Aquatic Sciences Meeting, Palma, 2023-06-05
T Panaïotis, A Poteau, É Diamond-Riquier, L Courchet, S Motreuil, C Catalano, L Coppola, M Picheral and JO Irisson

SCIENCES SORBONNE UNIVERSITÉ

Temporal evolution of particles and plankton distributions across a mesoscale front during the spring bloom

Describe community dynamics during the *bloom* over a *front*

What we know

Bloom in **Feb-March**

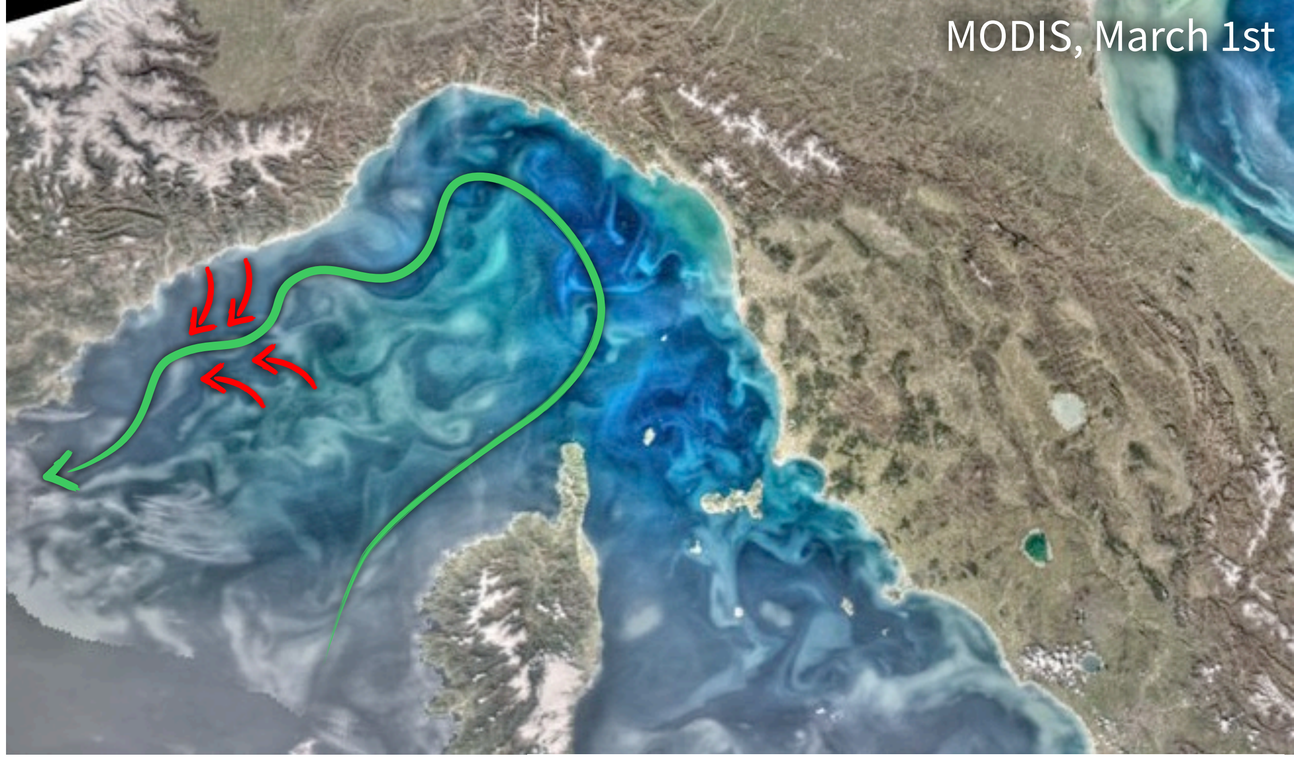
Succession: phytoplankton → zooplanktonic grazers → zooplanktonic predators

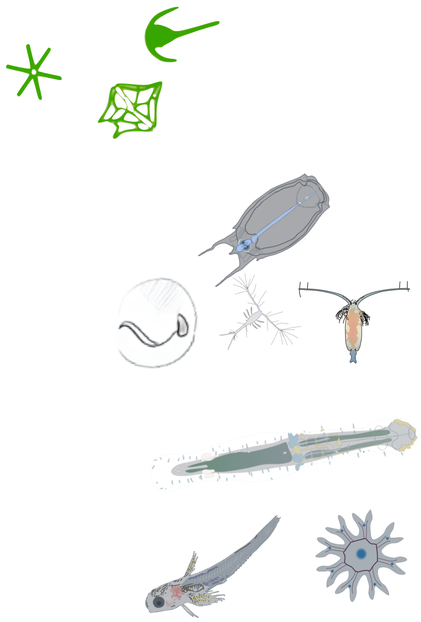
Ends with stratification, **oligotrophy** of surface and creation of Deep Chlorophyll Maximum

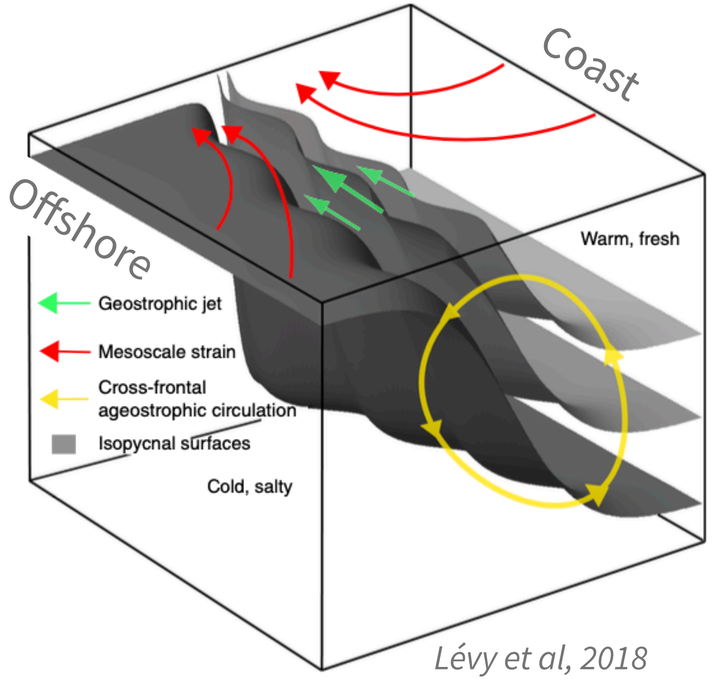
Permanent front, including **submesoscale** recirculation

Increased productivity and/or aggregation

Constrains **particle** distribution possibly **plankton**







Lévy et al, 2018

Needs

Okm resolution

several months

biogeochemistry → zooplankton

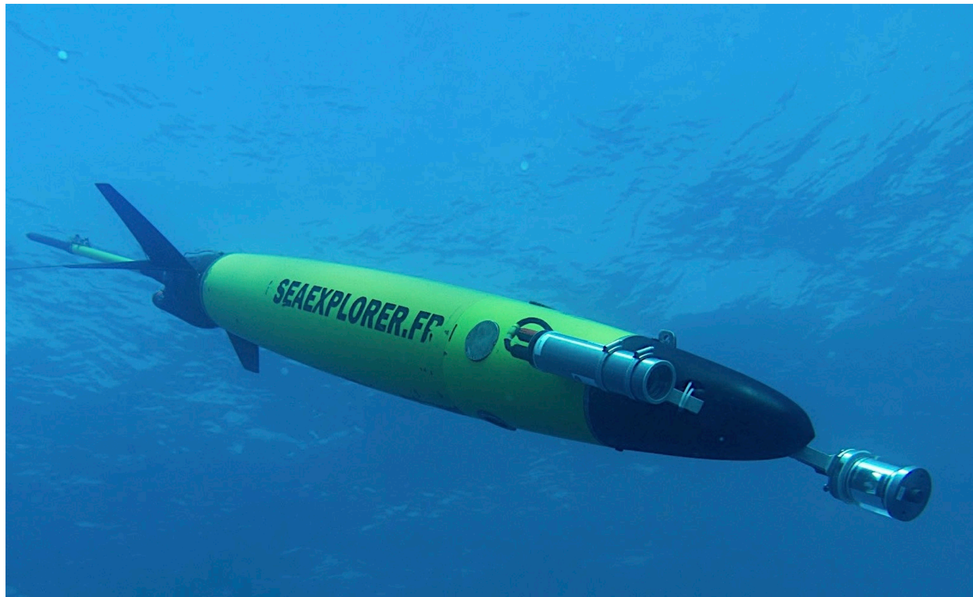
⇒

Glider + UVP6

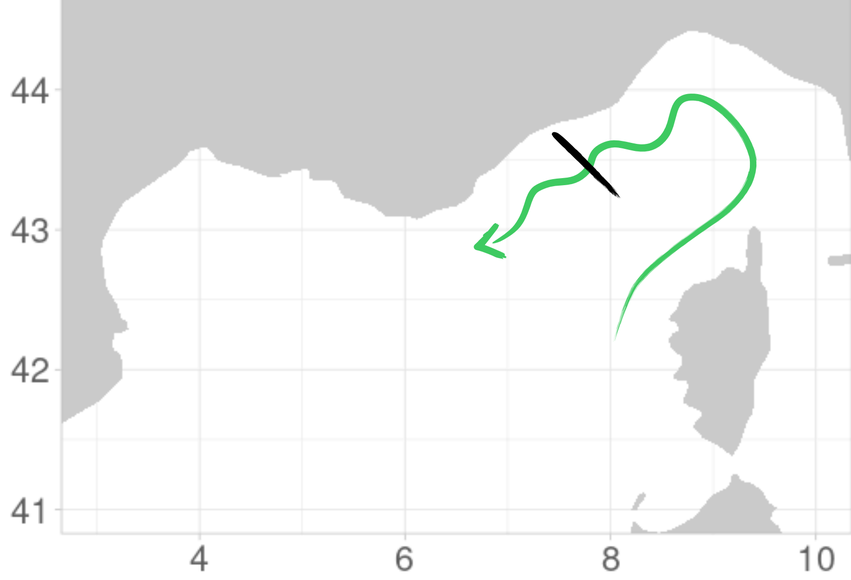
T°, sal

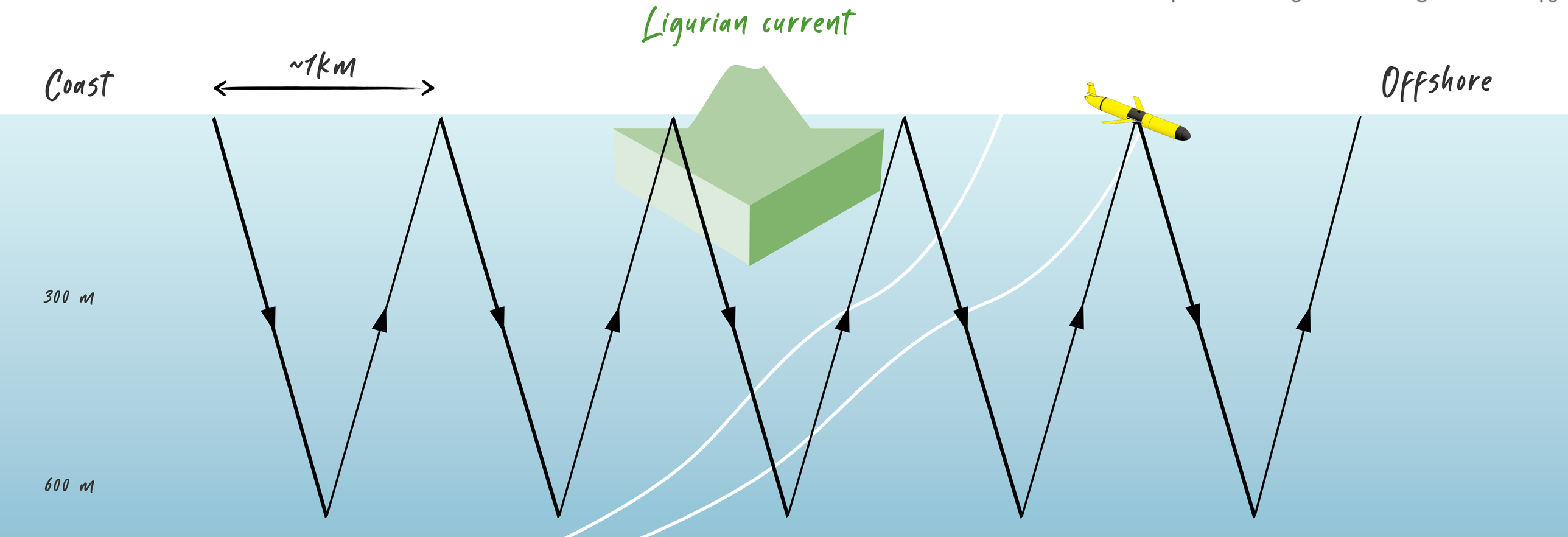
O_2, Chl a, CDOM, BB700

UVP6 LP
particles > 80 µm
organisms > ~1 mm



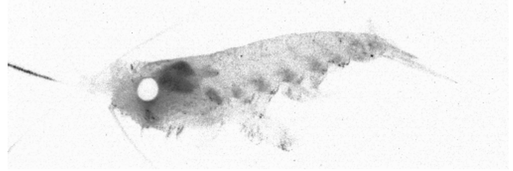
Sampling strategy

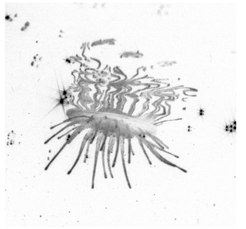
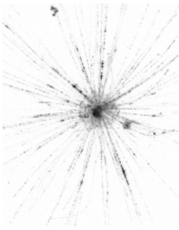




Glider campaign overview

5000 profiles
1.1 million images



J 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

F 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

M 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

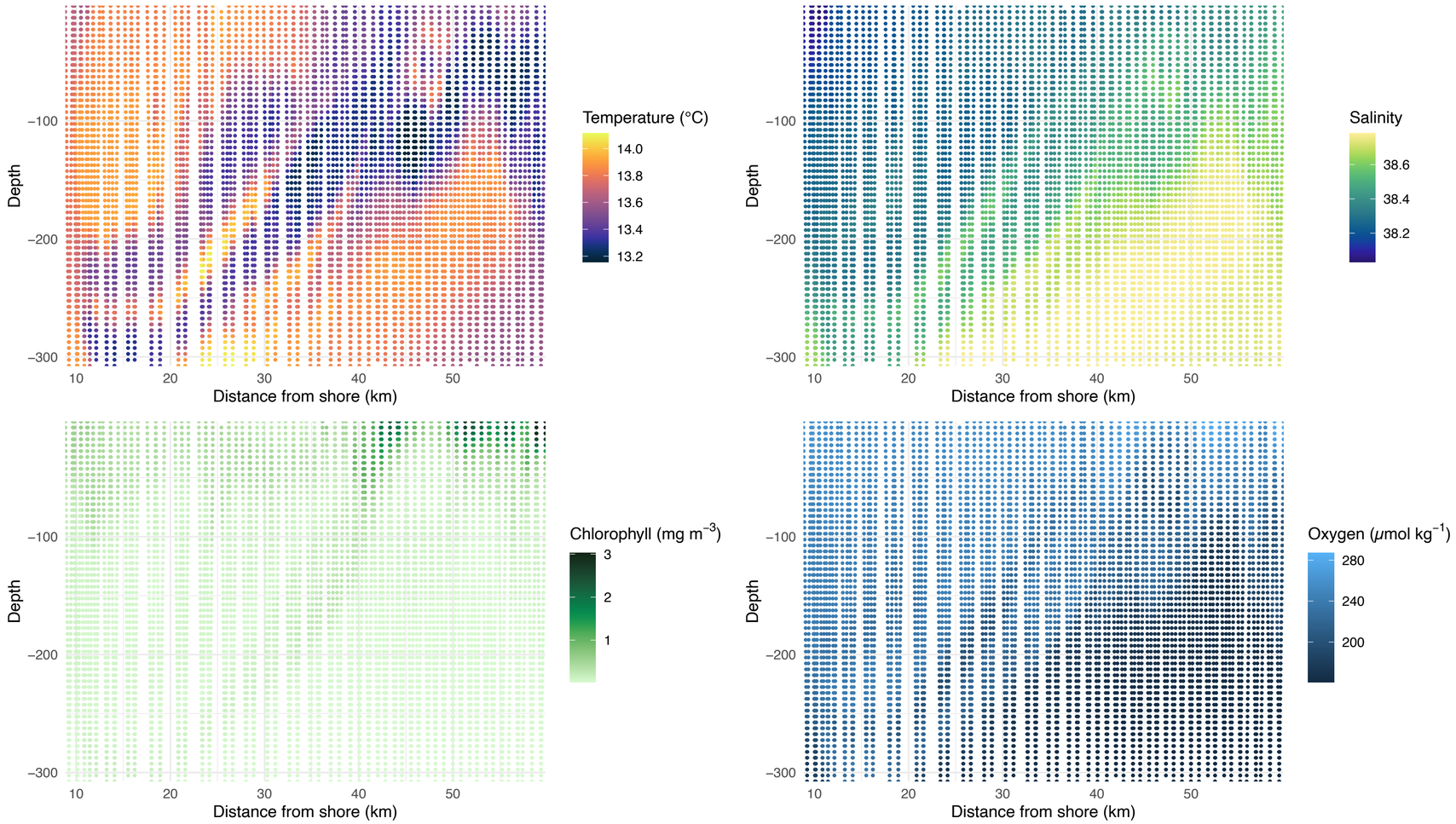
A 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

M 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

J 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

out back

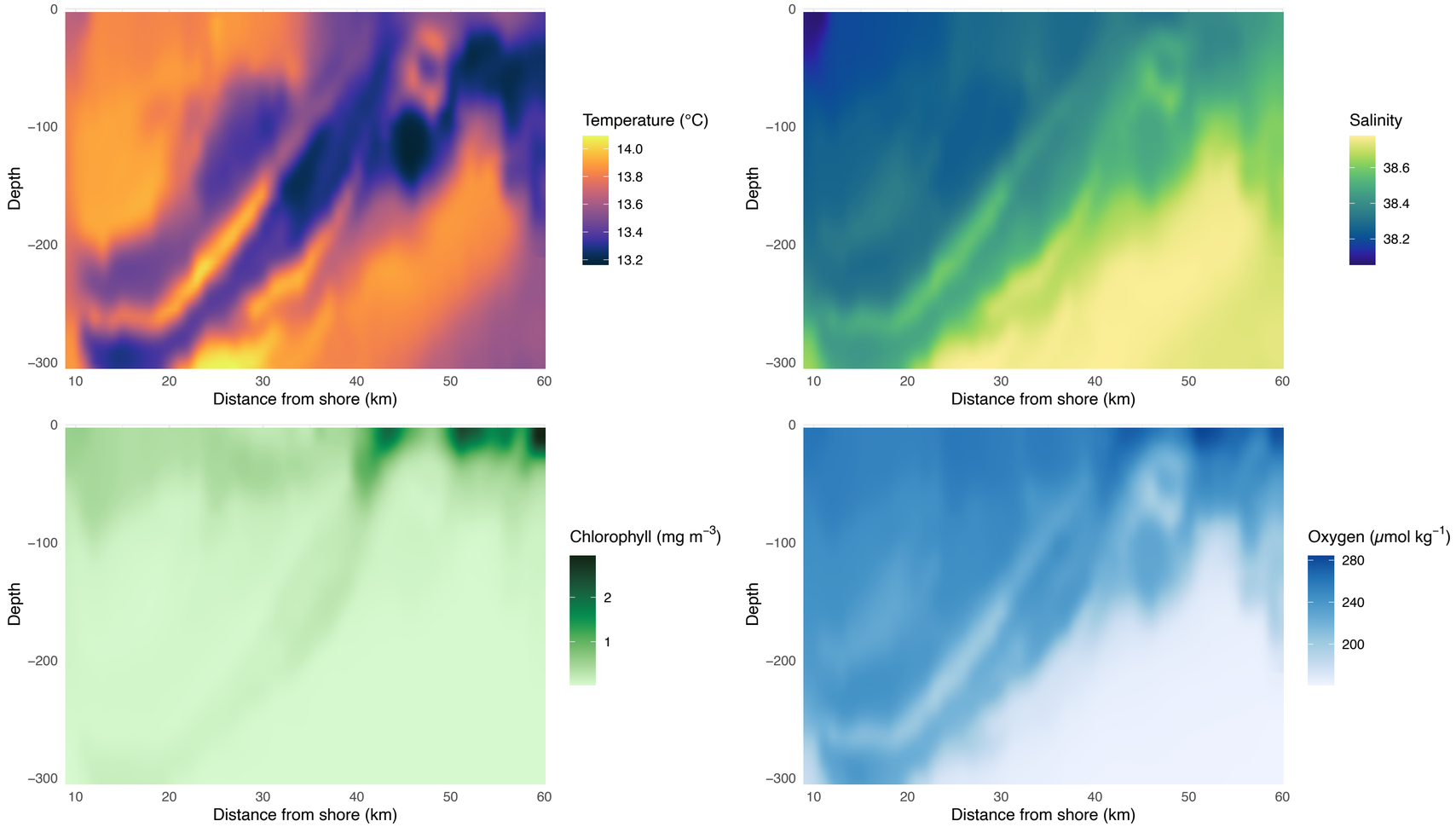
Biogeochemical data



Some sensors result in quite **noisy** data

- Filter out outliers, despike through moving median
- Bin 5 m depth
- Smooth through moving average

Biogeochemical data



Some sensors result in quite **noisy** data

- Filter out outliers, despike through moving median
- Bin 5 m depth
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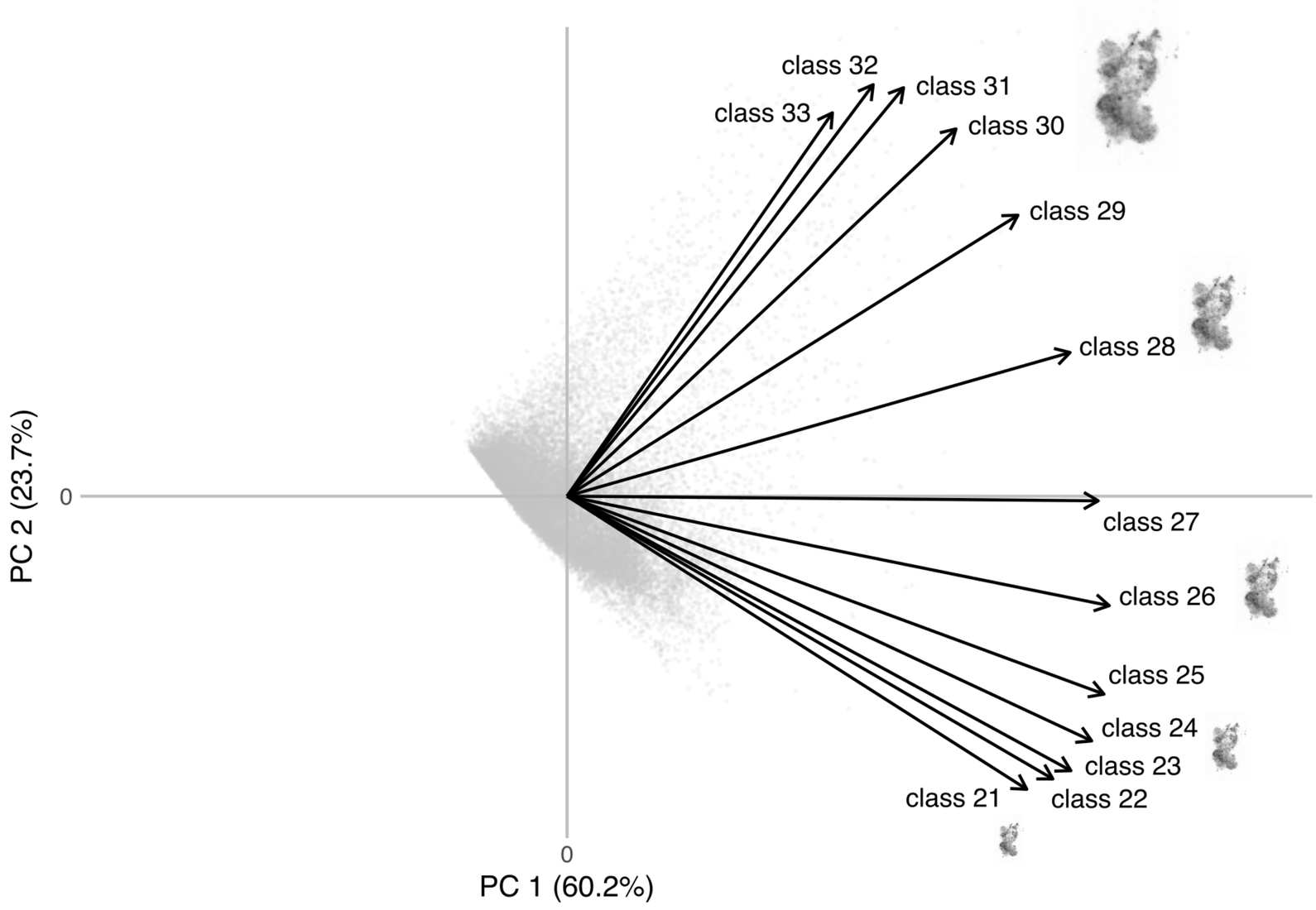
Interpolate over the whole domain (200 m in x, 0.5 m in y)

