
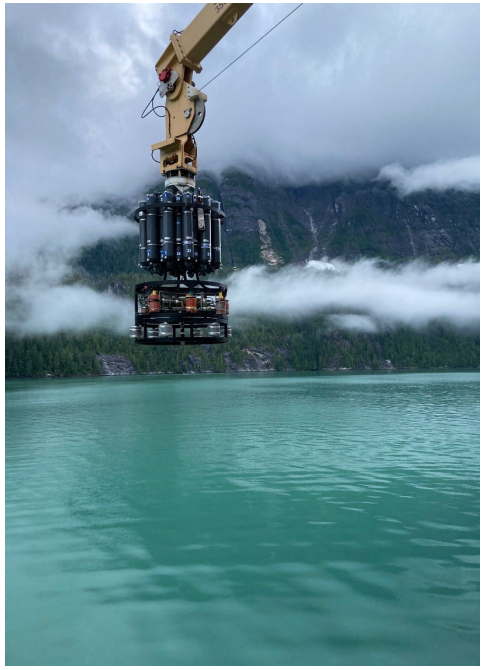

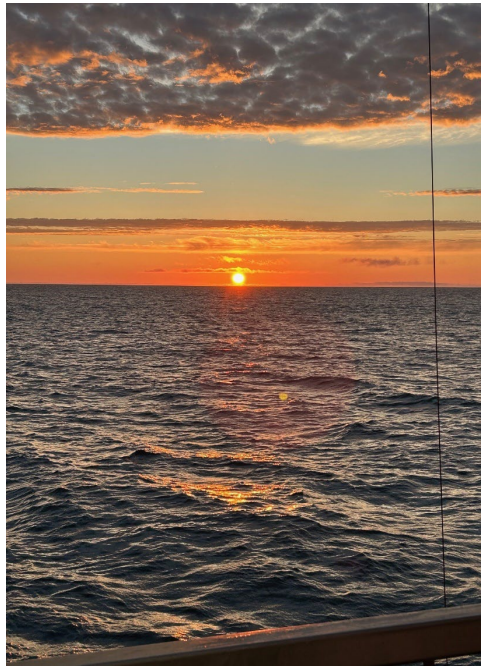
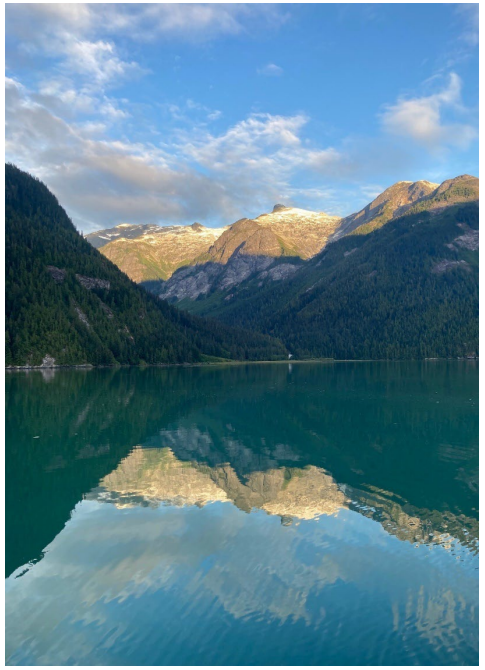

Trends in Subsurface Oxygen in British Columbia waters

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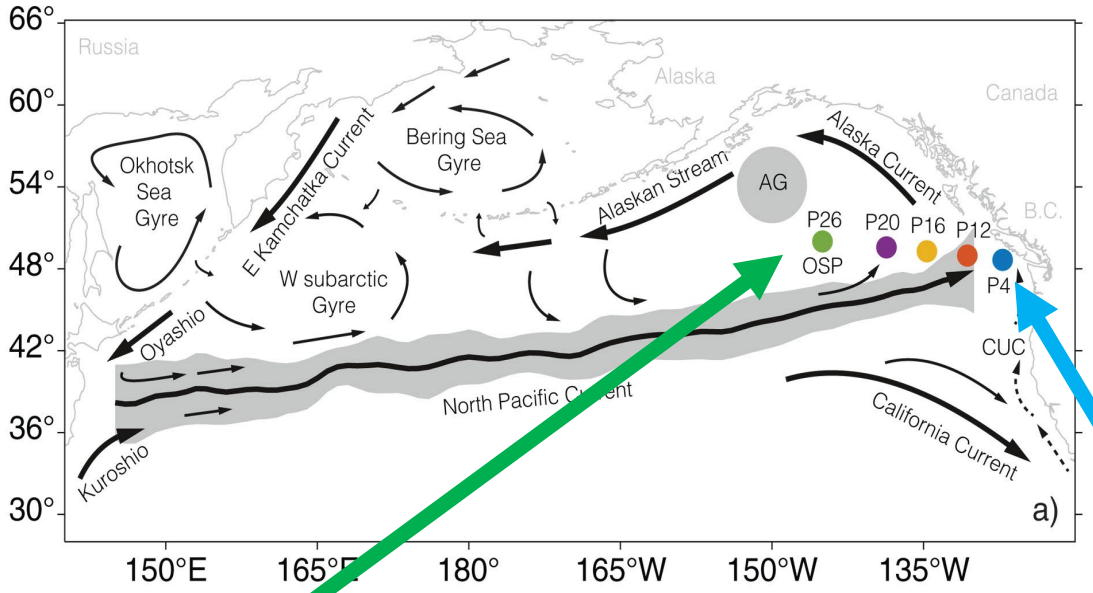
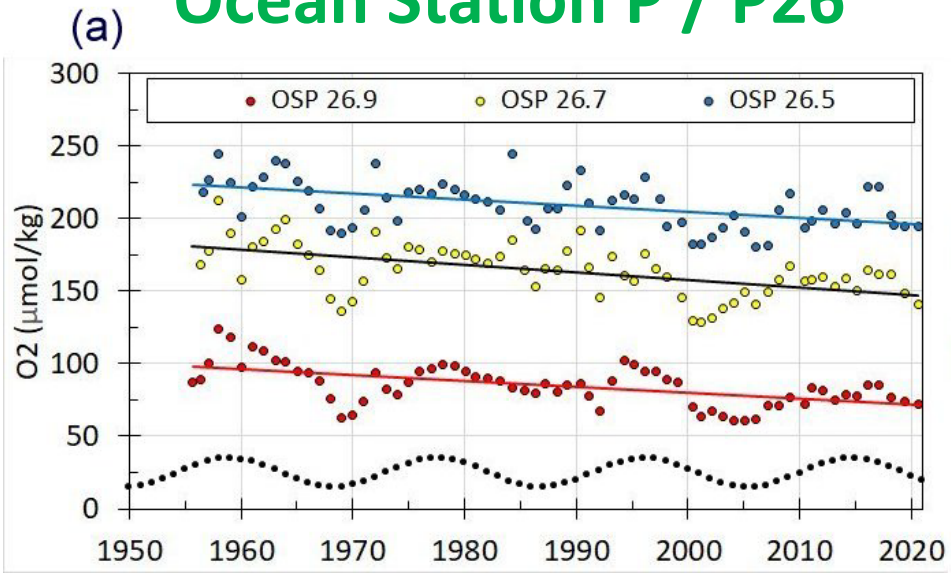
Michaela Maier, University of Victoria

