

Aquatic Sciences Meeting, Palma, 2023-06-05

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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**

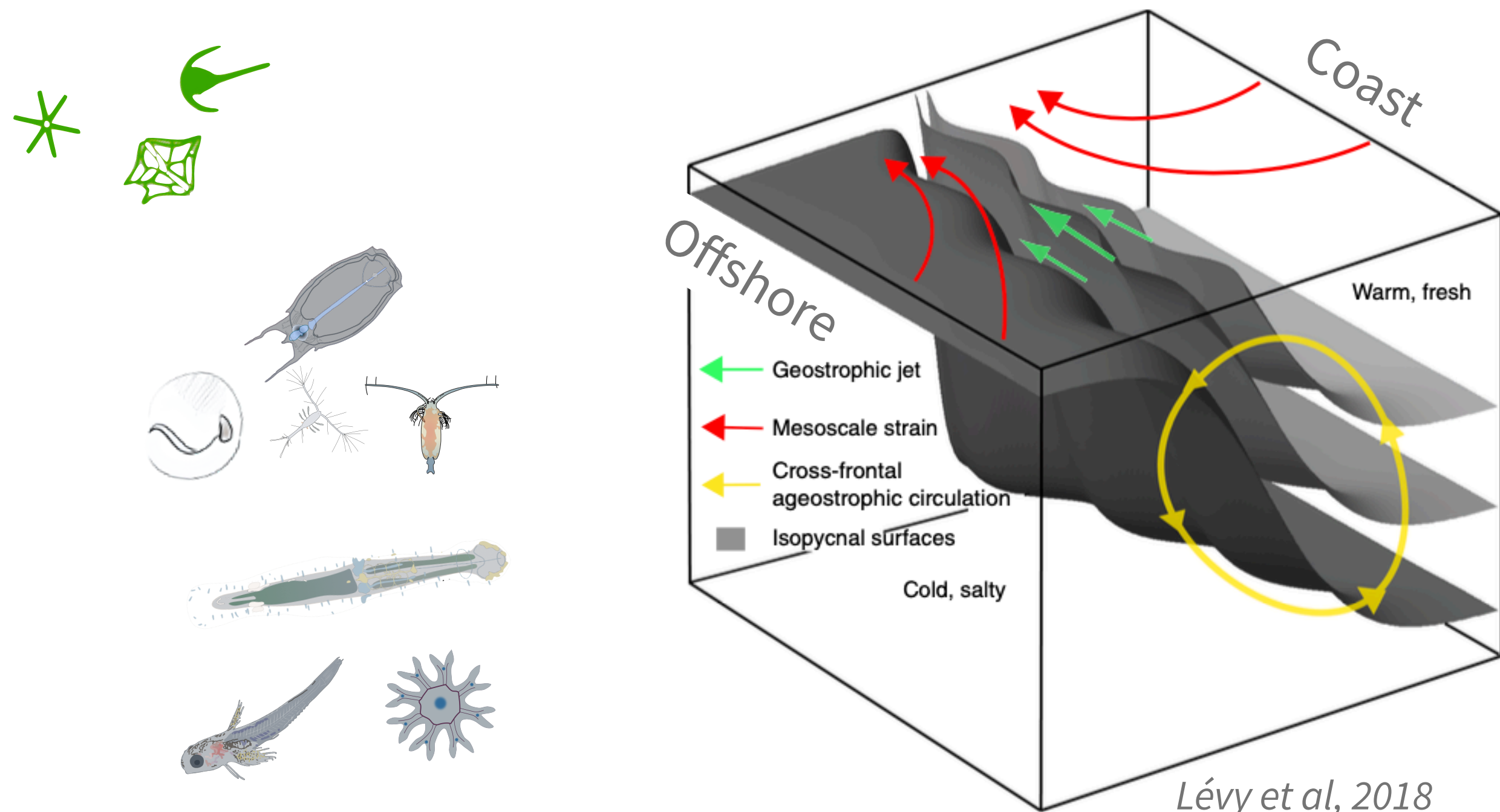
Succession: phytoplankton → zooplanktonic grazers → zooplanktonic predators

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**



Needs

Okm resolution

several months

biogeochemistry →
zooplankton



Glider + UVP6

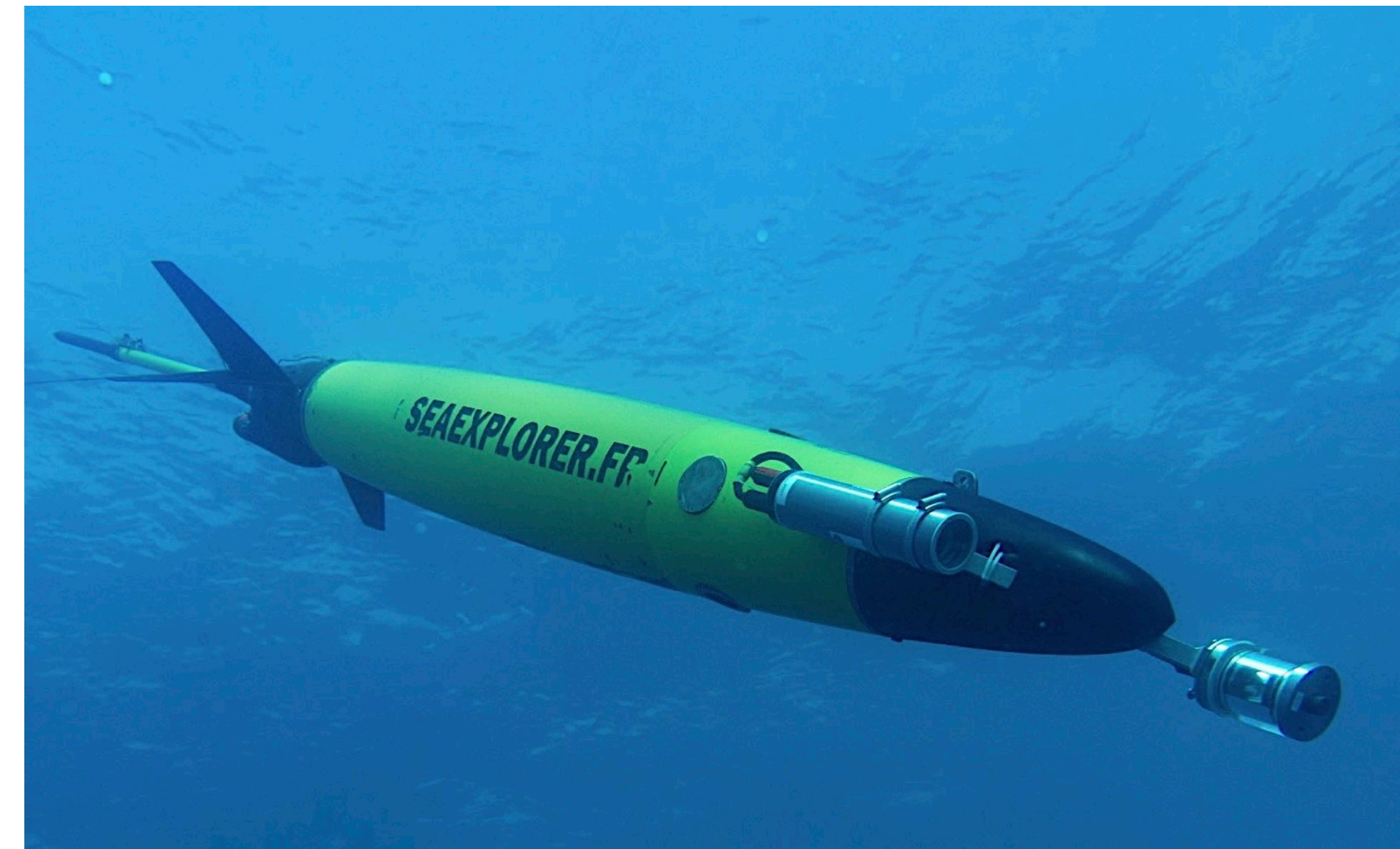
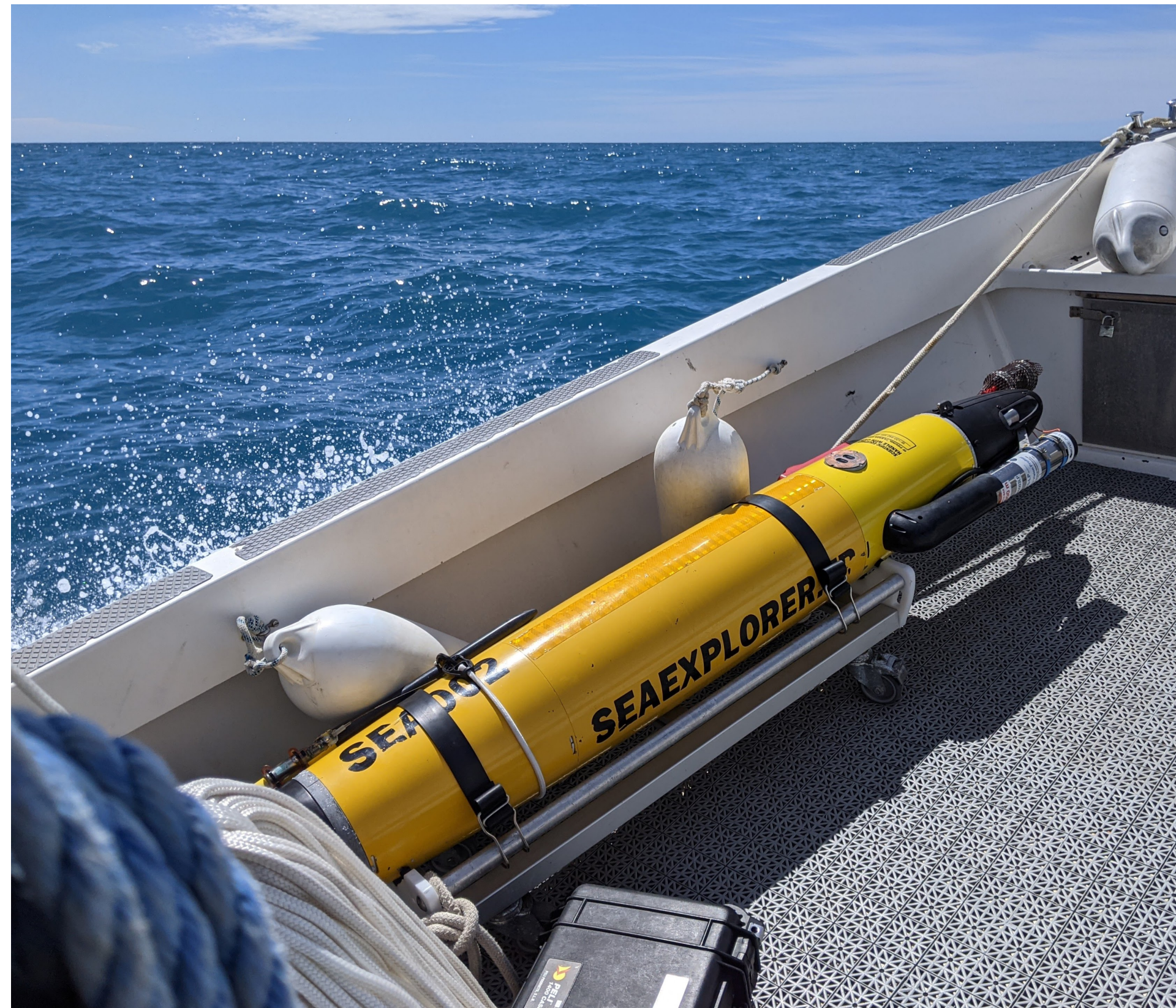
T°, sal