Particle data

13 particle **size classes**

PCA on log-transformed particle concentrations

Summarised by the first two components



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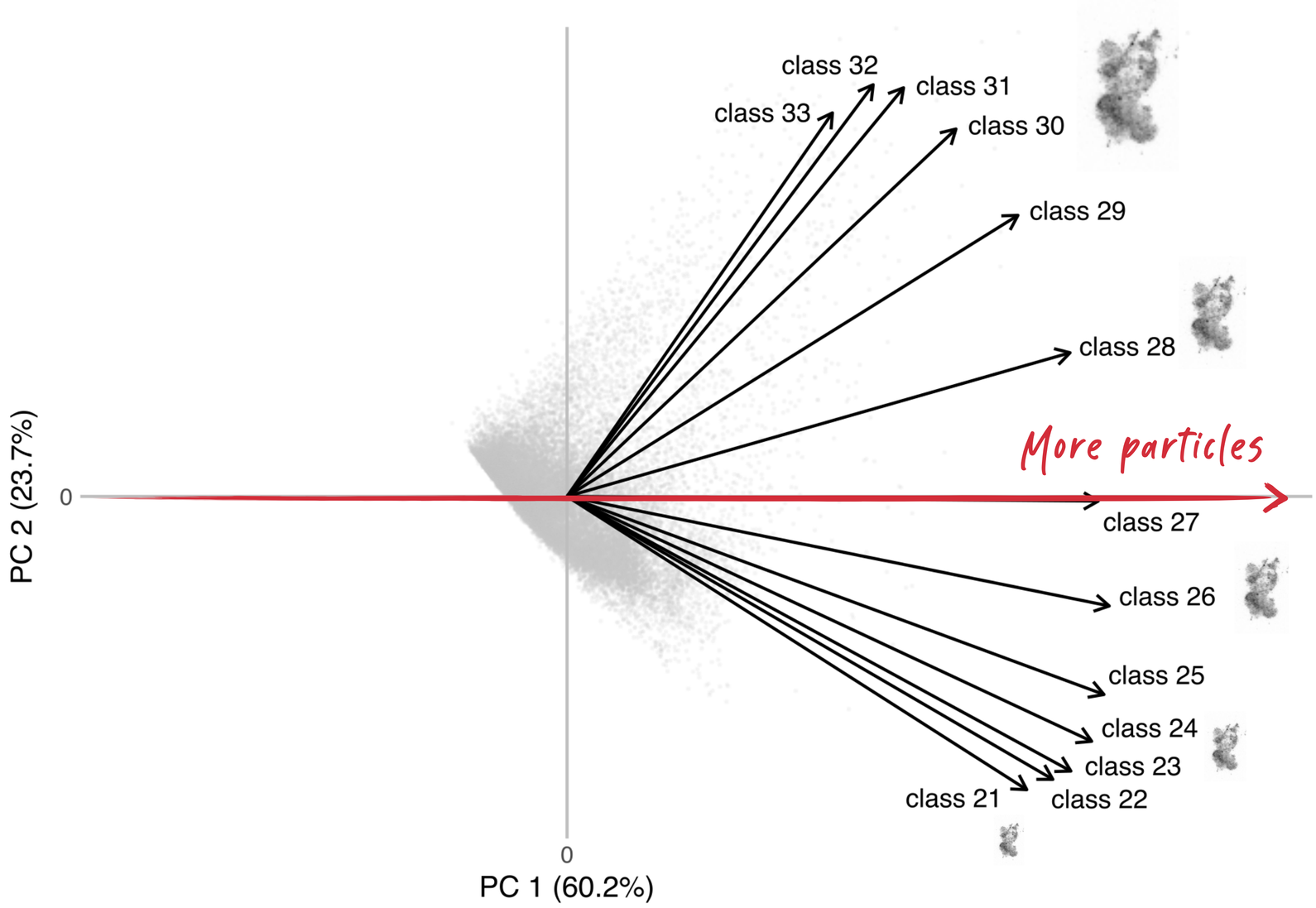

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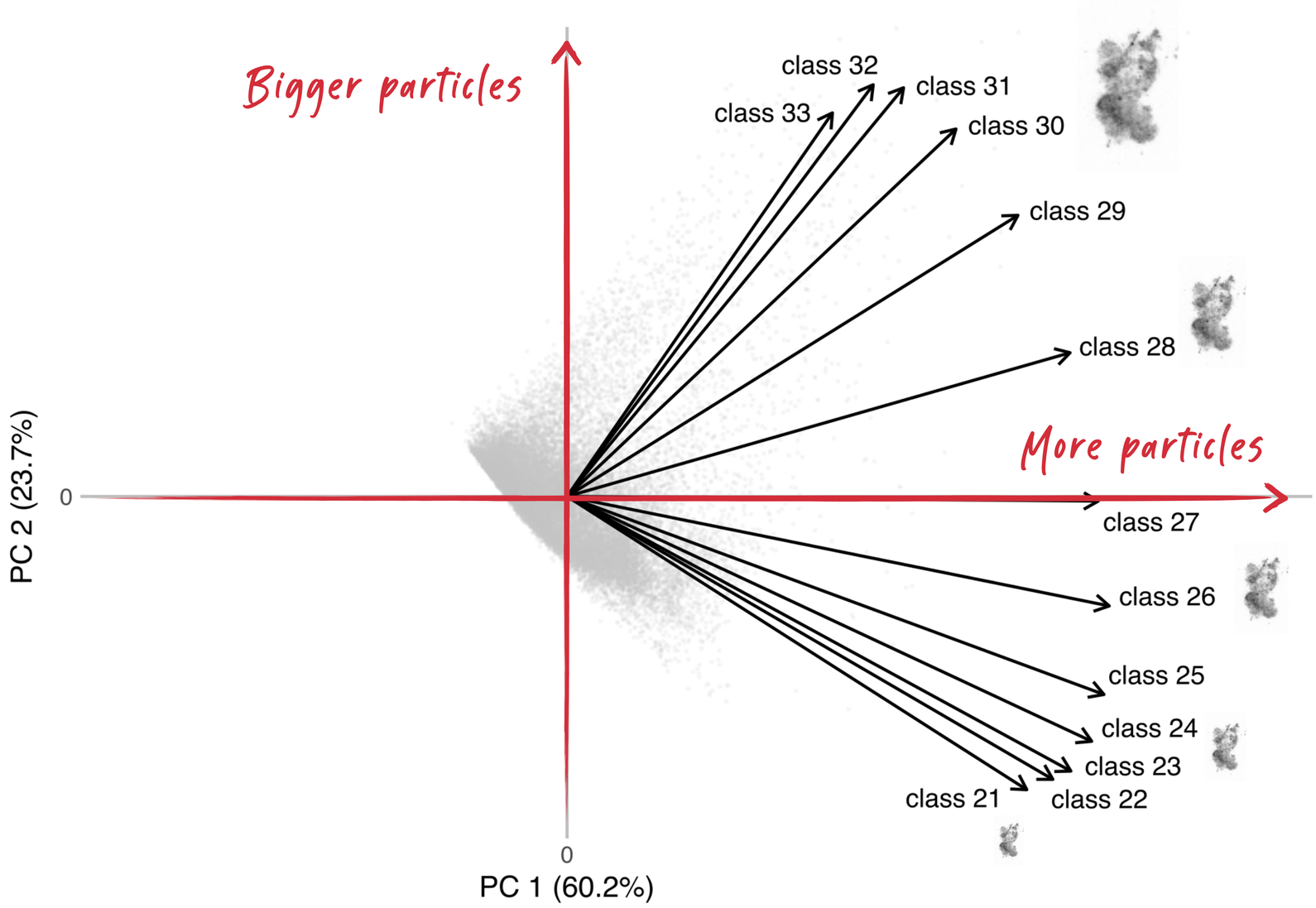
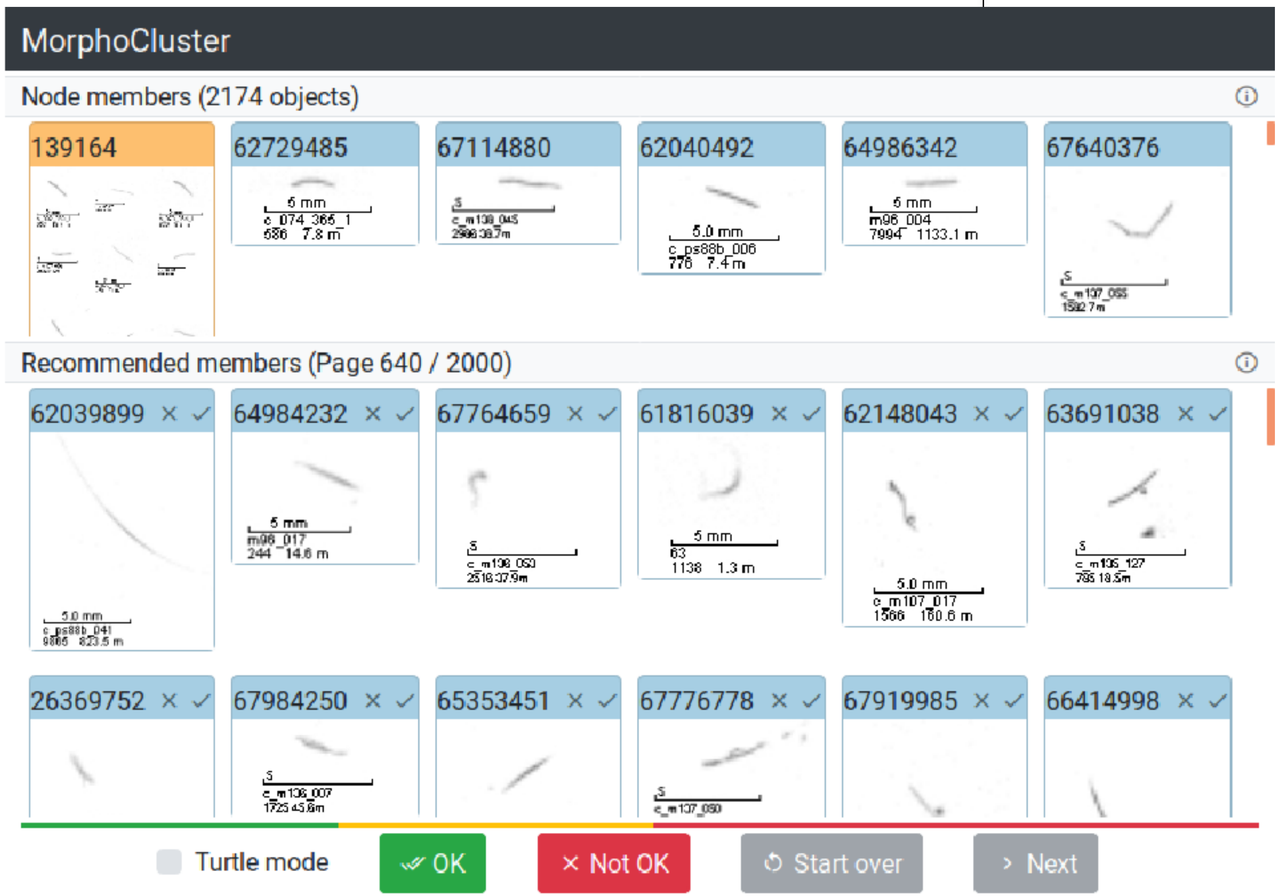
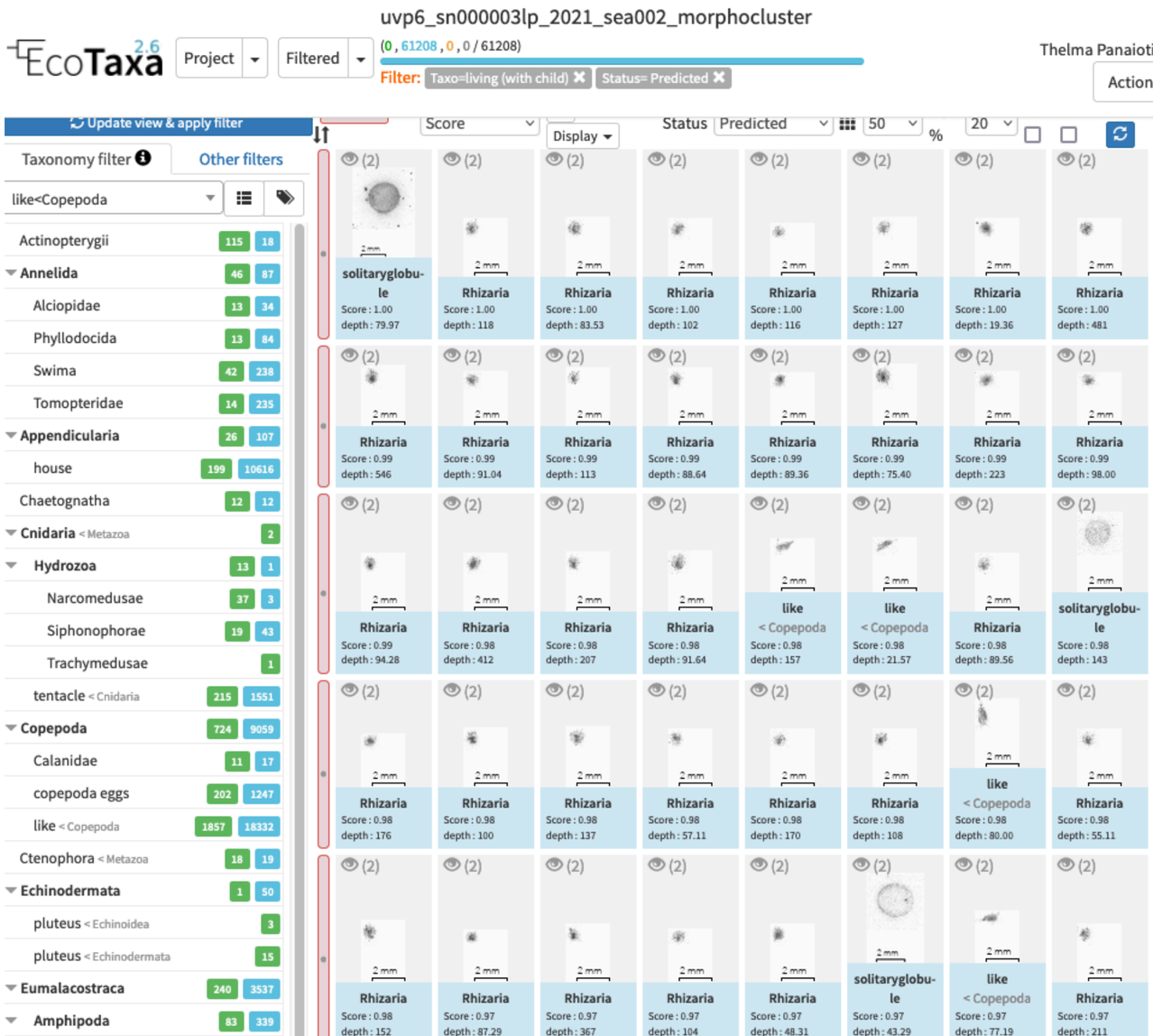


Plankton data

Machine Learning predictions + Morphocluster and EcoTaxa

13,000 planktonic organisms = concentrations on 20m × 5km bins





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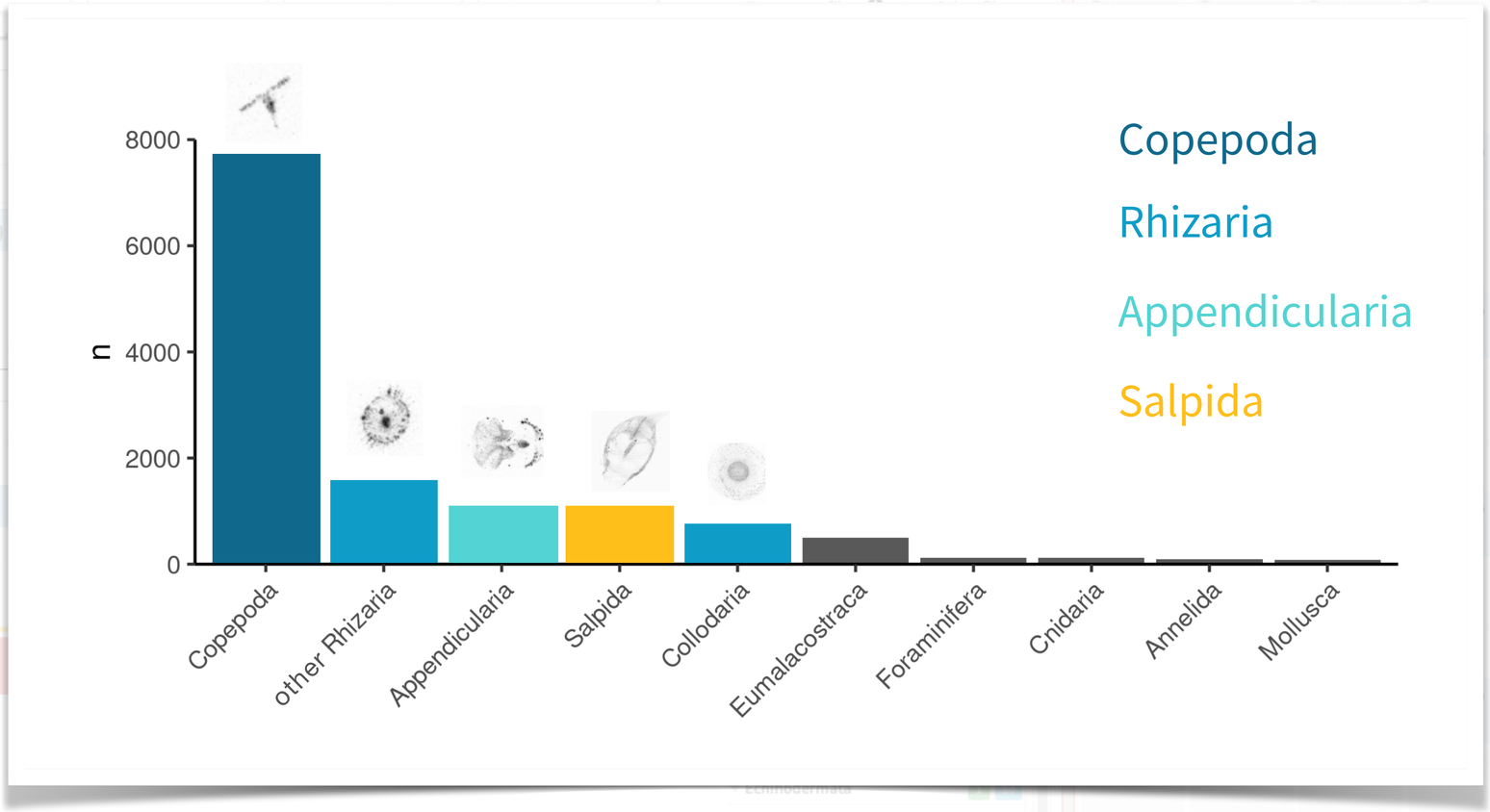
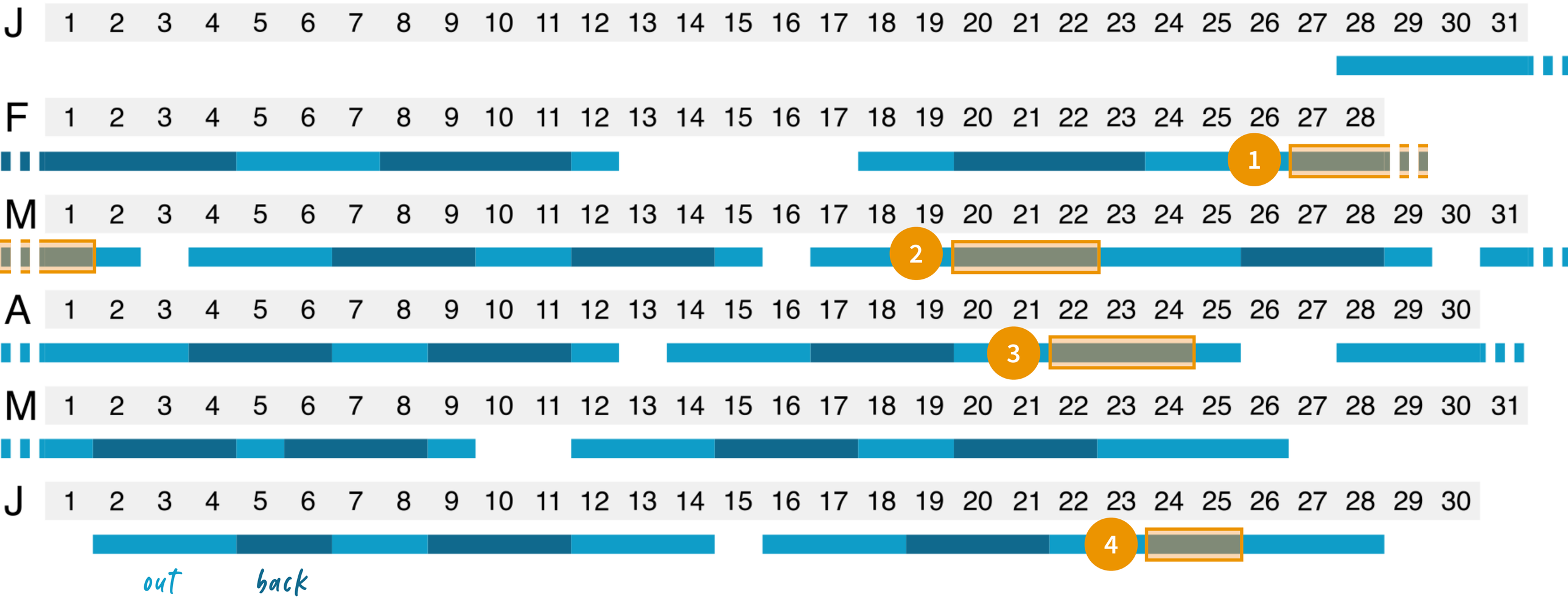
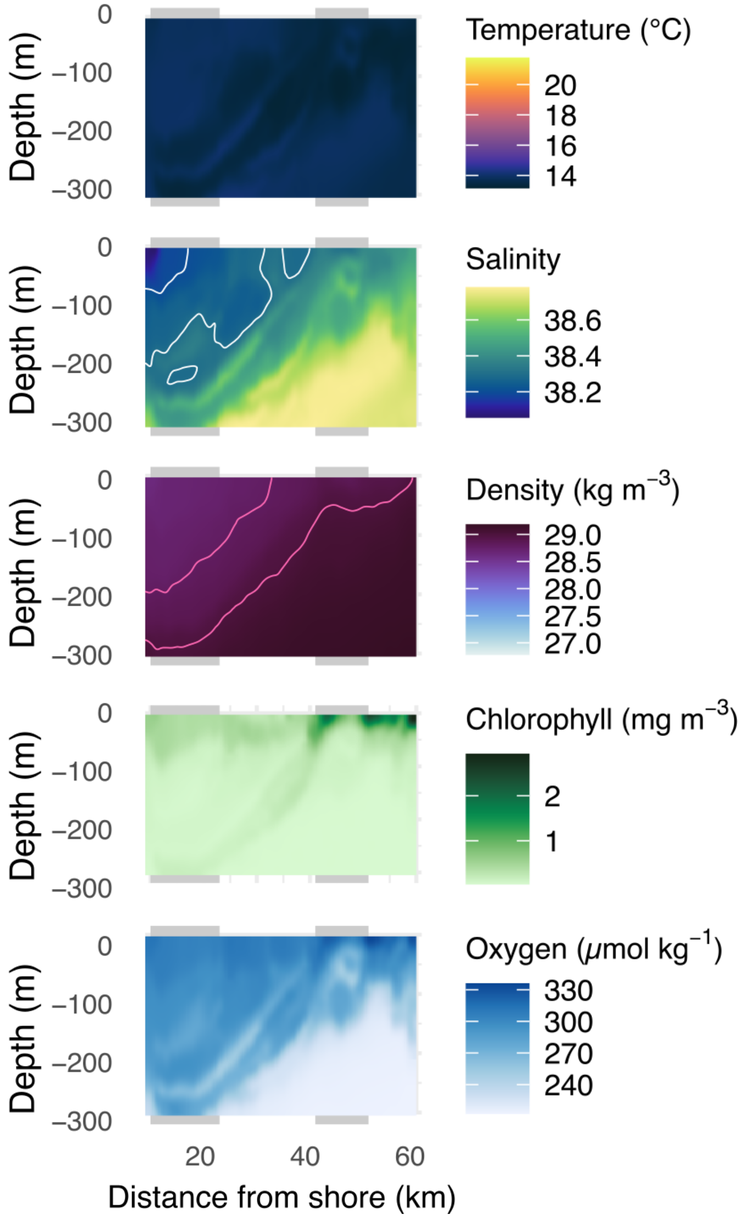


