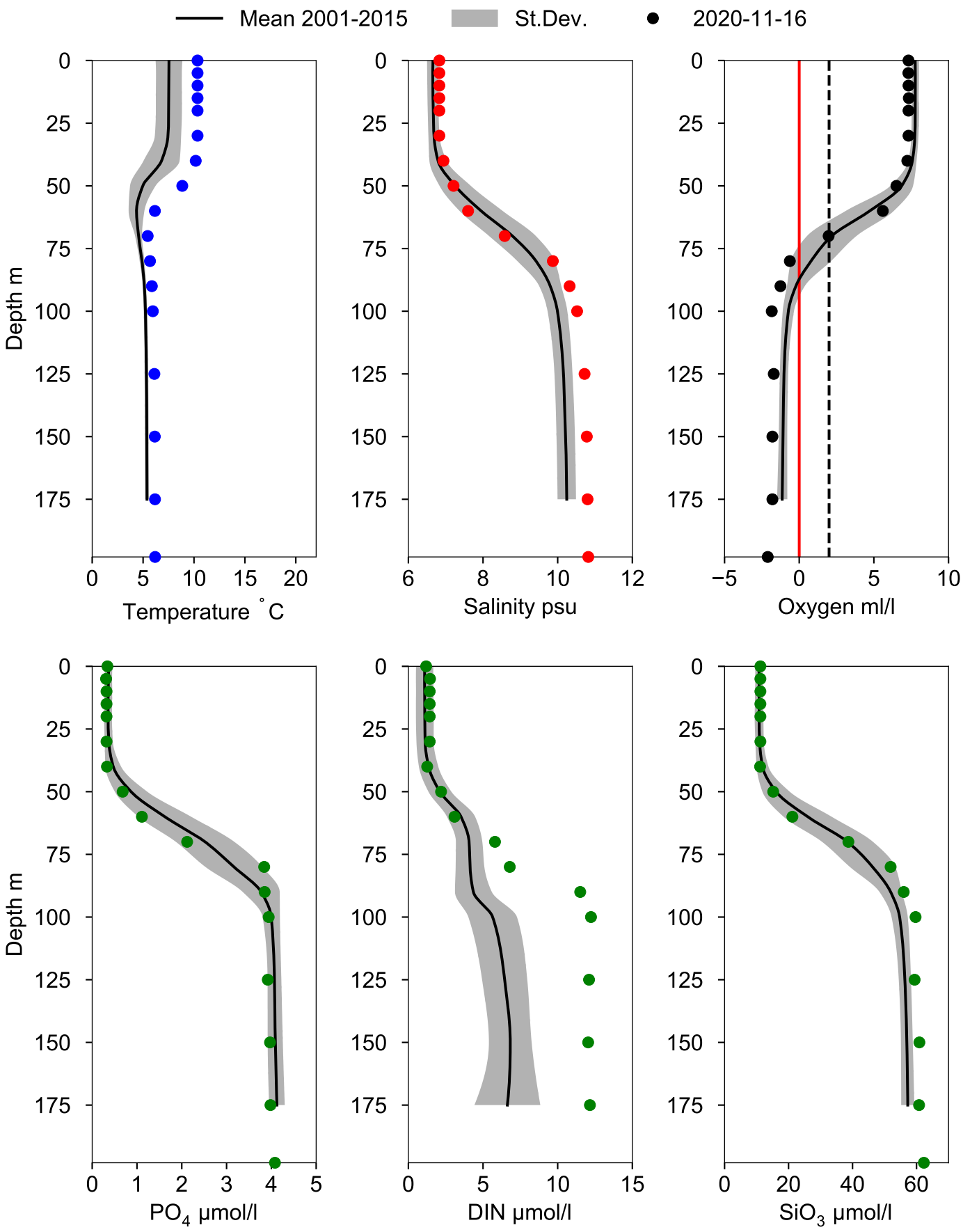
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 175 m)