O₂, Chl a, CDOM, BB700

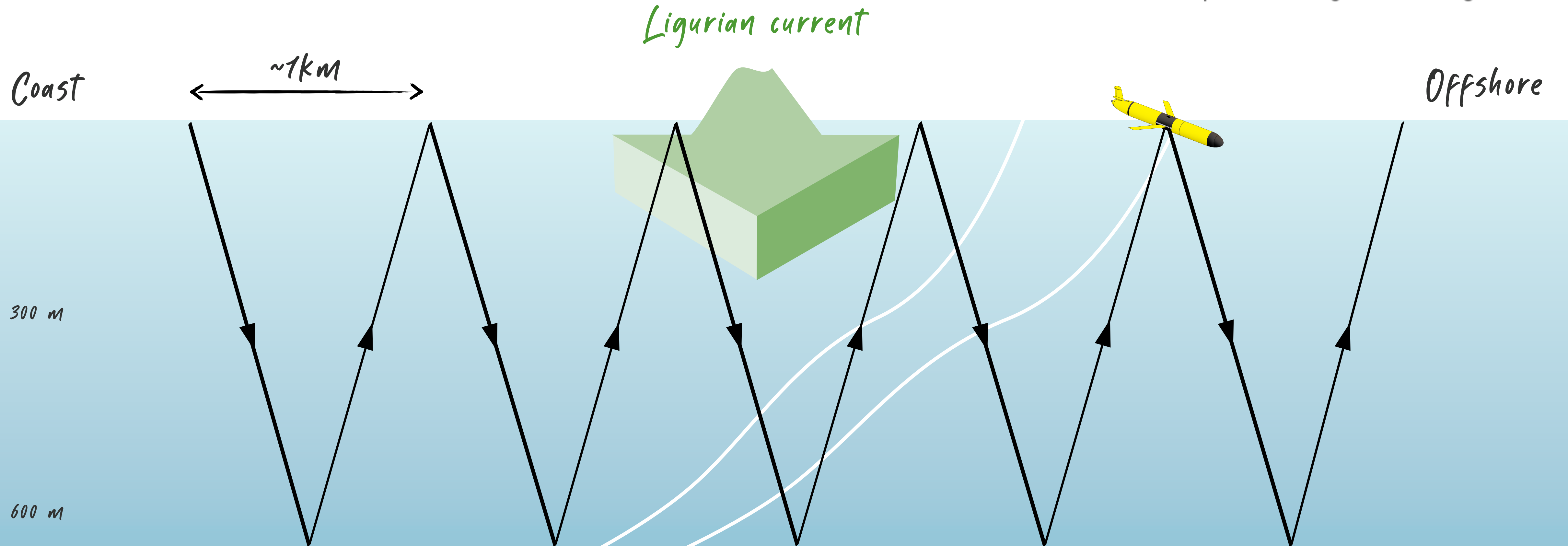
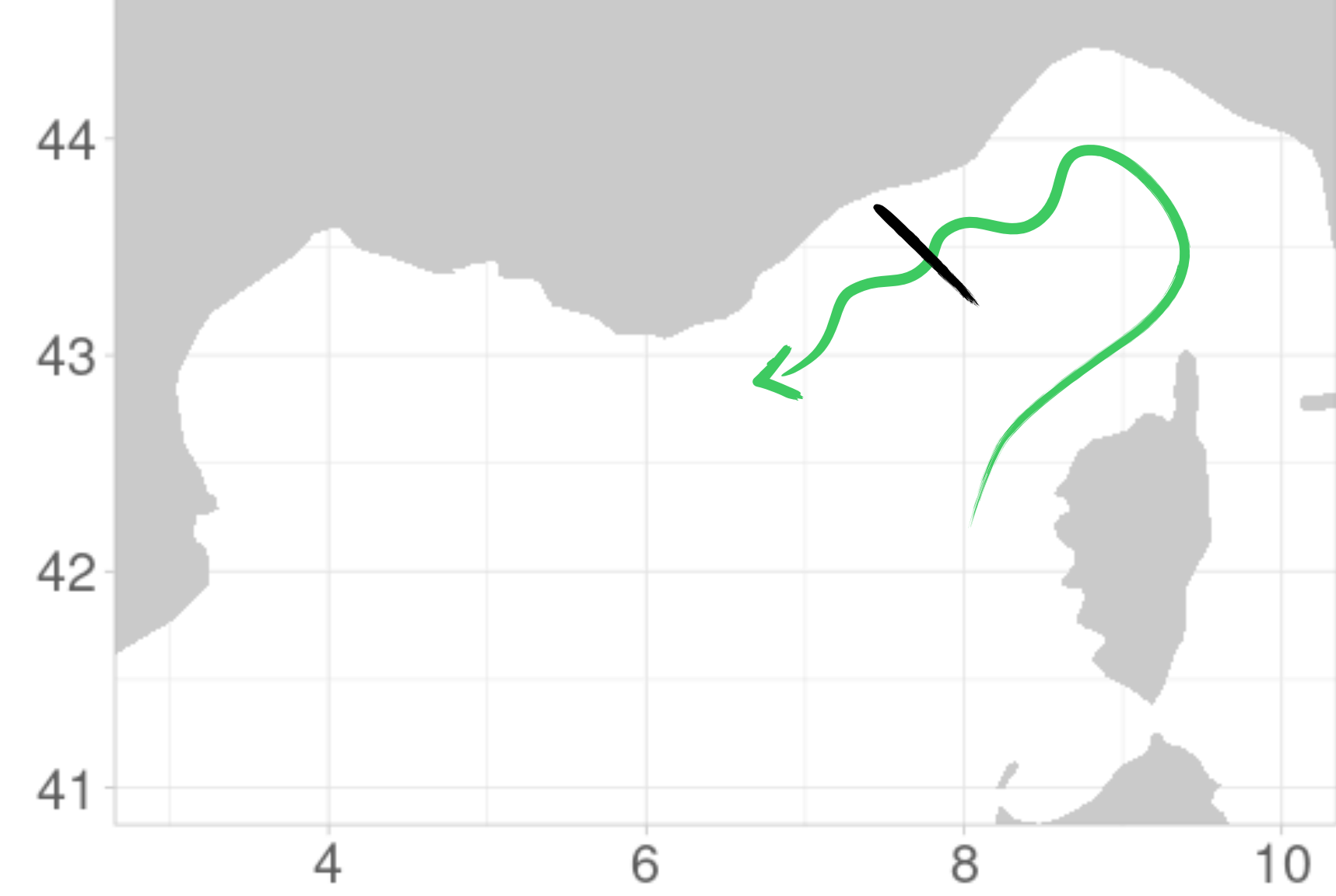
UVP6 LP

particles > 80 μm

organisms > ~1 mm

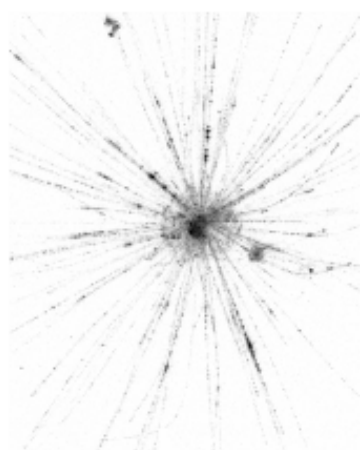
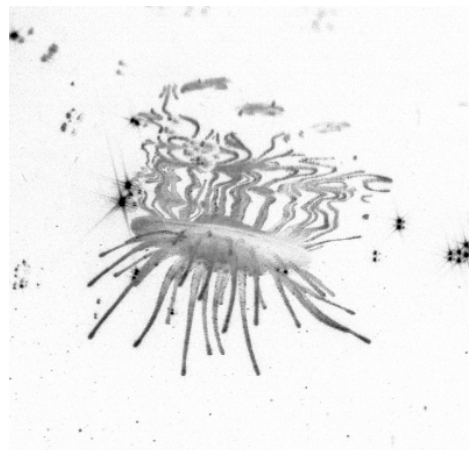