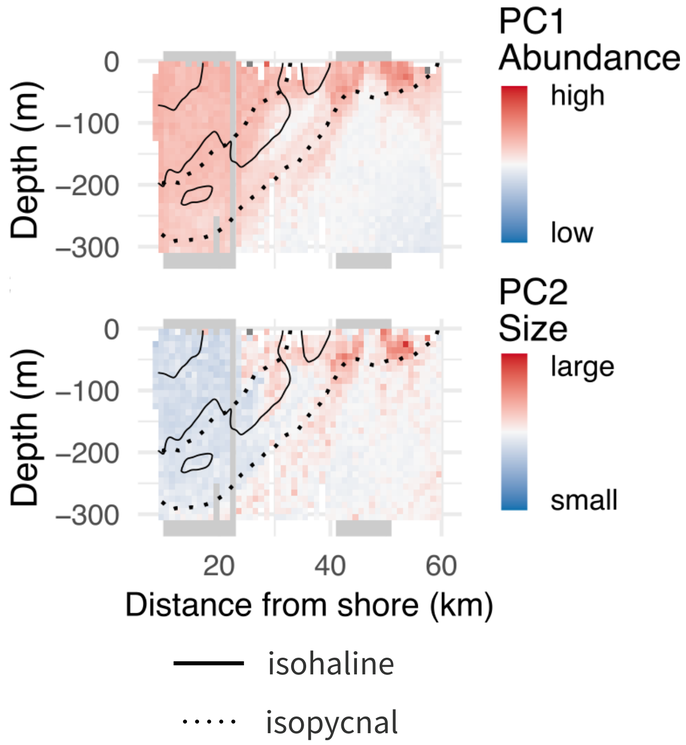
Selection of transects

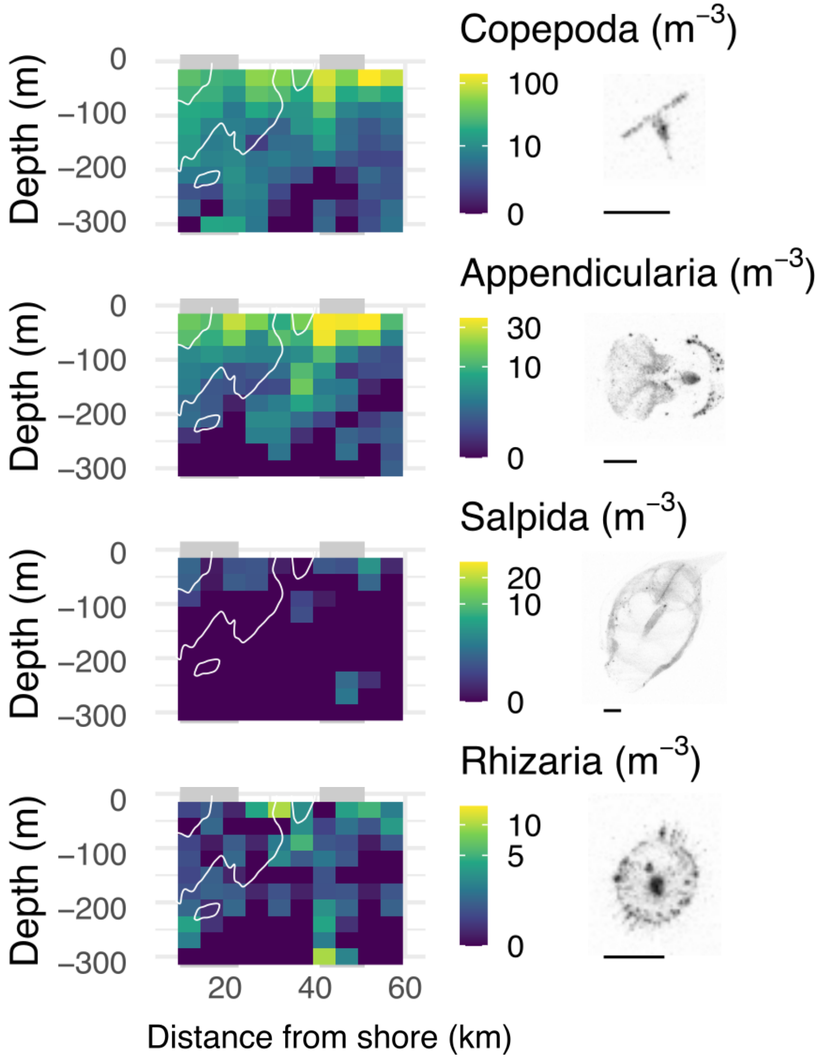
1: **early** bloom 2: **mid** bloom 3: **late** bloom 4: **post** bloom



1: Early bloom







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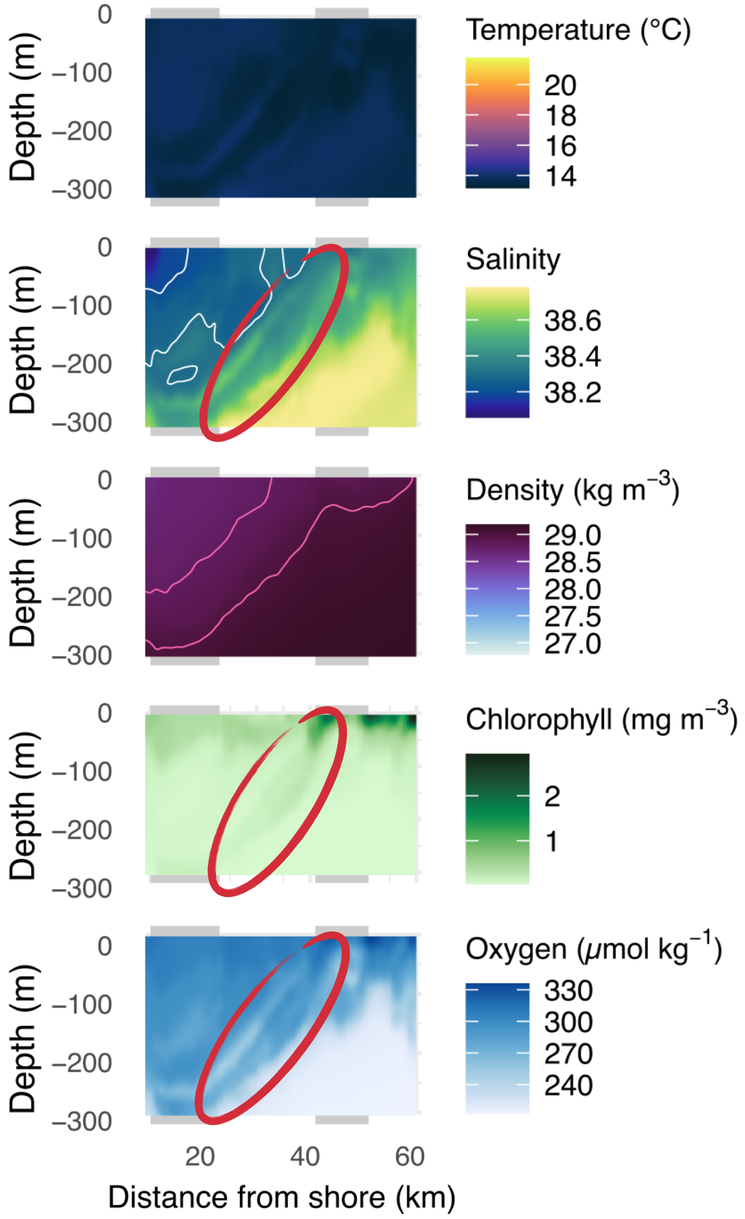

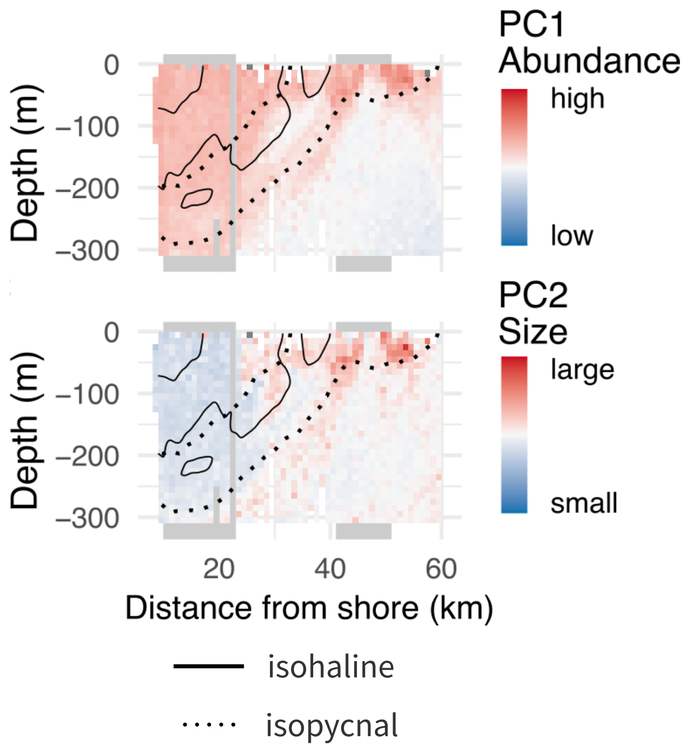

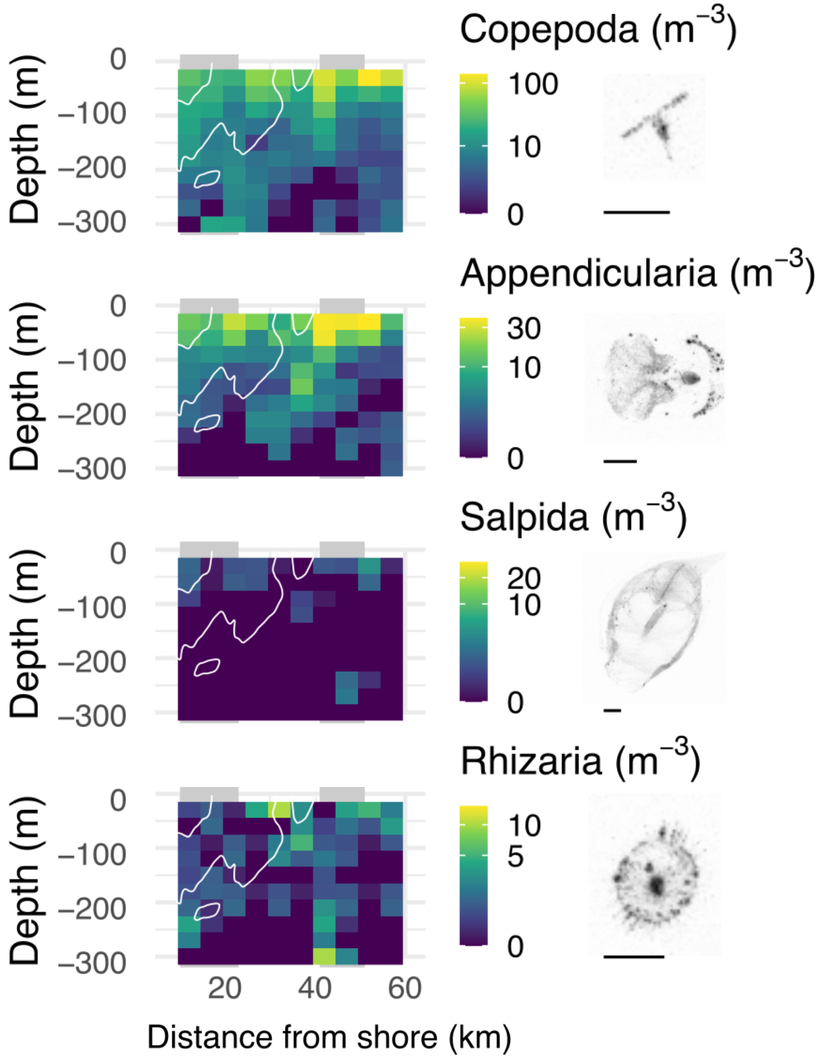

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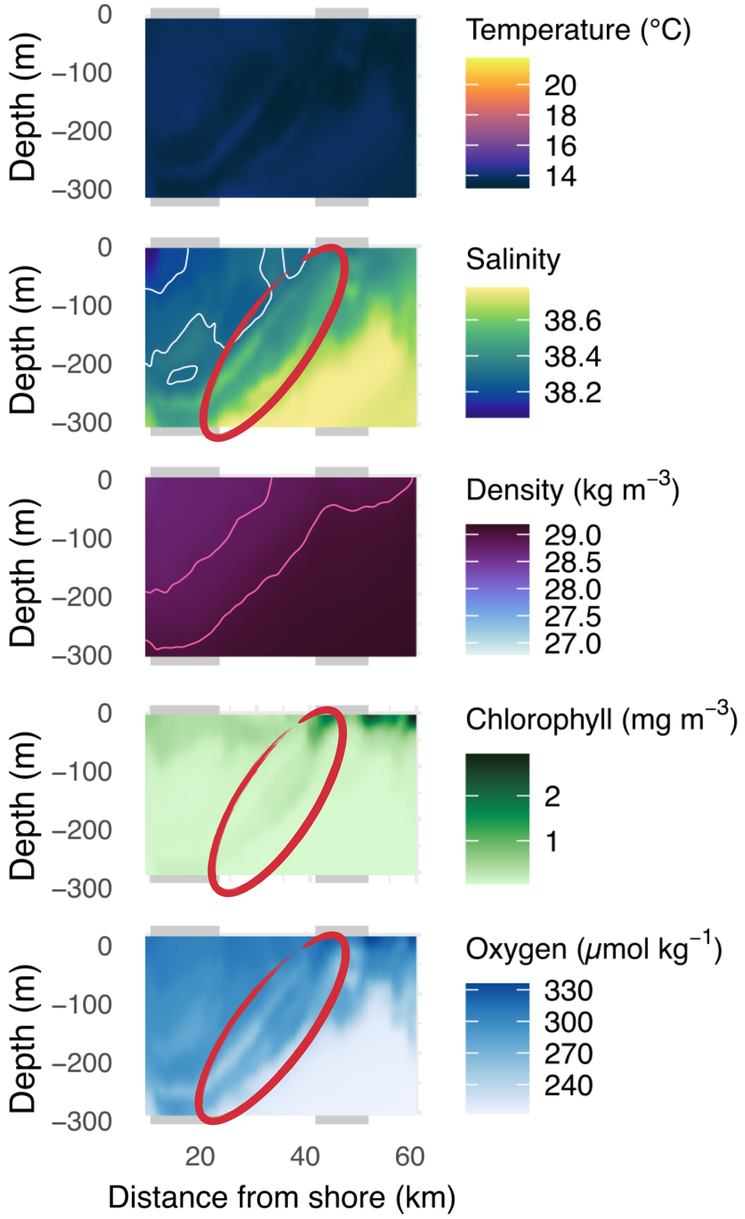

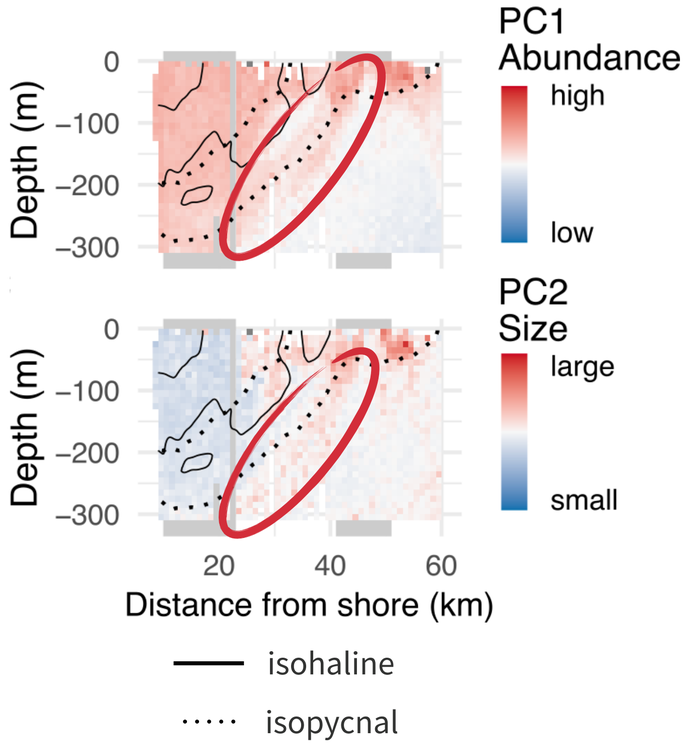

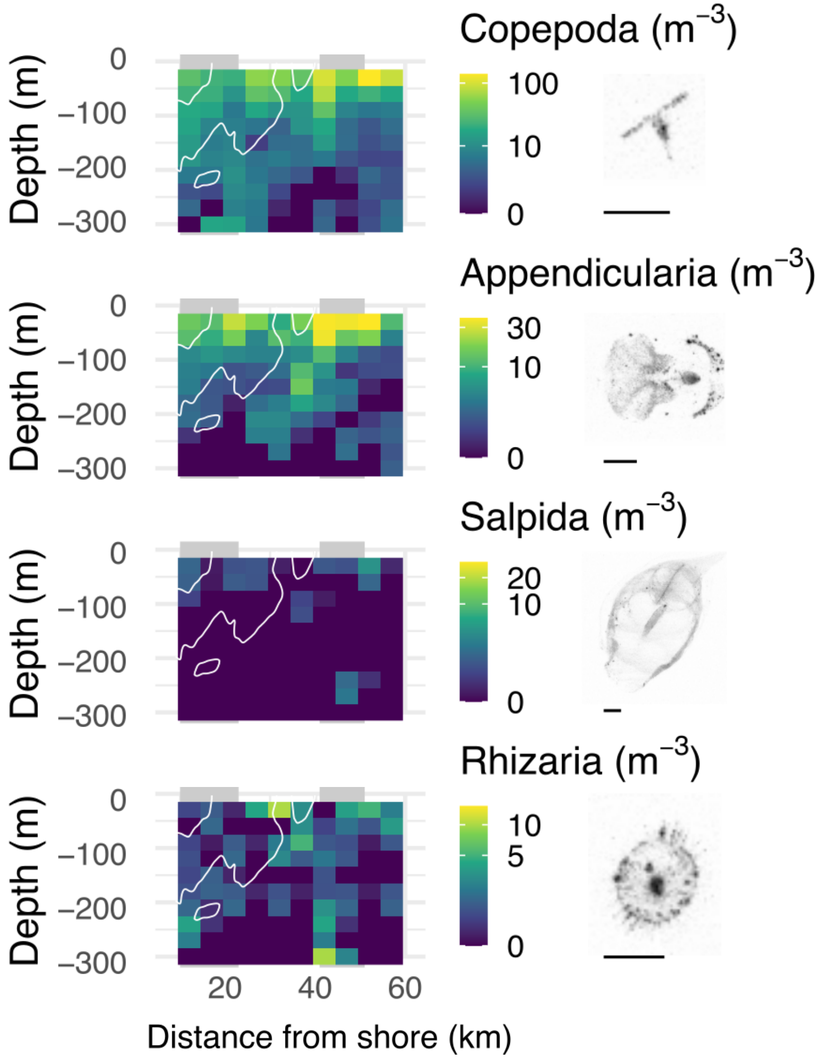

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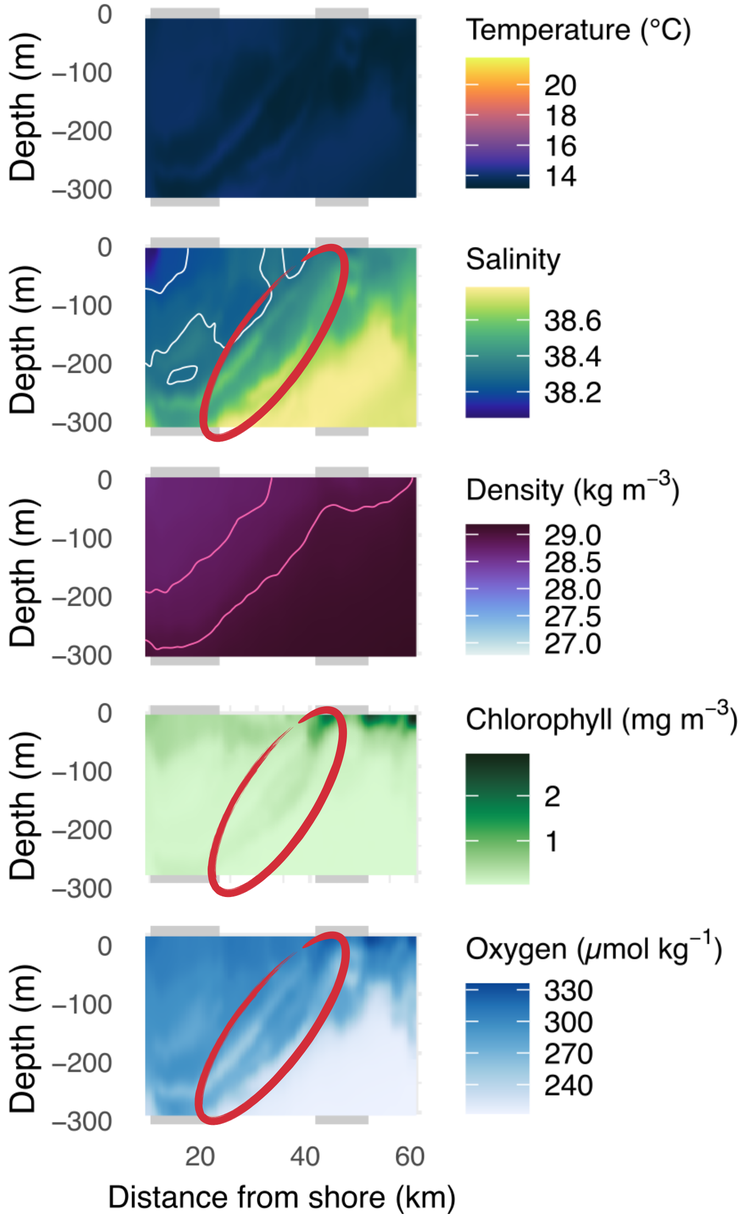