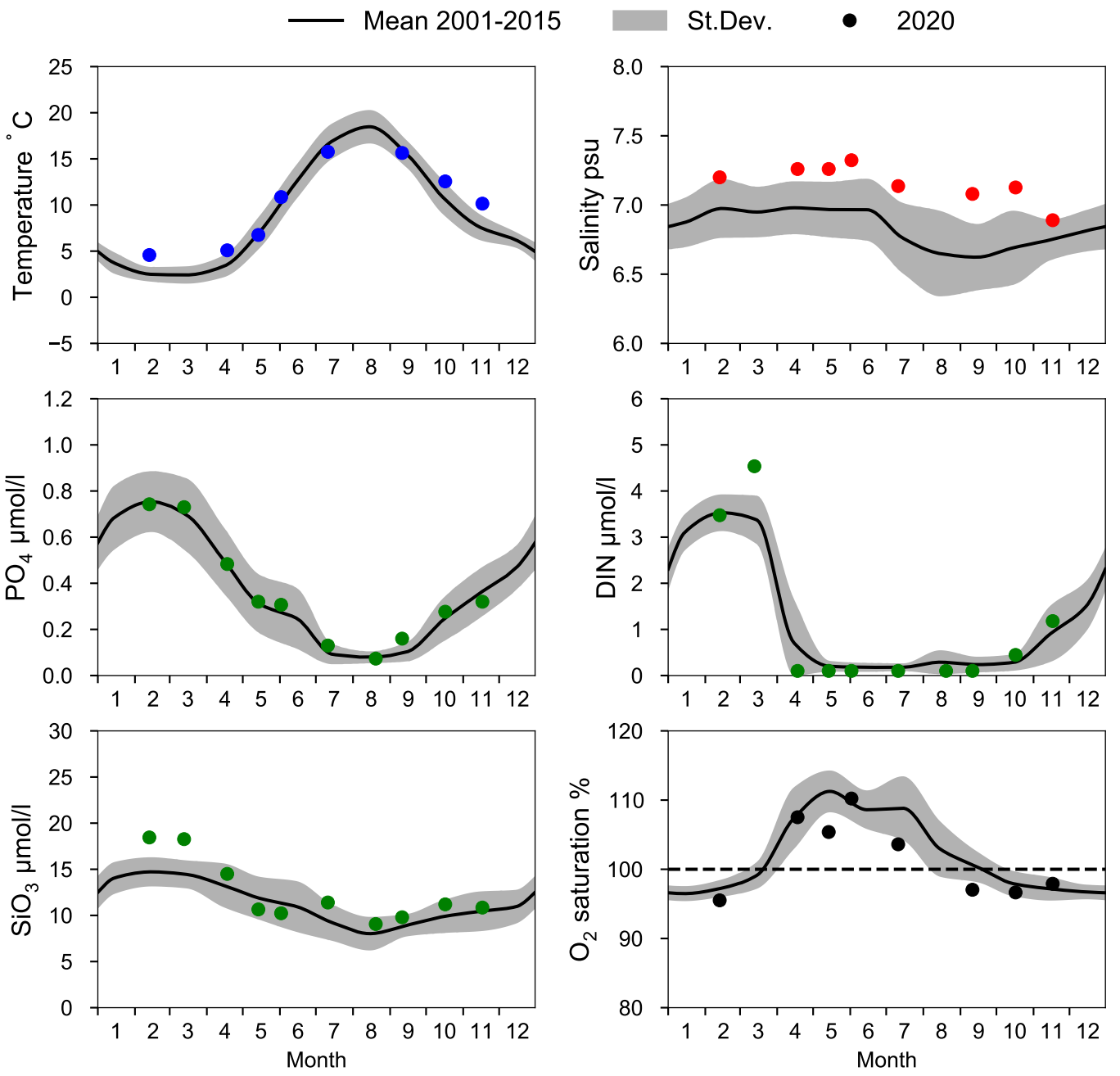


Vertical profiles BY32 NORRKÖPINGSDJ
November

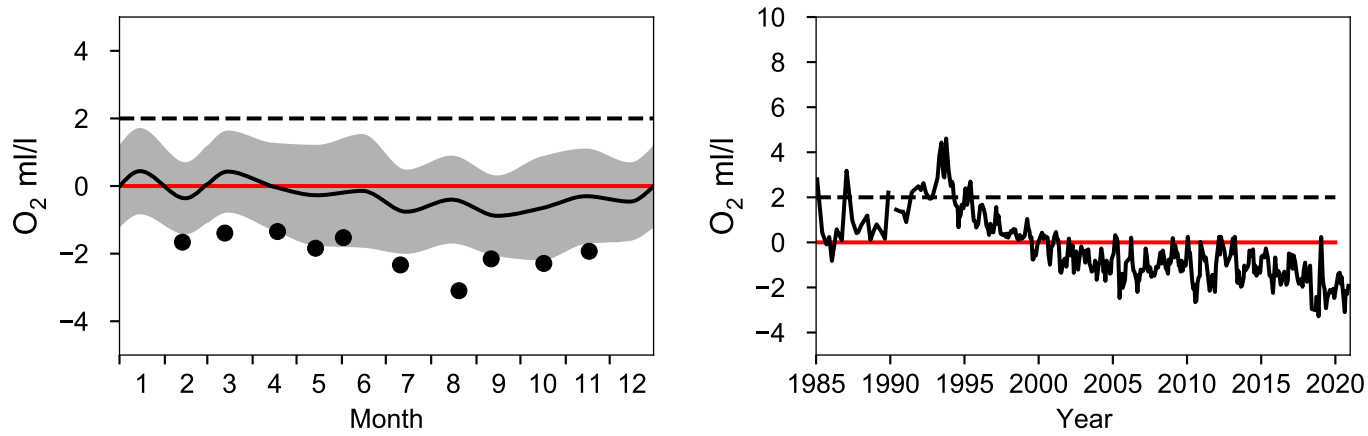