Sampling strategy



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

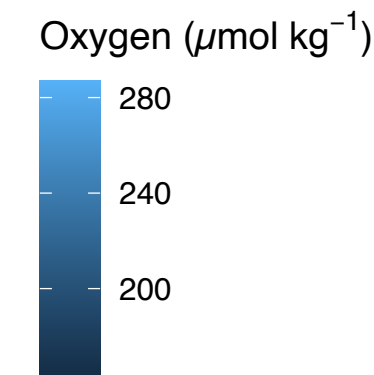
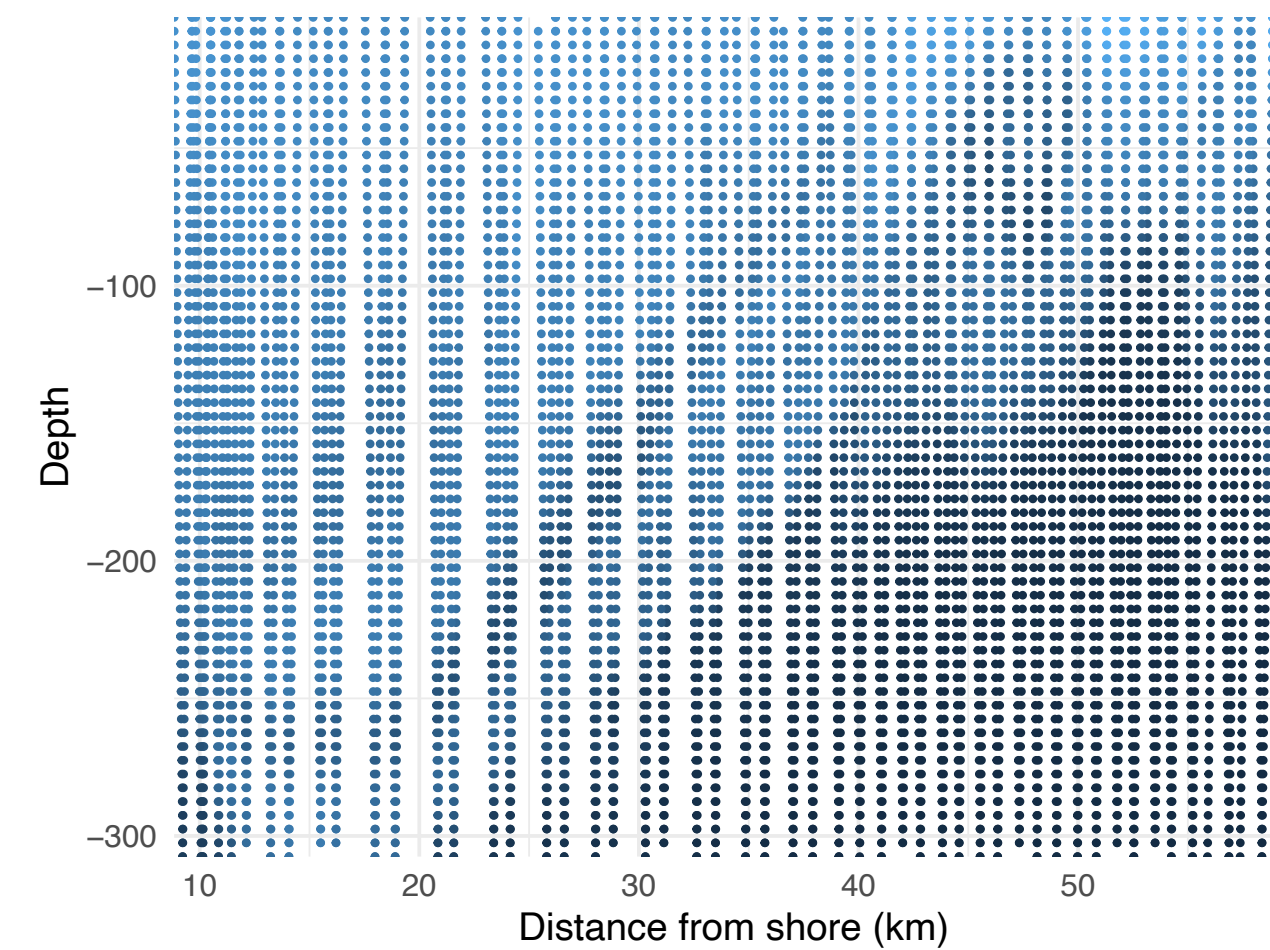
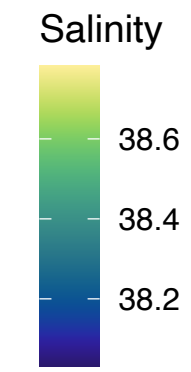
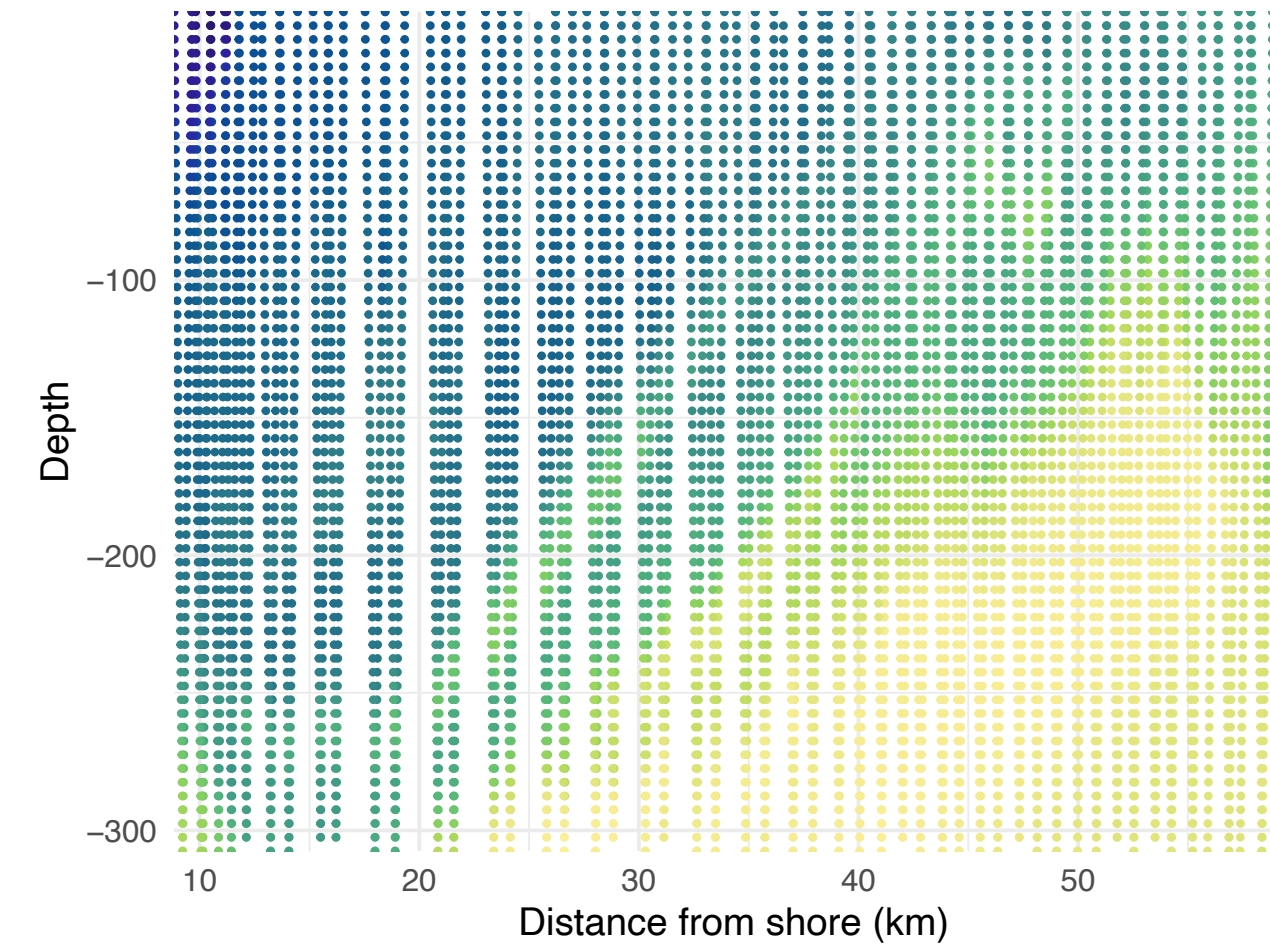
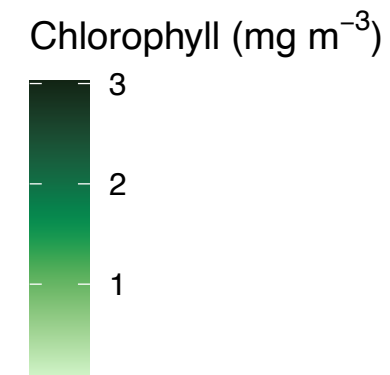
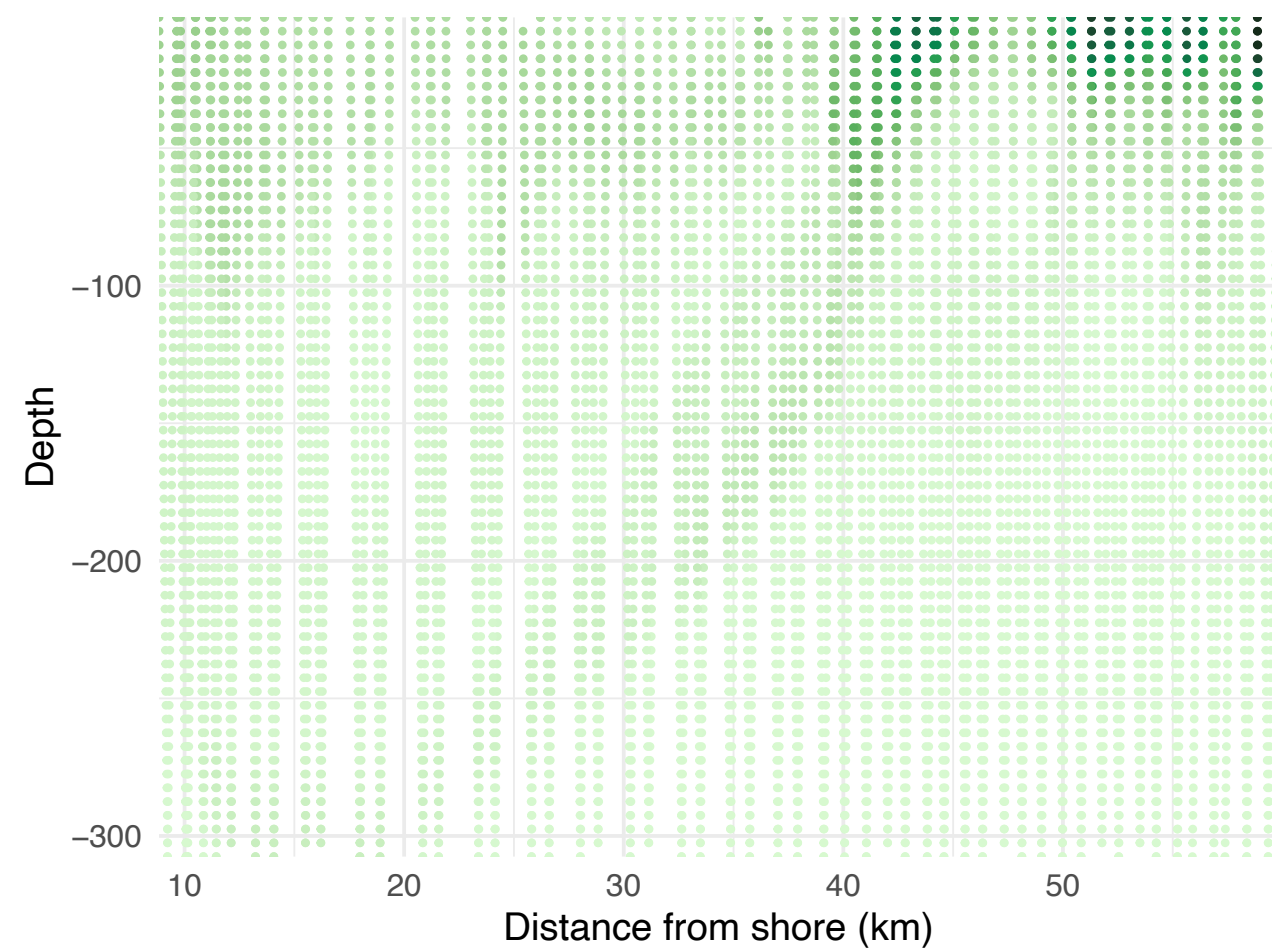
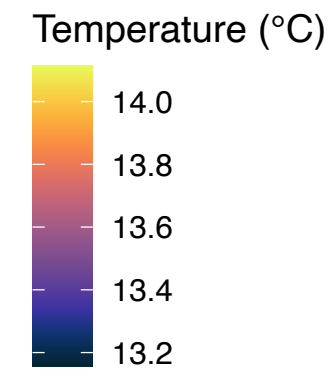
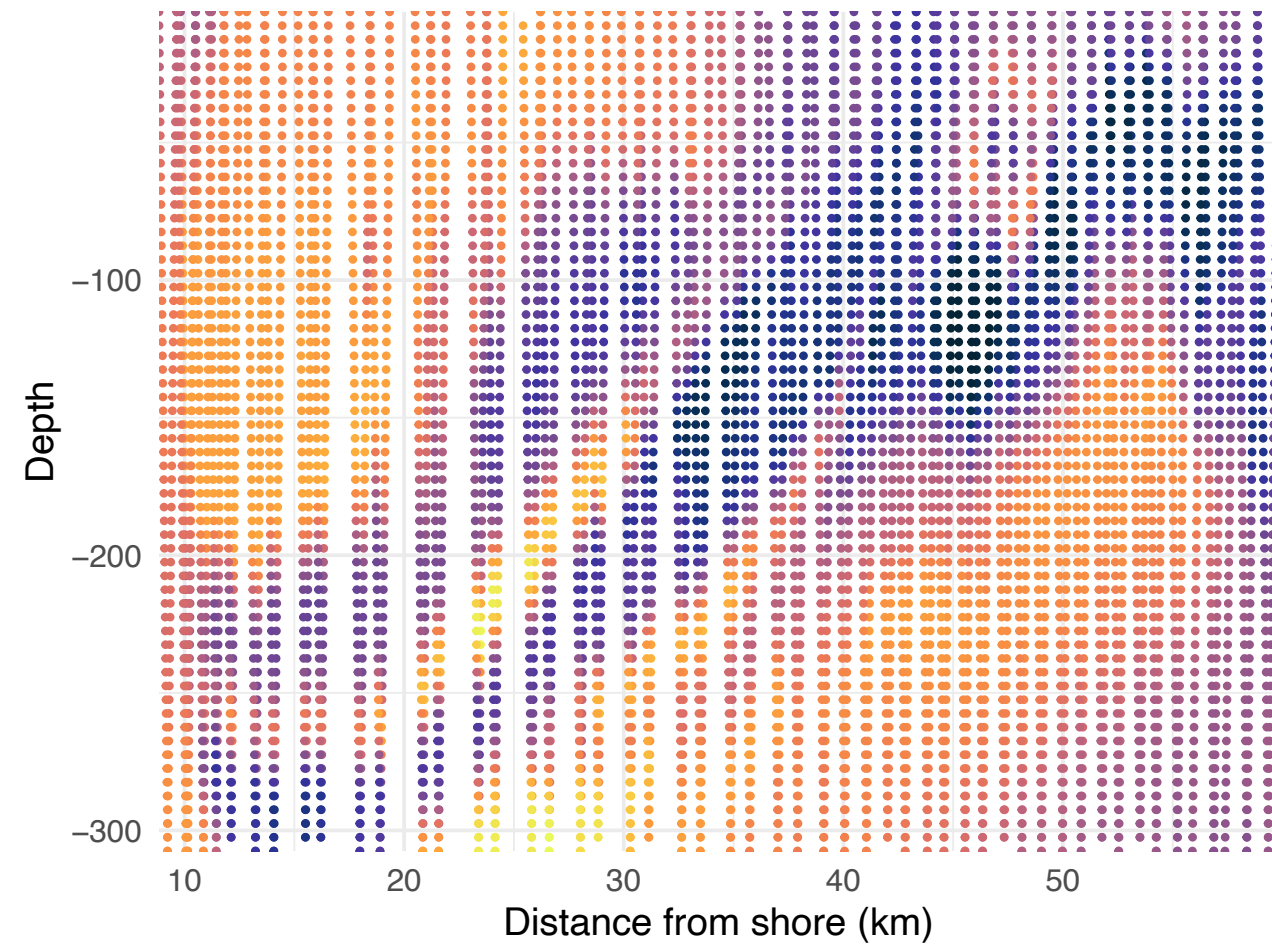