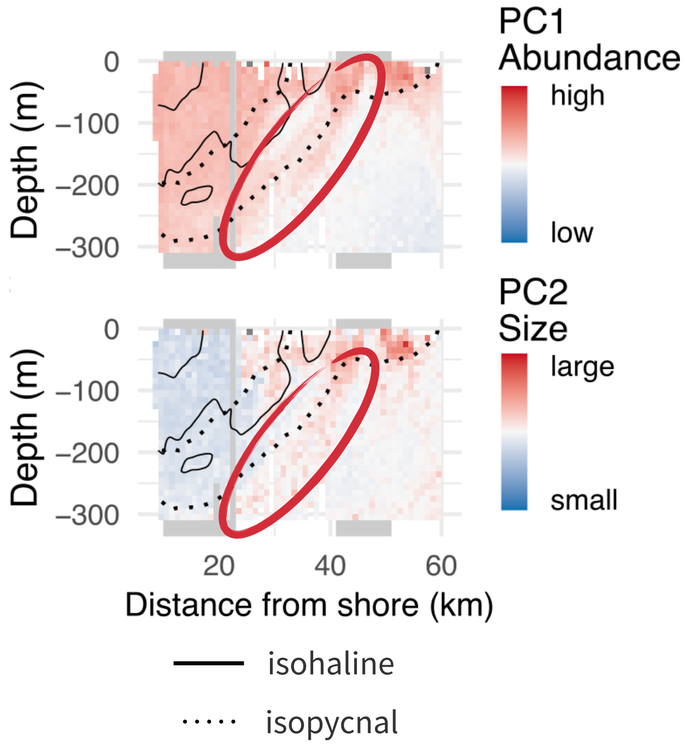

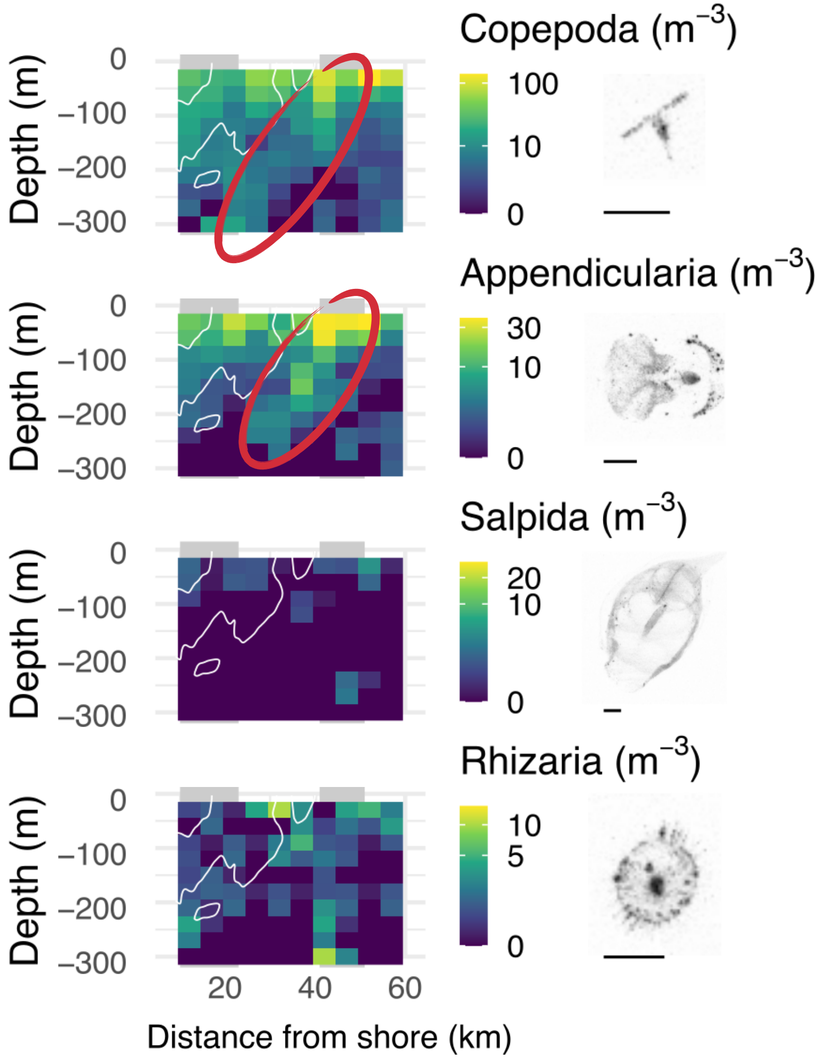

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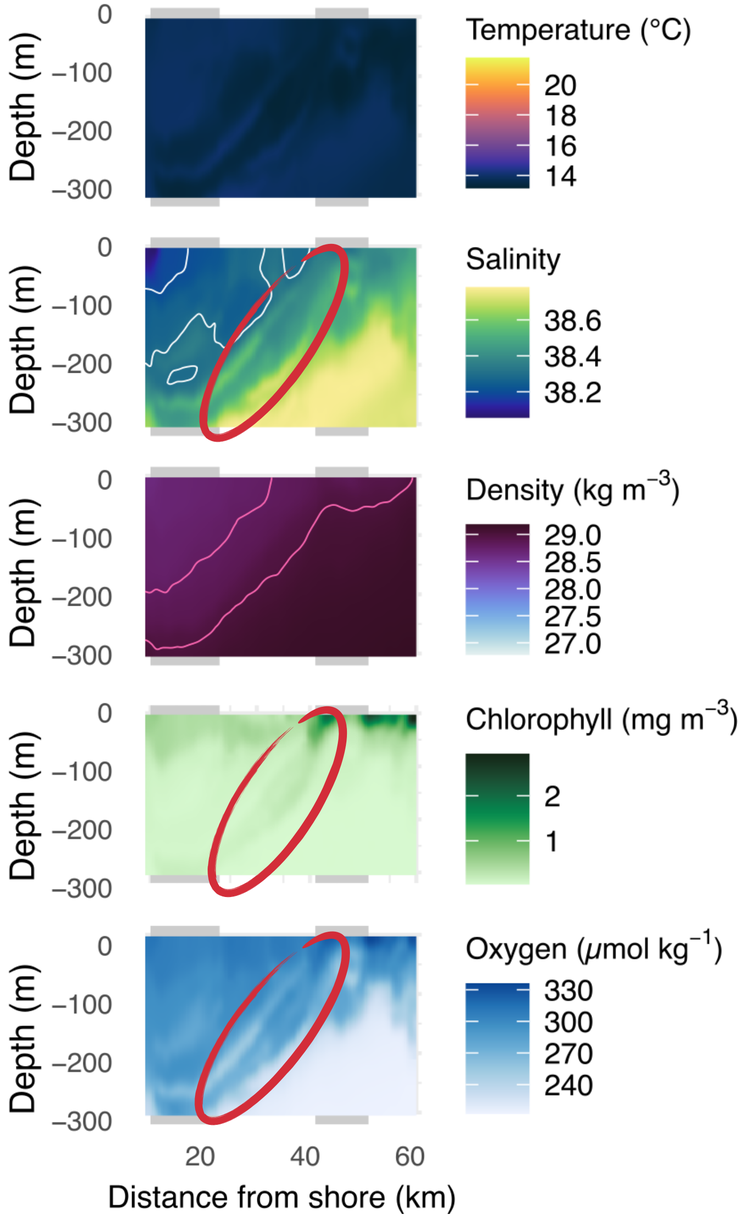
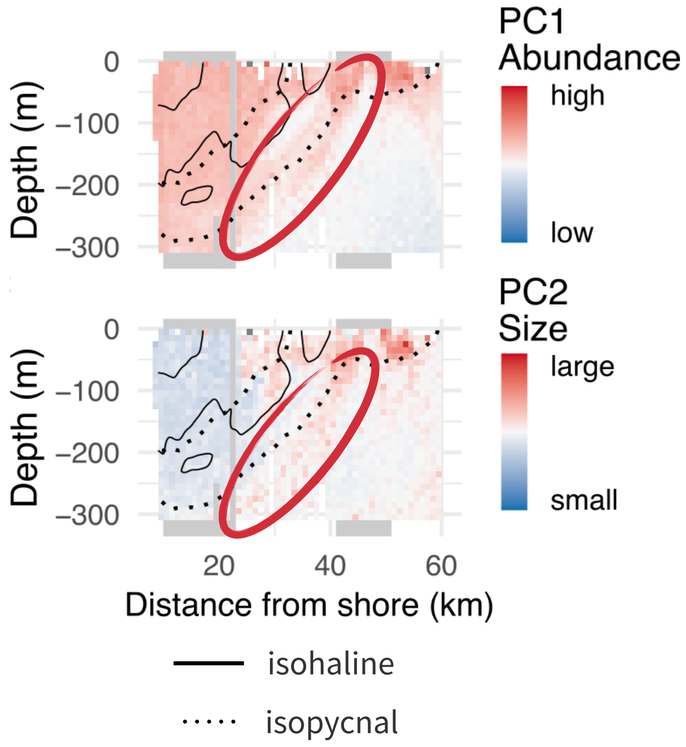
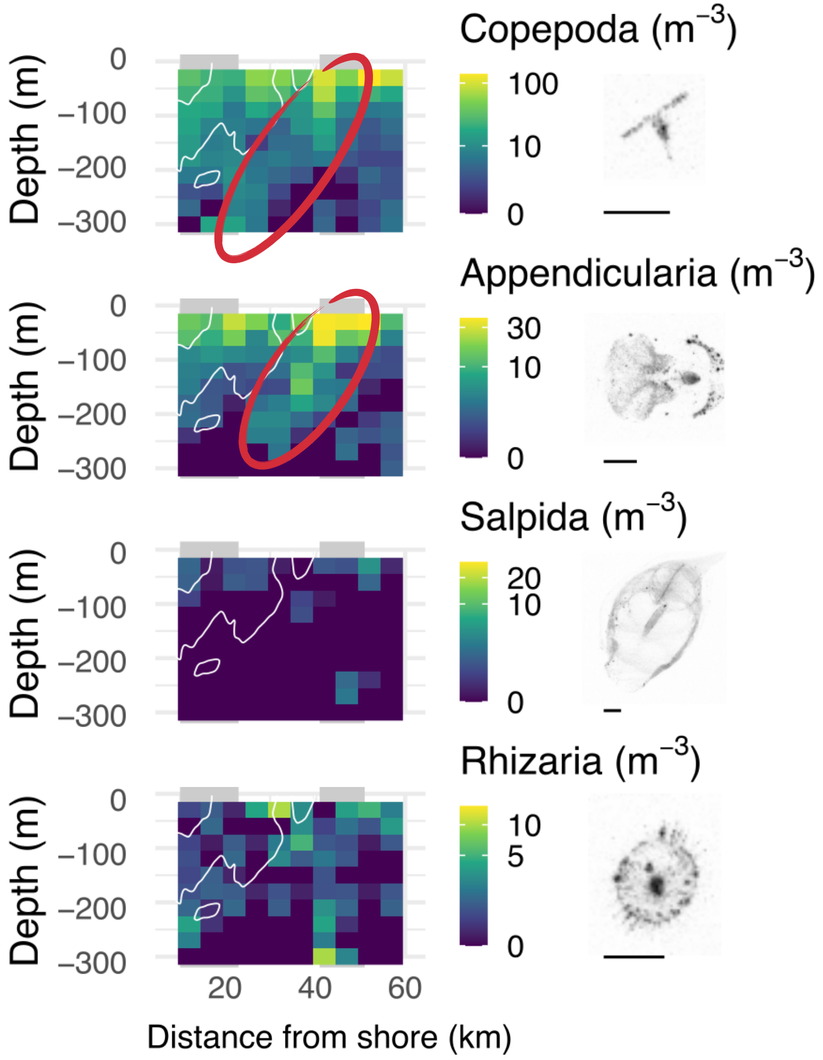




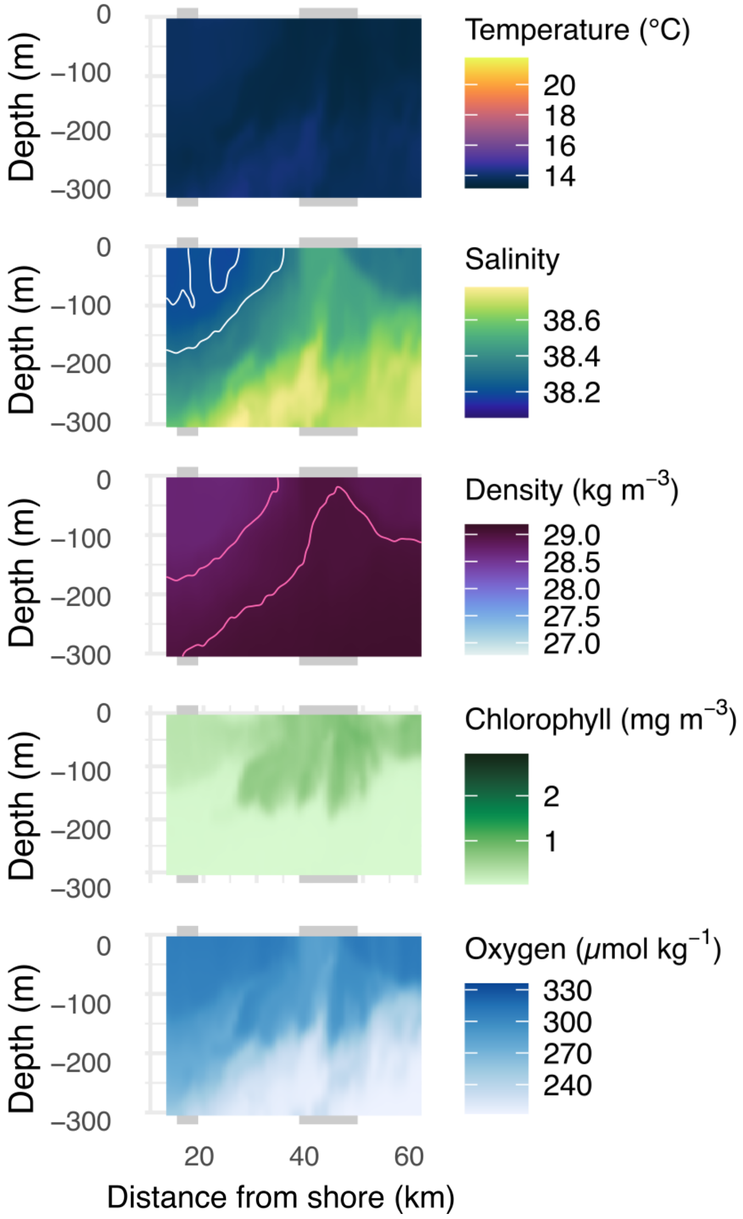
Subducting waters

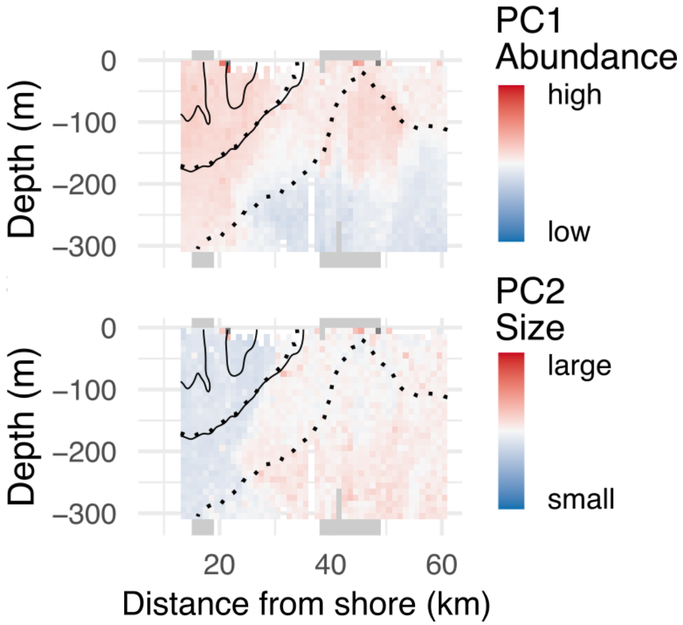
...affecting particles.
Copepods and Appendicularia

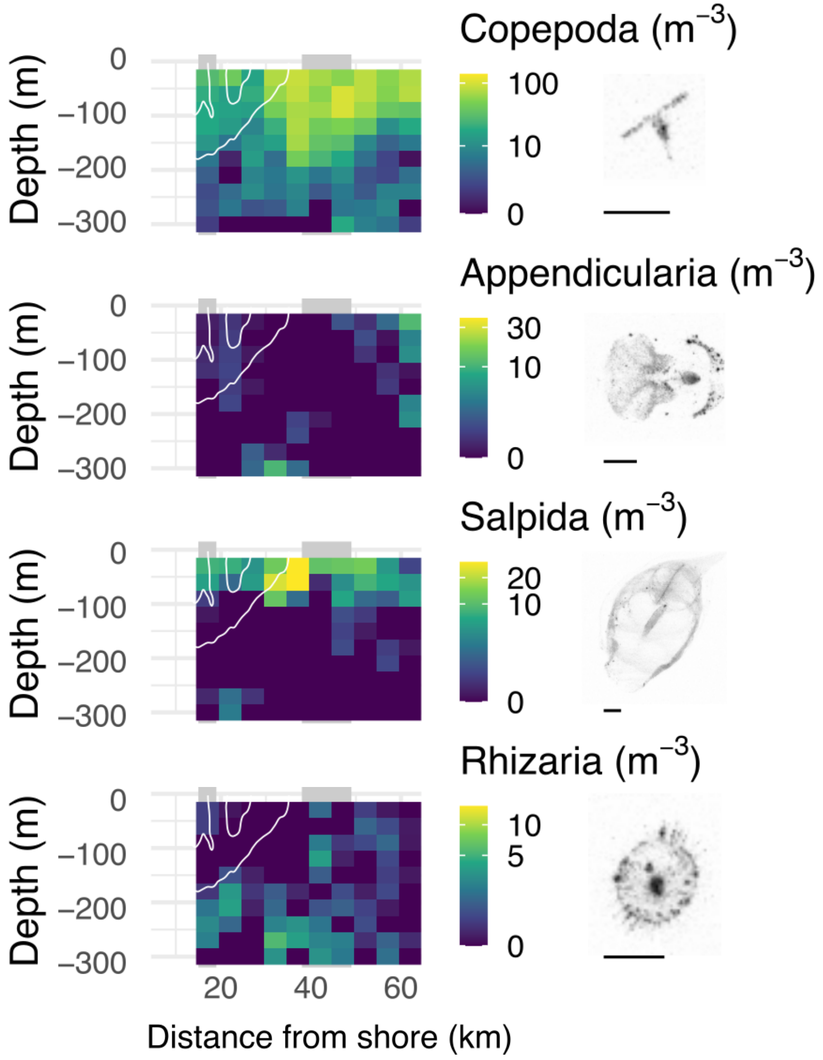
Discarded houses



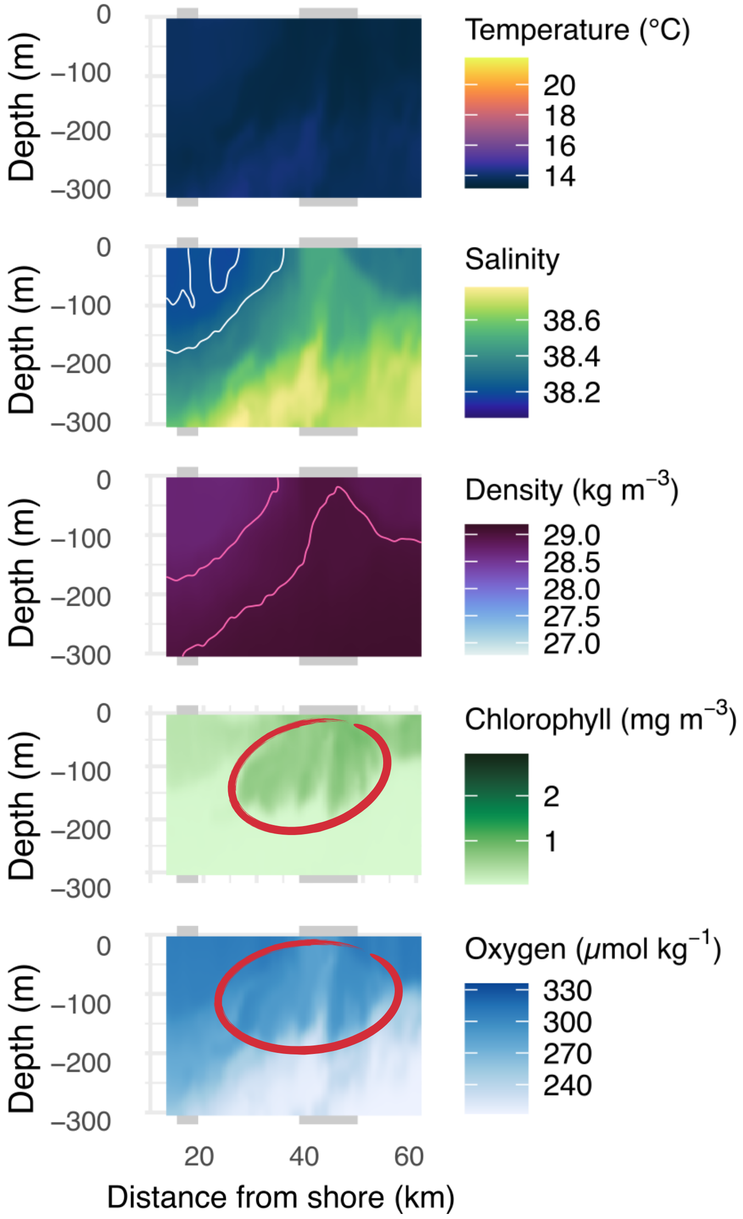
2: Mid bloom


Depth (m)
0
−100
−200
−300
Temperature (°C)
20
18
16
14
Salinity
38.6
38.4
38.2
Density (kg m^{-3})
29.0
28.5
28.0
27.5
27.0
Chlorophyll (mg m^{-3})
2
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
PC1
Abundance
high
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
Copepoda (m^{-3})
100
10
0
Appendicularia (m^{-3})
30
10
0
Salpida (m^{-3})
20
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