Unclassified - Non-Classifié

At OSP the oxygen trends on these isopycnals range from -4 to -6 µmol kg^{-1} decade^{-1} (Cummins and Ross, 2020).

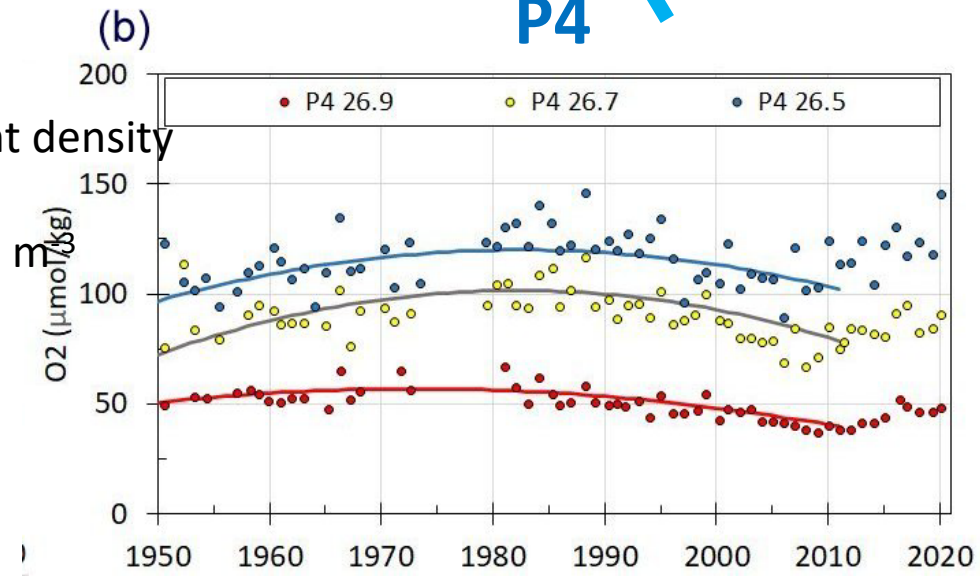


Ocean Station P / P26



Oxygen on constant density surfaces
26.5, **26.7**, **26.9** kg m^{-3}

P4

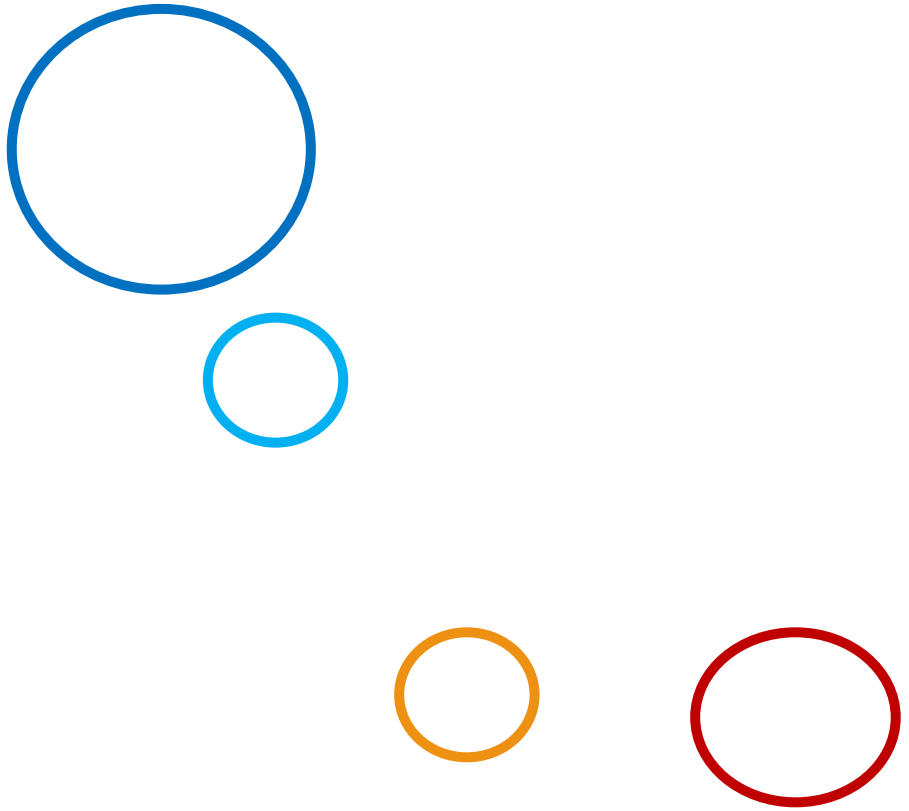


Collate archived temperature, salinity and oxygen data

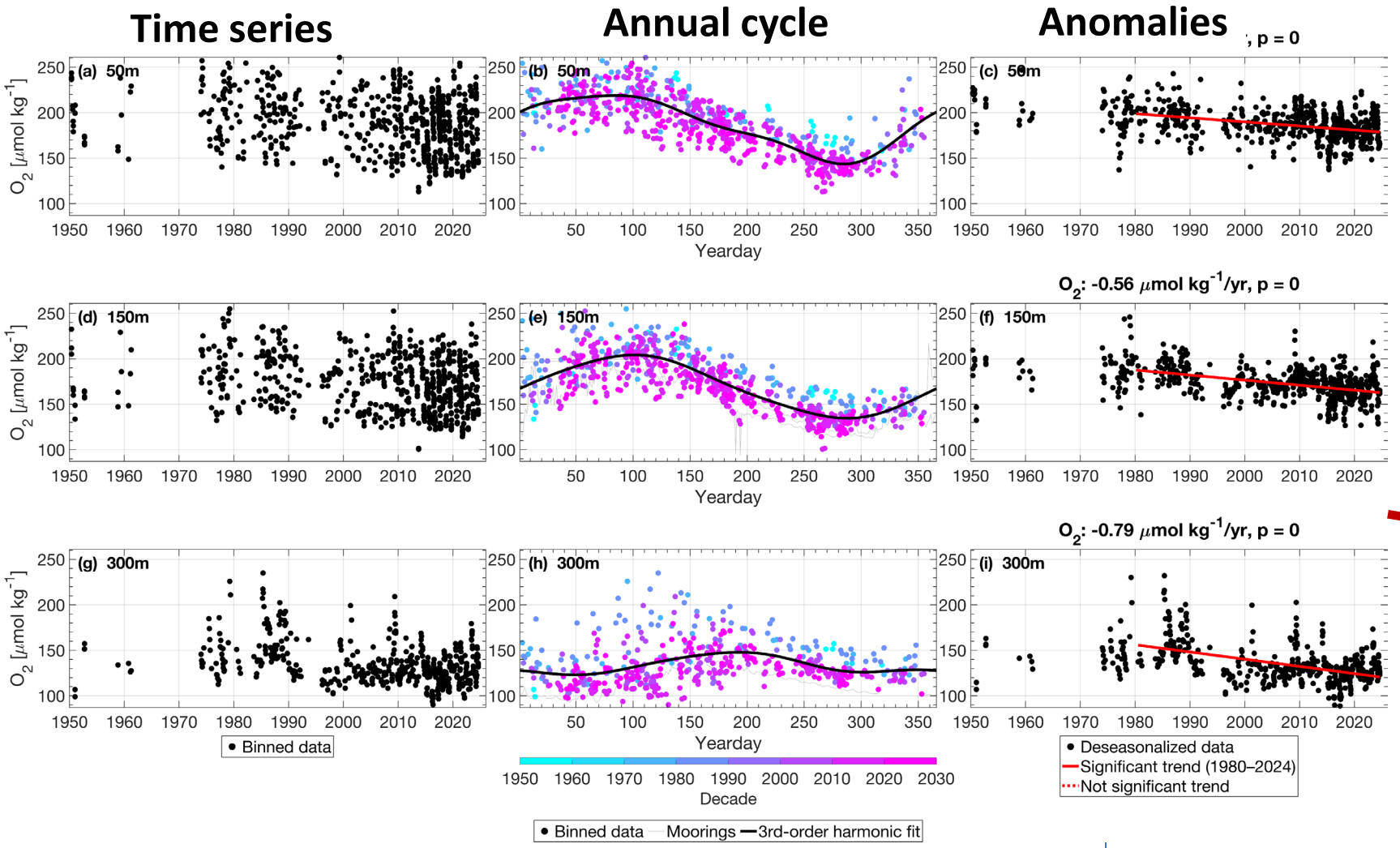
- **On the shelf at 50 m, 150 m, 300 m (or the bottom).**
- **Over the slope on constant density levels 26.0, 26.3, 26.5, 26.7, 26.9, 27.1 kg m^{-3}**