J 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30



out back

Biogeochemical data



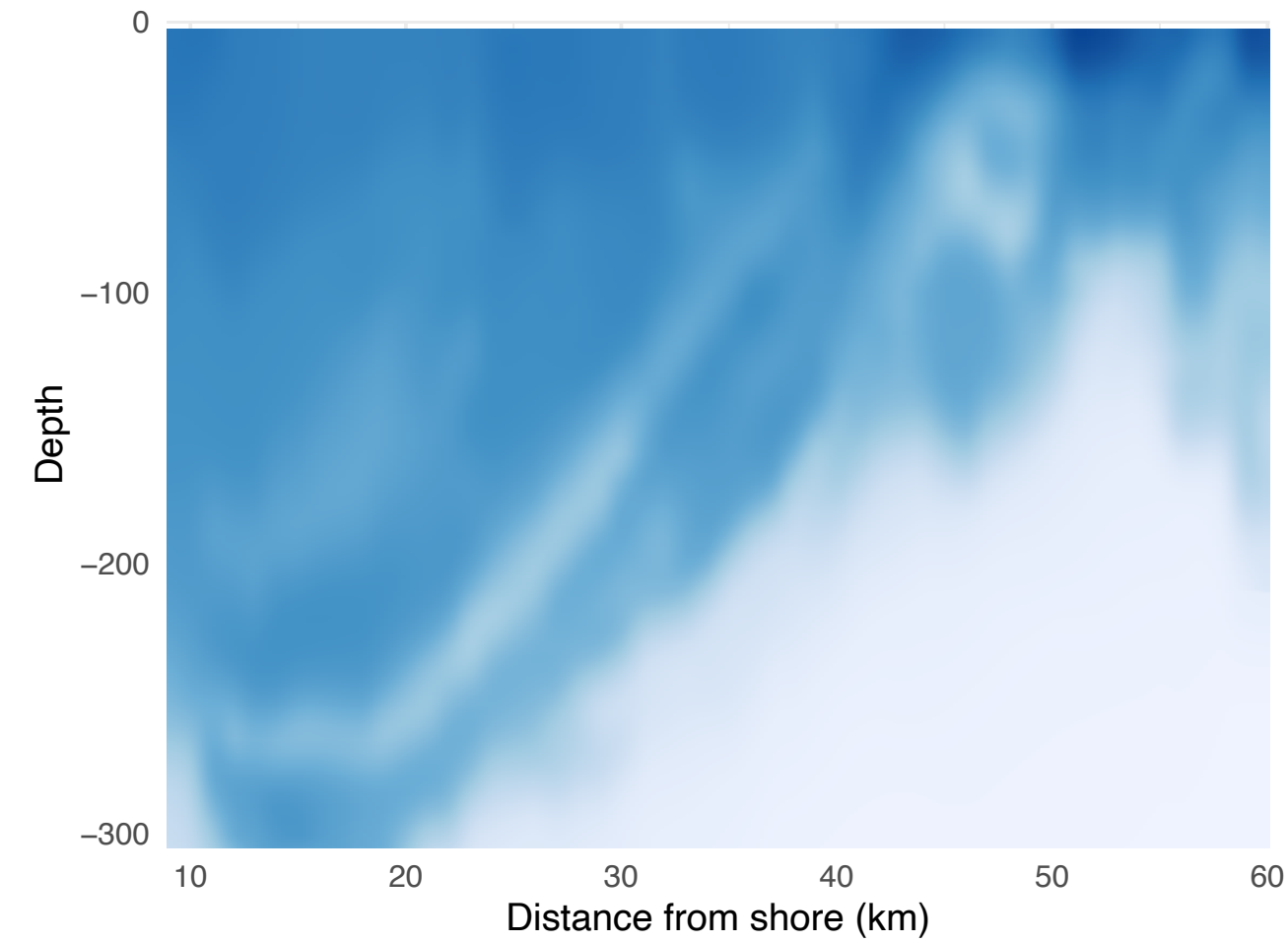
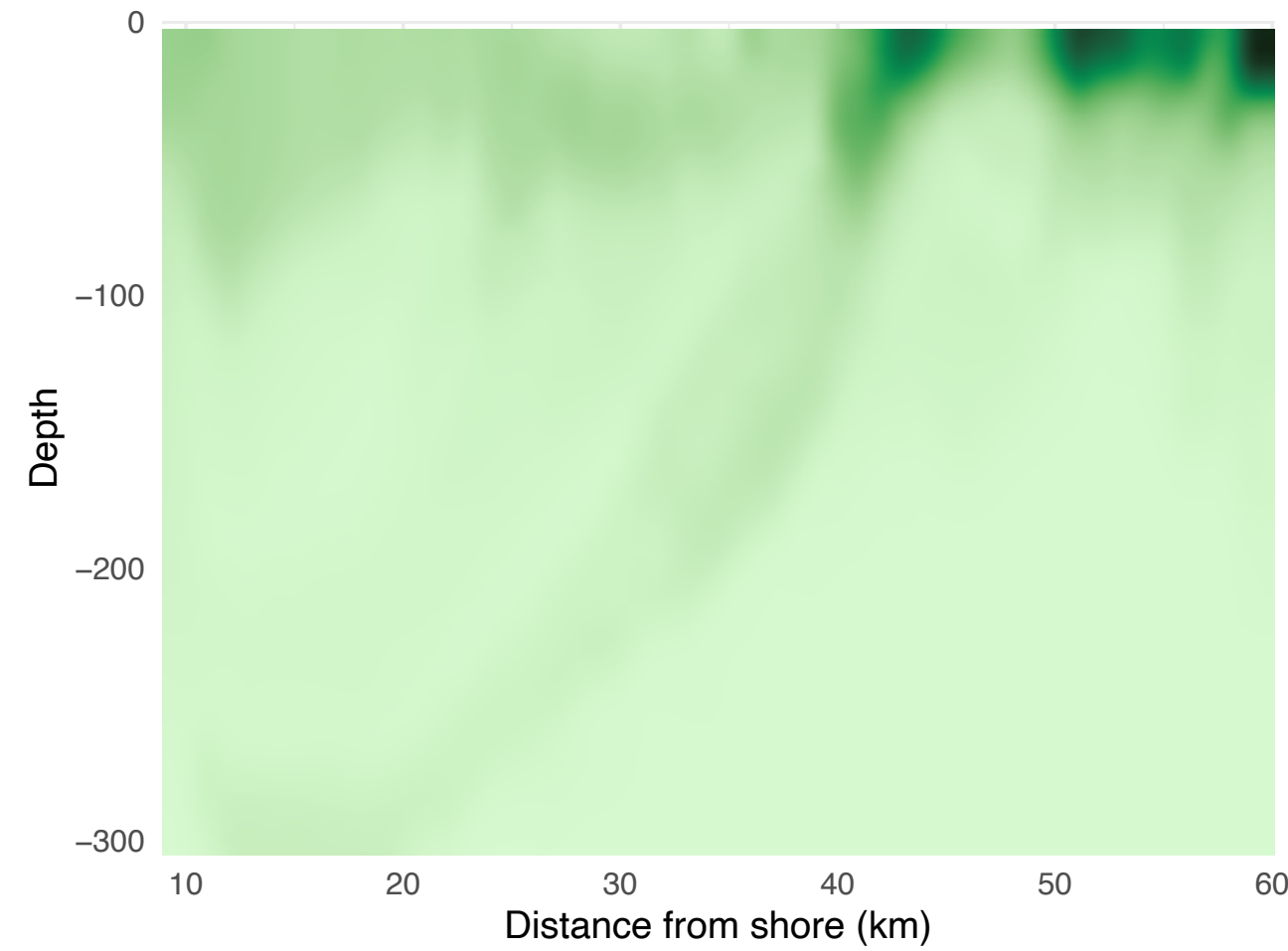
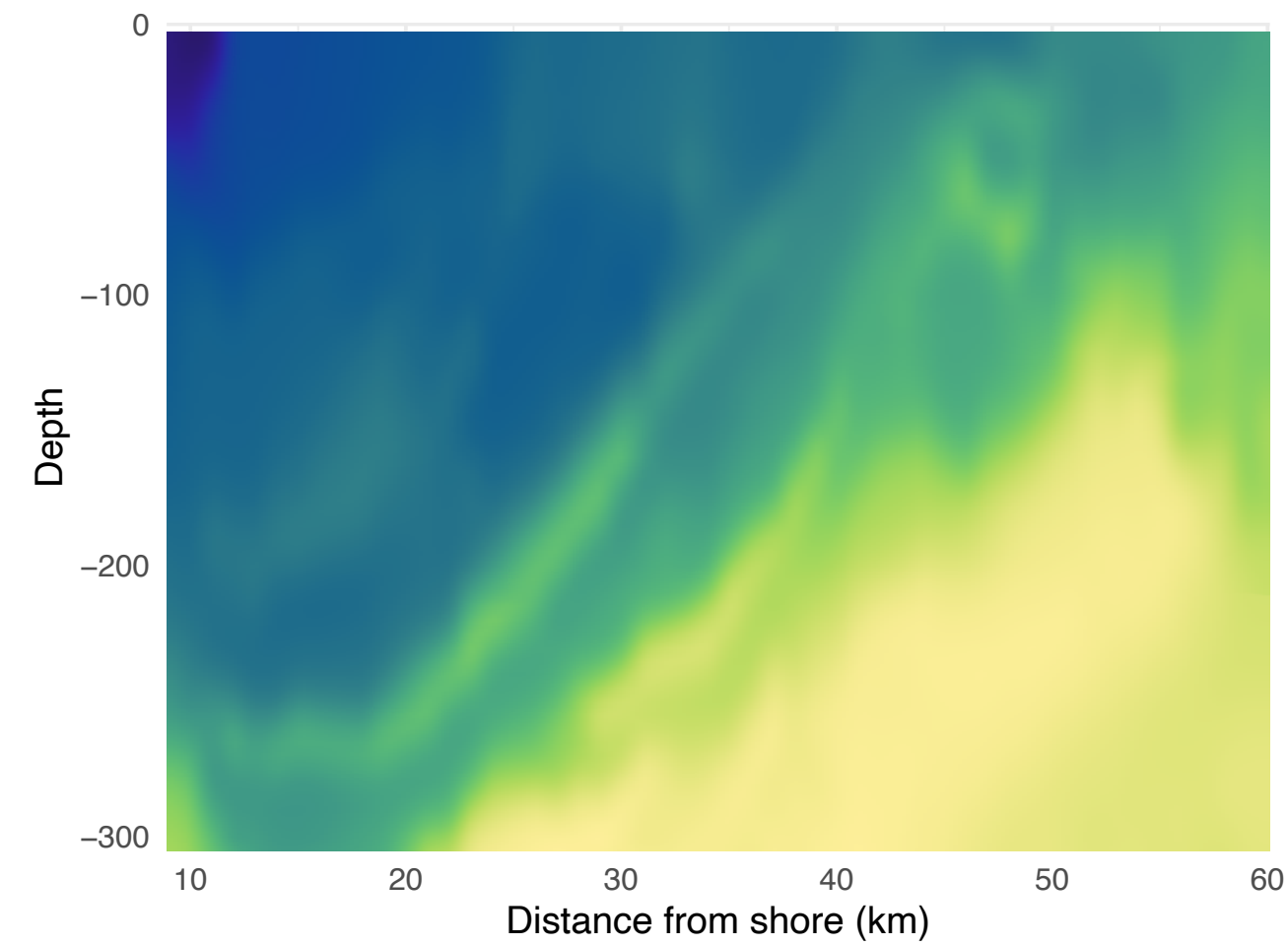
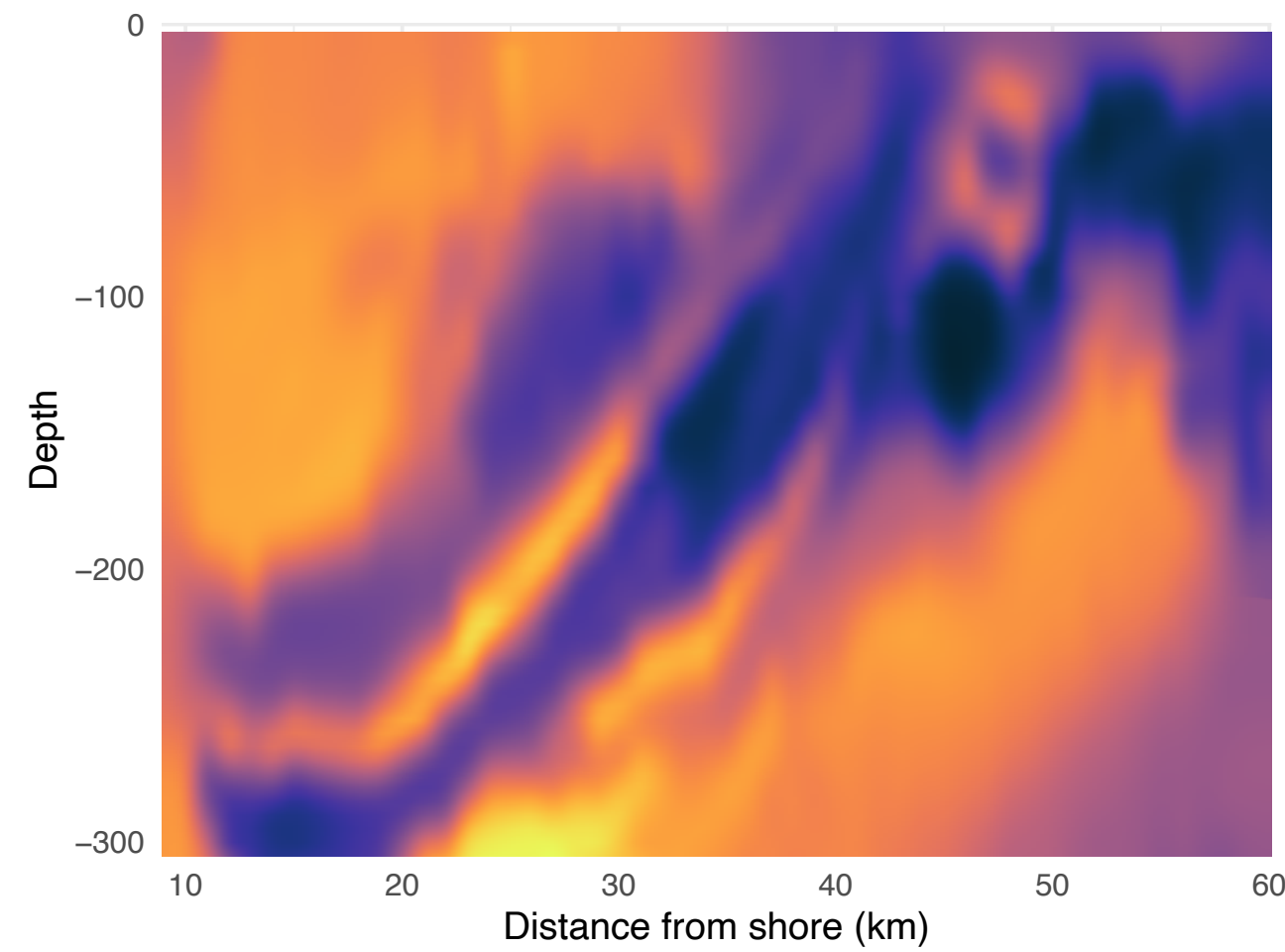
Some sensors result in quite **noisy** data