2: Mid bloom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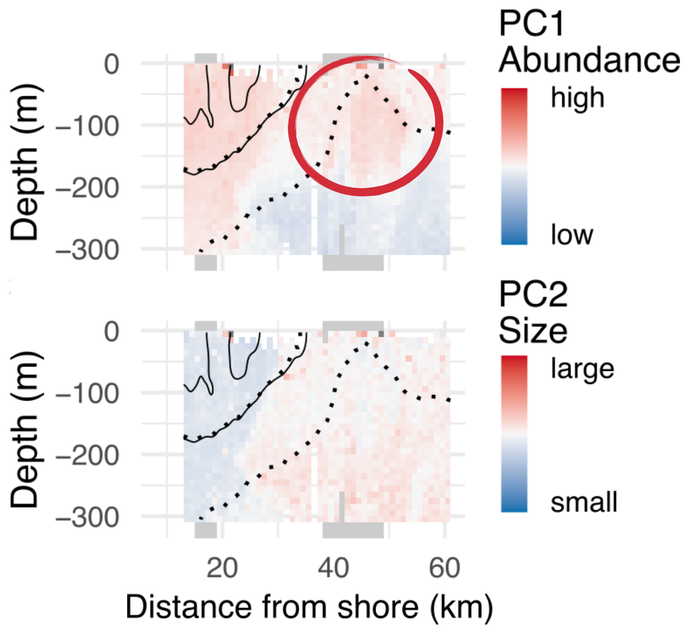
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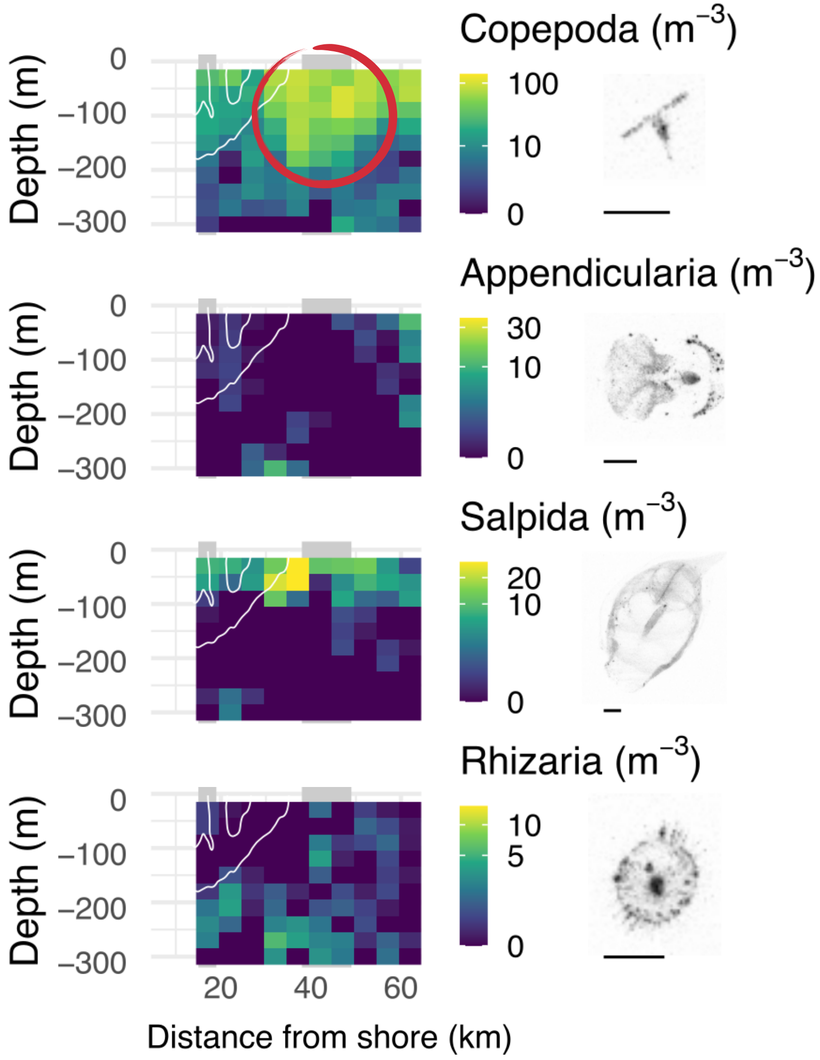
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Distance from shore (km)

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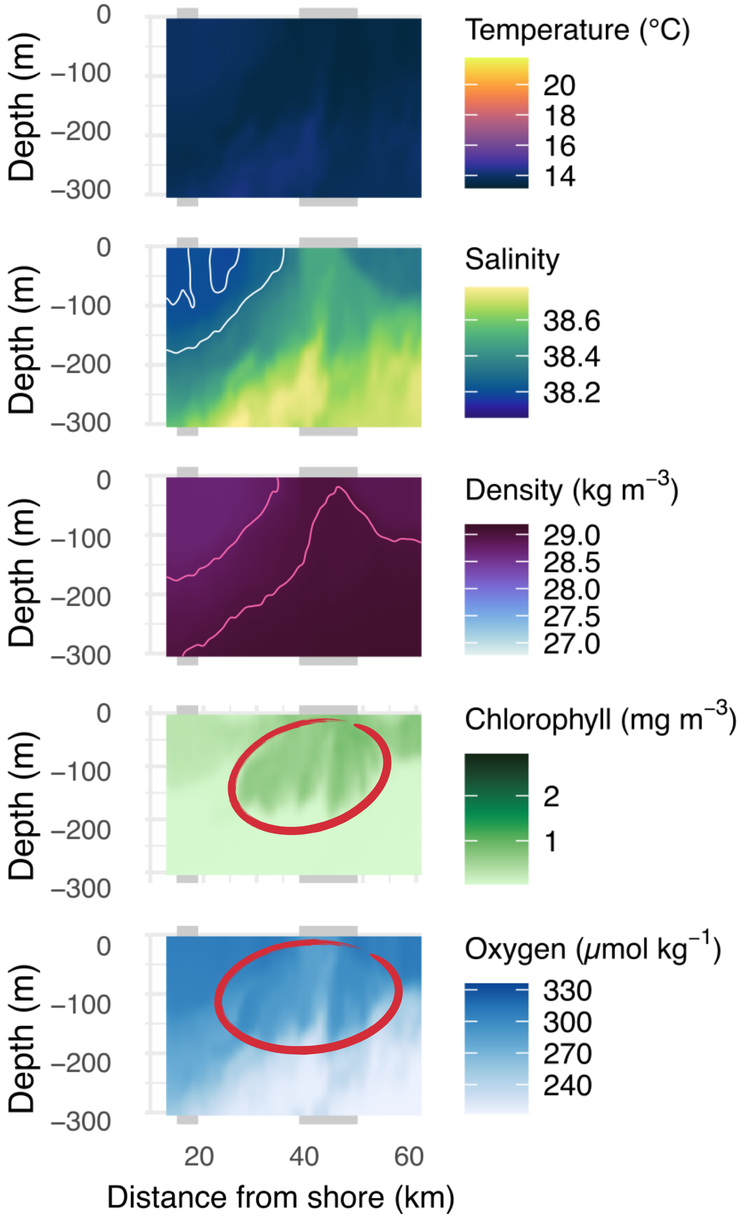
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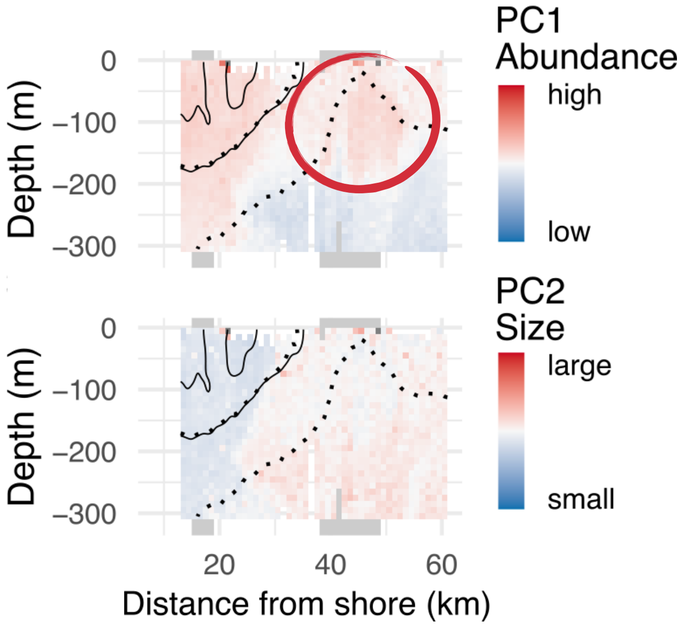
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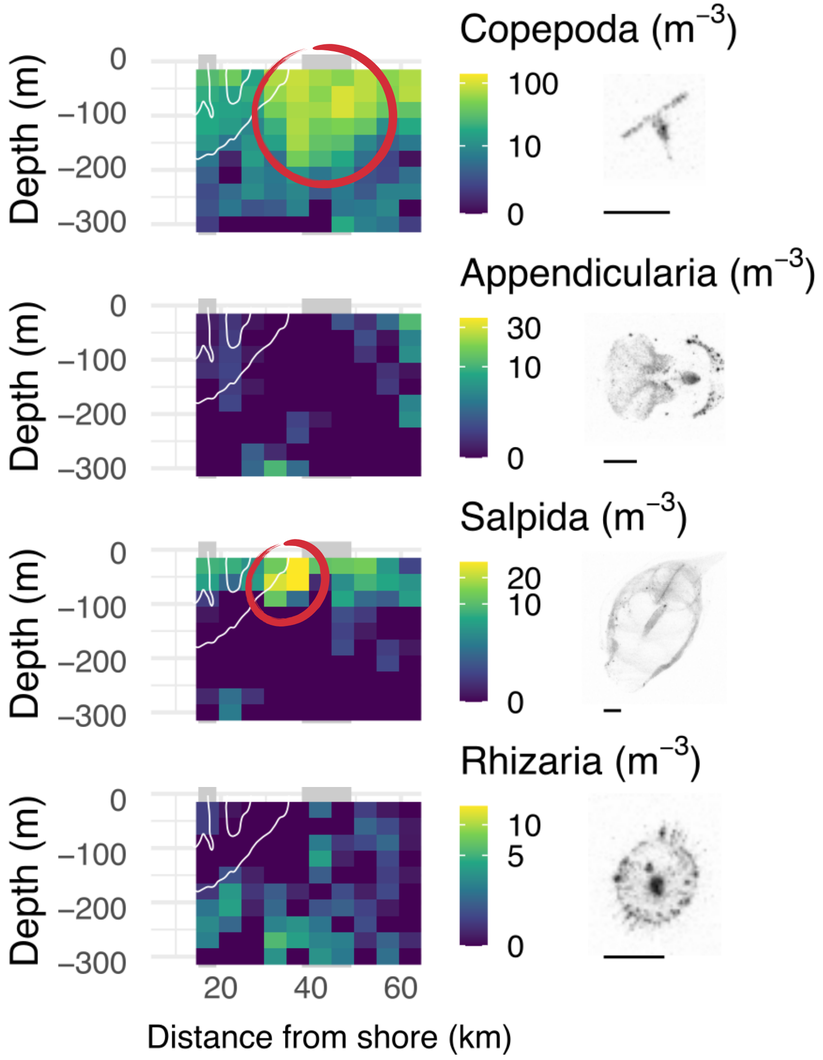
Distance from shore (km)


Depth (m)
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−100
−200
−300
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10
0
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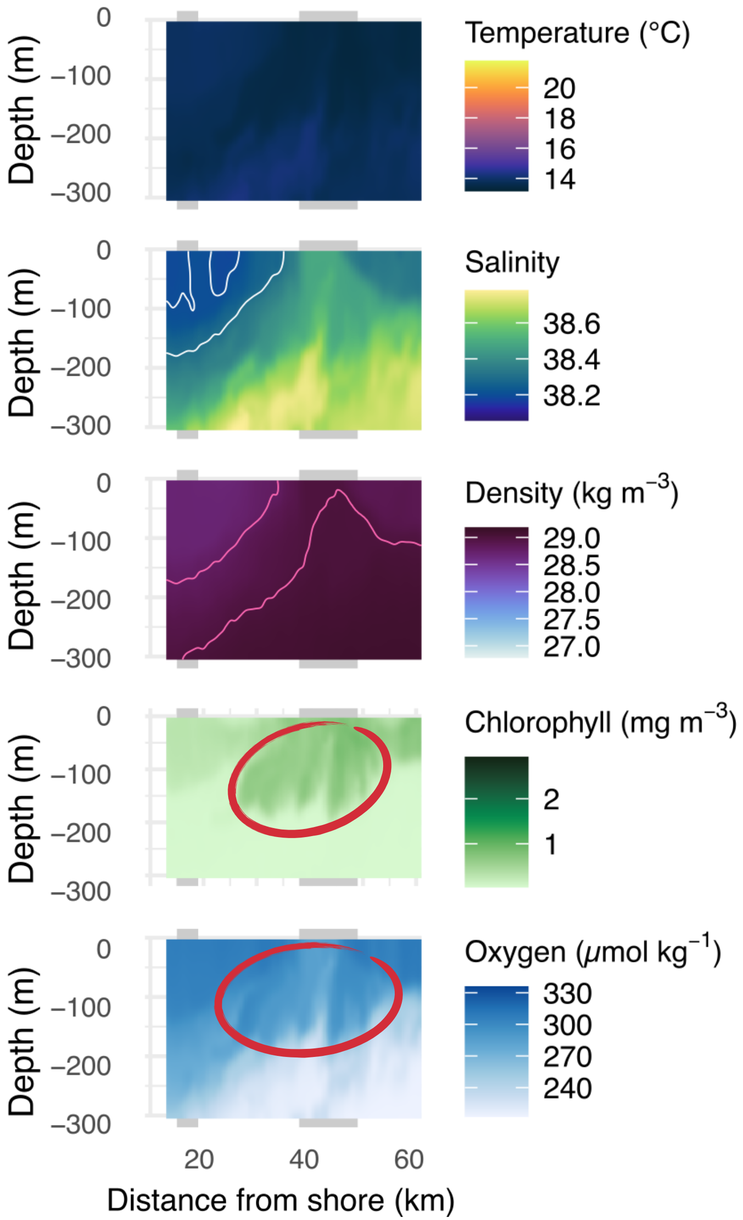
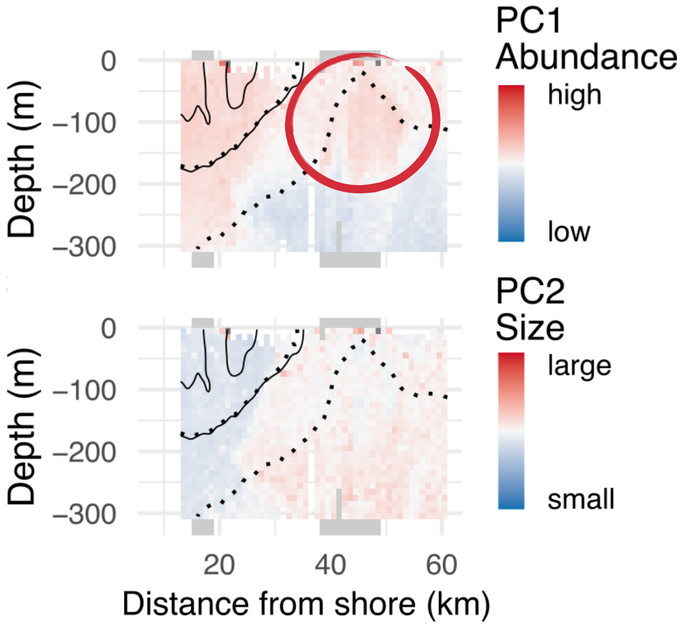
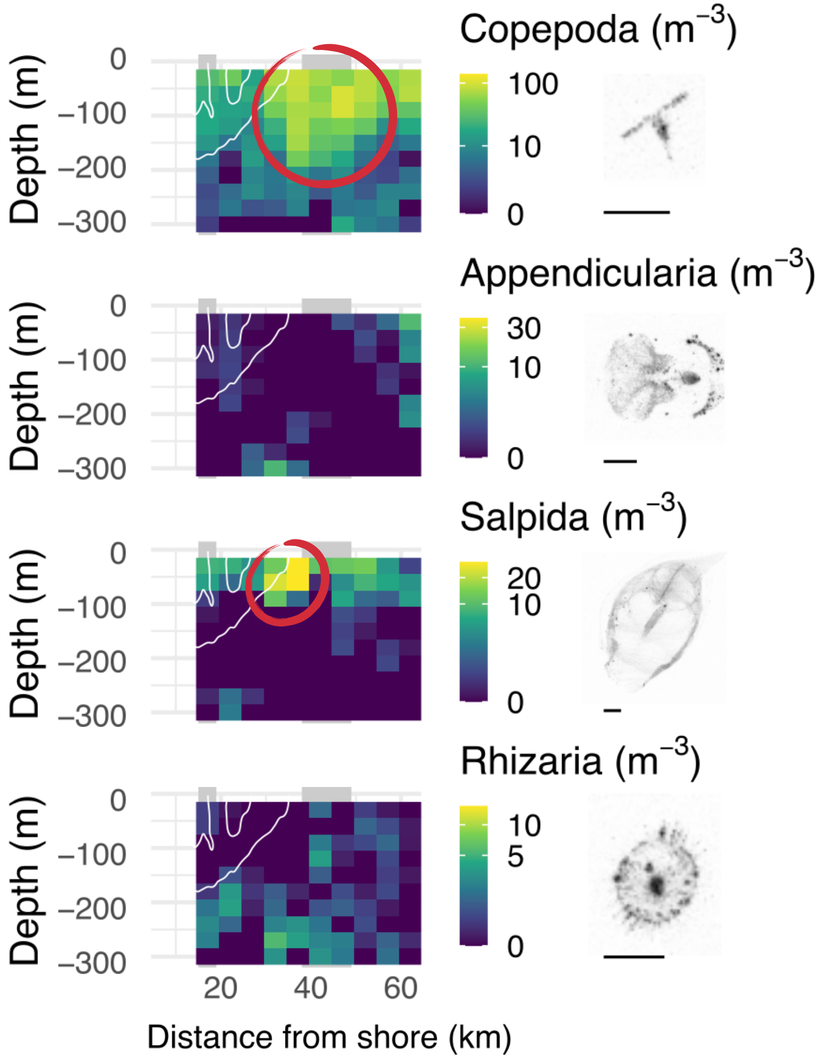
Distance from shore (km)

2: Mid bloom





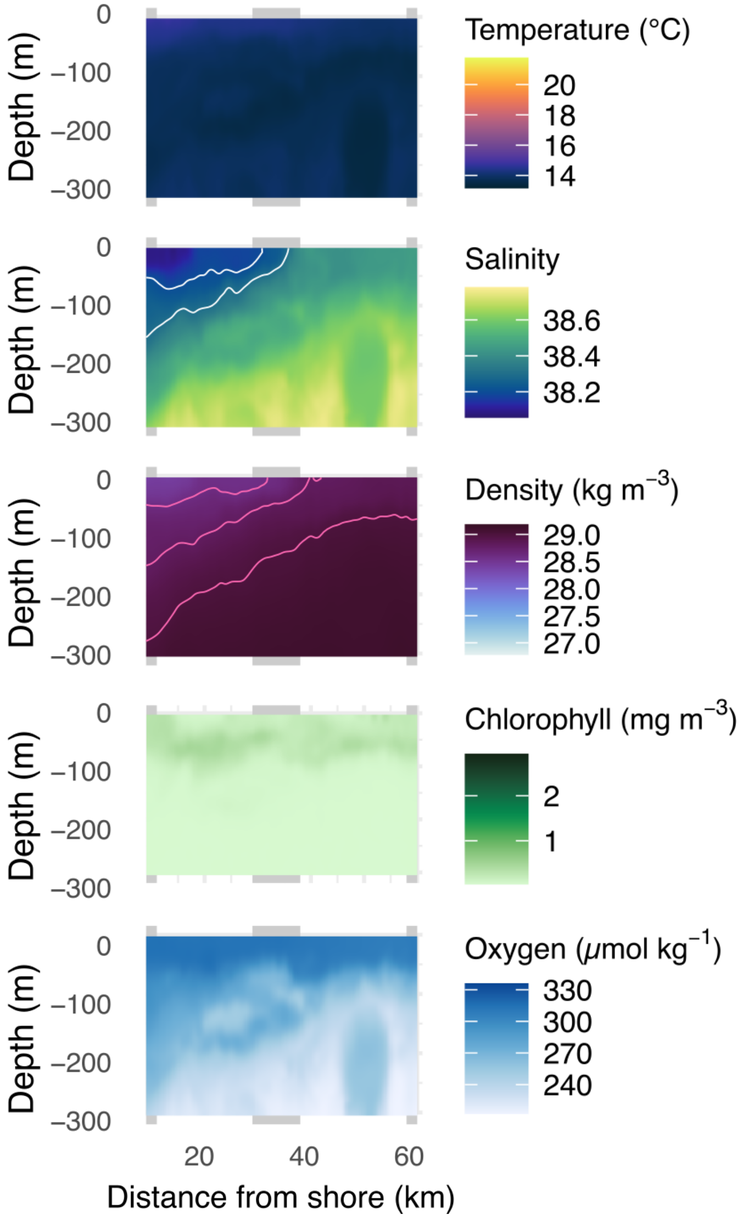


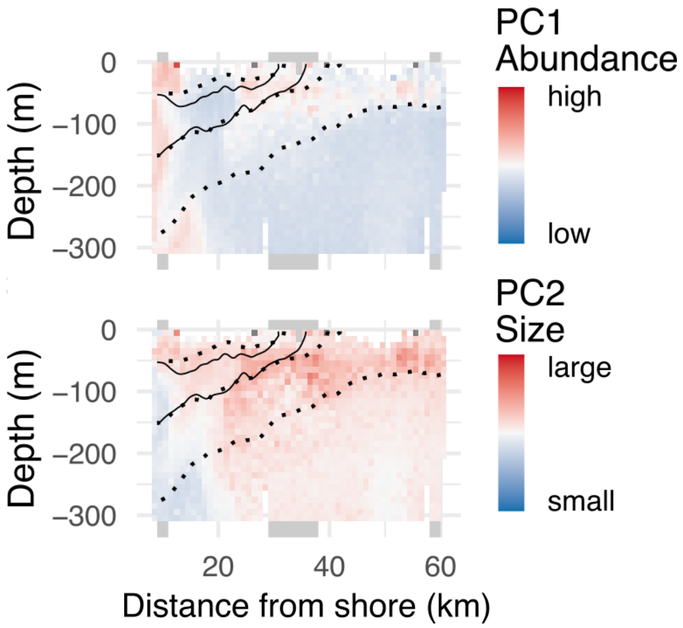
Mixing event affecting particles and plankton

