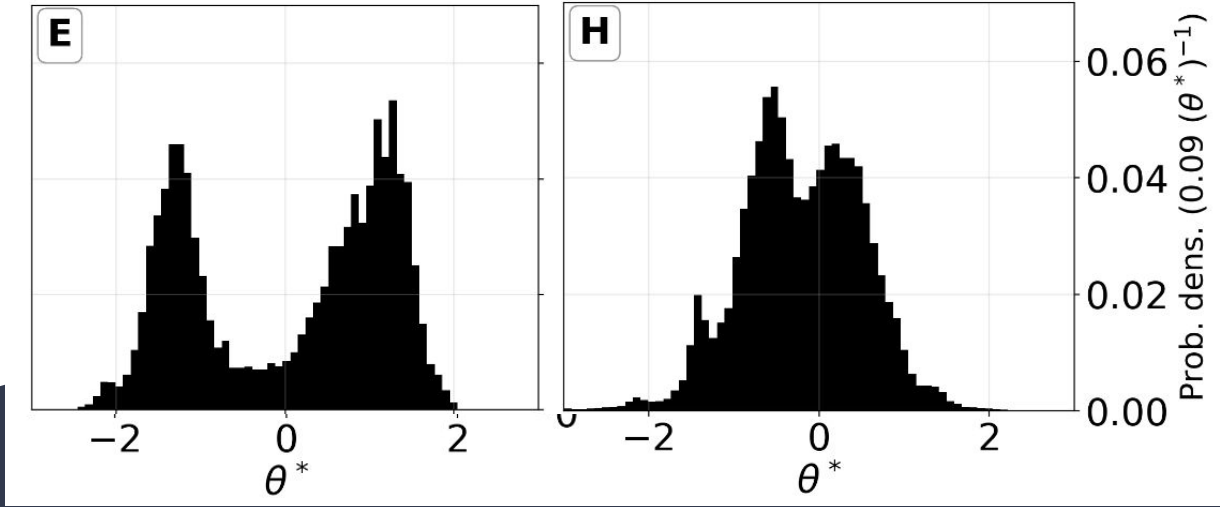
Lateral Stirring and Intermittent California Undercurrent Influence on the Southern Line

Giuliana Berden, Jody Klymak, Tetjana Ross and Guoqi Han



October 28, 2026 - PICES

Fisheries and Oceans Canada

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UVIC UNIVERSITY OF VICTORIA

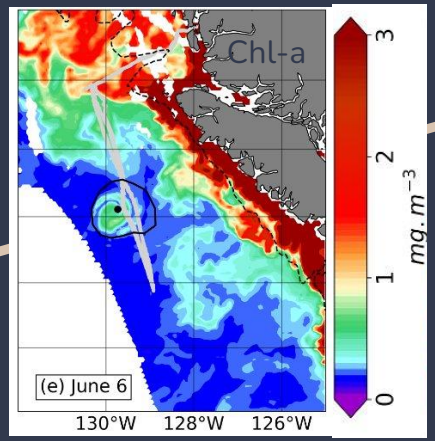
Ocean Physics Group

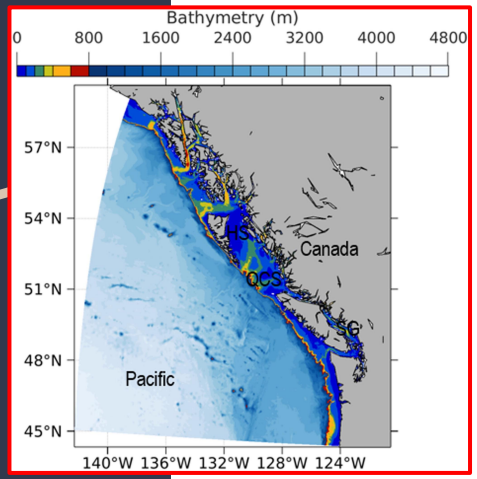
Lateral Stirring

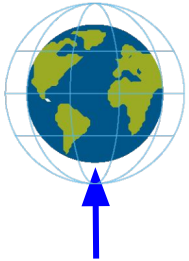
Heat - Salt - O2 - Carbon - Nutrients (e.g. Fe)

Regional Circulation & Climate

Primary production







1km 10km 25km 100km

1/36° regional models underestimate submesoscale variance (Talbot et al., 2026)

We need to improve these parametrizations

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Lateral Stirring

Heat - Salt - O2 - Carbon - Nutrients (e.g. Fe)

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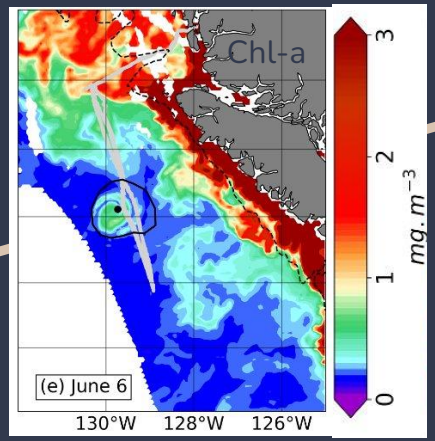
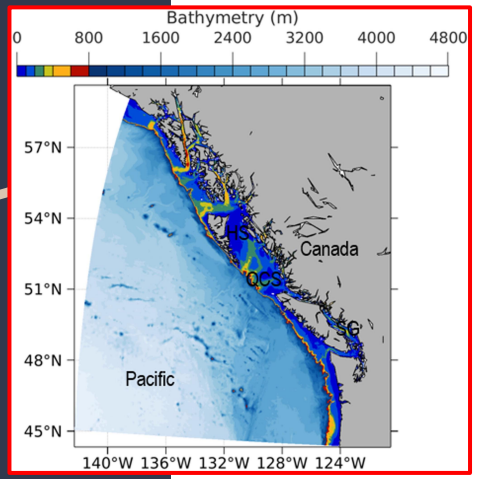
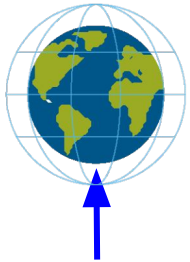




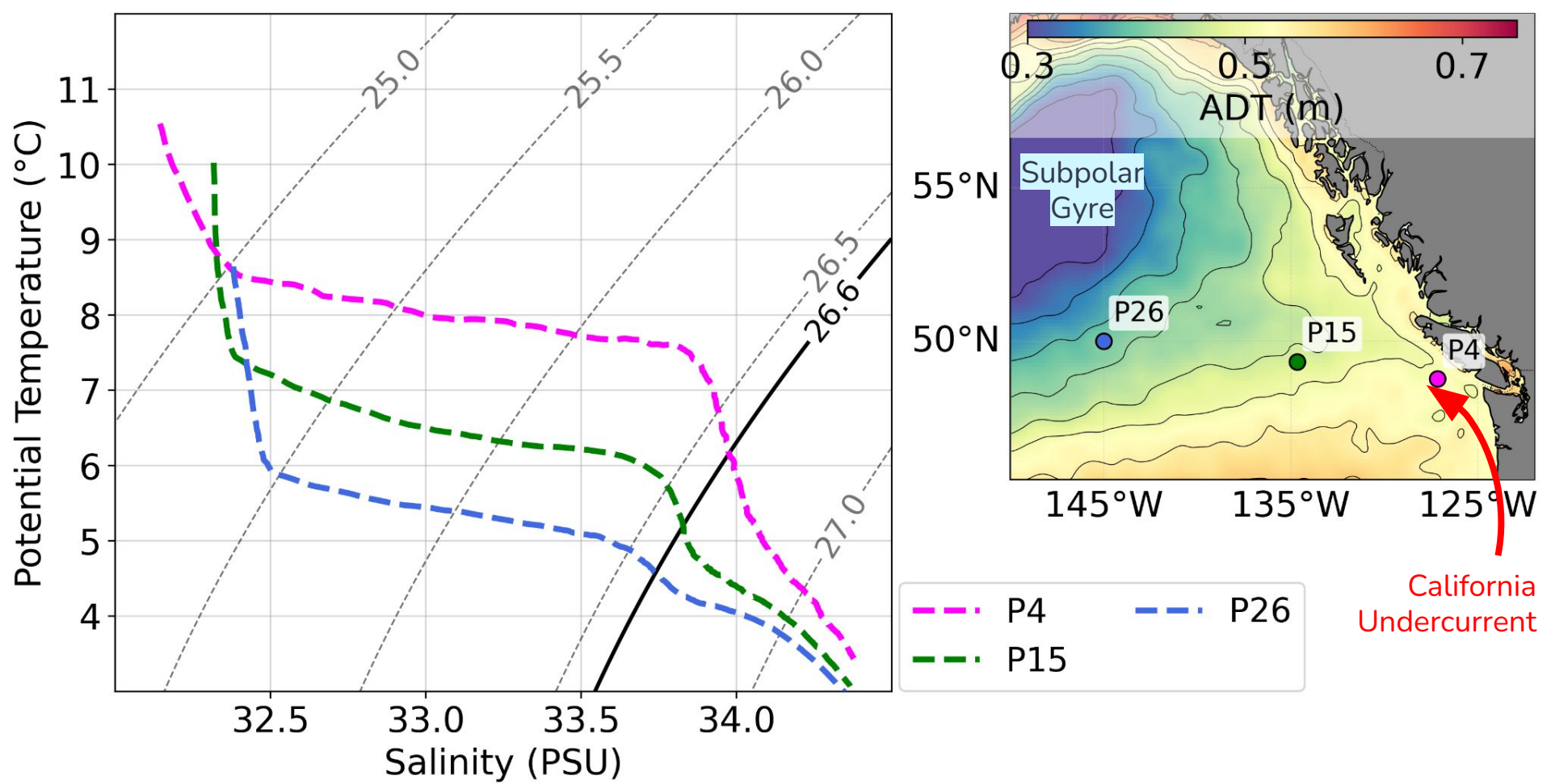


1km 10km 25km 100km

1/36° regional models underestimate submesoscale variance (Talbot et al., 2026)