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

Smooth through moving average

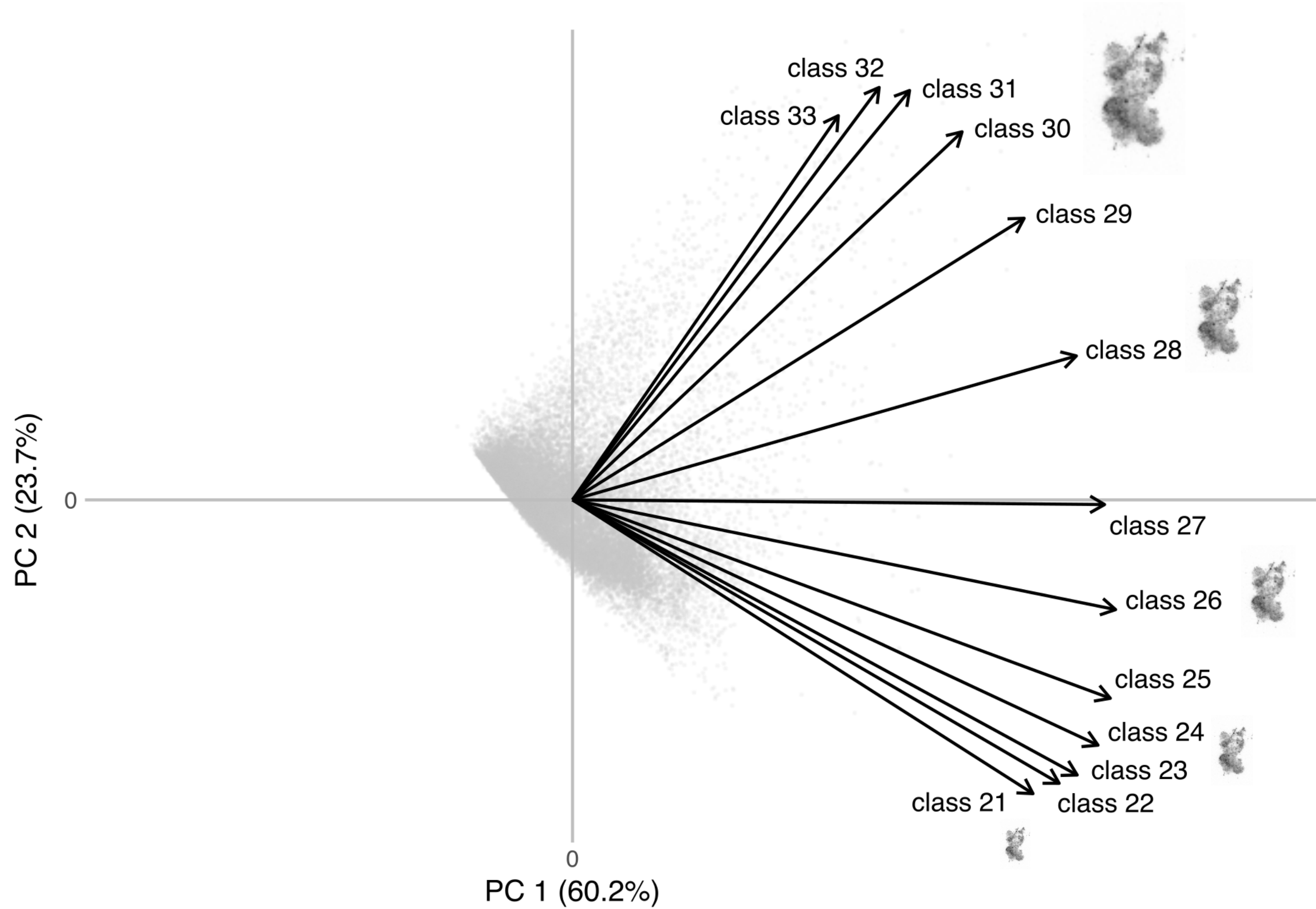
Interpolate over the whole domain (200 m in x, 0.5 m in y)

Particle data

13 particle **size classes**

PCA on log-transformed particle concentrations

Summarised by the first two components

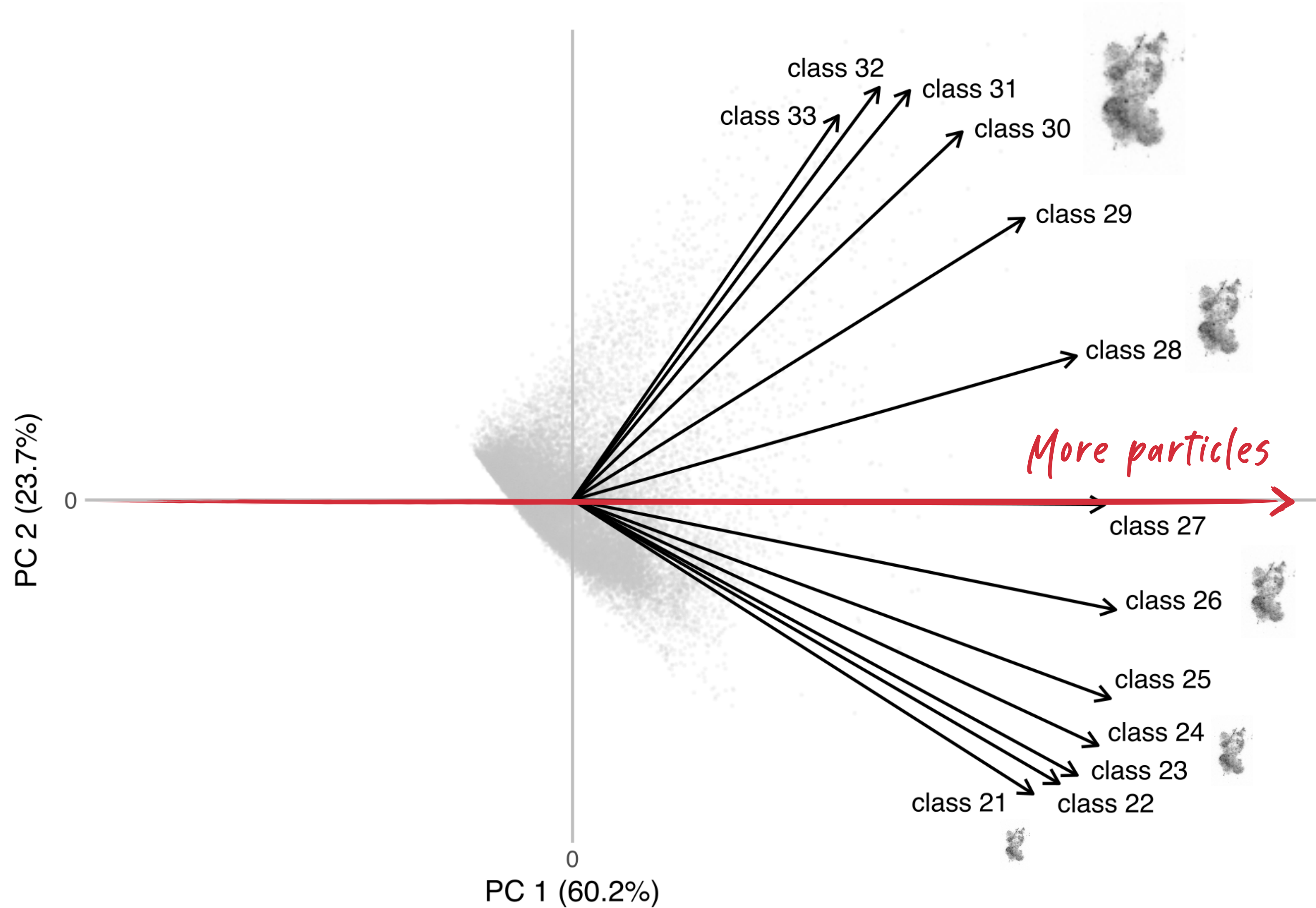


Particle data

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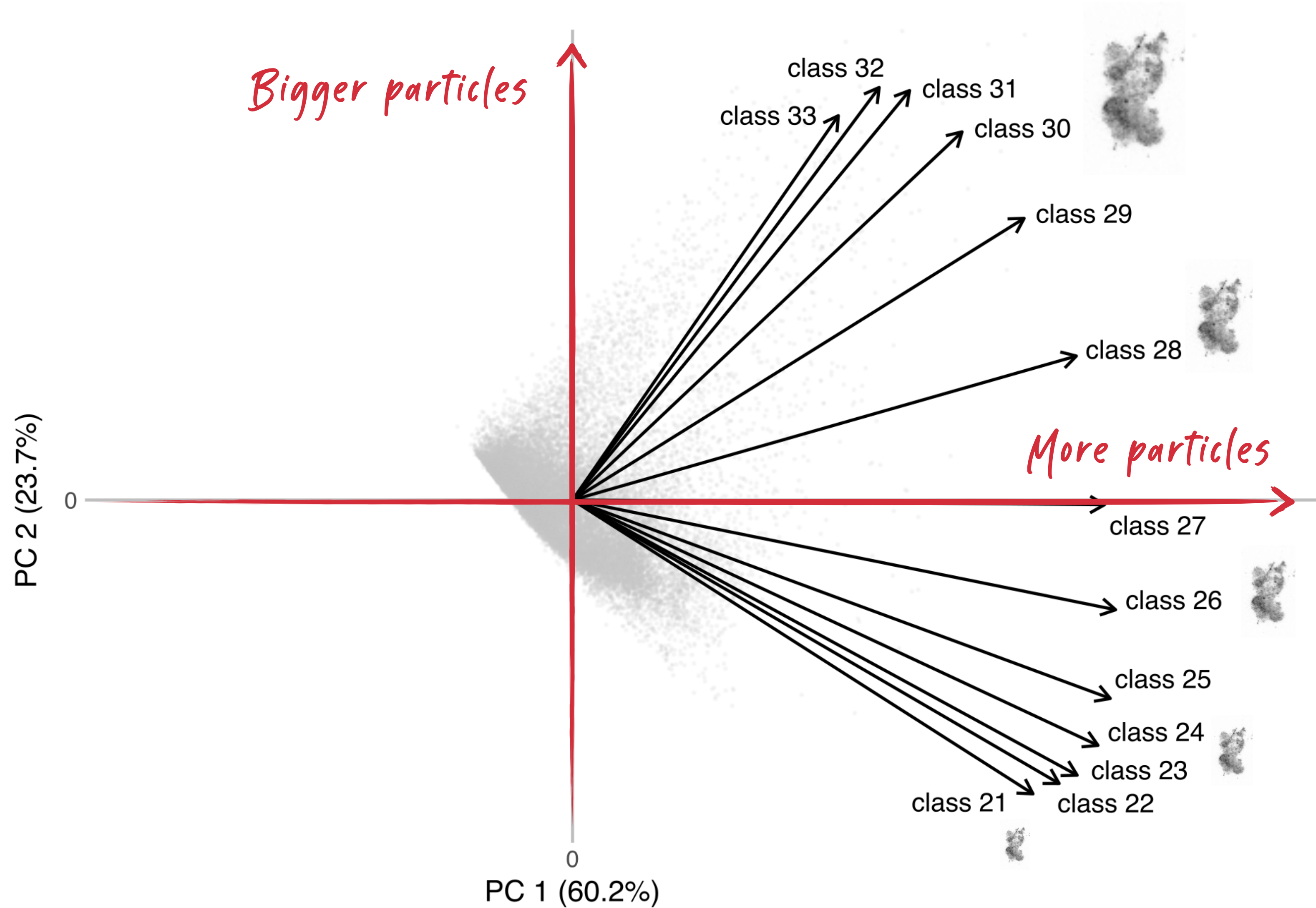


Particle data

13 particle **size classes**

PCA on log-transformed particle concentrations

Summarised by the first two components



Plankton data

Machine Learning predictions + Morphocluster and EcoTaxa

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

MorphoCluster

Node members (2174 objects)

Recommended members (Page 640 / 2000)

Turtle mode OK Not OK Start over Next

EcoTaxa 2.6 Project Filtered (0, 61208, 0, 0 / 61208)