STATION BY38 KARLSÖDJ SURFACE WATER (0-10 m)

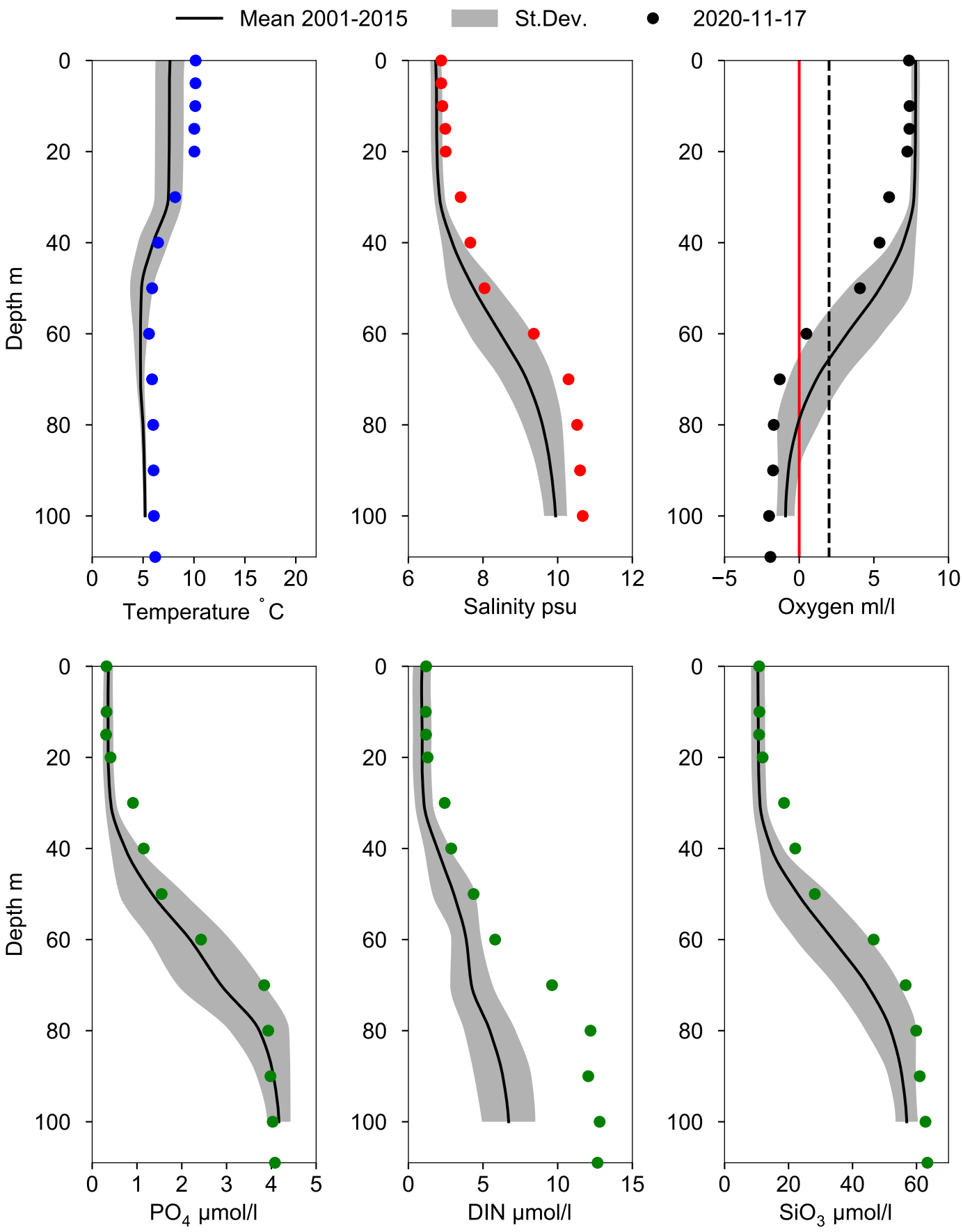
Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 100 m)