We will show

- **Strait of Georgia South**
- **E01**
- **CS09**
- **eastern Hecate Strait**



SoG – South : 1950-2024



50 m

150 m

300 m

Southern Strait of Georgia

Trends

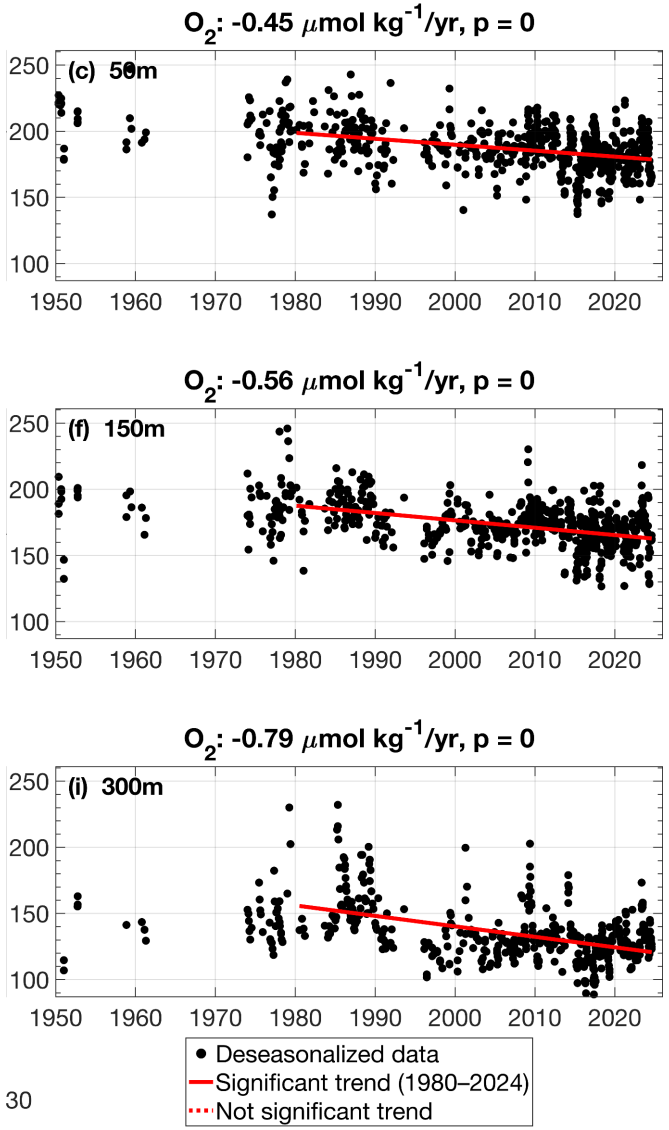
- **50 m: -0.45 µmol kg^{-1} yr^{-1}.**
- **150 m: -0.56 µmol kg^{-1} yr^{-1}**
- **300 m: -0.79 µmol kg^{-1} yr^{-1}**

Johannessen et al. 2014. *Limnology and Oceanography.*
For the period 1971-2009 and 200 m to bottom, report trend of about -0.9 µmol L^{-1} yr^{-1}.

Units
-0.5 µmol kg^{-1} yr^{-1} ~ -0.01 ml/l per year ~ -0.1 ml/l per decade.