Filter: Taxo=living (with child) Status= Predicted

Update view & apply filter

Taxonomy filter: like < Copepoda

Actinopterygii	115	18
▼ Annelida	46	87
Alciopidae	13	34
Phyllodocida	13	84
Swima	42	238
Tomopteridae	14	235
▼ Appendicularia	26	107
house	199	10616
Chaetognatha	12	12
▼ Cnidaria < Metazoa	2	
▼ Hydrozoa	13	1
Narcomedusae	37	3
Siphonophorae	19	43
Trachymedusae	1	
tentacle < Cnidaria	215	1551
▼ Copepoda	724	9059
Calanidae	11	17
copepoda eggs	202	1247
like < Copepoda	1857	18332
Ctenophora < Metazoa	18	19
▼ Echinodermata	1	50
pluteus < Echinoidea	3	
pluteus < Echinodermata	15	
▼ Eumalacostraca	240	3537
▼ Amphipoda	83	339

Score Display Status Predicted 50 % 20

solitaryglobule	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria
Score: 1.00 depth: 79.97	Score: 1.00 depth: 118	Score: 1.00 depth: 83.53	Score: 1.00 depth: 102	Score: 1.00 depth: 116	Score: 1.00 depth: 127	Score: 1.00 depth: 19.36	Score: 1.00 depth: 481	
Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria
Score: 0.99 depth: 546	Score: 0.99 depth: 91.04	Score: 0.99 depth: 113	Score: 0.99 depth: 88.64	Score: 0.99 depth: 89.36	Score: 0.99 depth: 75.40	Score: 0.99 depth: 223	Score: 0.99 depth: 98.00	
Rhizaria	Rhizaria	Rhizaria	Rhizaria	like < Copepoda	like < Copepoda	Rhizaria	solitaryglobule	
Score: 0.98 depth: 94.28	Score: 0.98 depth: 412	Score: 0.98 depth: 207	Score: 0.98 depth: 91.64	Score: 0.98 depth: 157	Score: 0.98 depth: 21.57	Score: 0.98 depth: 89.56	Score: 0.98 depth: 143	
Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	like	Rhizaria	
Score: 0.98 depth: 176	Score: 0.98 depth: 100	Score: 0.98 depth: 137	Score: 0.98 depth: 57.11	Score: 0.98 depth: 170	Score: 0.98 depth: 108	Score: 0.98 depth: 80.00	Score: 0.98 depth: 55.11	
Rhizaria	Rhizaria	Rhizaria	Rhizaria	Rhizaria	solitaryglobule	like	Rhizaria	
Score: 0.98 depth: 152	Score: 0.97 depth: 87.29	Score: 0.97 depth: 367	Score: 0.97 depth: 104	Score: 0.97 depth: 48.31	Score: 0.97 depth: 43.29	Score: 0.97 depth: 77.19	Score: 0.97 depth: 211	

Plankton data

Machine Learning predictions + Morphocluster and EcoTaxa

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

MorphoCluster

Node members (2174 objects)

139164 62729485 67114880 62040492 64986342 67640376

Recommended members (Page 640 / 2000)

62039899 64984232 67764659

26369752 67984250 65353451

Turtle mode OK

EcoTaxa 2.6 Project Filtered (0, 61208, 0, 0 / 61208)

Filter: Taxo=Living (with child) Status=Predicted

Update view & apply filter

Score Display Status Predicted 50 % 20

Taxonomic Group	Number of Organisms (n)
Copepoda	~7800
other Rhizaria	~1600
Appendicularia	~1100
Salpida	~1100
Collodaria	~800
Eumalacostraca	~500
Foraminifera	~100
Cnidaria	~100
Annelida	~100
Mollusca	~100