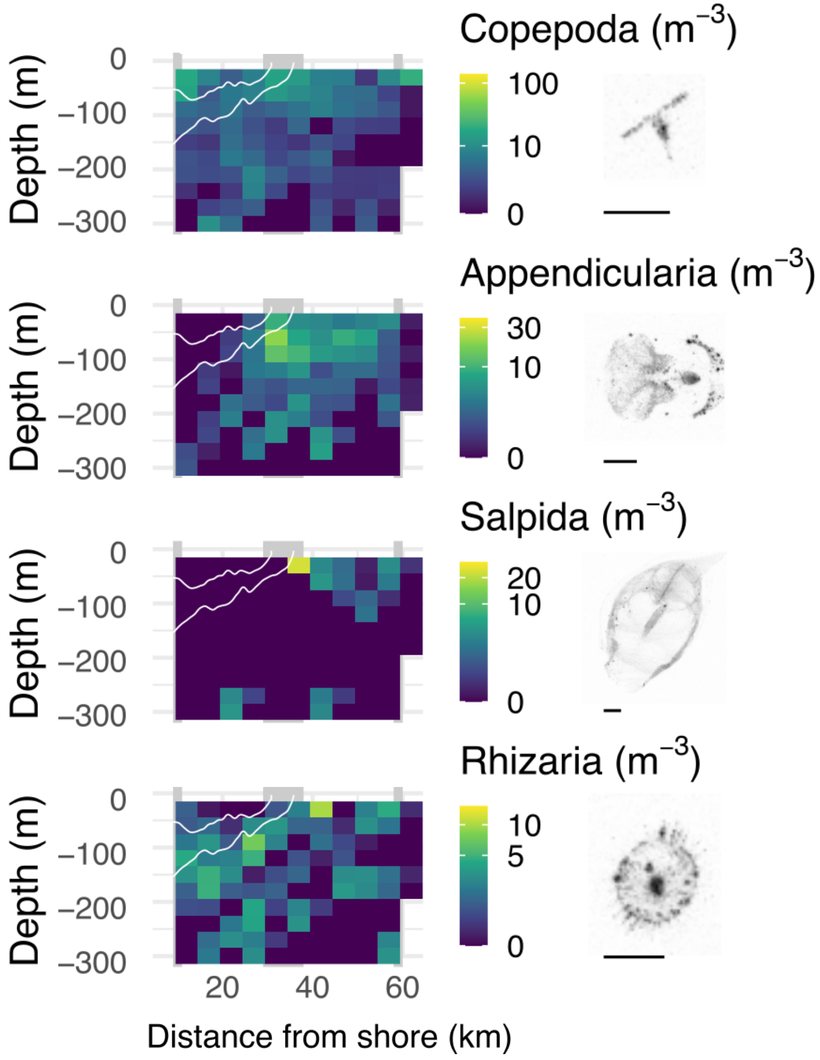
Appendicularians → Salps

Concentration increase at front

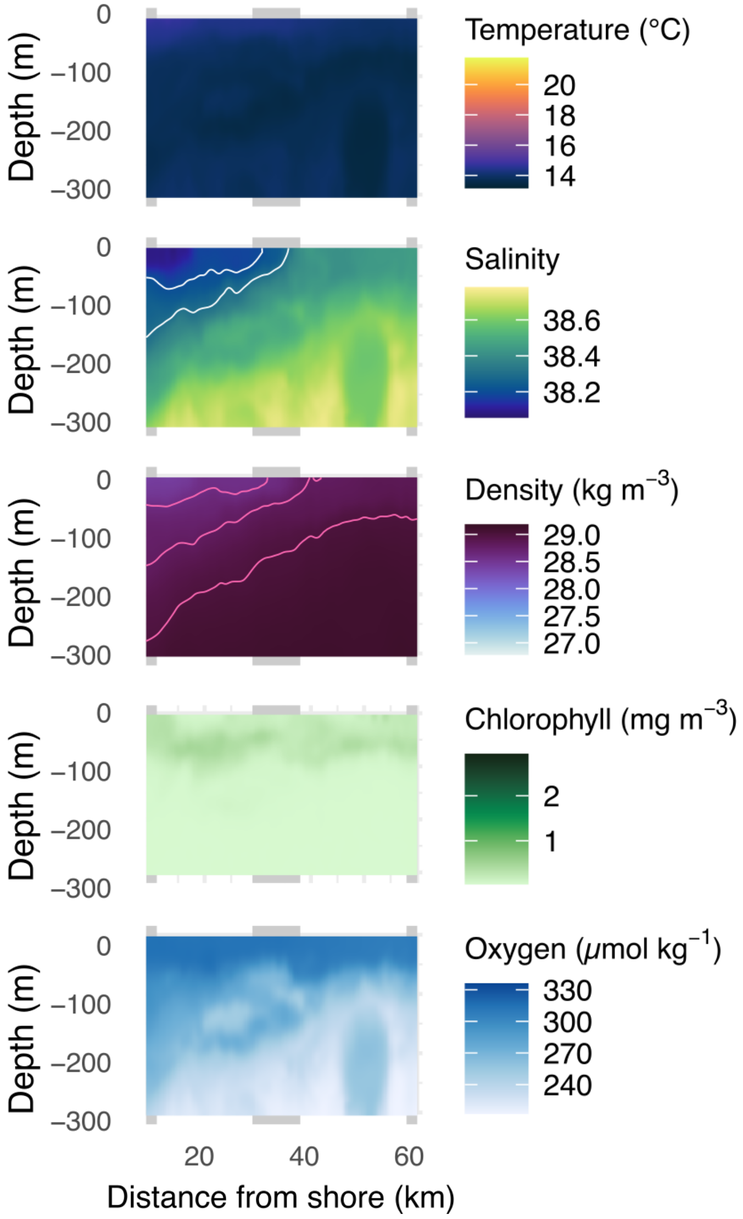
3: Late bloom


Depth (m)
0
−100
−200
−300
Temperature (°C)
20
18
16
14
Salinity
38.6
38.4
38.2
Density (kg m^{-3})
29.0
28.5
28.0
27.5
27.0
Chlorophyll (mg m^{-3})
2
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
PC1
Abundance
high
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
Copepoda (m^{-3})
100
10
0
Appendicularia (m^{-3})
30
10
0
Salpida (m^{-3})
20
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

3: Late bloom


Depth (m)
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−100
−200
−300
Temperature (°C)
20
18
16
14
Salinity
38.6
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38.2
Density (kg m^{-3})
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27.0
Chlorophyll (mg m^{-3})
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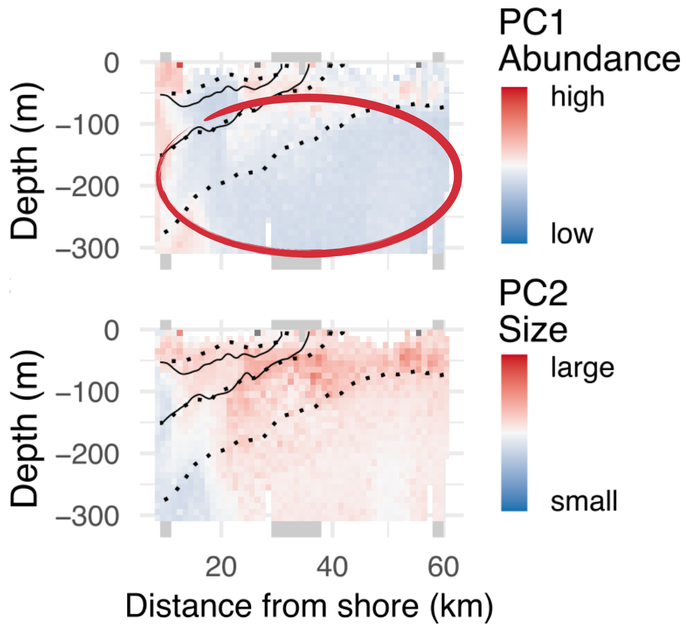
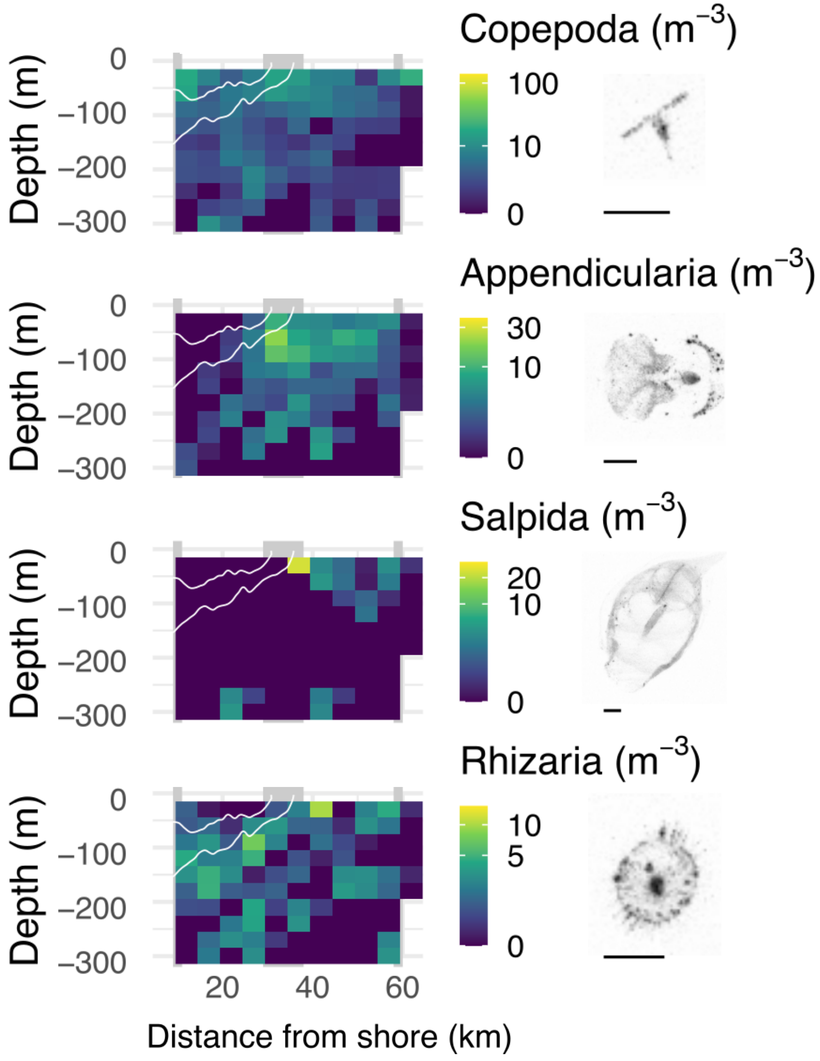
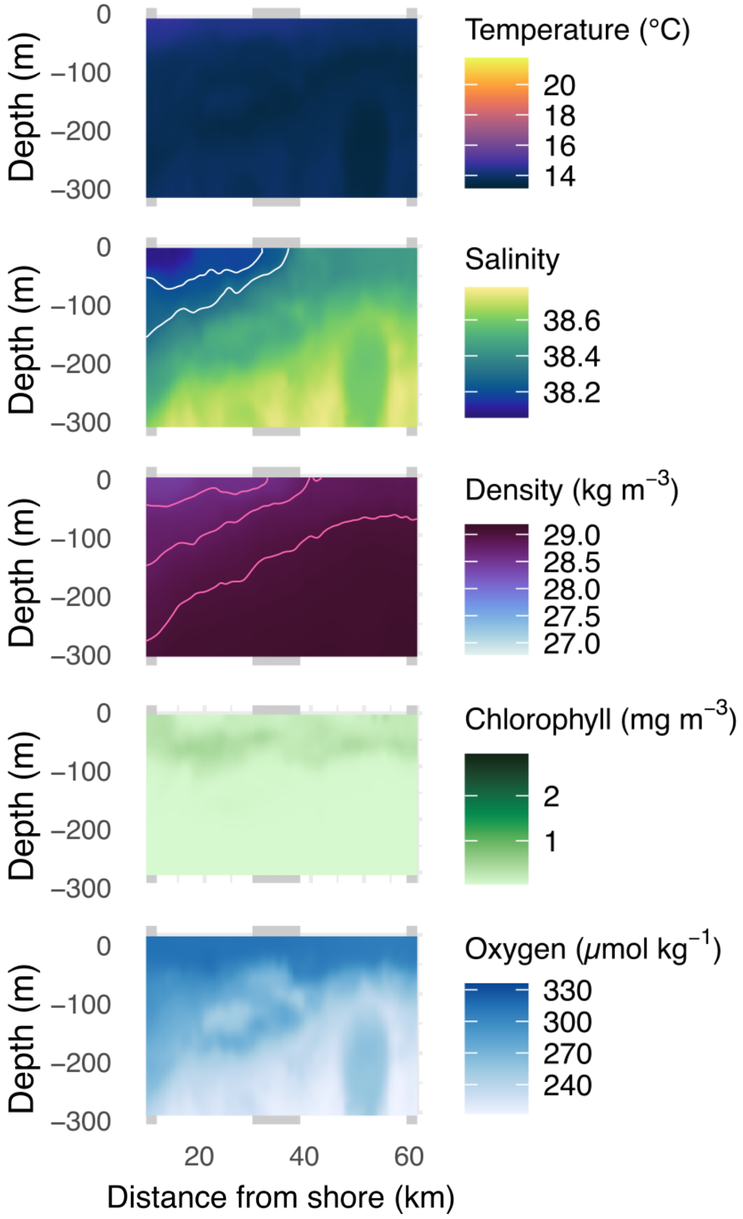
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
PC1
Abundance
high
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
Copepoda (m^{-3})
100
10
0
Appendicularia (m^{-3})
30
10
0
Salpida (m^{-3})
20
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

3: Late bloom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Temperature (°C)
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38.6
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Density (kg m^{-3})
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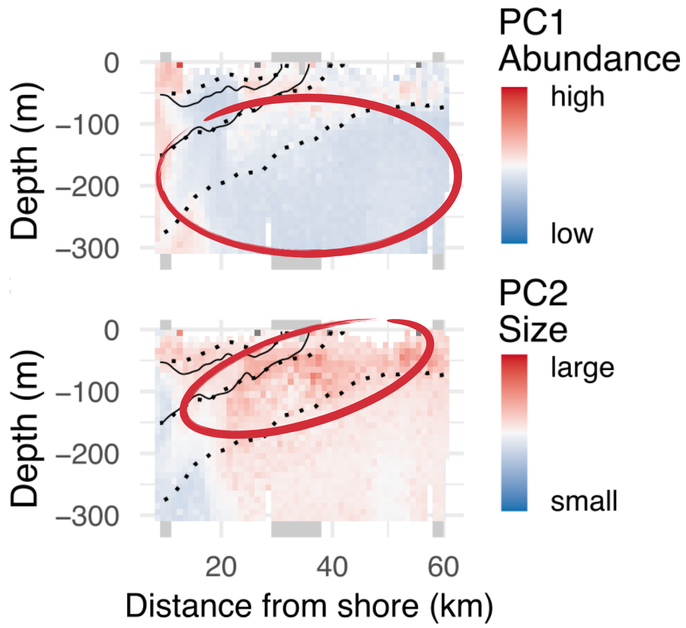
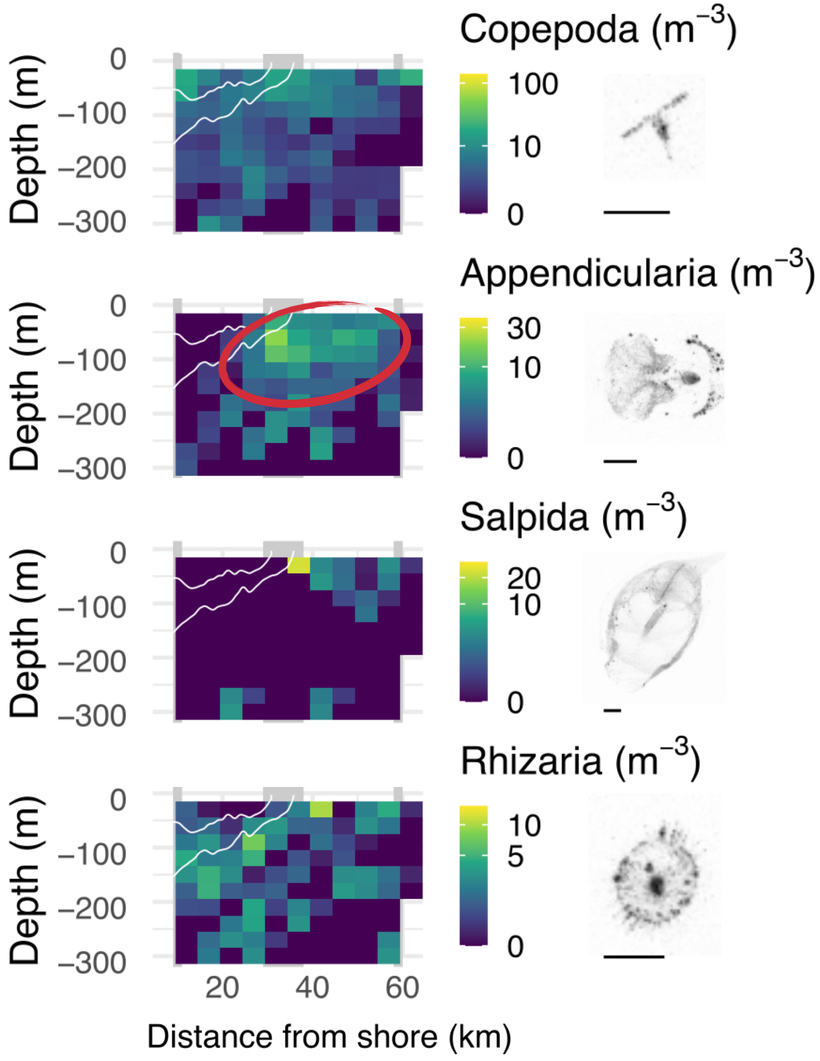
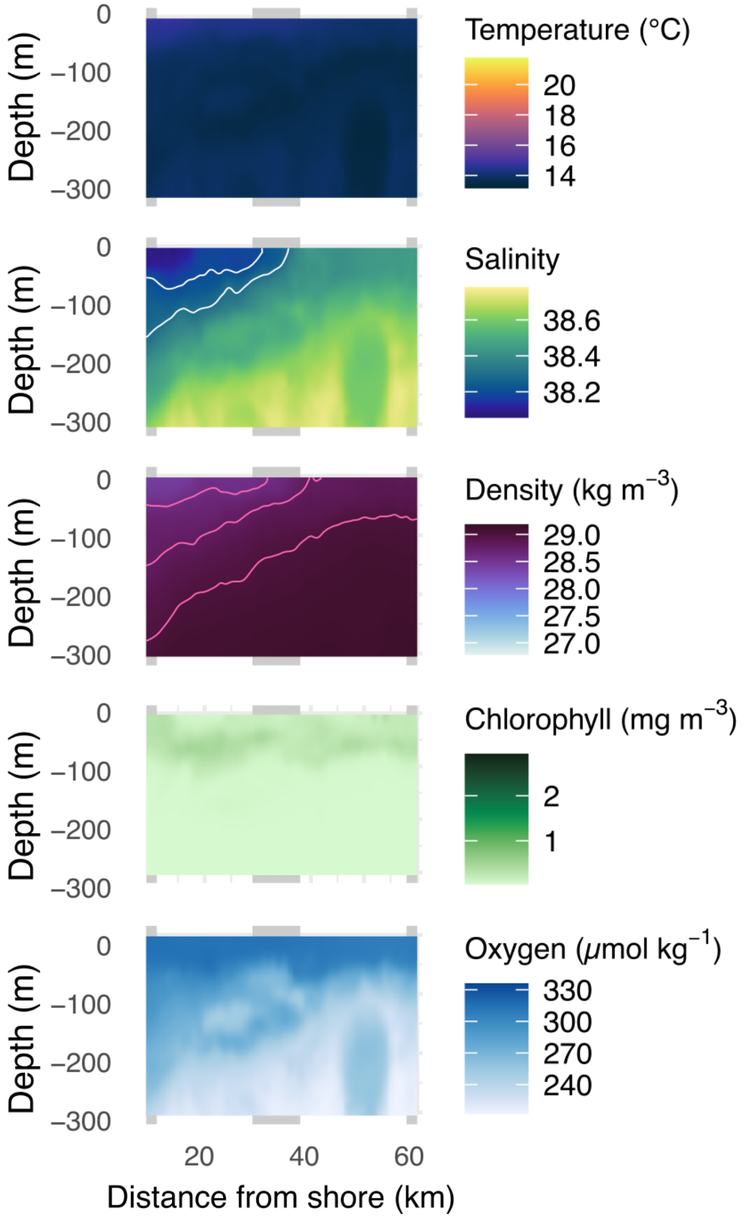
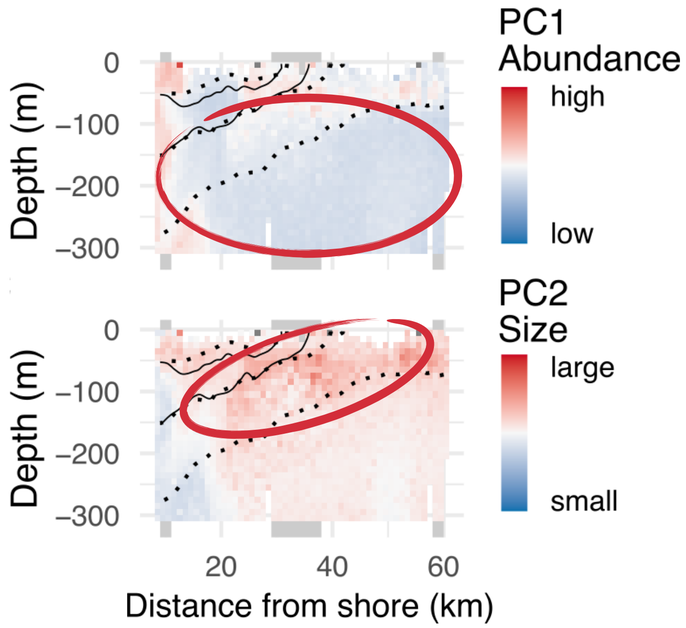
27.0
Chlorophyll (mg m^{-3})
2
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)

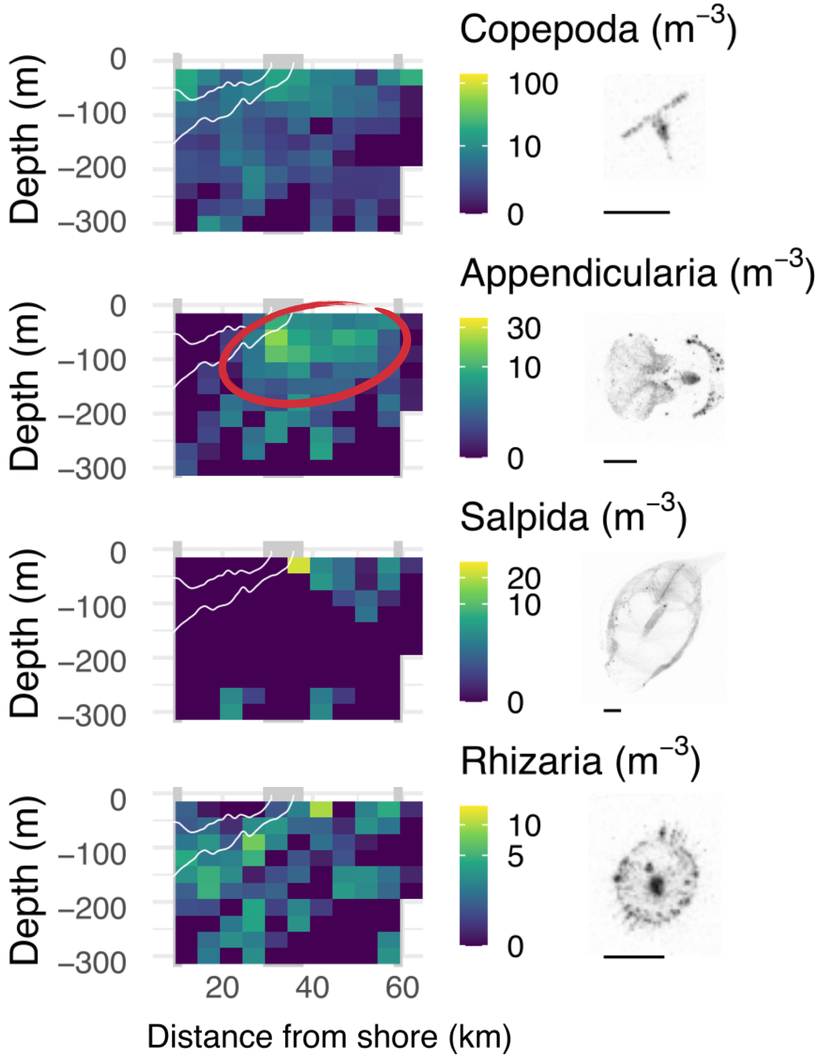

Depth (m)
0
−100
−200
−300
PC1
Abundance
high
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
Copepoda (m^{-3})
100
10
0
Appendicularia (m^{-3})
30
10
0
Salpida (m^{-3})
20
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