Line P -0.4 to -0.6 µmol kg^{-1} yr^{-1}

Strait of Georgia South



50 m

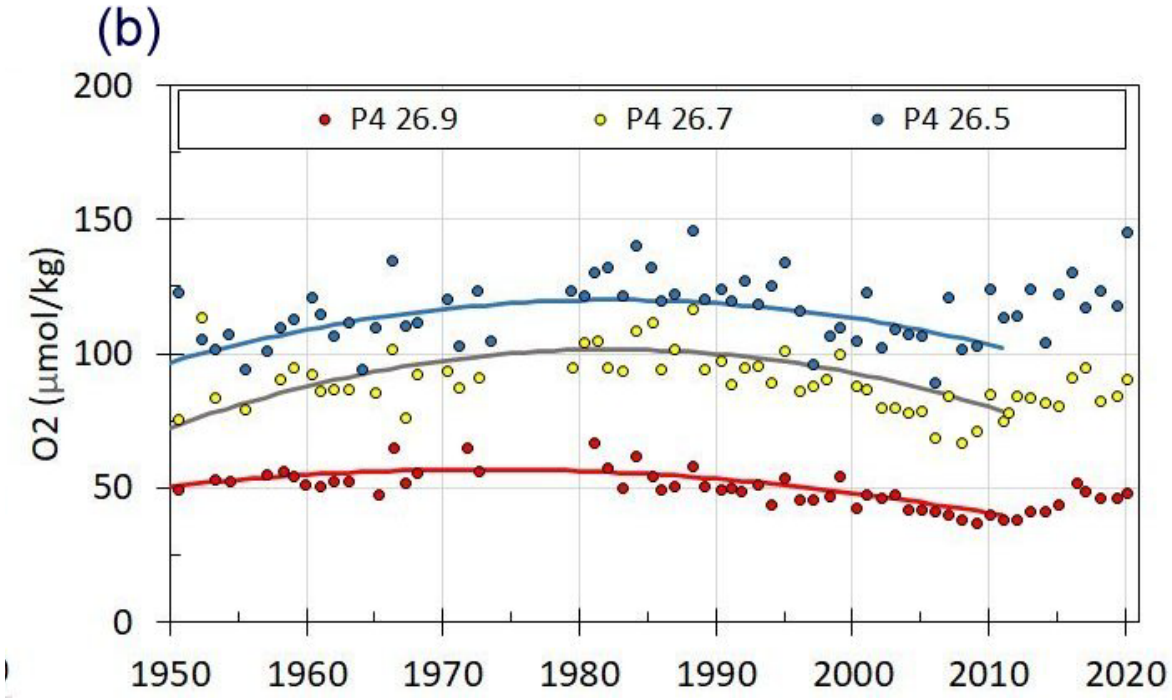
150 m

300 m

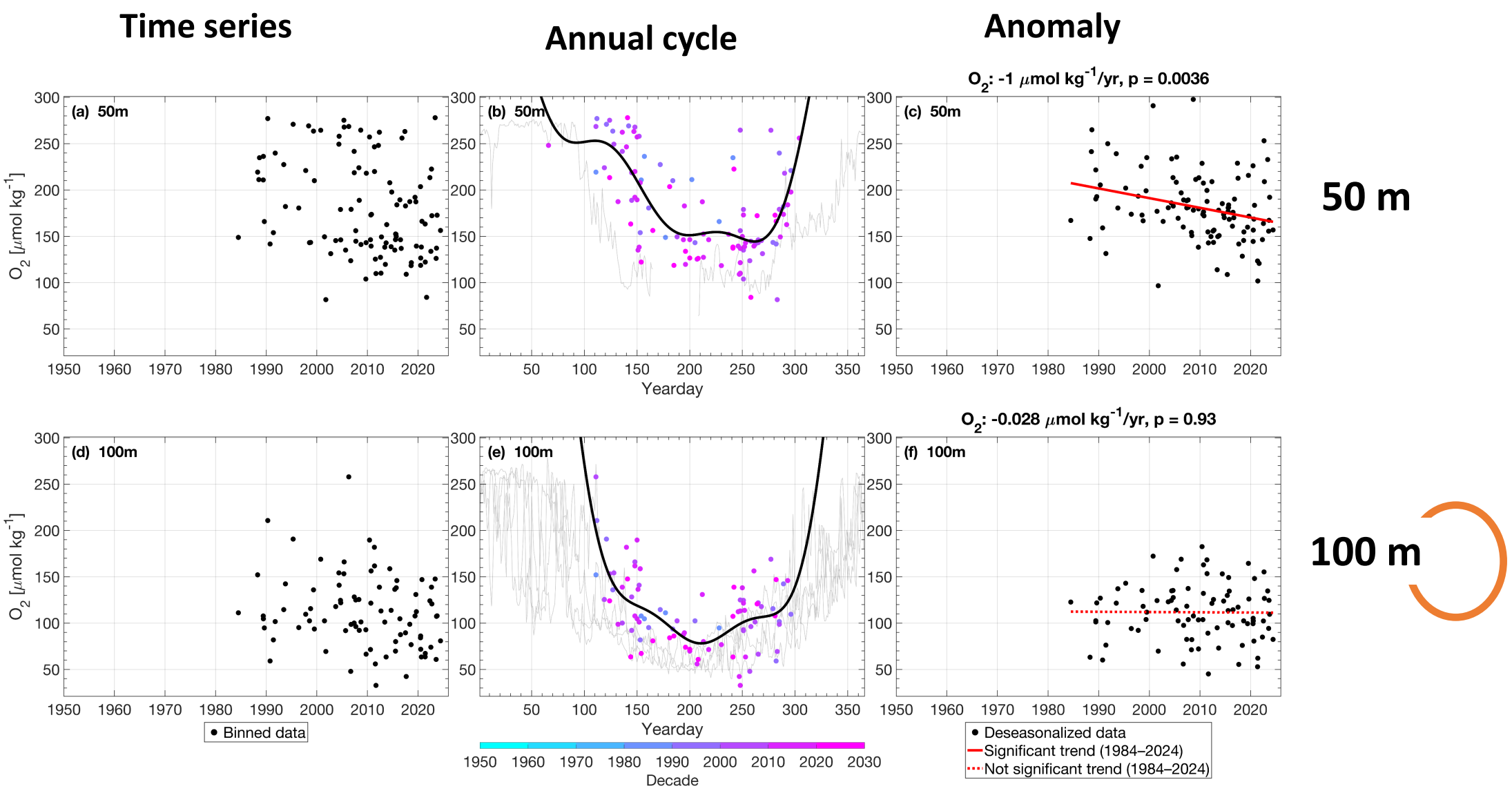
P4 – Slope water

26.5 isopycnal is about 150 m