We need to improve these parametrizations

Observations



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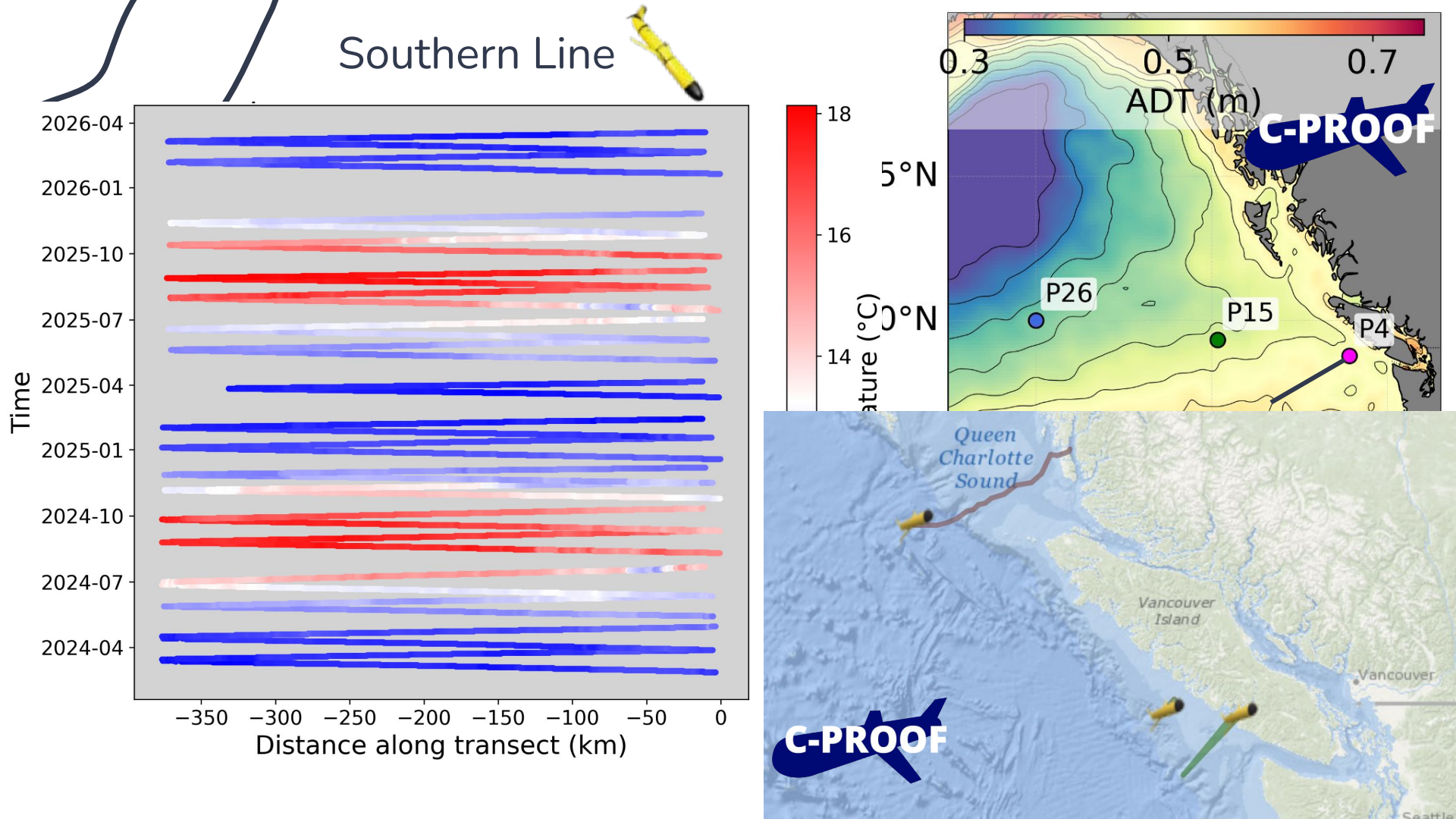
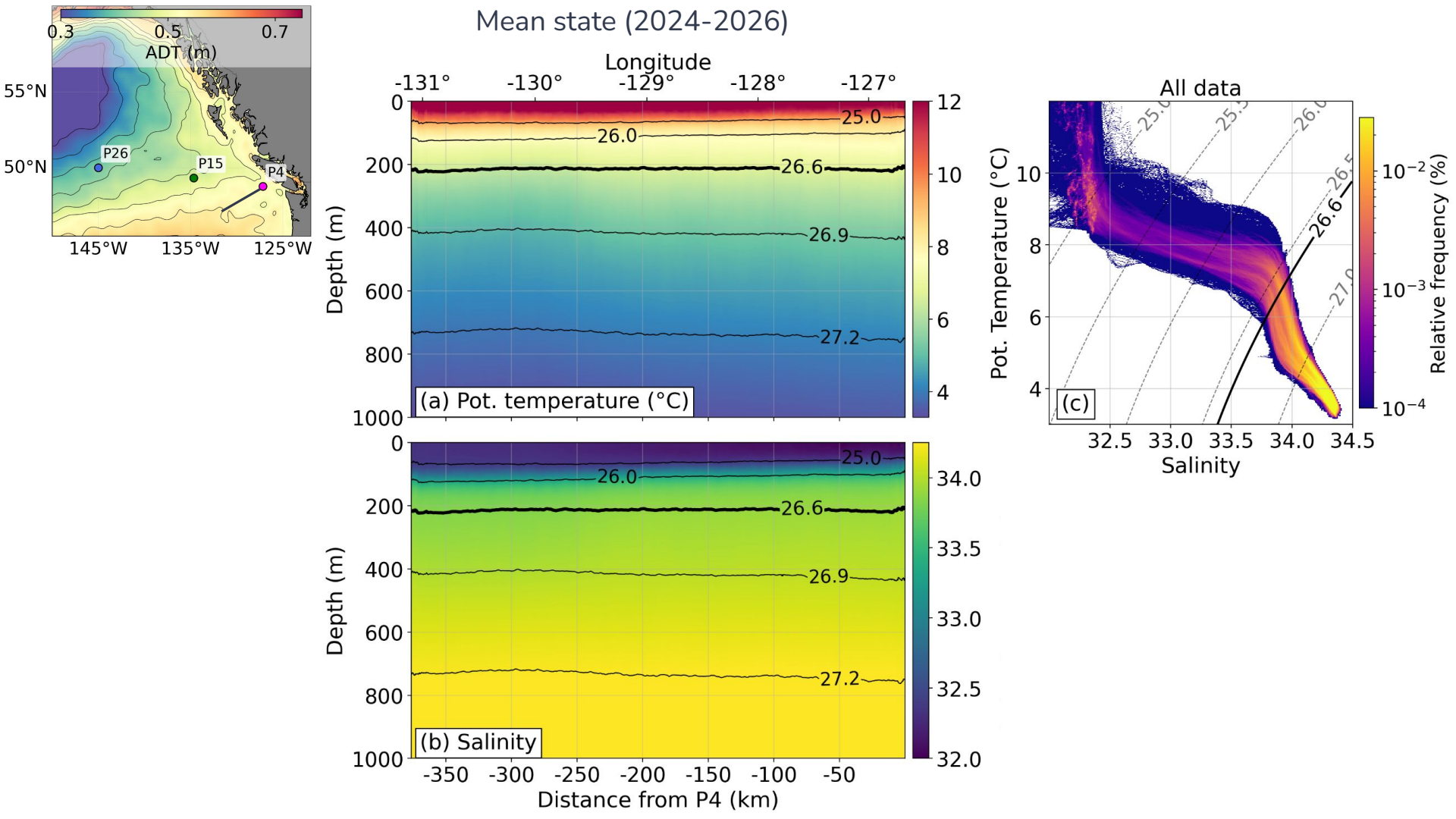
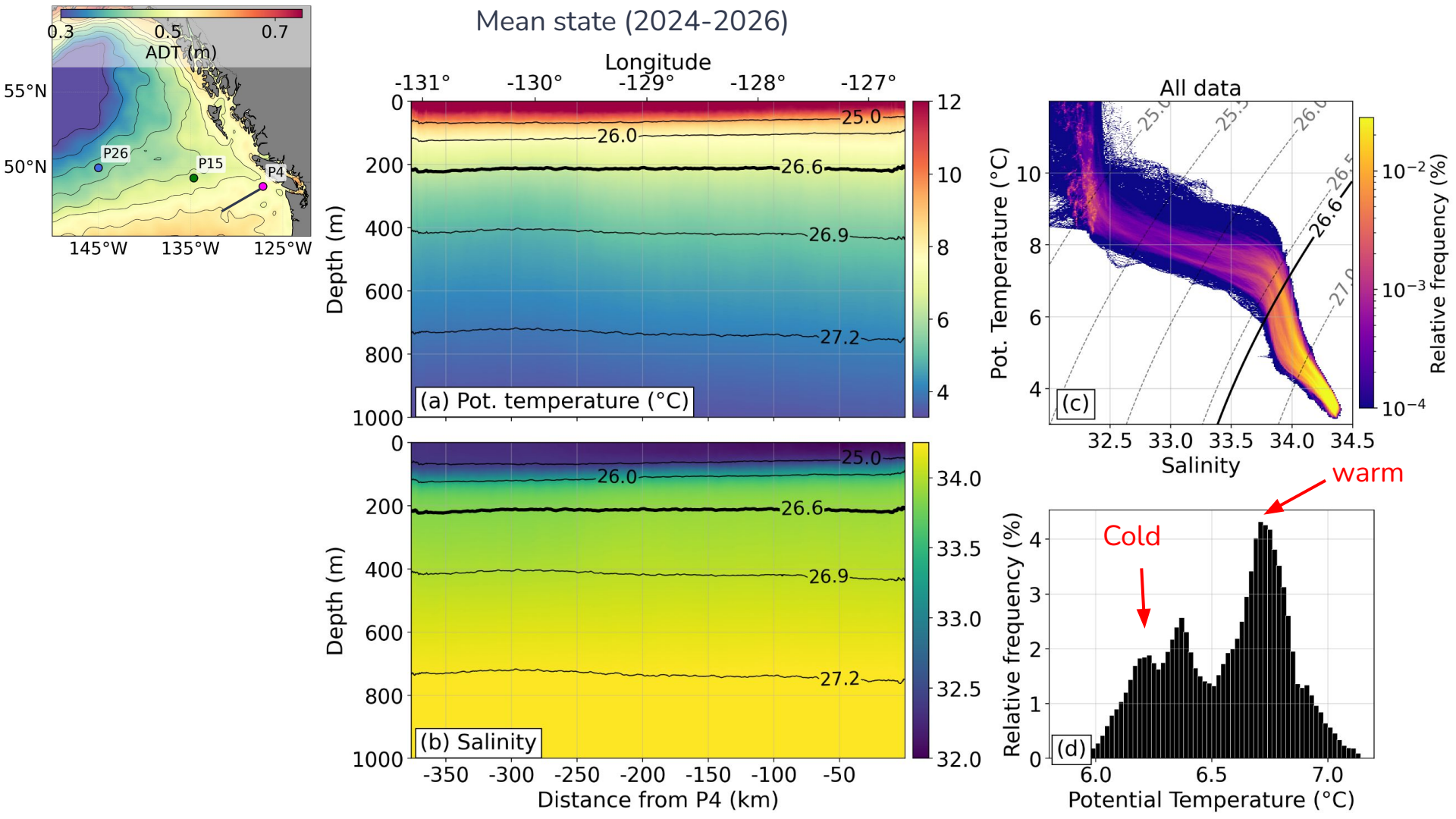
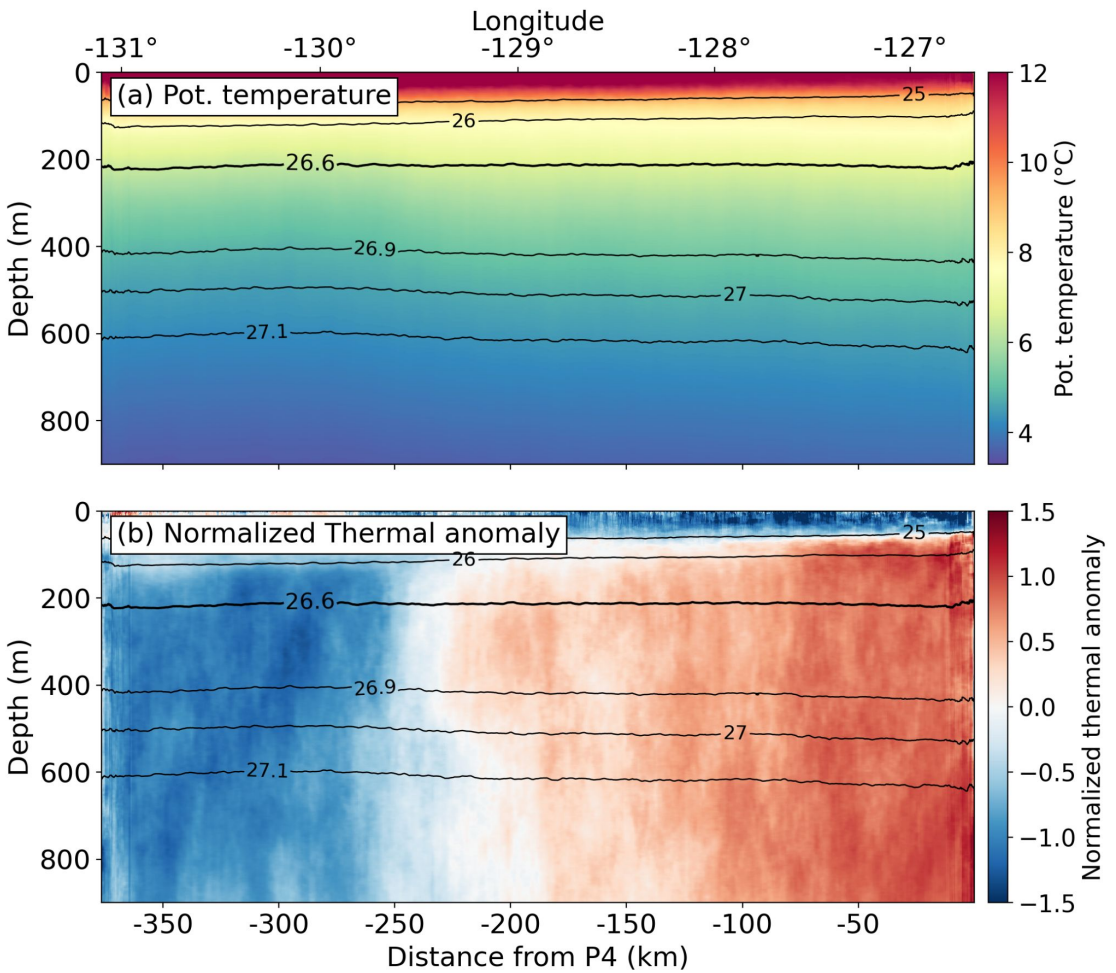