Copepoda

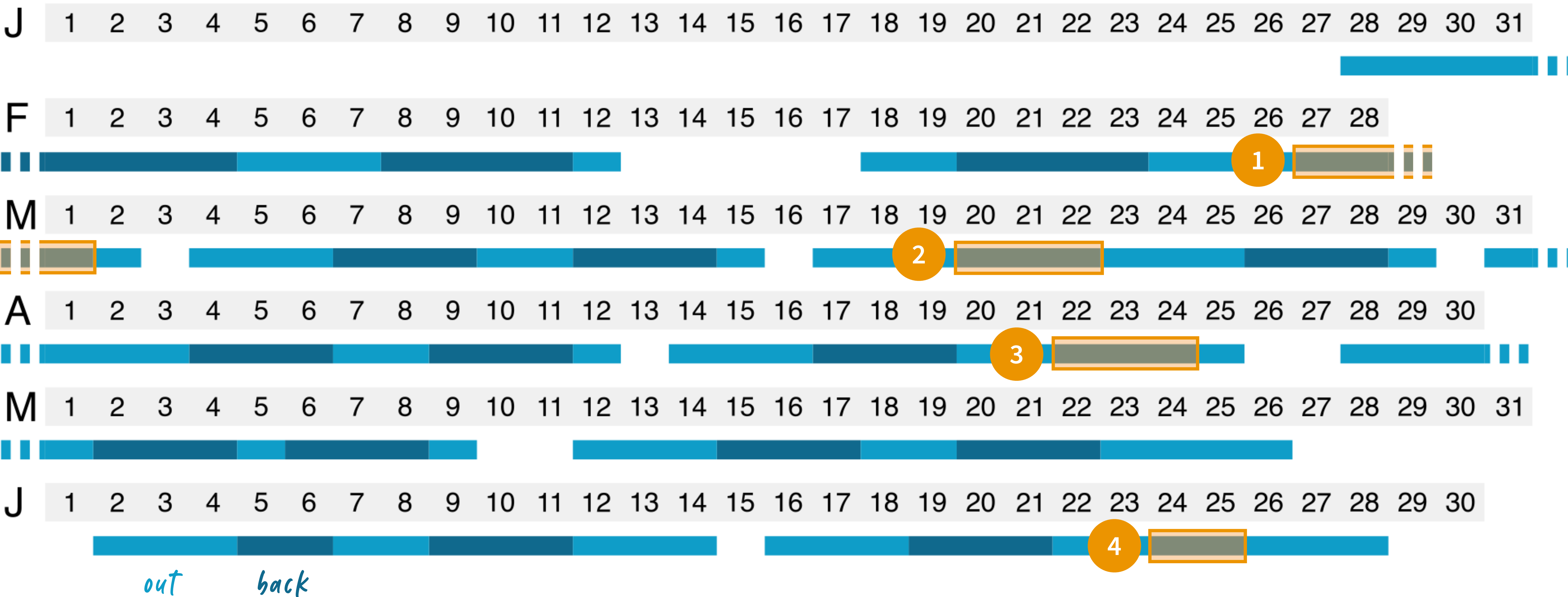
Rhizaria

Appendicularia

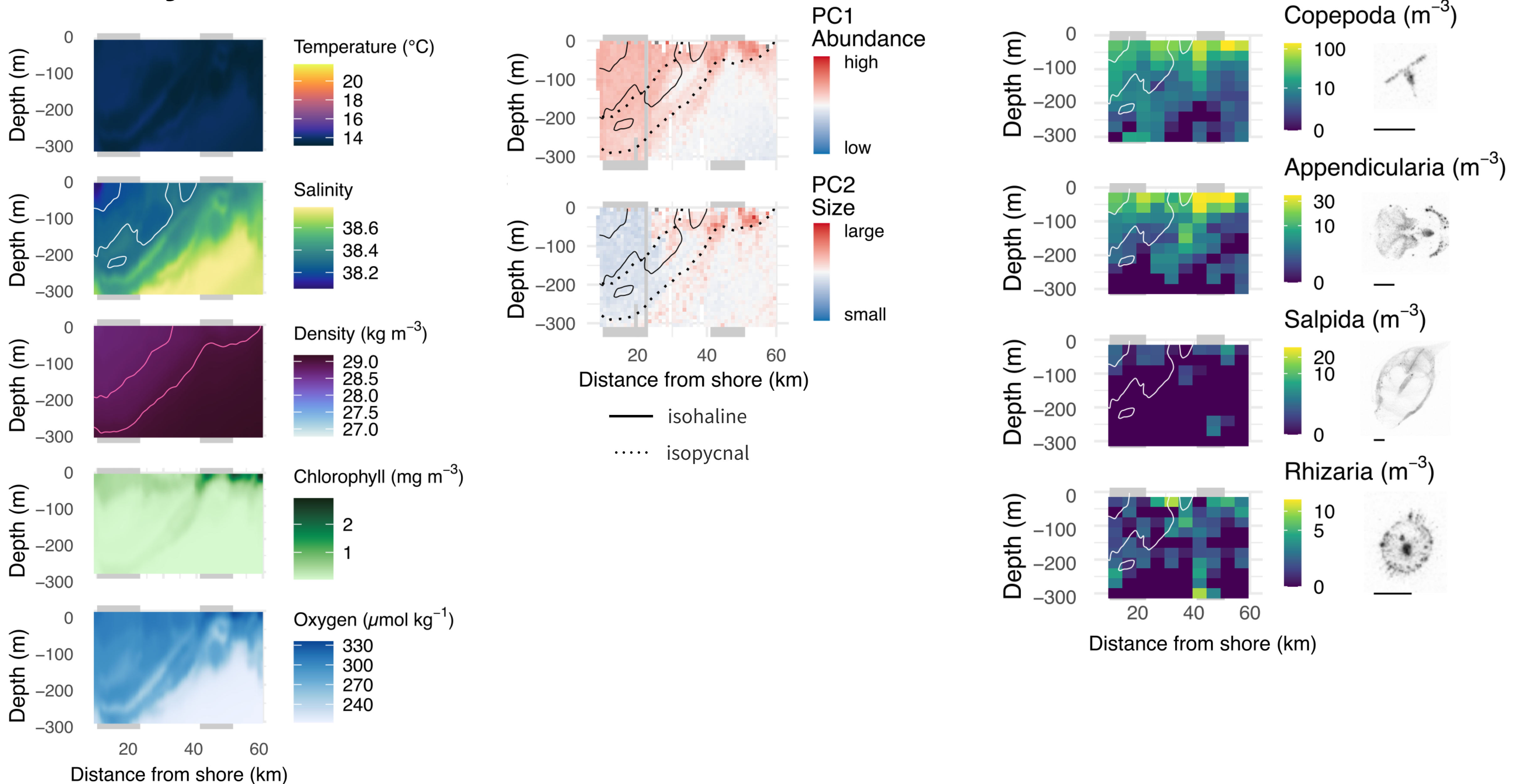
Salpida

Selection of transects

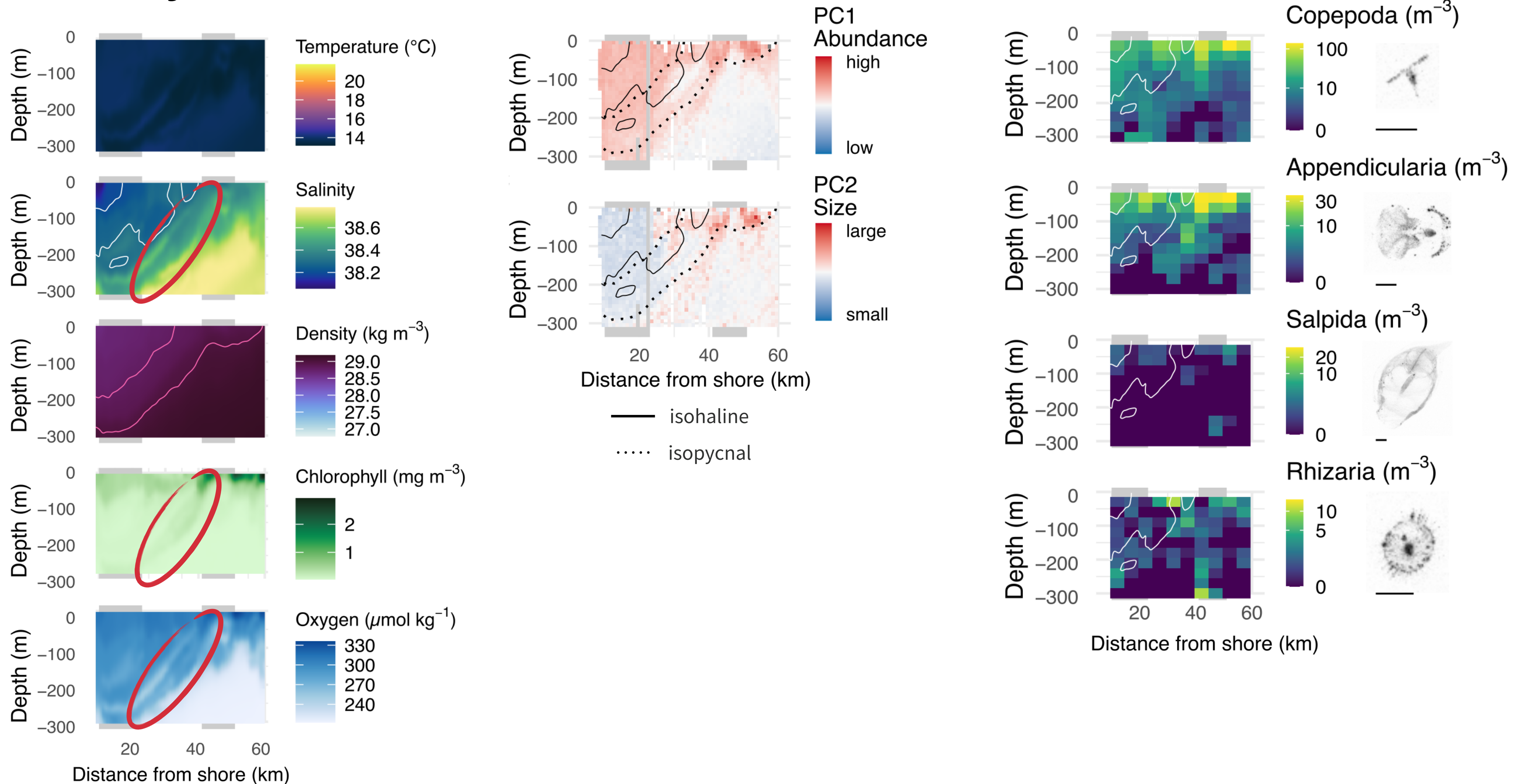