26.7 isopycnal is about 250 m



E01 1985-2024



E01

Trends

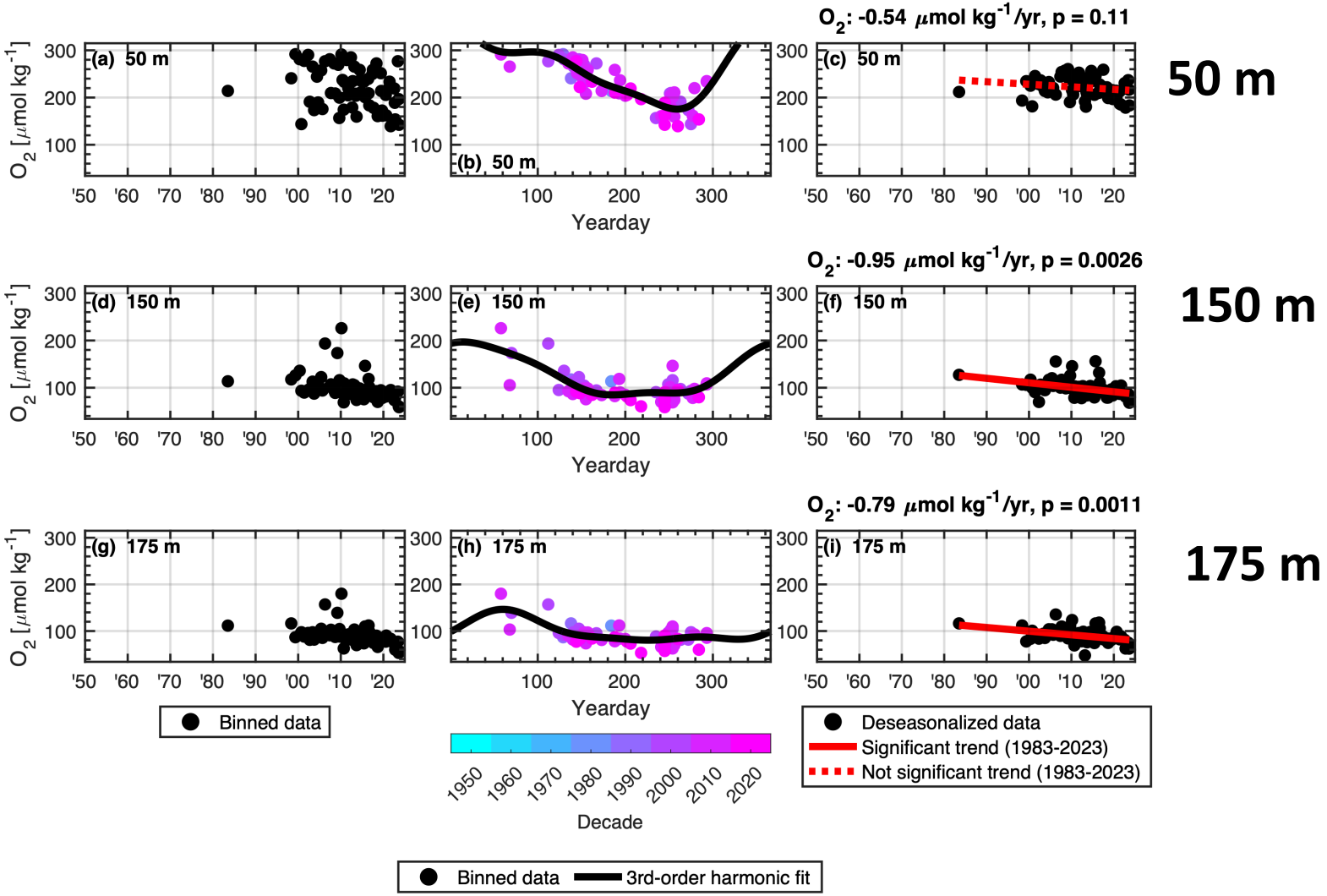
- **50 m: -1.0 µmol kg^{-1} yr^{-1}.**
- **100 m: -0.03 µmol kg^{-1} yr^{-1} Not Significant**