3: Late bloom





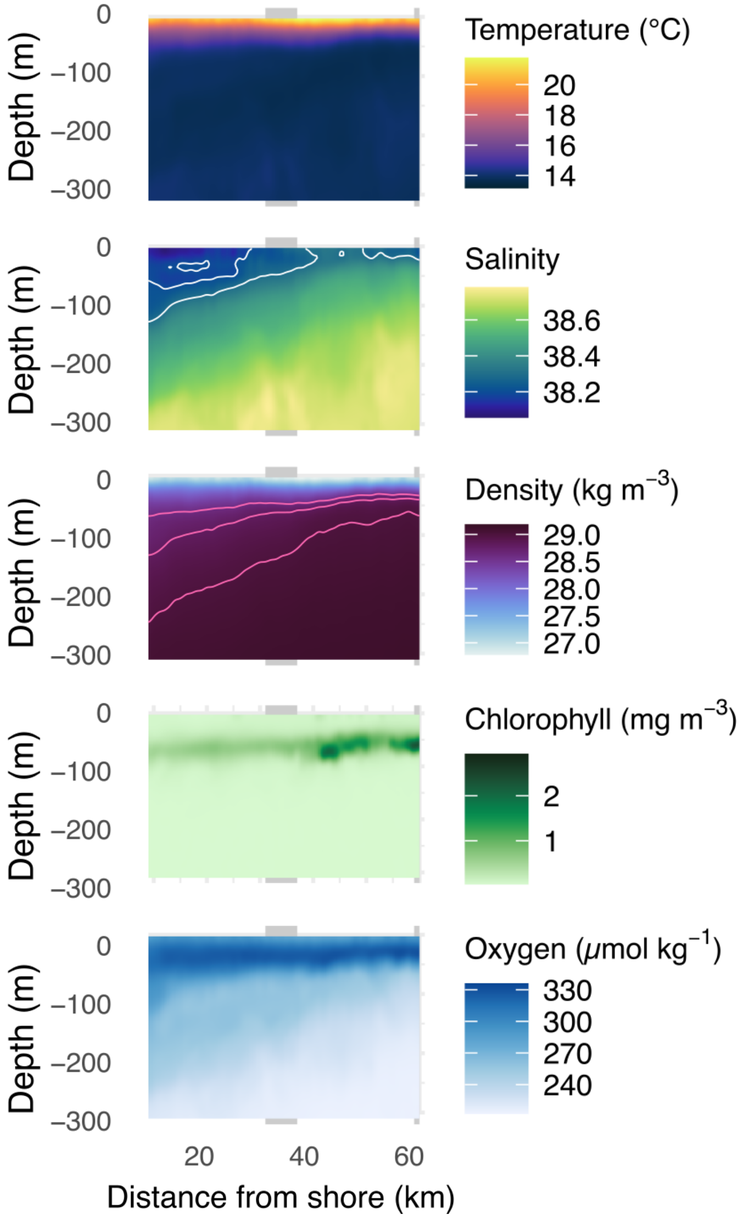


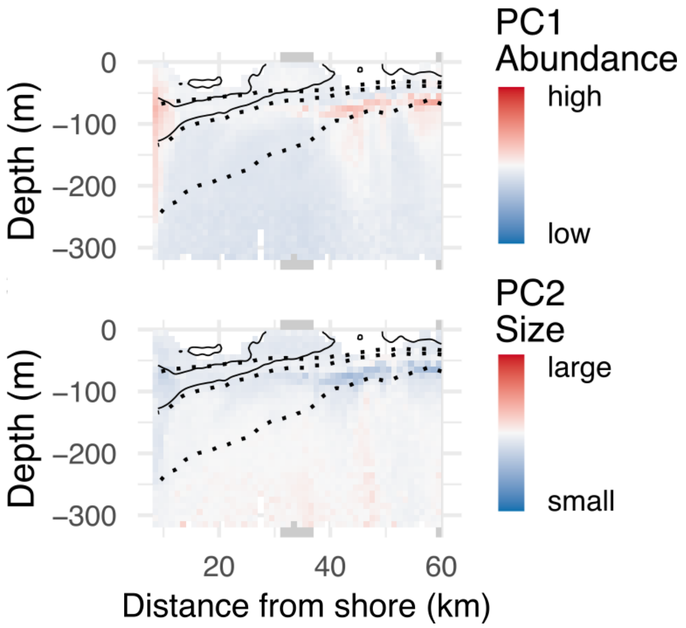
Very few particles

Salps → Appendicularians

Discarded houses

4: Post bloom


Depth (m)
0
−100
−200
−300
Temperature (°C)
20
18
16
14
Salinity
38.6
38.4
38.2
Density (kg m^{-3})
29.0
28.5
28.0
27.5
27.0
Chlorophyll (mg m^{-3})
2
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)


Depth (m)
0
−100
−200
−300
PC1
Abundance
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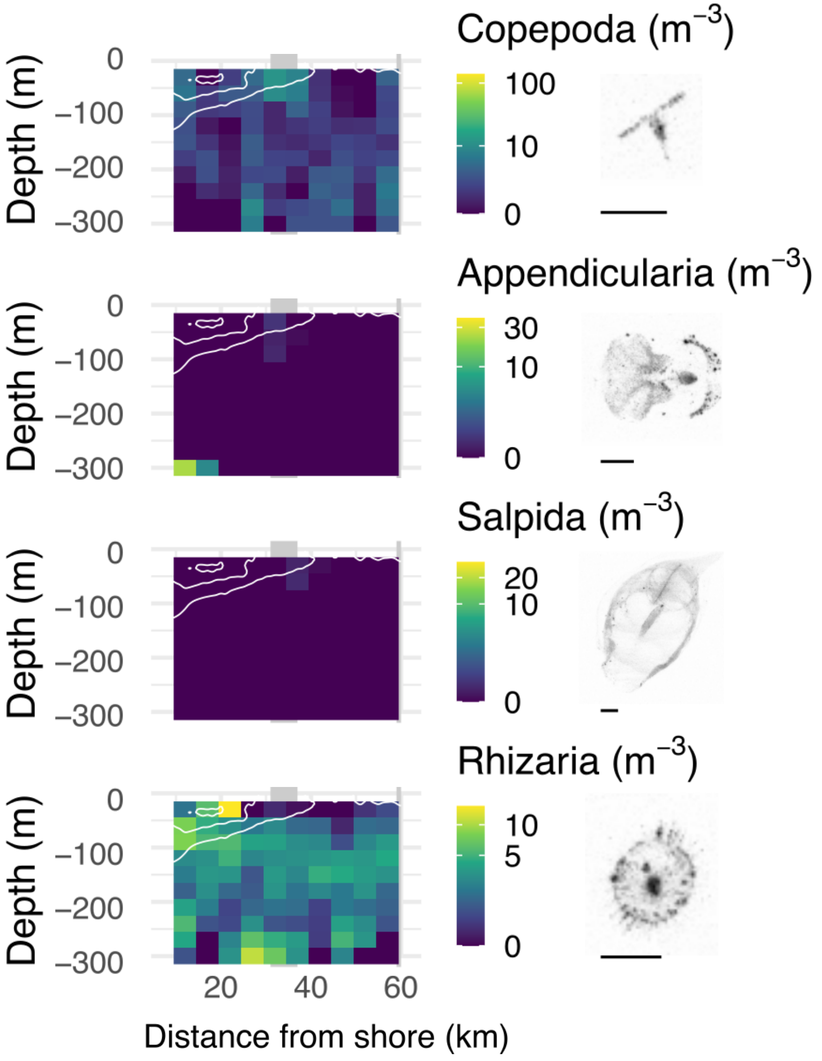
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
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Salpida (m^{-3})
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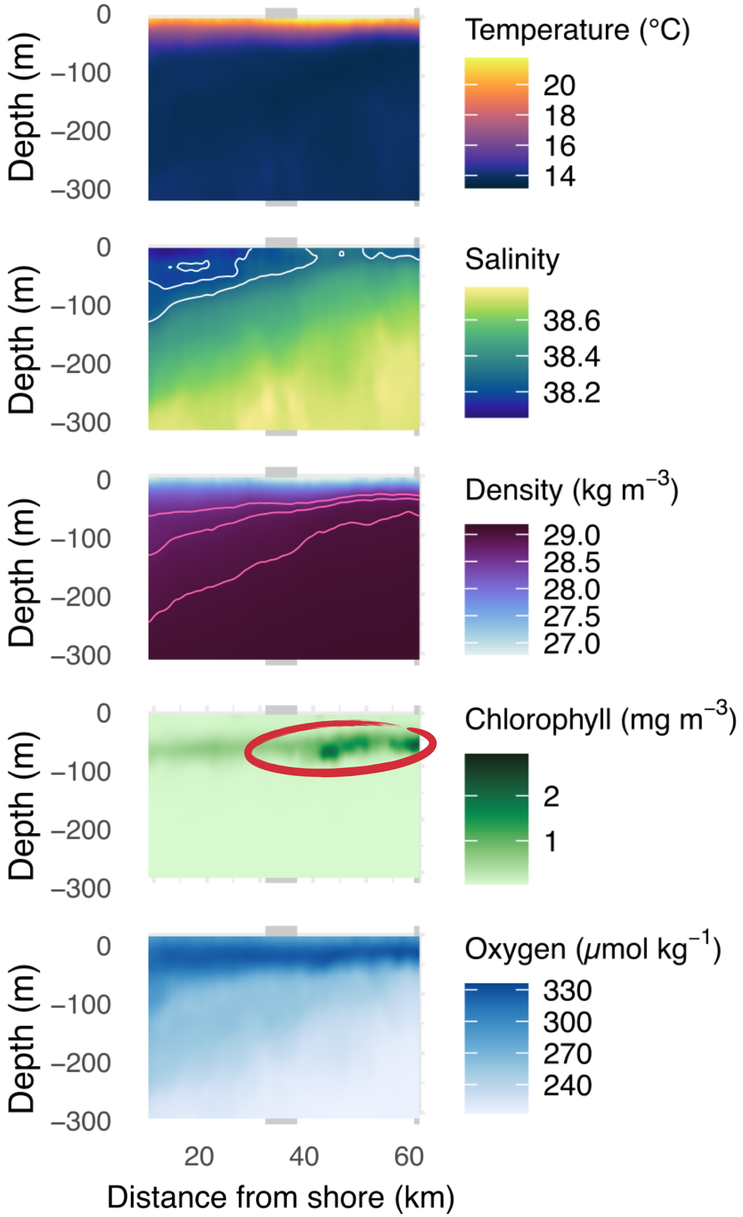
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

4: Post bloom


Depth (m)
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−100
−200
−300
Temperature (°C)
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18
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Salinity
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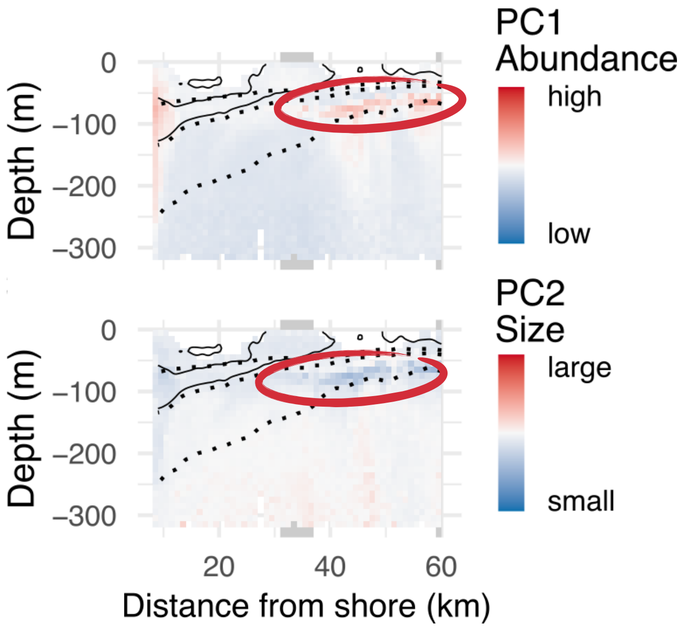
Distance from shore (km)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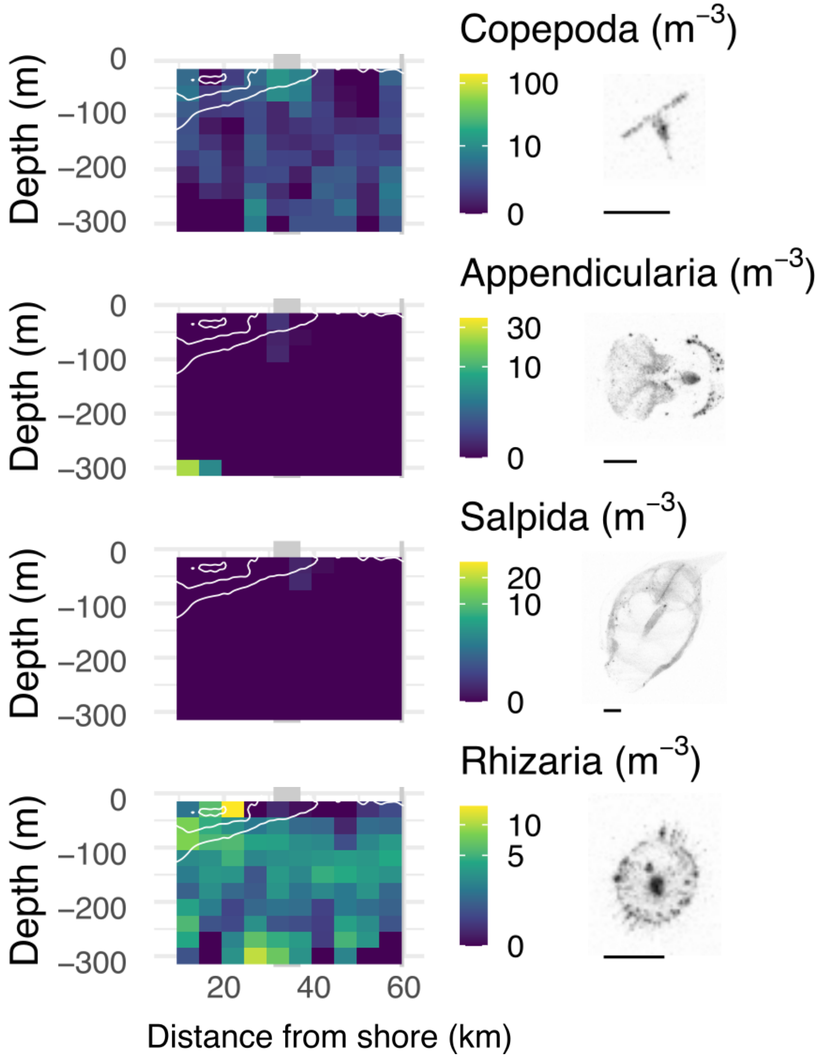
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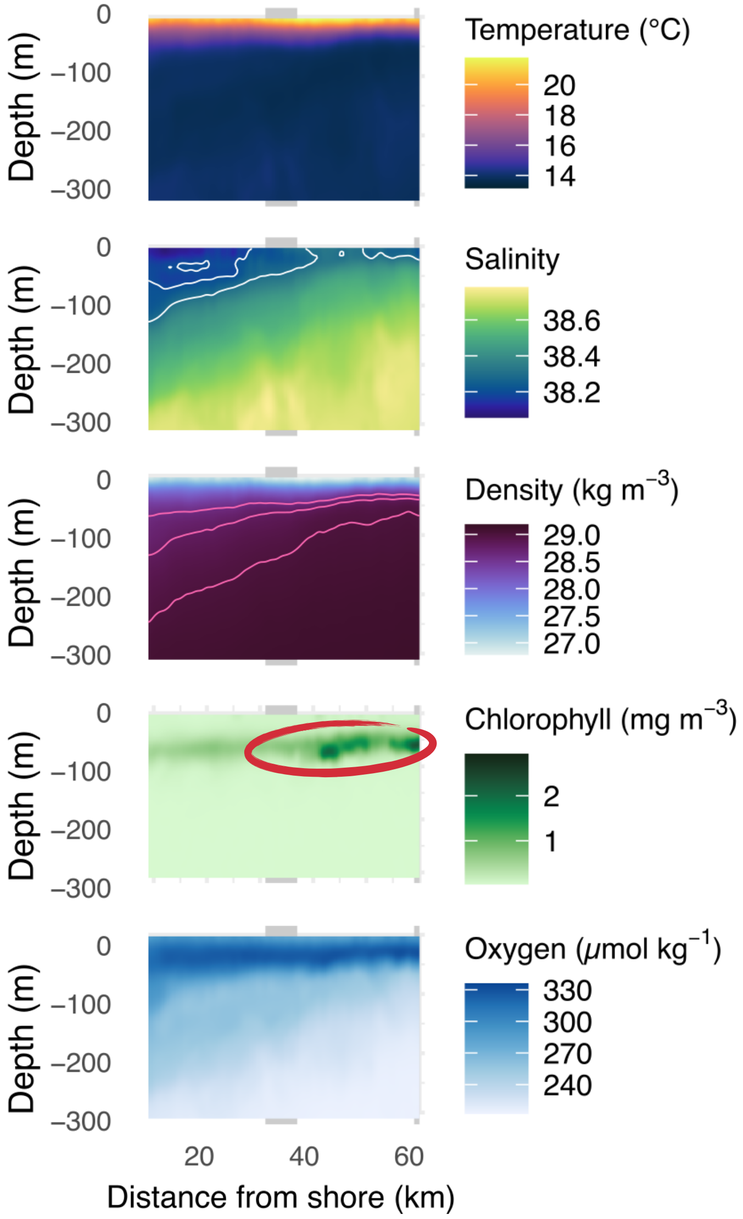
4: Post bloom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Temperature (°C)
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Density (kg m^{-3})
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28.5
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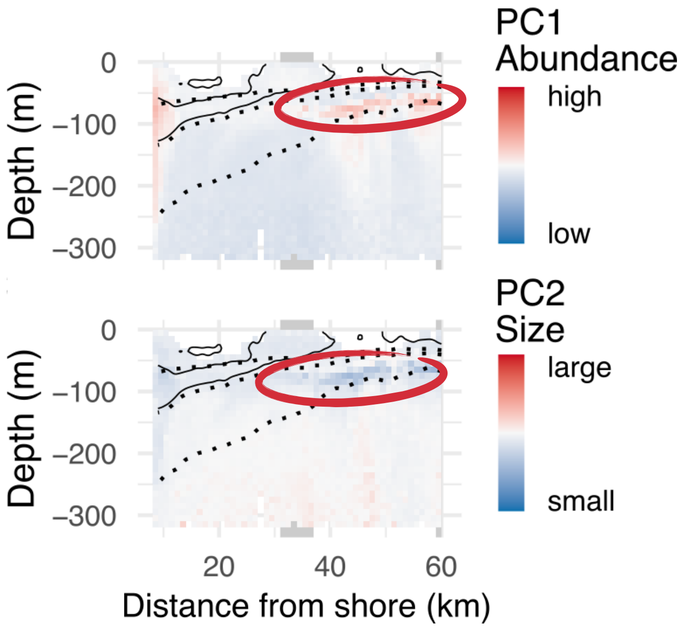
27.5
27.0
Chlorophyll (mg m^{-3})
2
1
Oxygen (μmol kg^{-1})
330
300
270
240
20
40
60
Distance from shore (km)


Depth (m)
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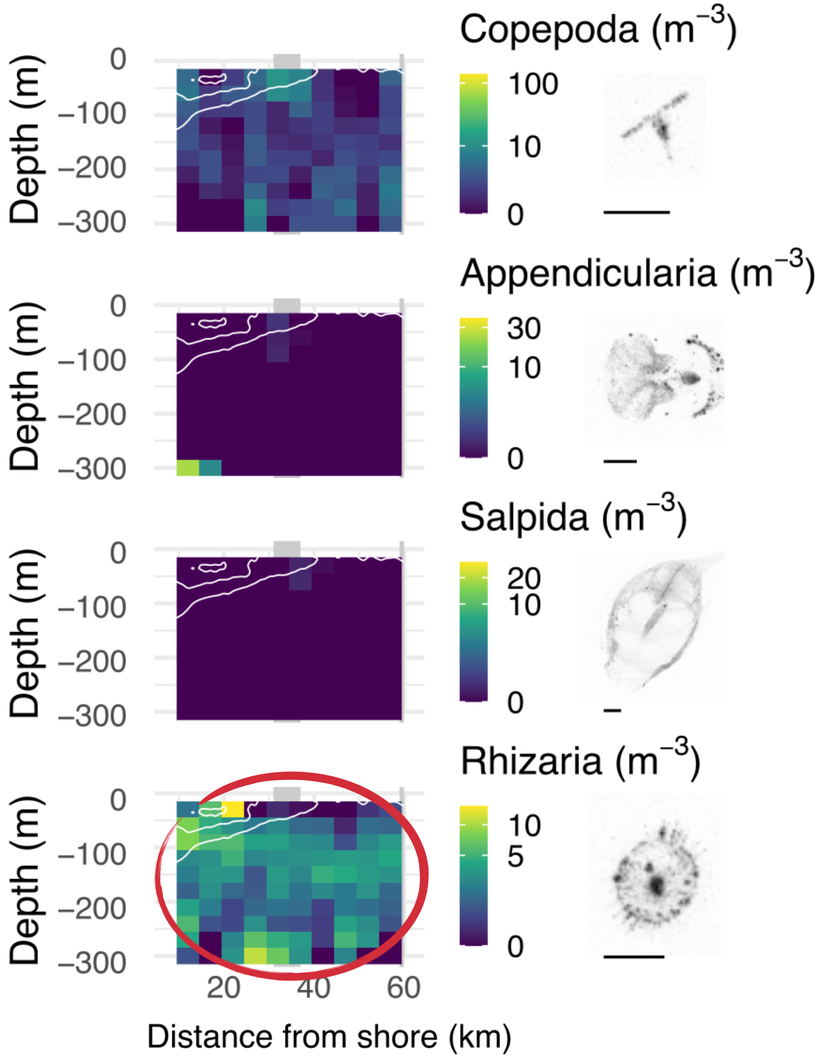
−300
PC1
Abundance
high
low
PC2
Size
large
small
20
40
60
Distance from shore (km)