Southern Line
2026-04
2026-01
2025-10
2025-07
2025-04
2025-01
2024-10
2024-07
2024-04
Time
−350
−300
−250
−200
−150
−100
−50
0
Distance along transect (km)
18
16
14
0.3
0.5
0.7
ADT (m)
C-PROOF
5°N
0°N
P26
P15
P4
Queen Charlotte Sound
Vancouver Island
Vancouver
C-PROOF


Mean state (2024-2026)
0.3
0.5
0.7
ADT (m)
55°N
50°N
P26
P15
P4
145°W
135°W
125°W
Longitude
-131°
-130°
-129°
-128°
-127°
Depth (m)
0
200
400
600
800
1000
25.0
26.0
26.6
26.9
27.2
(a) Pot. temperature (°C)
12
10
8
6
4
(b) Salinity
34.0
33.5
33.0
32.5
32.0
-350
-300
-250
-200
-150
-100
-50
Distance from P4 (km)
All data
Pot. Temperature (°C)
10
8
6
4
(c)
32.5
33.0
33.5
34.0
34.5
Salinity
Relative frequency (%)
10^{-2}
10^{-3}
10^{-4}


Mean state (2024-2026)
0.3
0.5
0.7
ADT (m)
55°N
50°N
P26
P15
P4
145°W
135°W
125°W
Longitude
-131°
-130°
-129°
-128°
-127°
Depth (m)
25.0
26.0
26.6
26.9
27.2
(a) Pot. temperature (°C)
(b) Salinity
Distance from P4 (km)
All data
Pot. Temperature (°C)
Salinity
Relative frequency (%)
(c)
warm
Cold
(d)
Potential Temperature (°C)

$$\theta^* = \frac{T_{sigma} - \bar{T}_{sigma}}{std(T_{sigma})}$$



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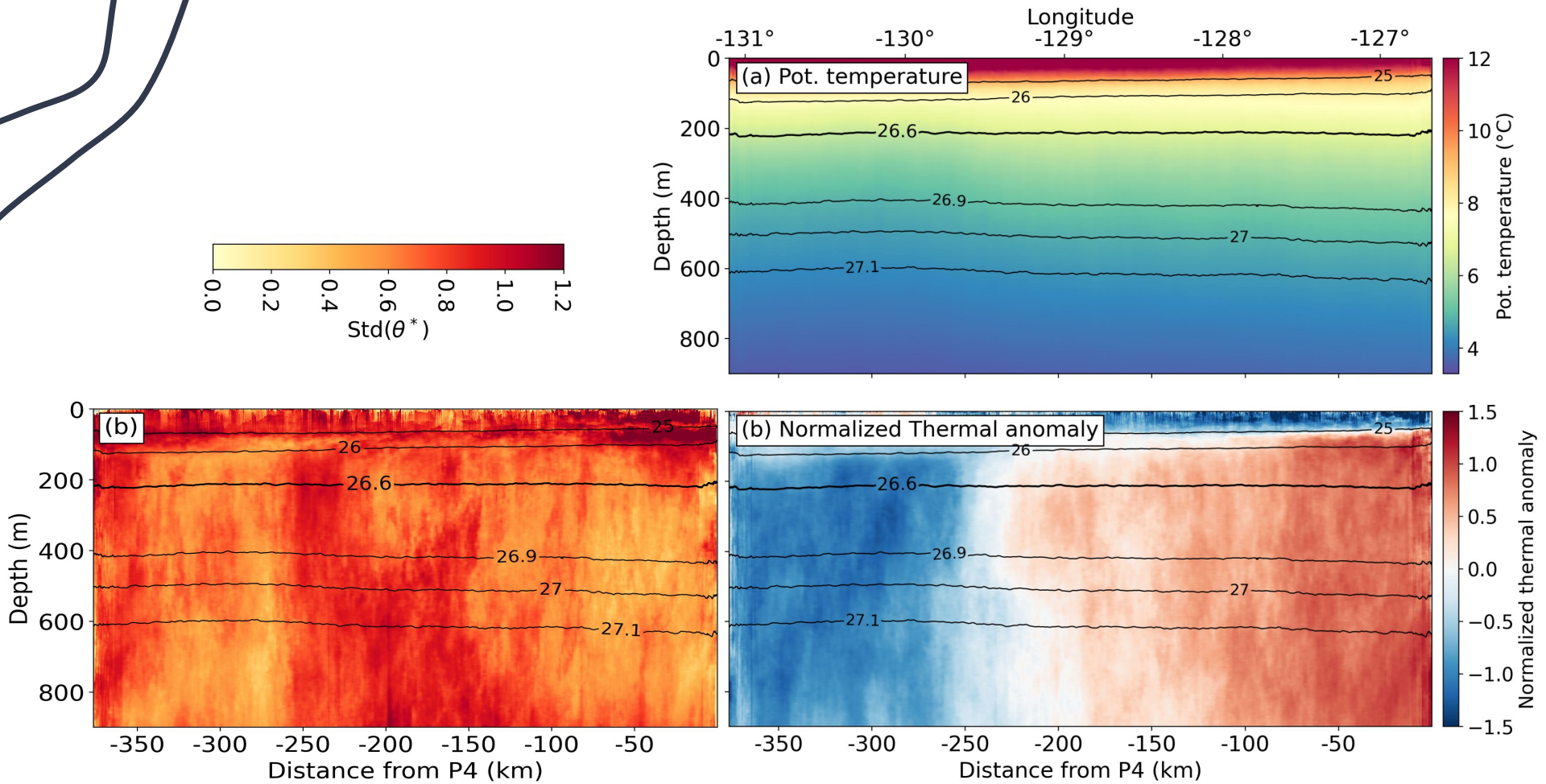