Units

-1.0 µmol kg^{-1} yr^{-1} ~ -0.02 ml/l per year ~ -0.2 ml/l per decade.

Unclassified - Non-Classifié

CS09



CS09

Trends

- **50 m: -0.5 µmol kg^{-1} yr^{-1}. Not Signicant**
- **150 m: -0.95 µmol kg^{-1} yr^{-1}. Significant**
- **175 m: -0.80 µmol kg^{-1} yr^{-1} . Significant**

Units

-1.0 µmol kg^{-1} yr^{-1} ~ -0.02 ml/l per year ~ -0.2 ml/l per decade.

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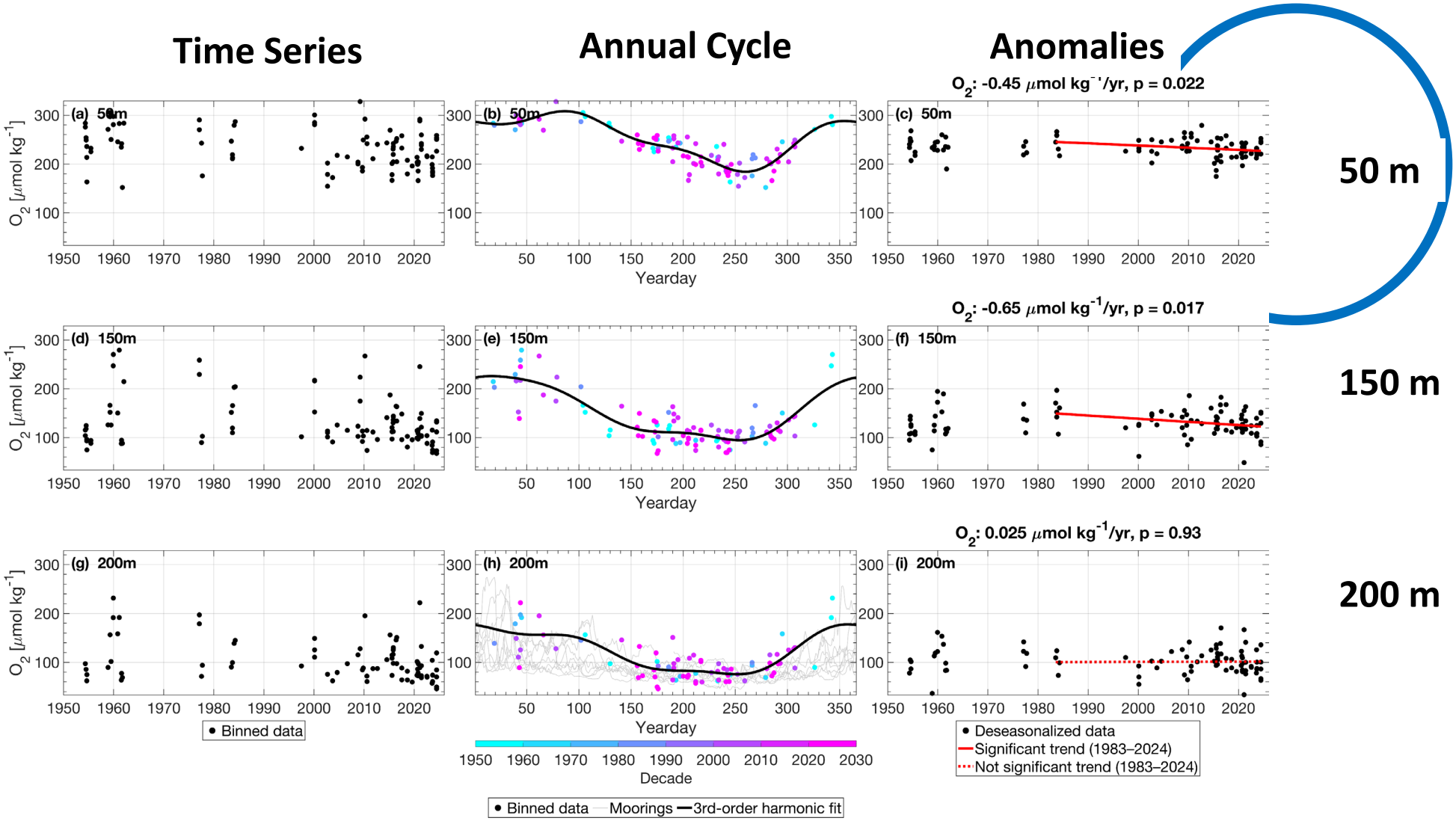
Hecate Strait – eastern side