Depth (m)
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−100
−200
−300
Copepoda (m^{-3})
100
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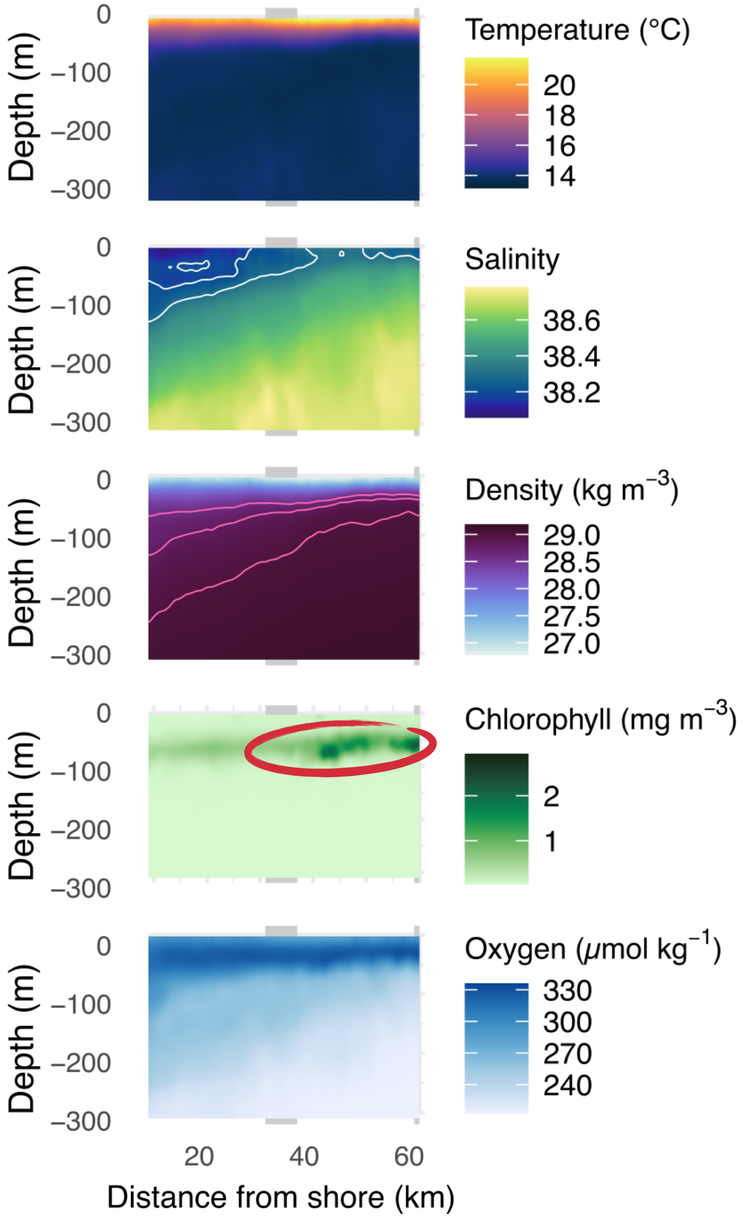
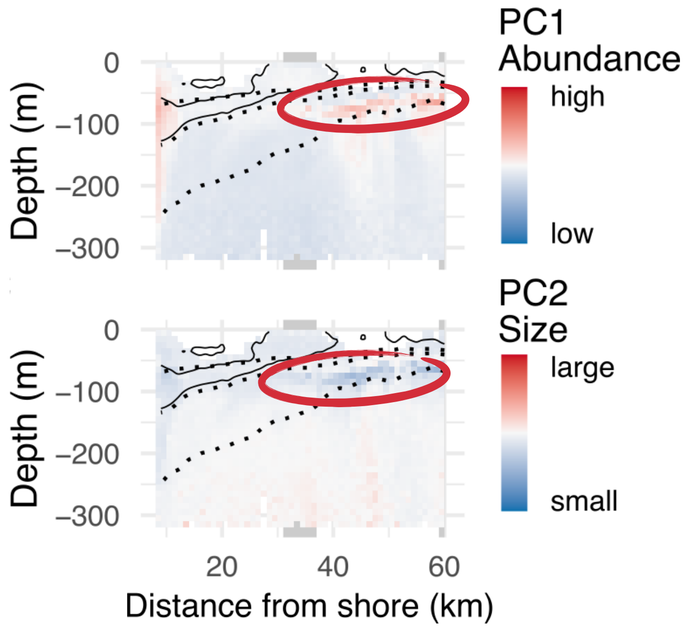
0
Appendicularia (m^{-3})
30
10
0
Salpida (m^{-3})
20
10
0
Rhizaria (m^{-3})
10
5
0
20
40
60
Distance from shore (km)

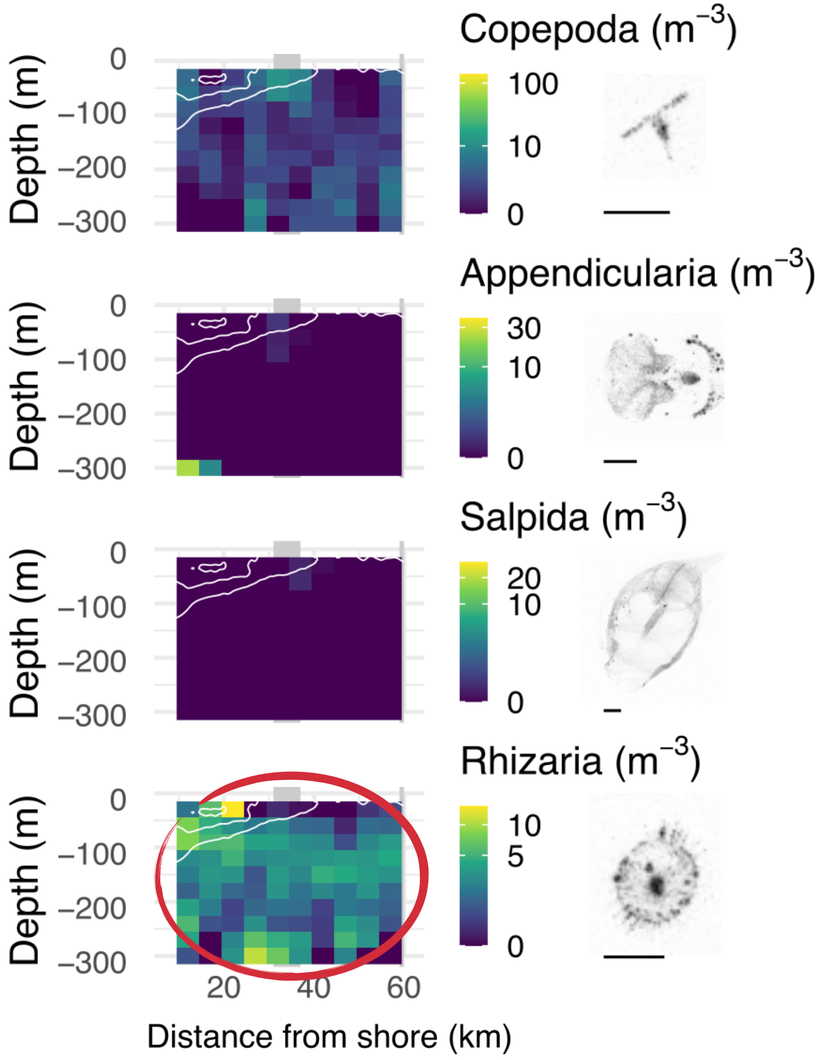
4: Post bloom





Effect of DCM on particle distribution

Rhizaria



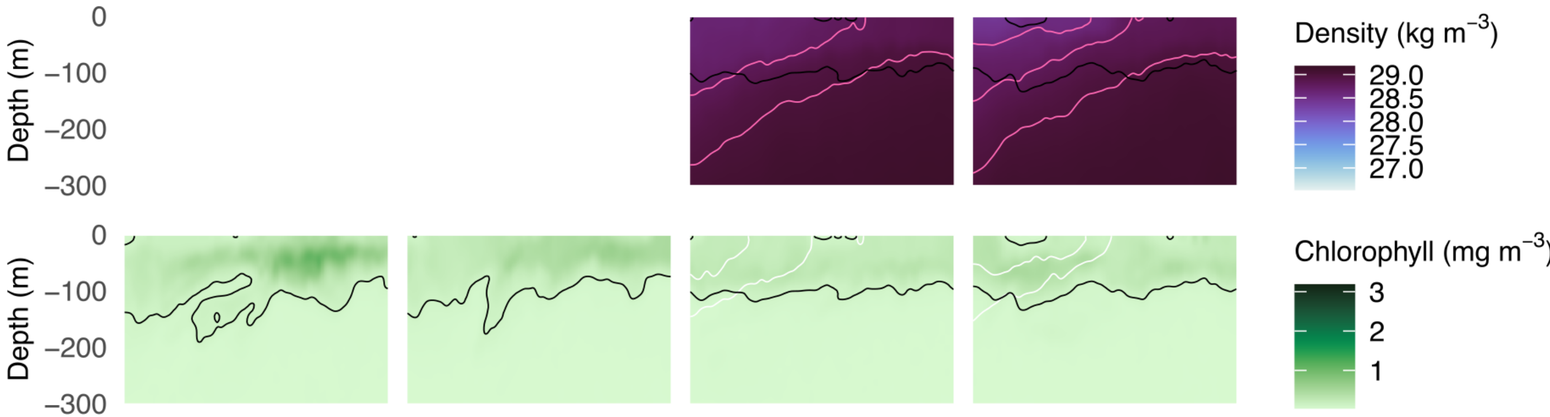
Limitations

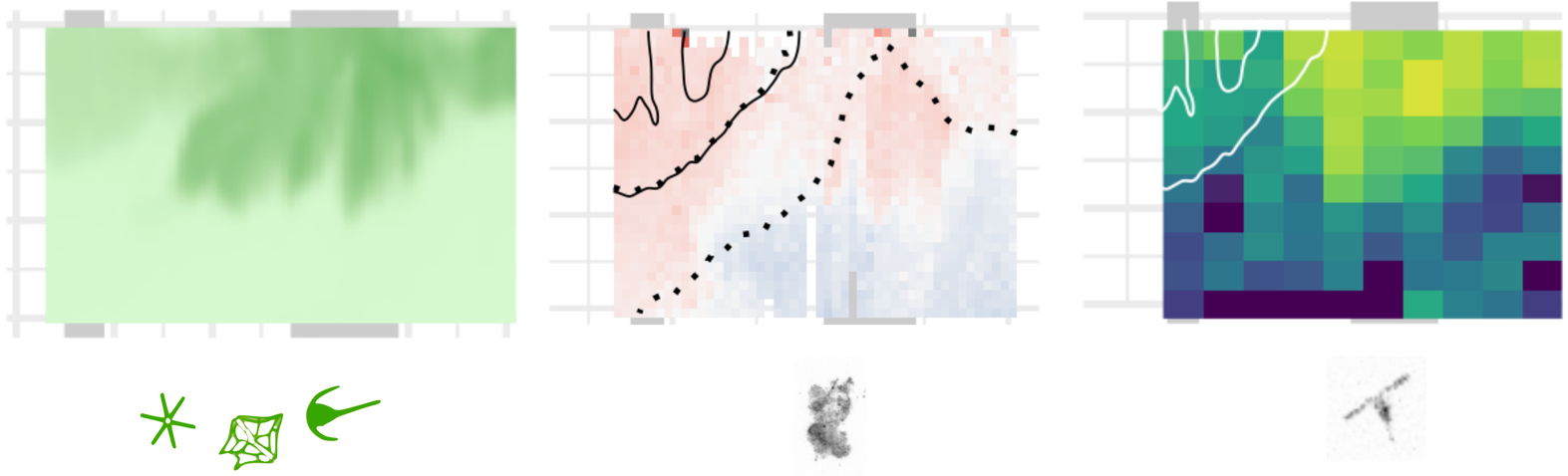
Some **instrument failure** (e.g. no CTD for ~15 days)

Limited **taxonomic** resolution from images and **imperfect** automated classification (>90% total accuracy but ~70% on living organisms)

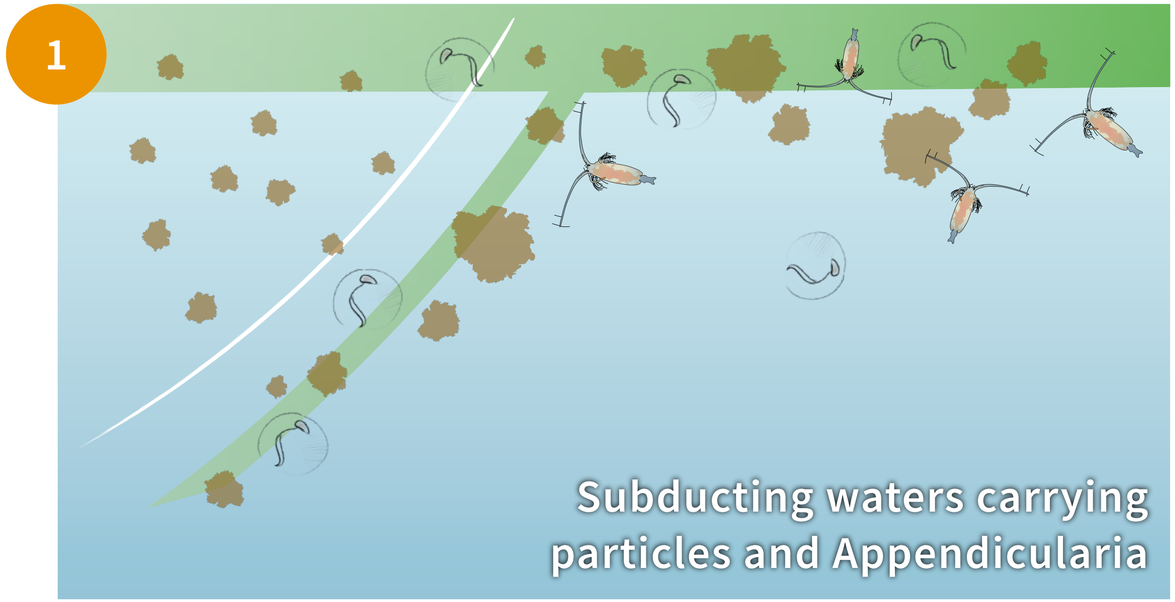
Not enough organisms ⟹ lower resolution in biological concentrations than in particles/biogeochemistry

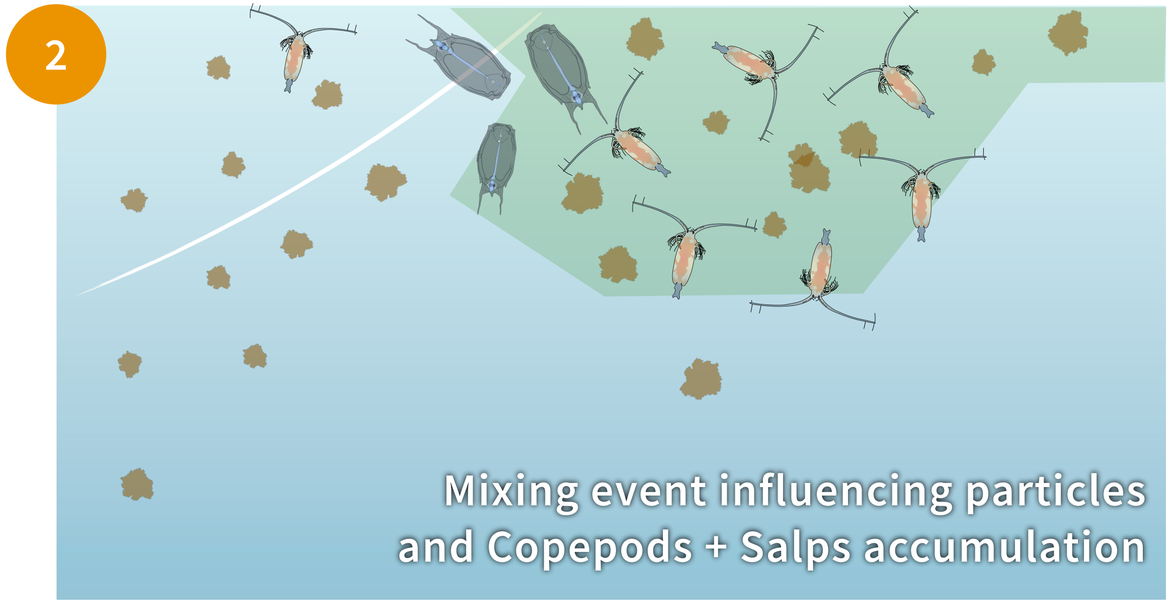
- sampling rate of 0.25L/s but oligotrophic area
- solution: UVP6 HF = less autonomy but higher sampling rate

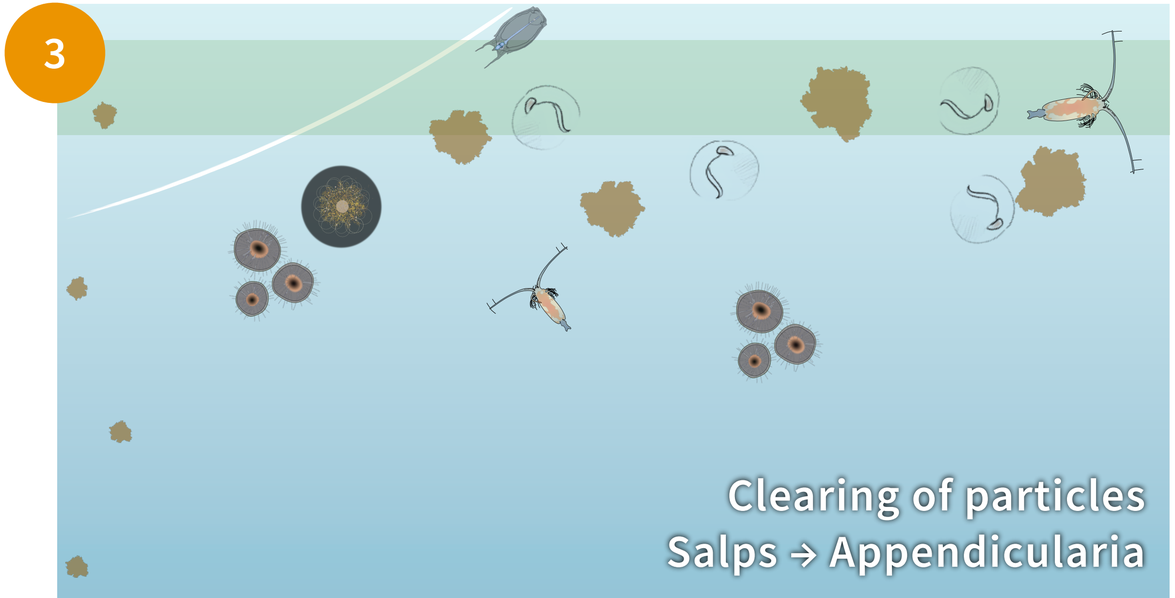


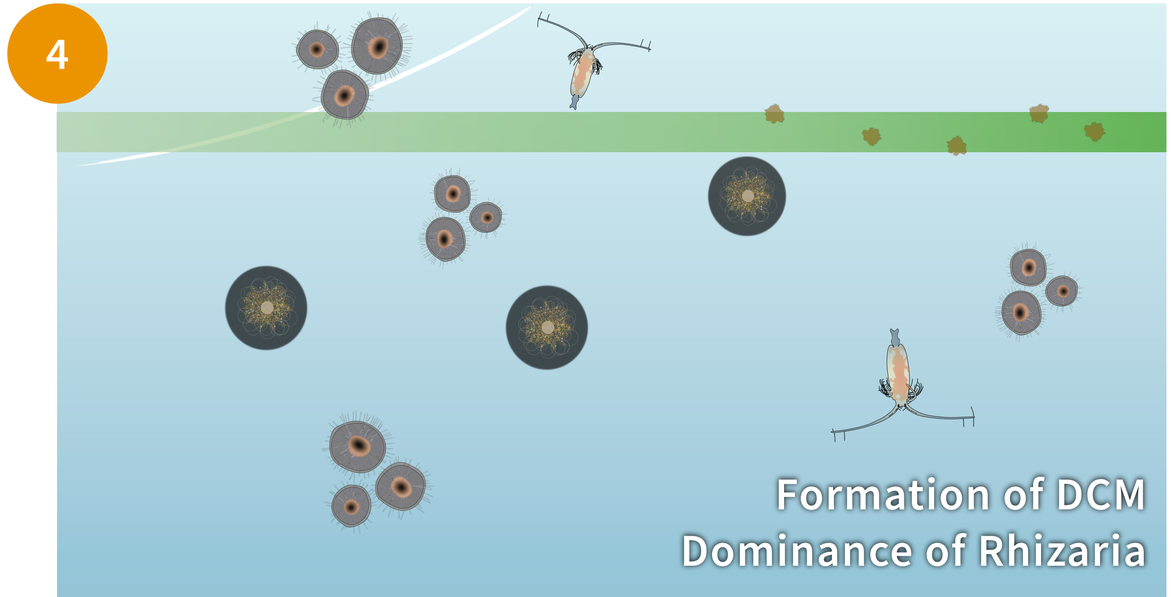


Summary: bloom dynamics

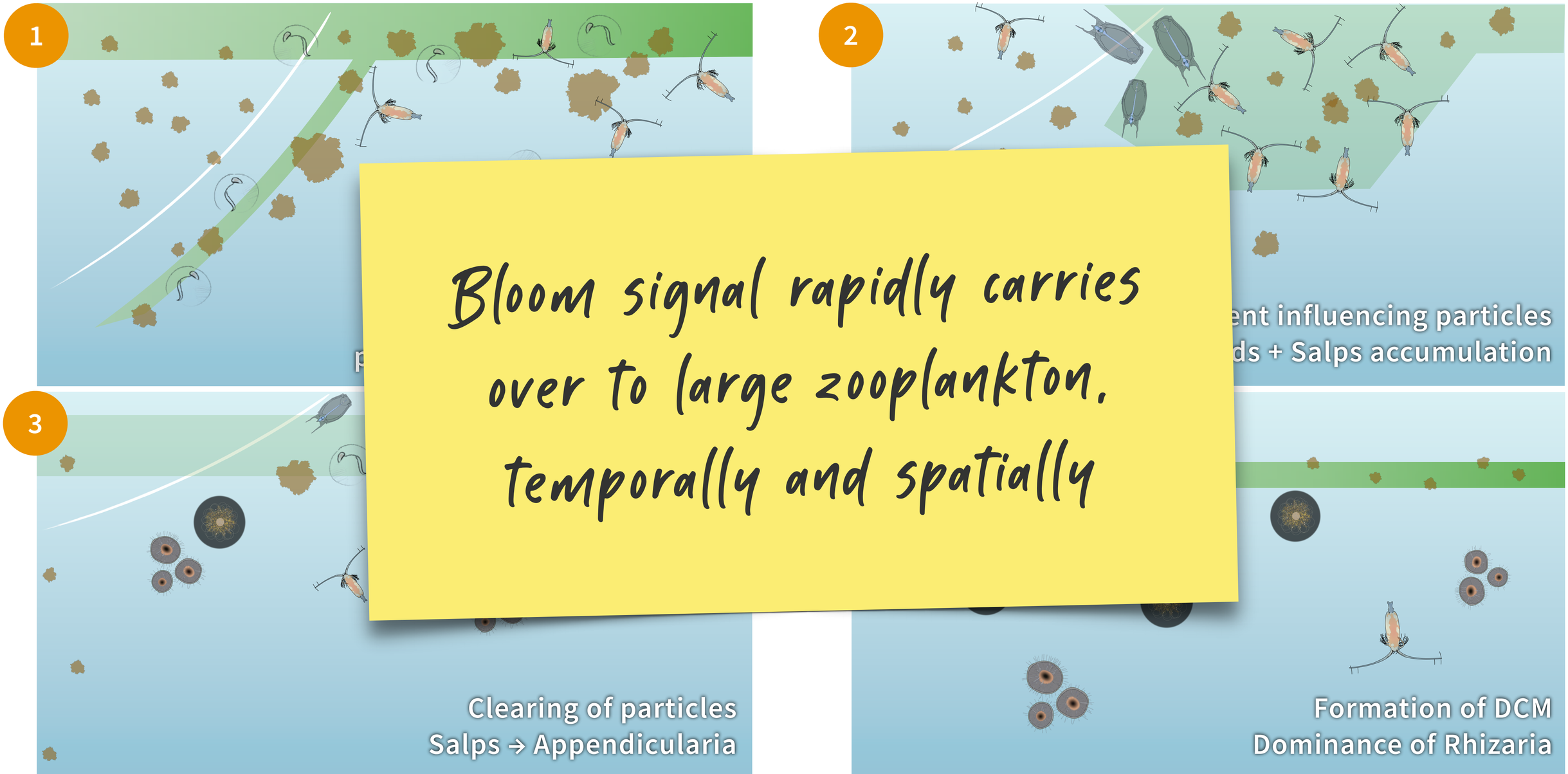








Summary: bloom dynamics



thelma.panaiotis@imev-mer.fr

Thank you

PIC

LOV LABORATOIRE D'OCÉANOGRAPHIE DE VILLEFRANCHE

BELMONT FORUM

cnrs

SCIENCES SORBONNE UNIVERSITÉ