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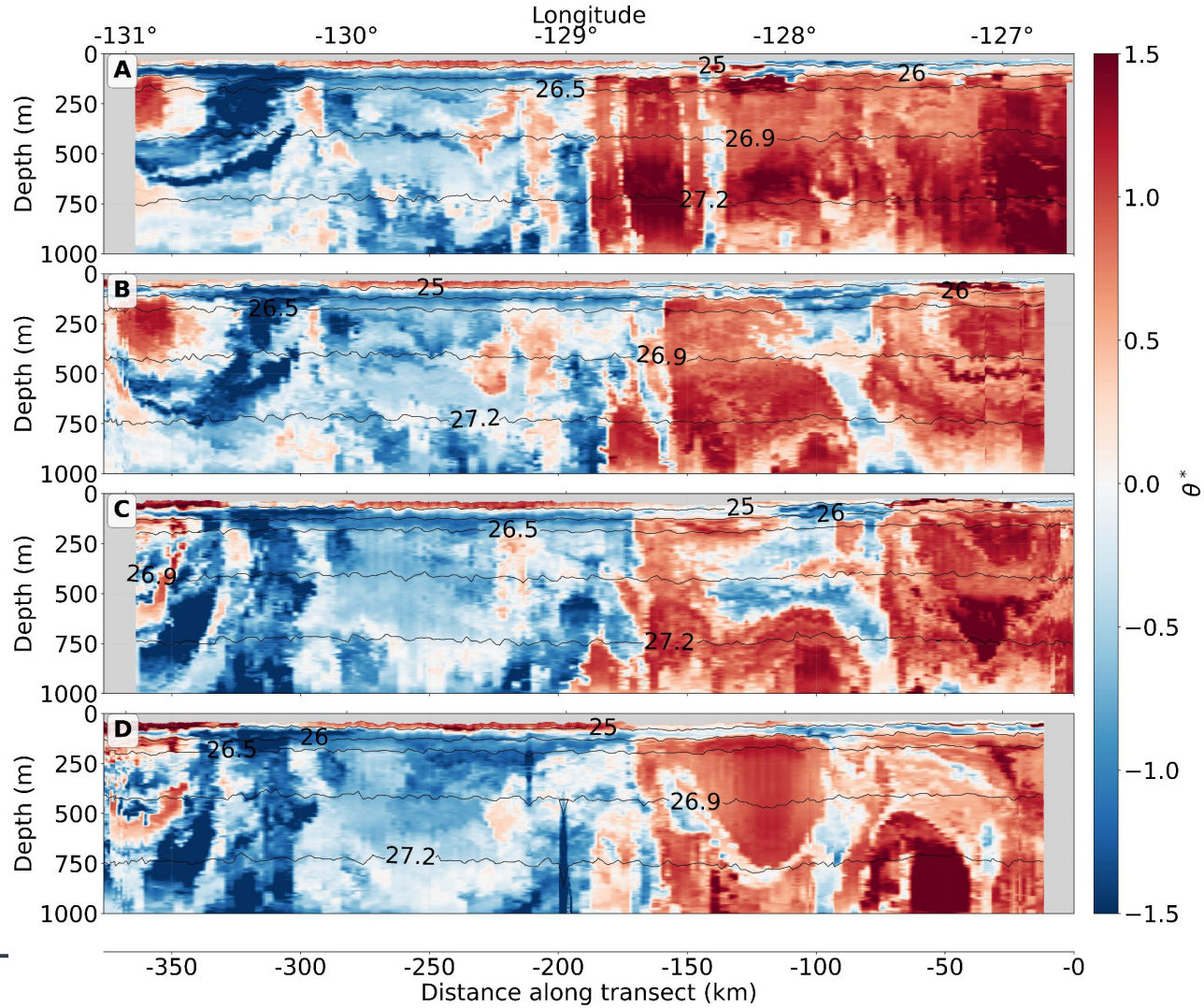

Summer 2024

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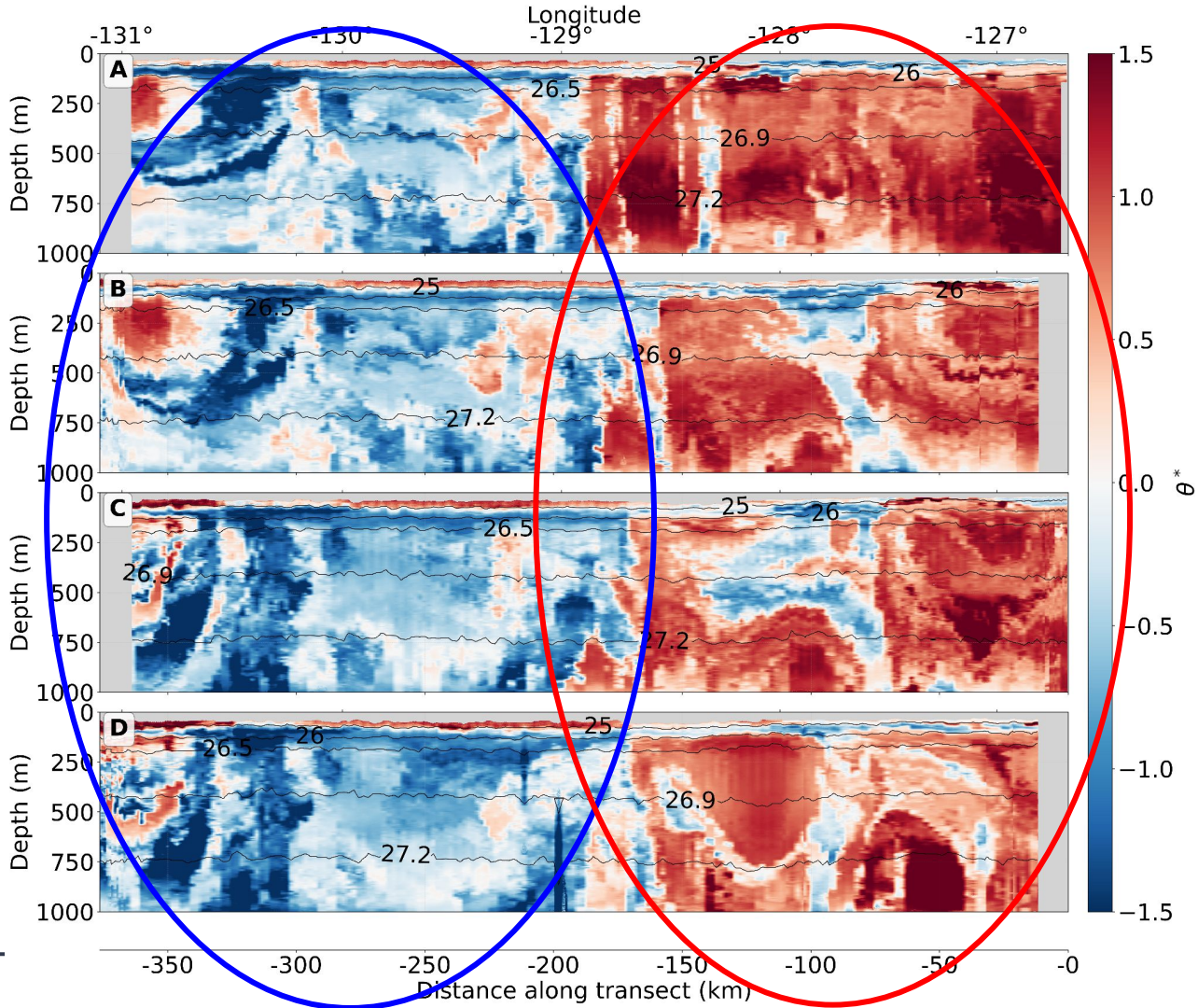
Colder water
–> Offshore



Warm water
–> CUC

Summer 2024

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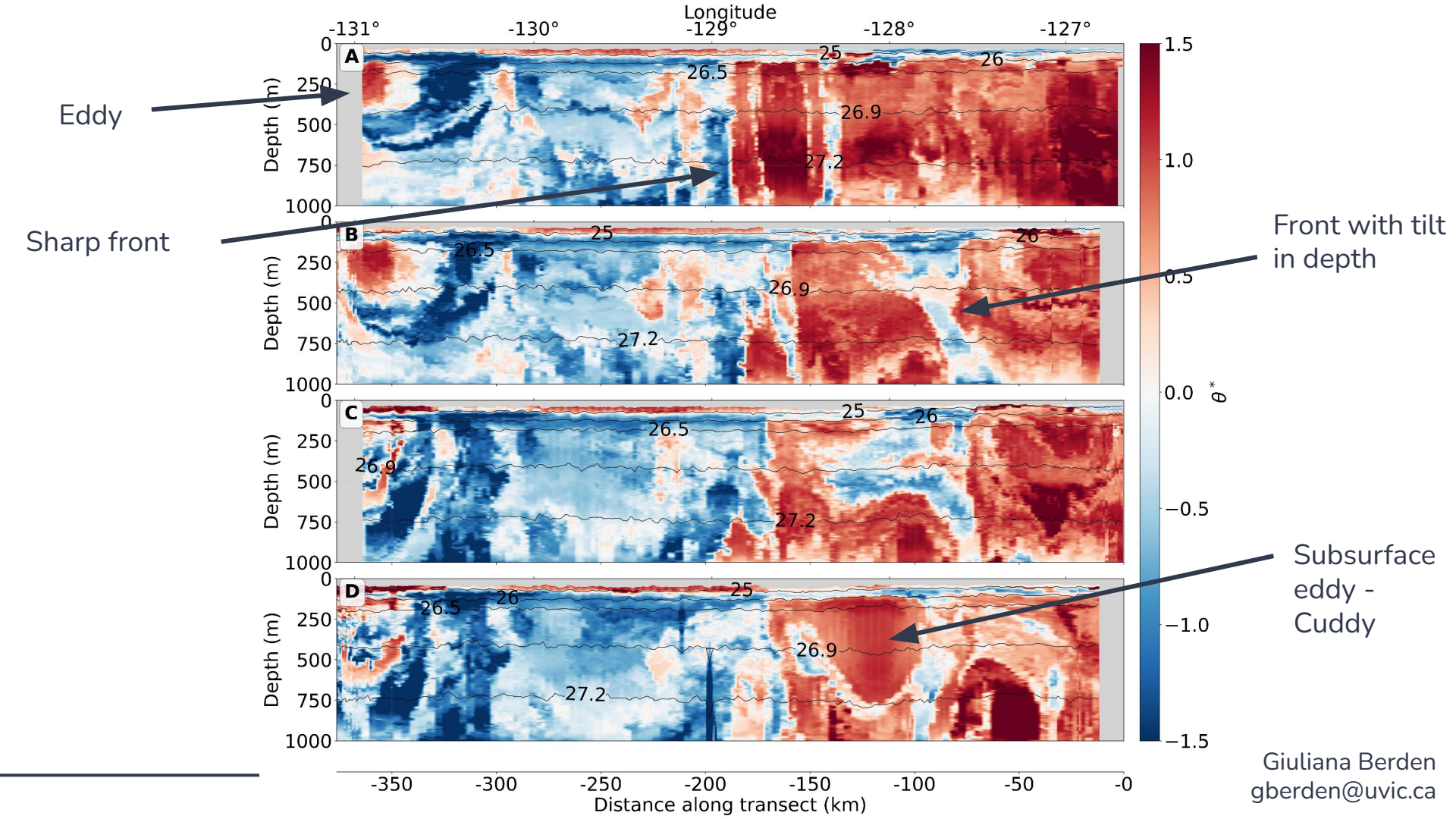