Hecate Strait – eastern side

Trends

- **50 m: -0.45 µmol kg^{-1} yr^{-1}.**
- **150 m: -0.65 µmol kg^{-1} yr^{-1}**
- **200 m: -0.025 µmol kg^{-1} yr^{-1} Not Significant**

Units

-0.5 µmol kg^{-1} yr^{-1} ~ -0.01 ml/l per year ~ -0.1 ml/l per decade.

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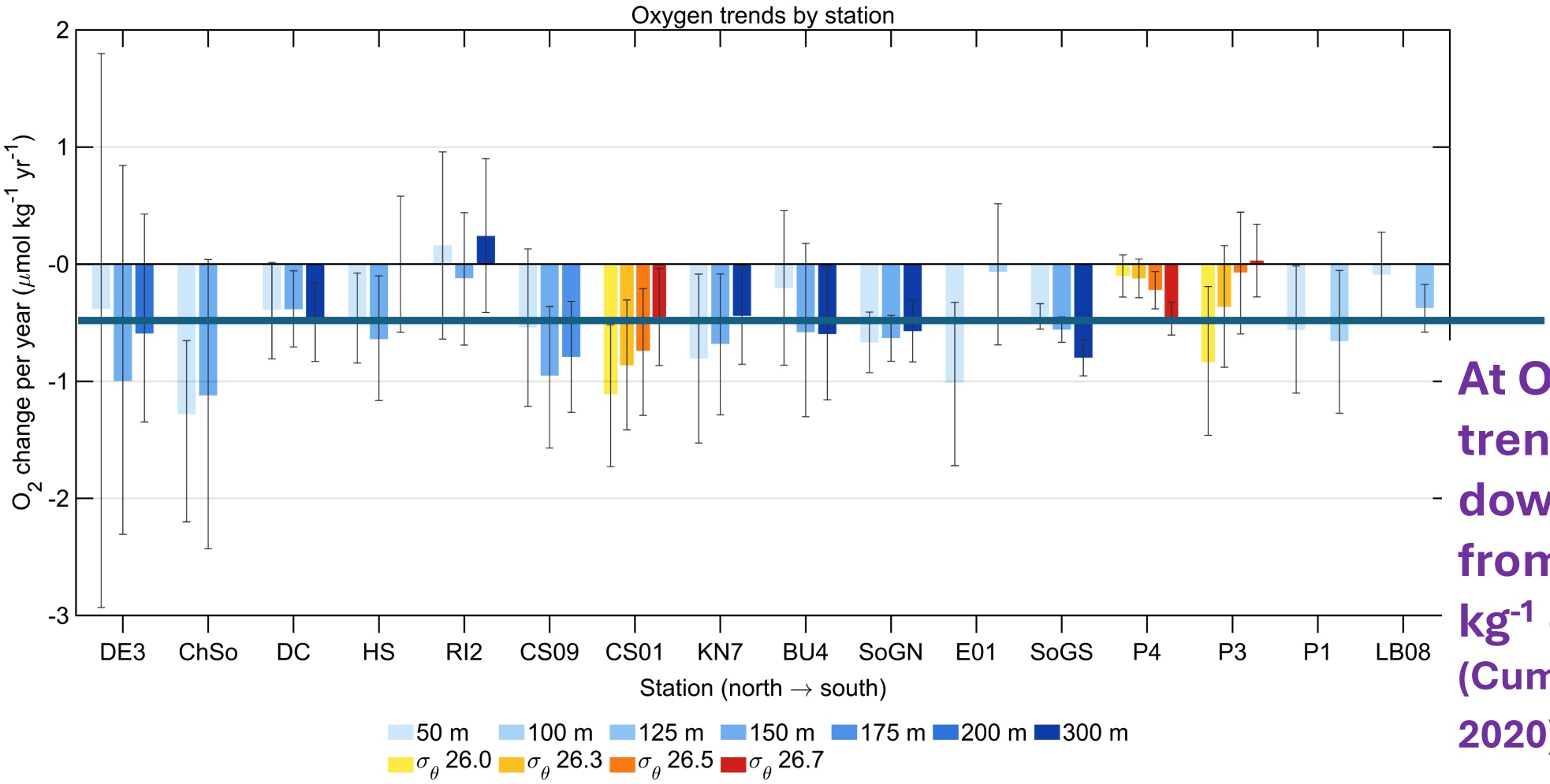
Summary of Trends



At OSP the oxygen trends on isopycnals down to 300 m range from -4 to -6 µmol kg^{-1} decade^{-1} (Cummins and Ross, 2020).

Connecting Queen Charlotte Sound with the western North Pacific

- Comparing oxygen concentration fluctuations observed in QCS with those observed in NW Pacific 8 years prior.
- The connection between Queen Charlotte Sound and P4 is weak.

Stevens et al. 2025. Dissolved oxygen variability on the Canadian Pacific shelf: Trends, drivers, and projections in the context of emerging hypoxia in Queen Charlotte Sound. *Global Biogeochemical Cycles*.