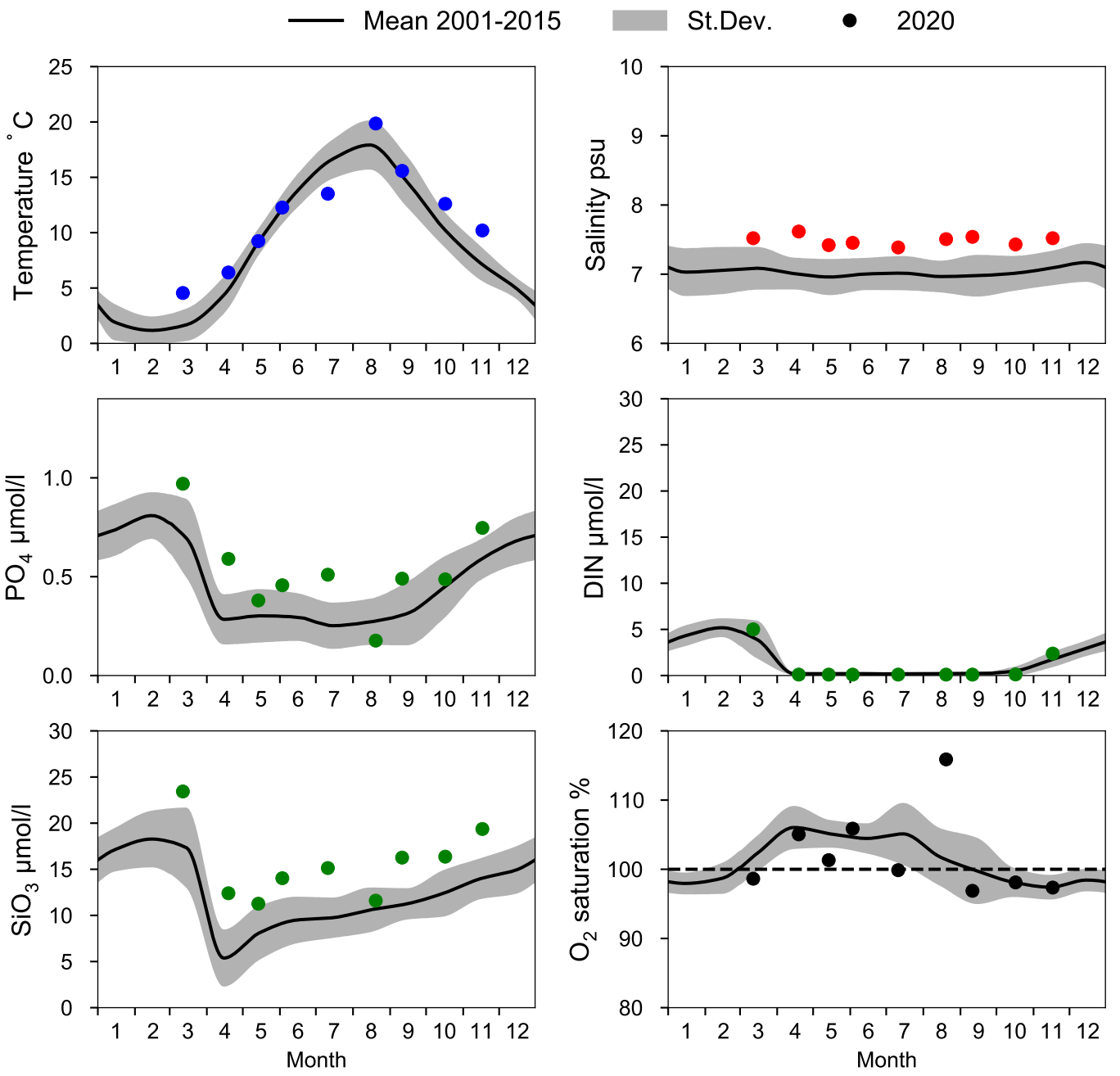


Vertical profiles BY38 KARLSÖDJ
November

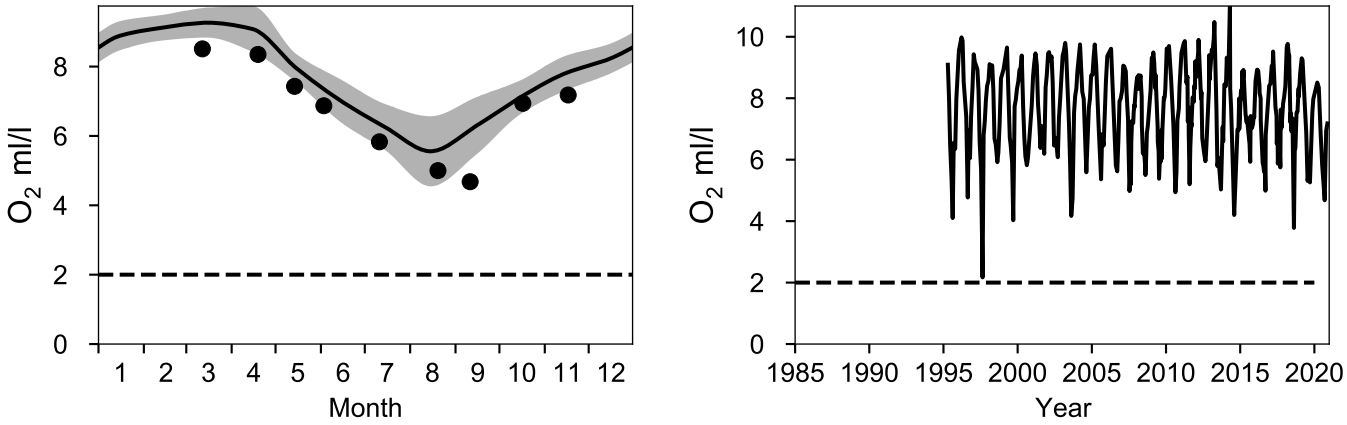


STATION REF M1V1 SURFACE WATER (0-10 m)

Annual Cycles



OXYGEN IN BOTTOM WATER (depth >= 15 m)



Vertical profiles REF M1V1
November