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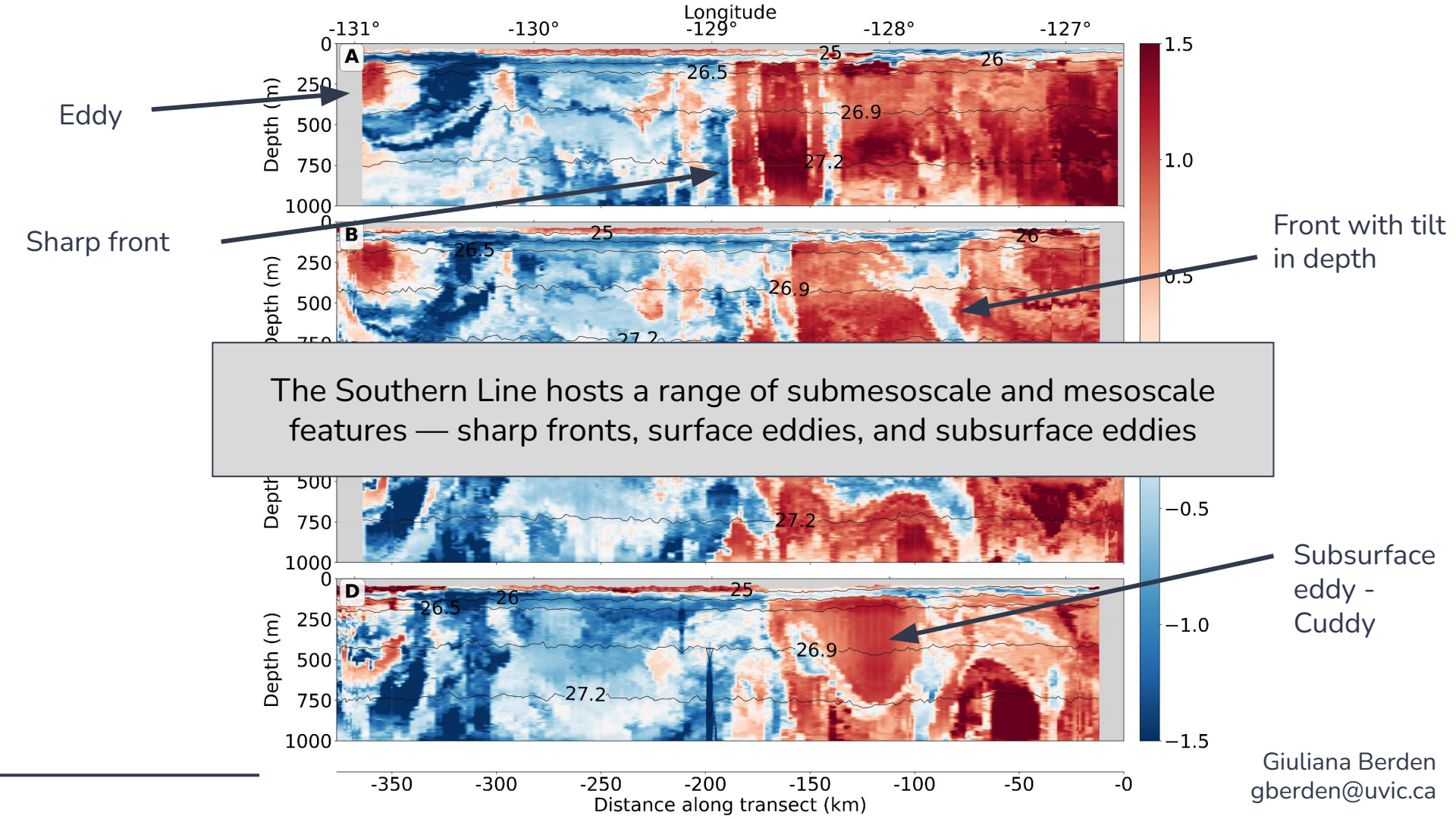

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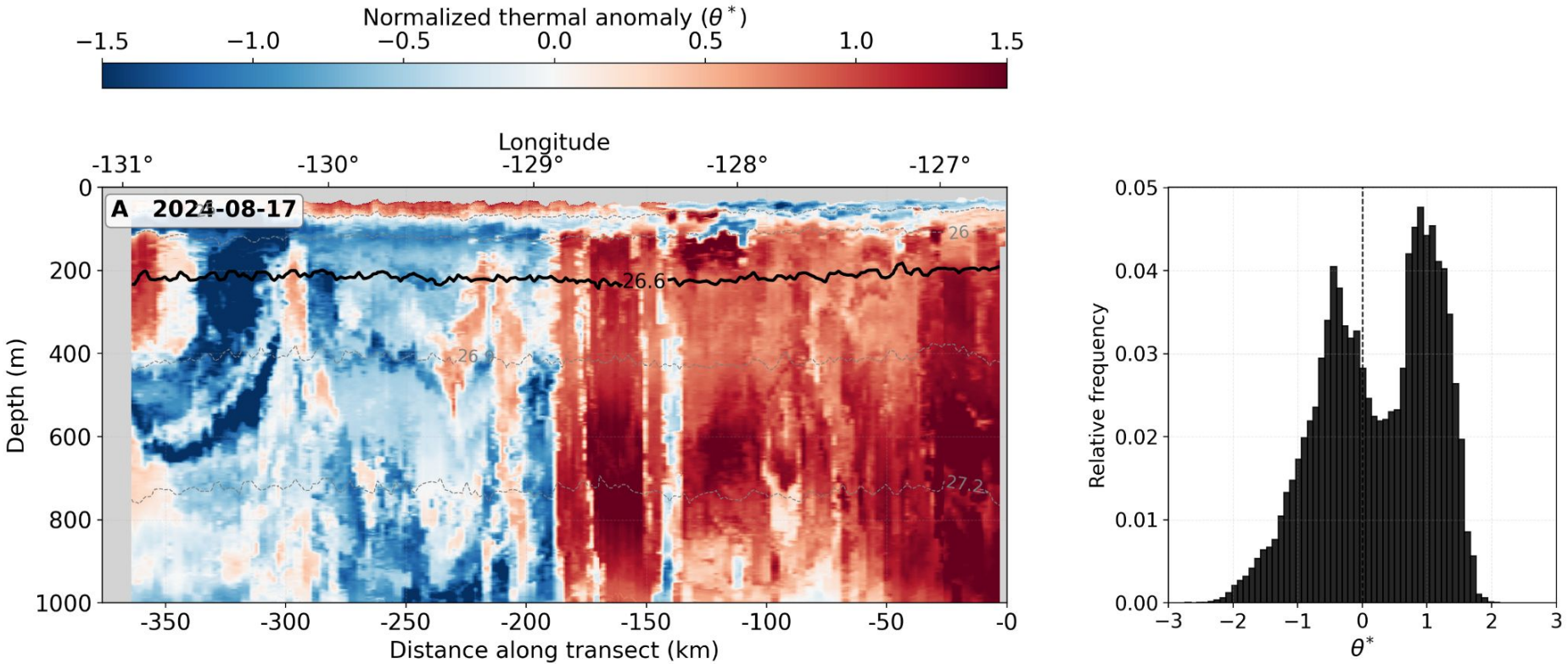
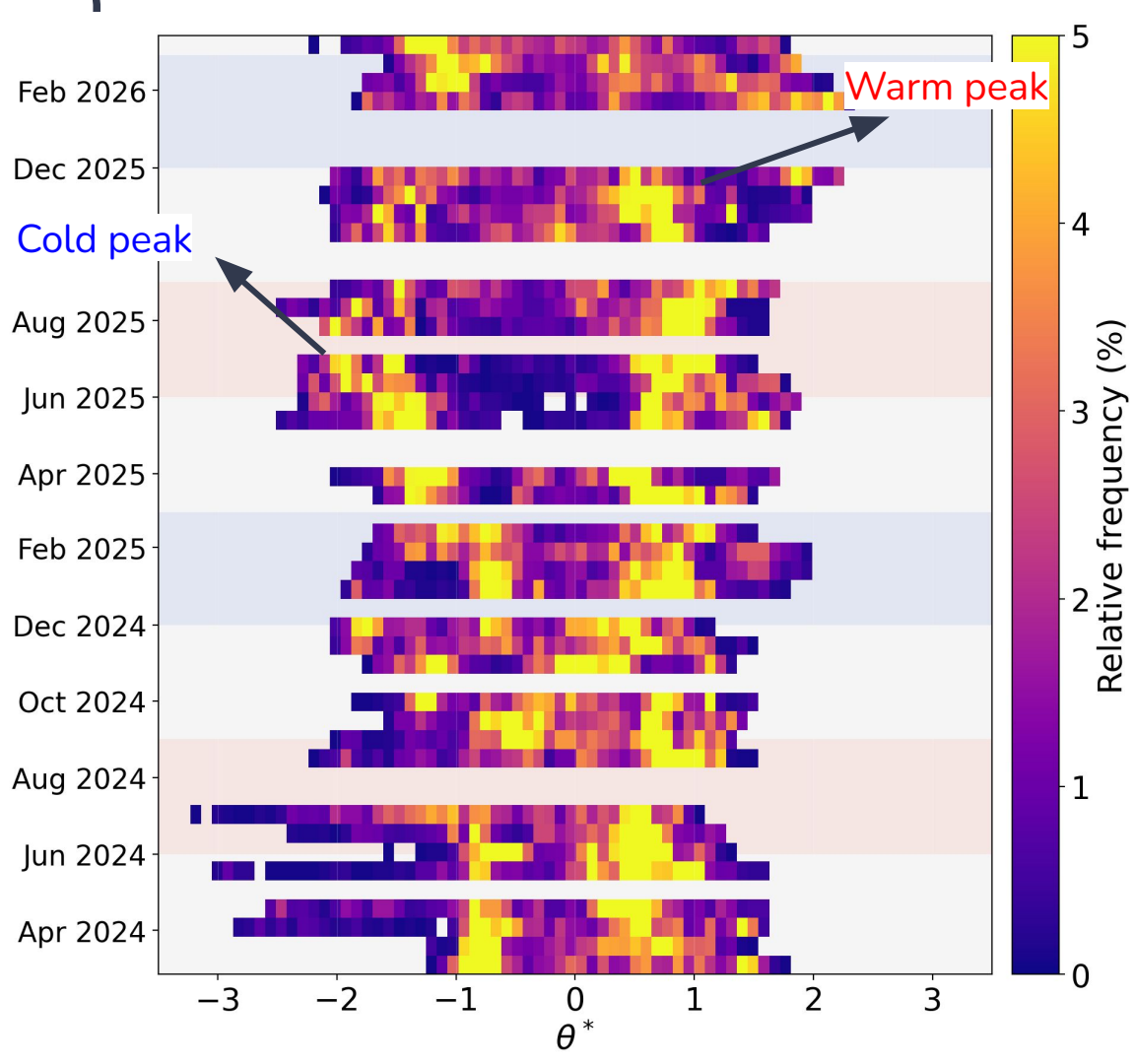

Normalized thermal anomaly (θ^*)
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
Longitude
-131°
-130°
-129°
-128°
-127°
A 2024-08-17
26
26.6
26.9
27.2
Depth (m)
0
200
400
600
800
1000
-350
-300
-250
-200
-150
-100
-50
-0
Distance along transect (km)
Relative frequency
0.05
0.04
0.03
0.02
0.01
0.00
−3
−2
−1
0
1
2
3
θ^*