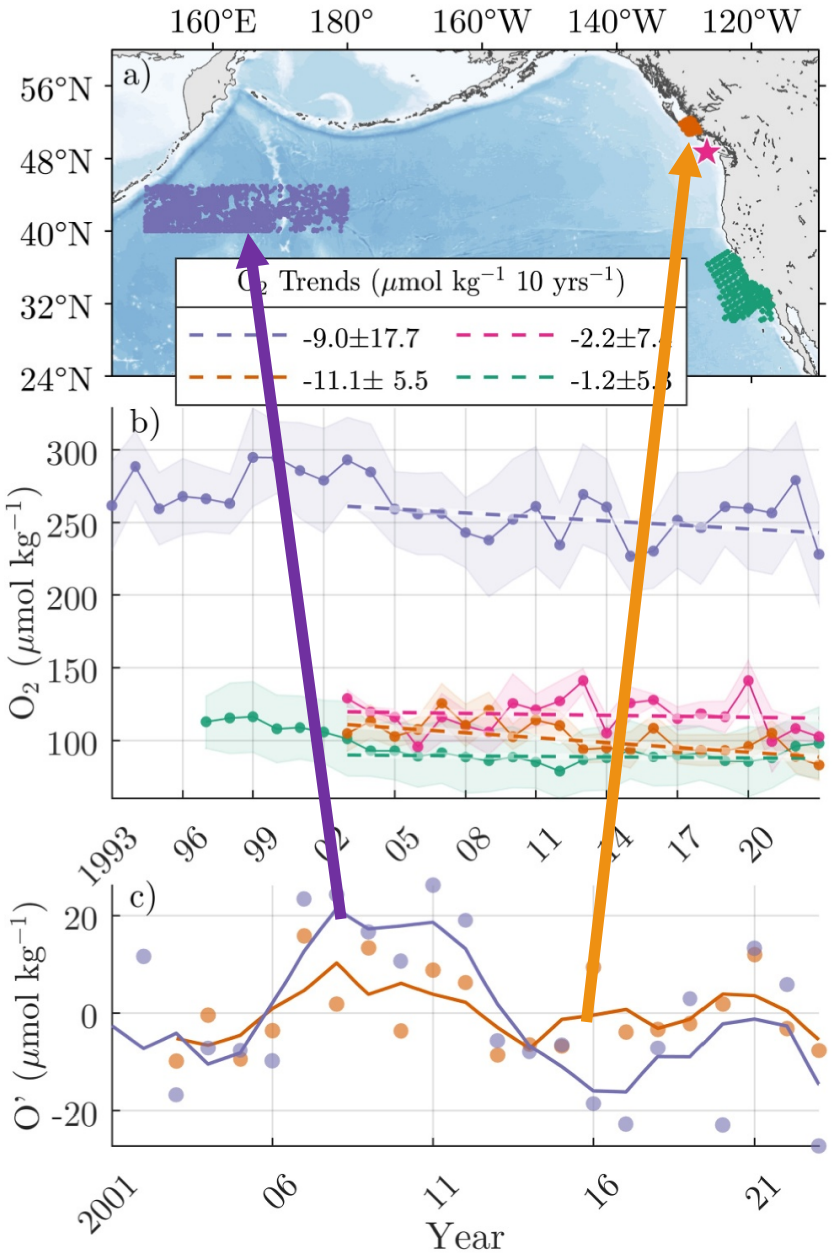


Figure 8. Mean annual O_2 ($\overline{O_2}$) on the 26.50 σ_θ isopycnal in the subarctic

Unclassified - Non-Classifié

Shelf – Slope Coupling

- **Spice – that quantity which is orthogonal to density in T-S space.**
- **It is useful for tracing water masses.**
- **Off southern Vancouver Island, springtime oxygen declines around the 26.0 / 26.3 isopycnals on the slope are almost entirely explained by an increasing contribution of oxygen-poor southern water. Maier et al., submitted.**
- **On the shelf, biological processes contribute to additional oxygen loss on these shallow isopycnals.**
- **Biological oxygen demand reduces the useful of water mass analysis.**

- **No seasonal changes are observed on the deepest regularly upwelled isopycnal (26.6) on either the slope or shelf.**

Unclassified - Non-Classifié

Summary Points (1/2)

- **The average rate of decline of subsurface oxygen for 13 locations around the British Columbia shelf, where the trends are statistically different from zero at 95% confidence, is about 5 µmol kg^{-1} $decade^{-1}$ (0.1 ml l^{-1} $decade^{-1}$).**
- **This is consistent with the declining trends reported for Ocean Station Papa since the 1950s.**
- **But are they connected via cause and effect?**
- **Stevens and Hannah (submitted) show that about 1/3 of oxygen variability over the slope is due to changes in the fraction of subpolar and equatorial water present in slope water. Analysis on the 26.5 isopycnal.**

Summary Points (2/2)

- **Declining oxygen trends are not just a near bottom feature.**
  - **In many cases the declines observed at 50 m are as large, or larger, than the near bottom ones.**
  - **At some stations there is a declining trend at 50 m and no evidence of a near-bottom trend.**
- **On the shelf we don't see the decadal scale variability observed at P4**
  - **Low in the 1950s, high in the 1970s, declining through the 2010s, not declining since.**
  - **Shelf looks more like a secular decline with noise, or no decline at all.**
  - **One exception in Douglas Channel, a fjord on the north coast.**
- **20 years of oxygen data if not really enough to draw firm conclusions about connections to the open North Pacific.**
- **Don't have a single consistent story to explain how it all works.**
- **PICES WG59 on Physical and Biogeochemical Connectivity in the North Pacific is pursuing the large-scale connectivity story for oxygen across the North Pacific.**

The End