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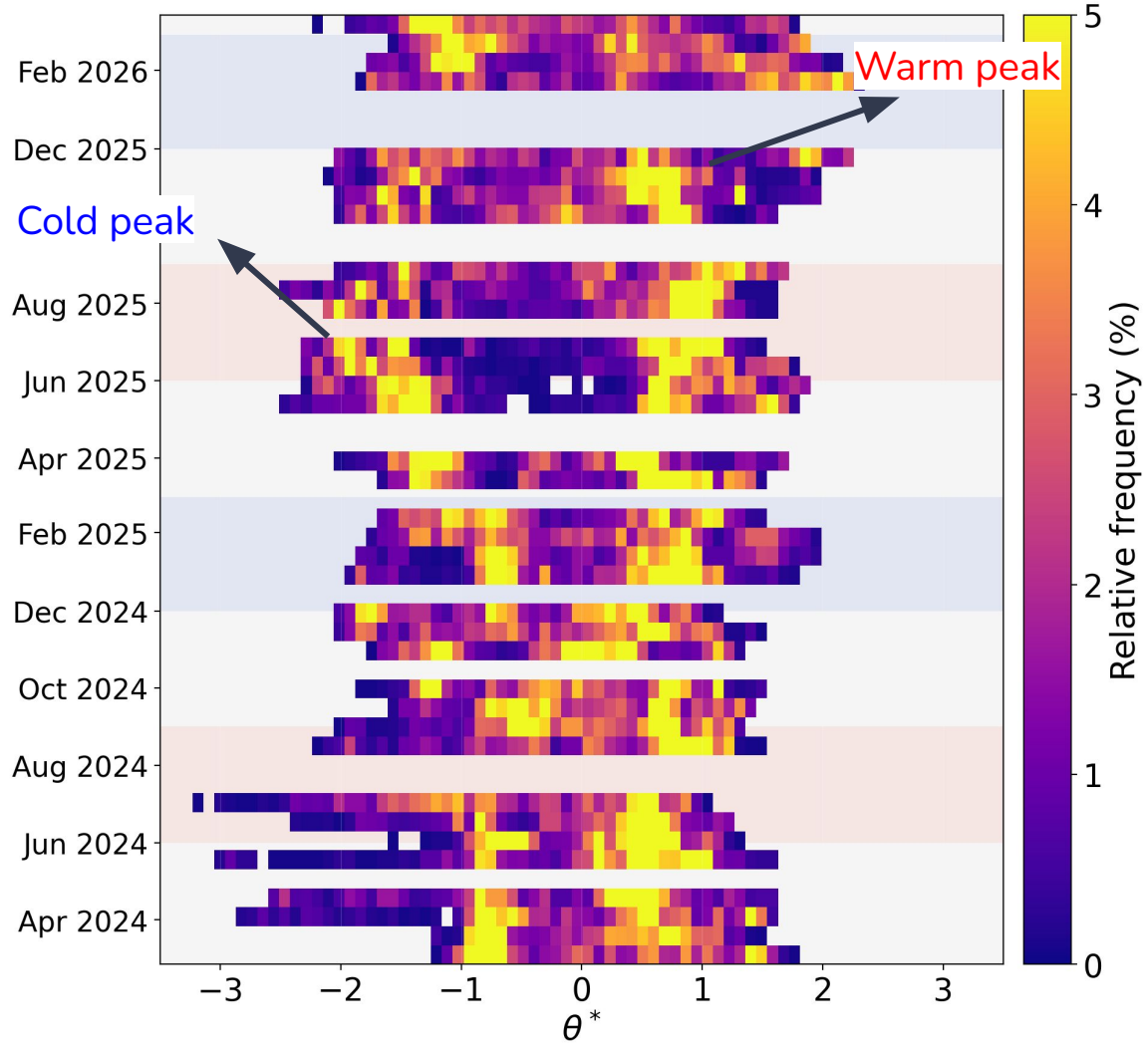

Index: Peak detection and peak-to-valley ratio (PVR)

$$PVR = \frac{\min(h_{\text{peak1}},\, h_{\text{peak2}})}{h_{\text{valley}}}$$

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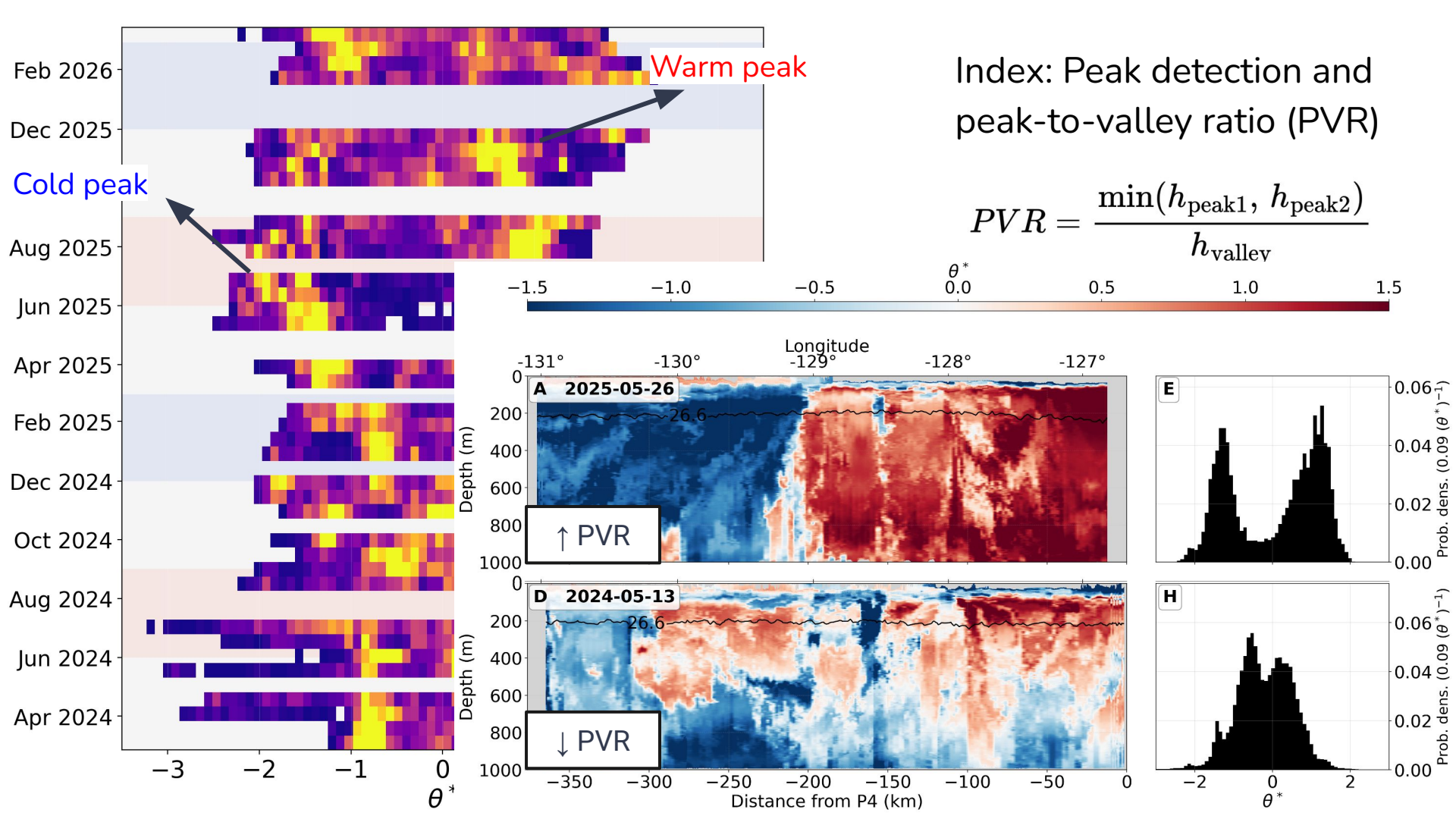
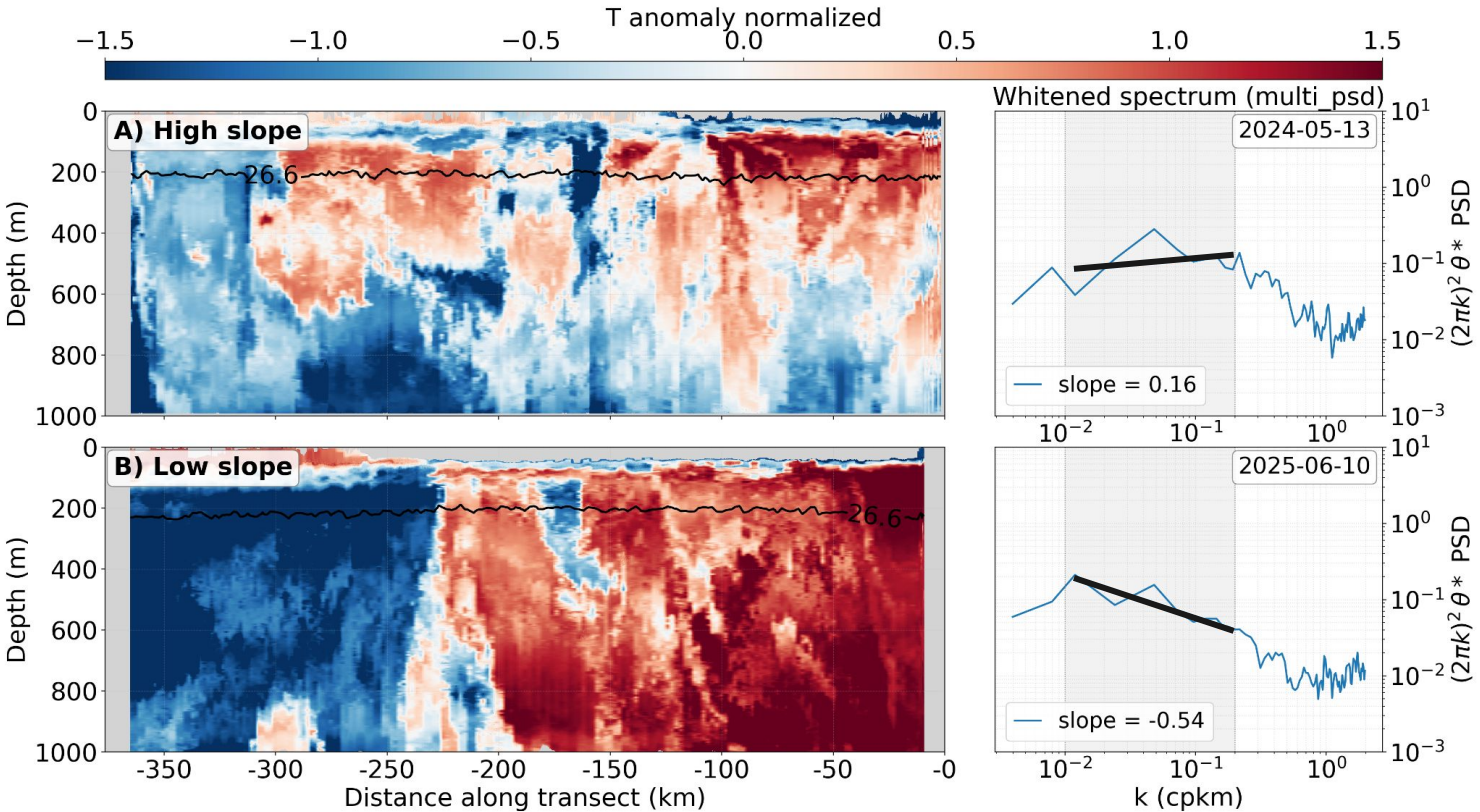
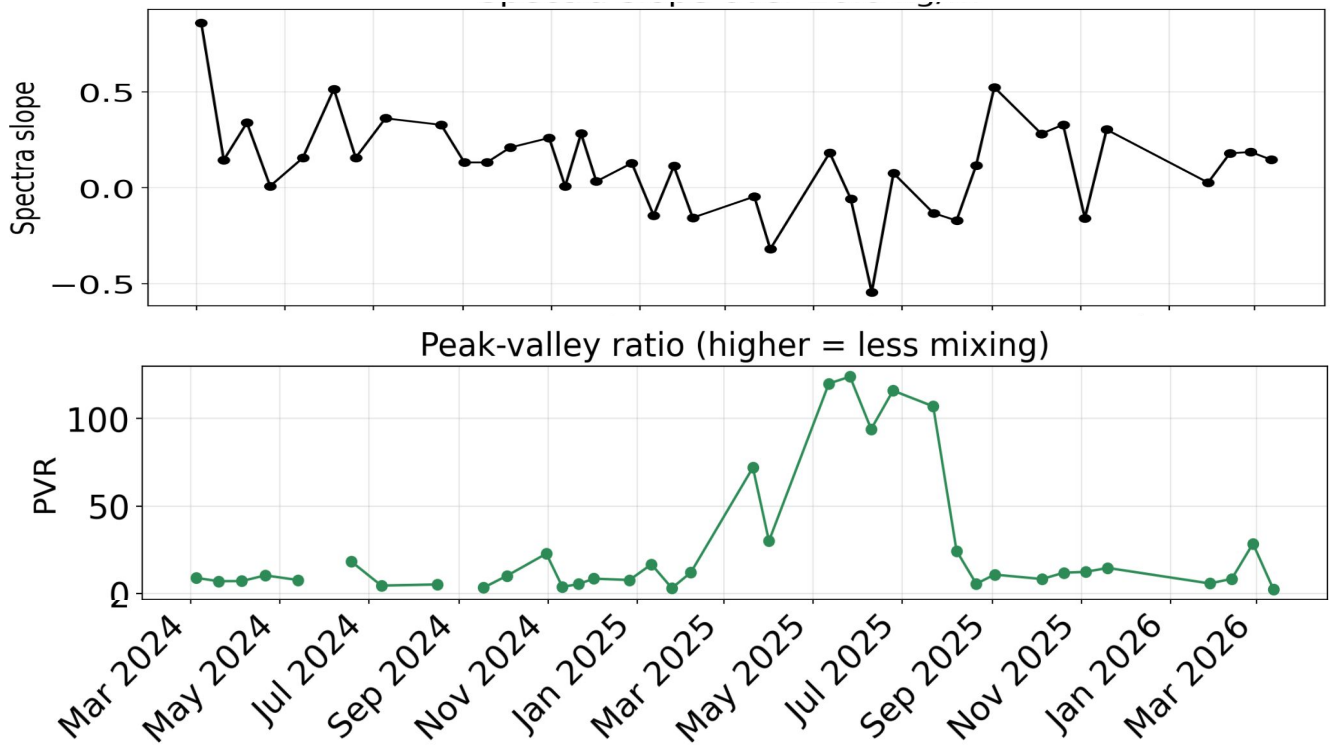

Warm peak
Cold peak
Feb 2026
Dec 2025
Aug 2025
Jun 2025
Apr 2025
Feb 2025
Dec 2024
Oct 2024
Aug 2024
Jun 2024
Apr 2024
−3
−2
−1
0
θ*
Index: Peak detection and peak-to-valley ratio (PVR)
$PVR = \frac{\min(h_{\text{peak1}},\, h_{\text{peak2}})}{h_{\text{valley}}}$
θ*
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
Longitude
-131°
-130°
-129°
-128°
-127°
A 2025-05-26
26.6
↑ PVR
Depth (m)
0
200
400
600
800
1000
D 2024-05-13
26.6
↓ PVR
−350
−300
−250
−200
−150
−100
−50
0
Distance from P4 (km)
E
H
Prob. dens. (0.09 (θ*)⁻¹)
0.00
0.02
0.04
0.06
−2
0
2
θ*

Spectral Slope



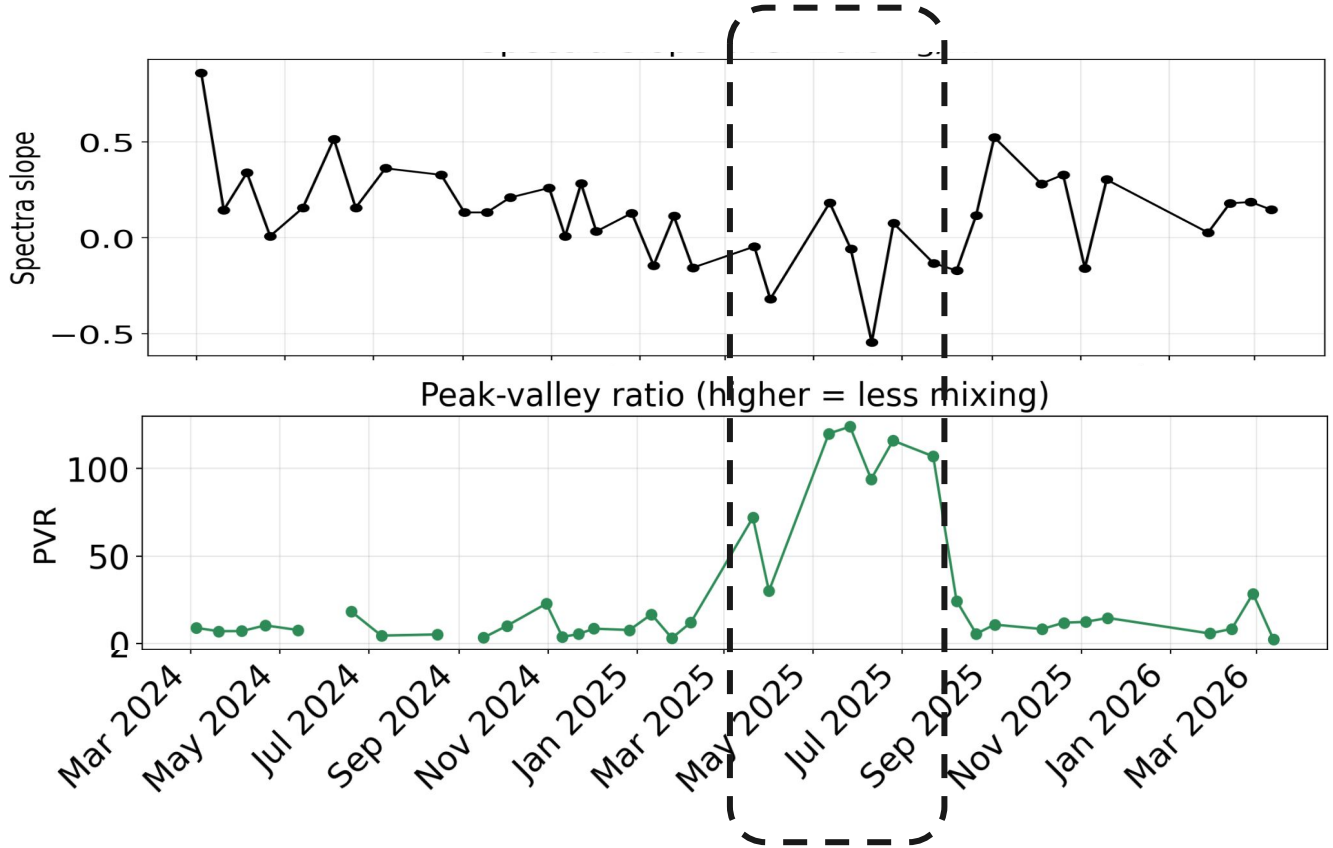
↑submesoscale
↓mesosclae

↓submesoscale
↑mesosclae

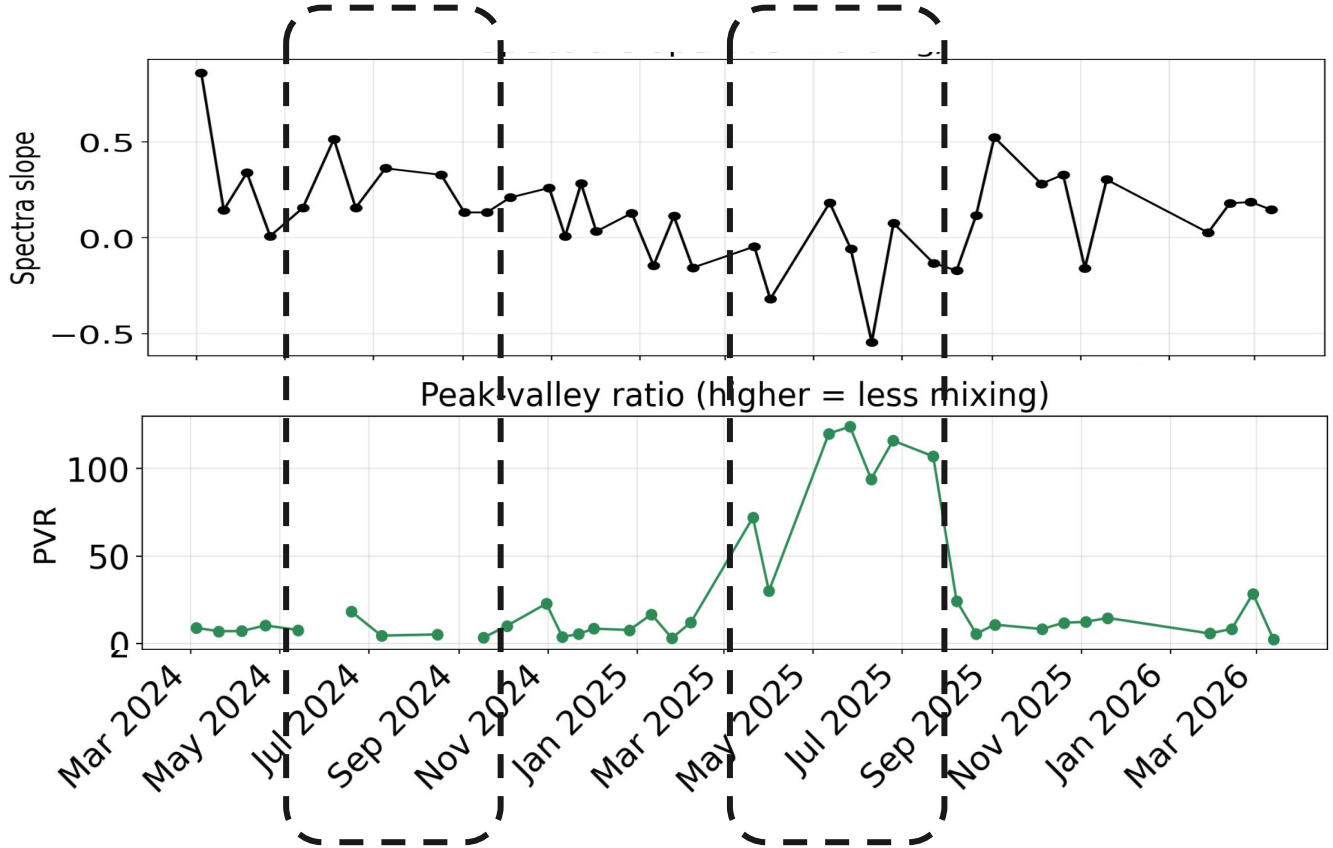


How is the variance distributed?

How distinct are the water masses?



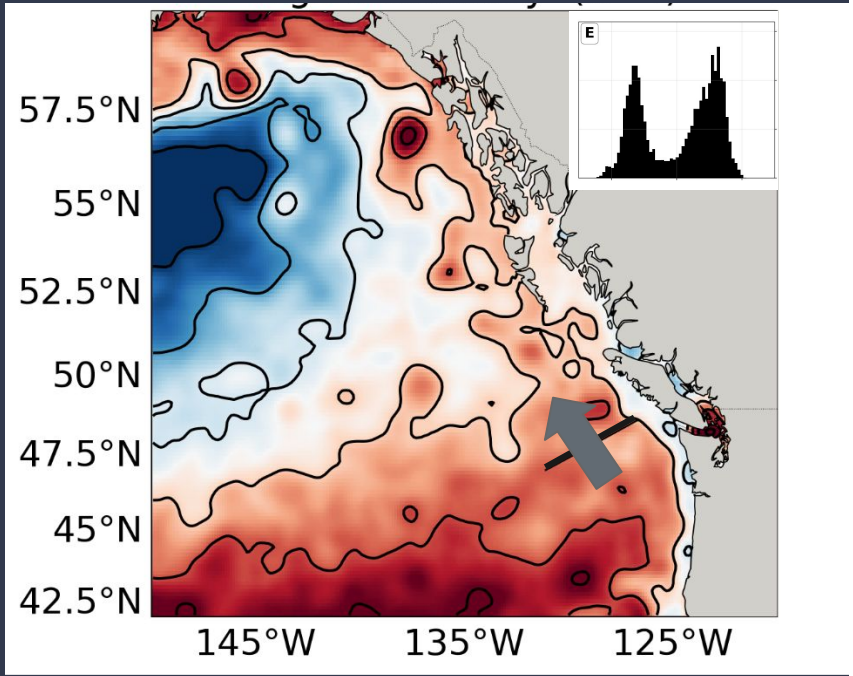
- Distintics water masses
- ↓ submesoscale variance, ↑mesoscale variance

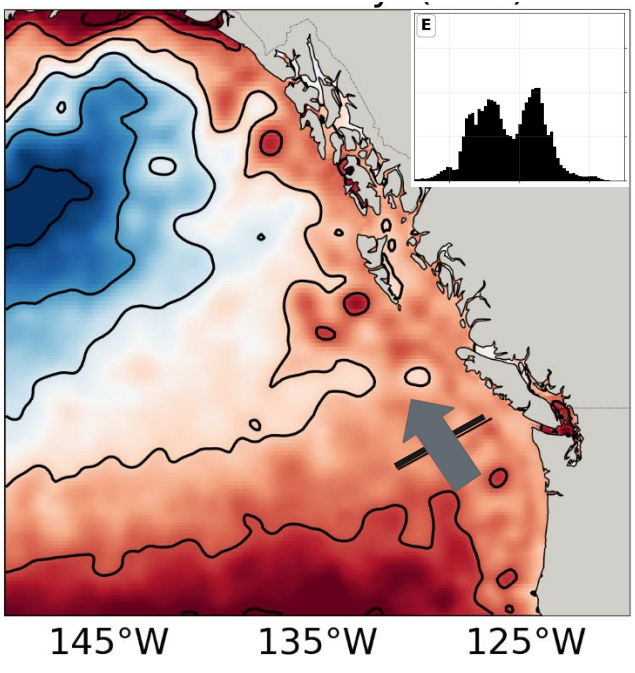


- Distintics water masses
- ↓ submesoscale variance, ↑mesoscale variance

The question: why?

Upwelling, EKE, CUC, transport





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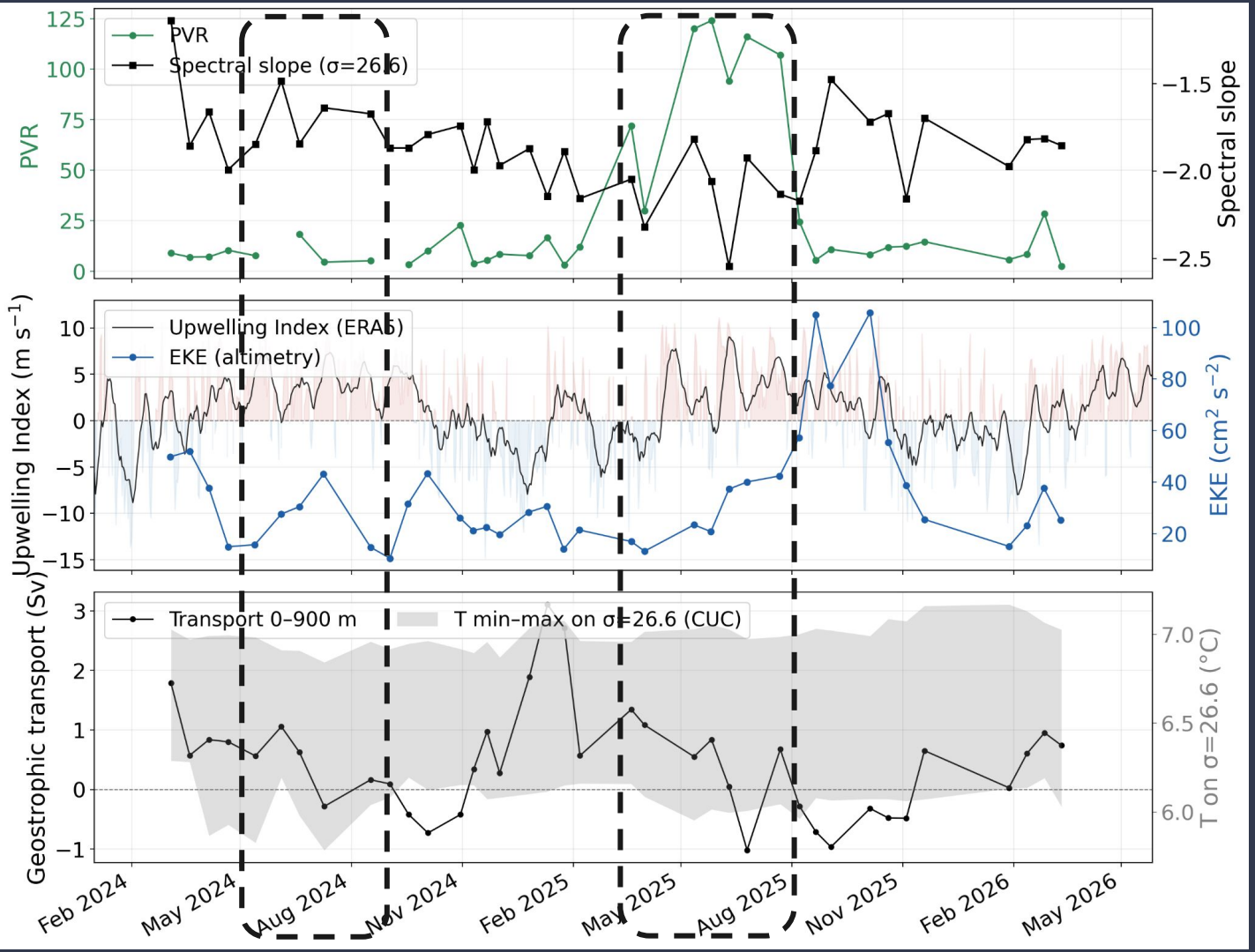
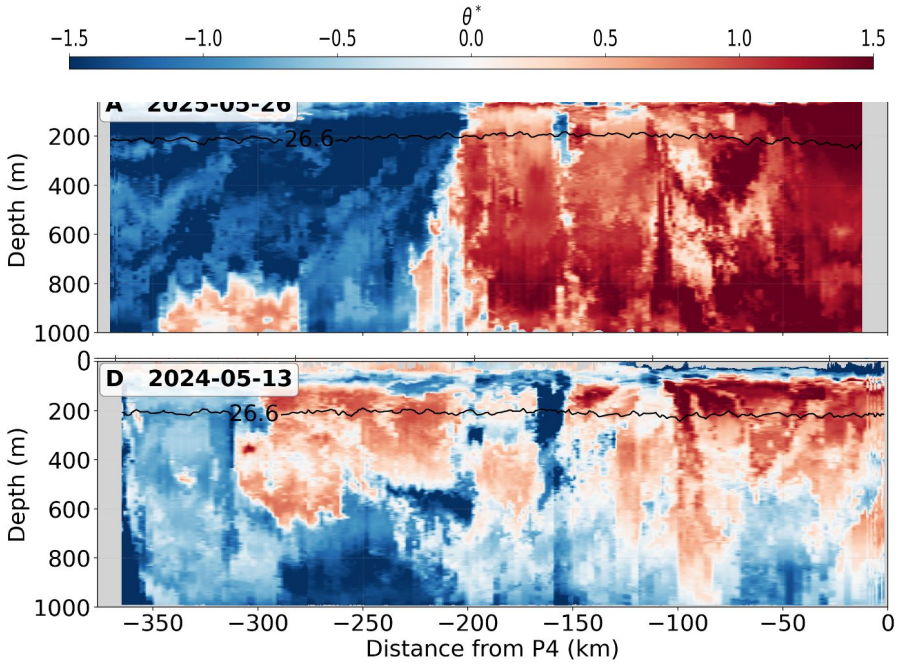


Possible drivers:

- Upwelling ✖
- EKE ✖
- CUC ✖
- Transport ✖

Takeaways:

- CUC influence on the Southern Line is intermittent
- Fronts, surface eddies and subsurface cuddies are resolved by the glider lines.
- **More distinct water masses ↔ less submesoscale variance.**
- No single driver (upwelling, EKE, CUC influence, transport) explains the spectral slope on its own.



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