1: early bloom 2: mid bloom 3: late bloom 4: post bloom



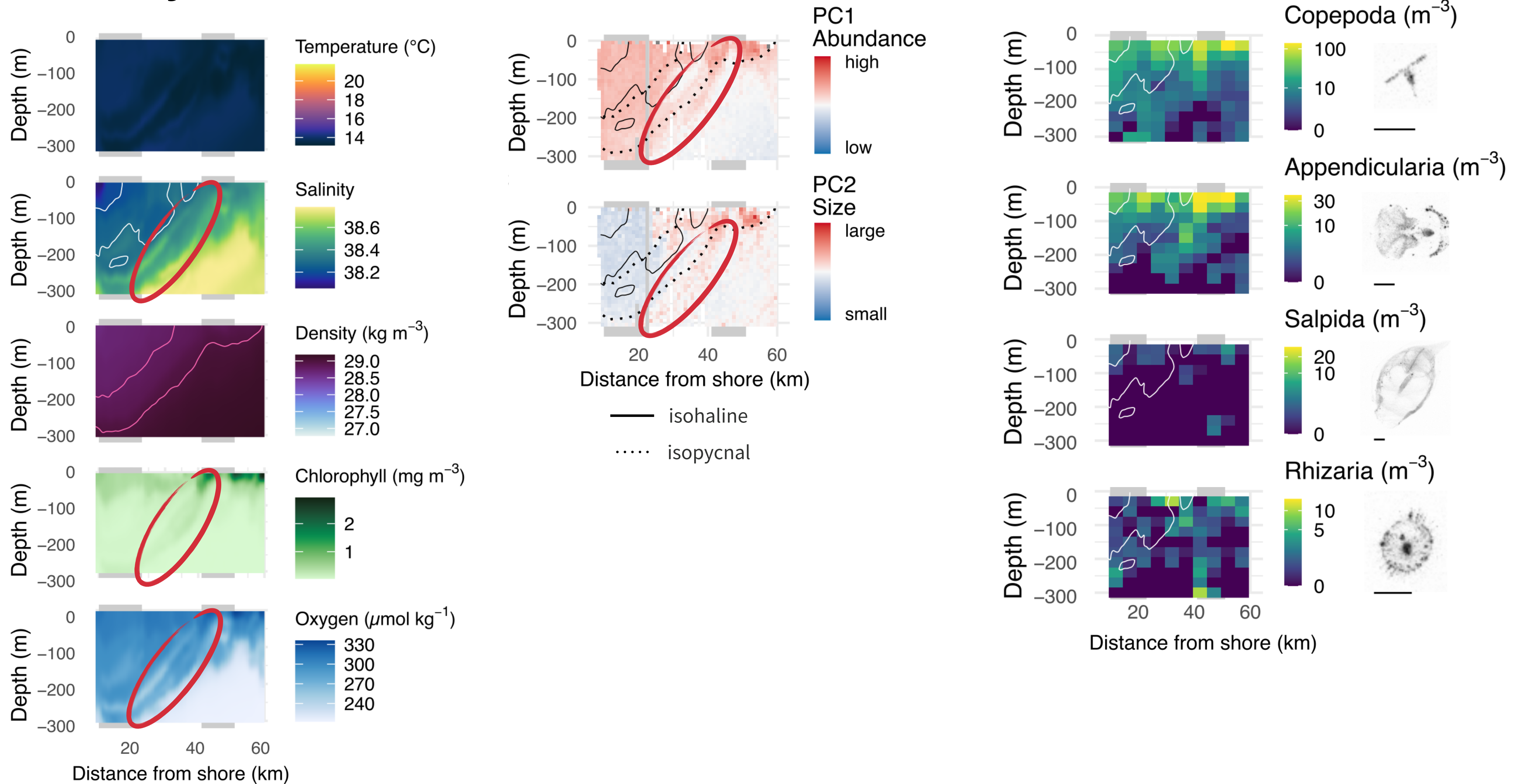
1: Early bloom



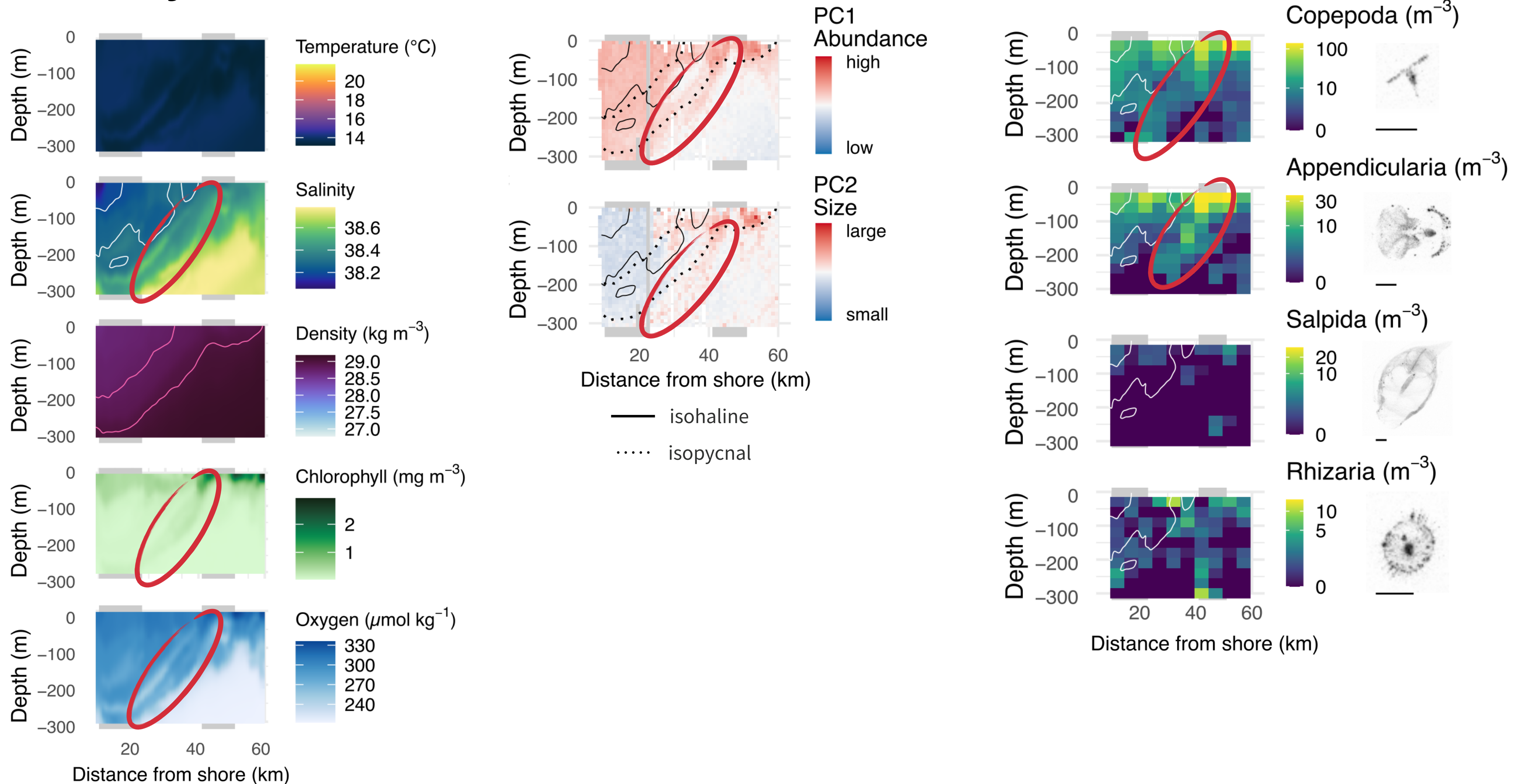
1: Early bloom



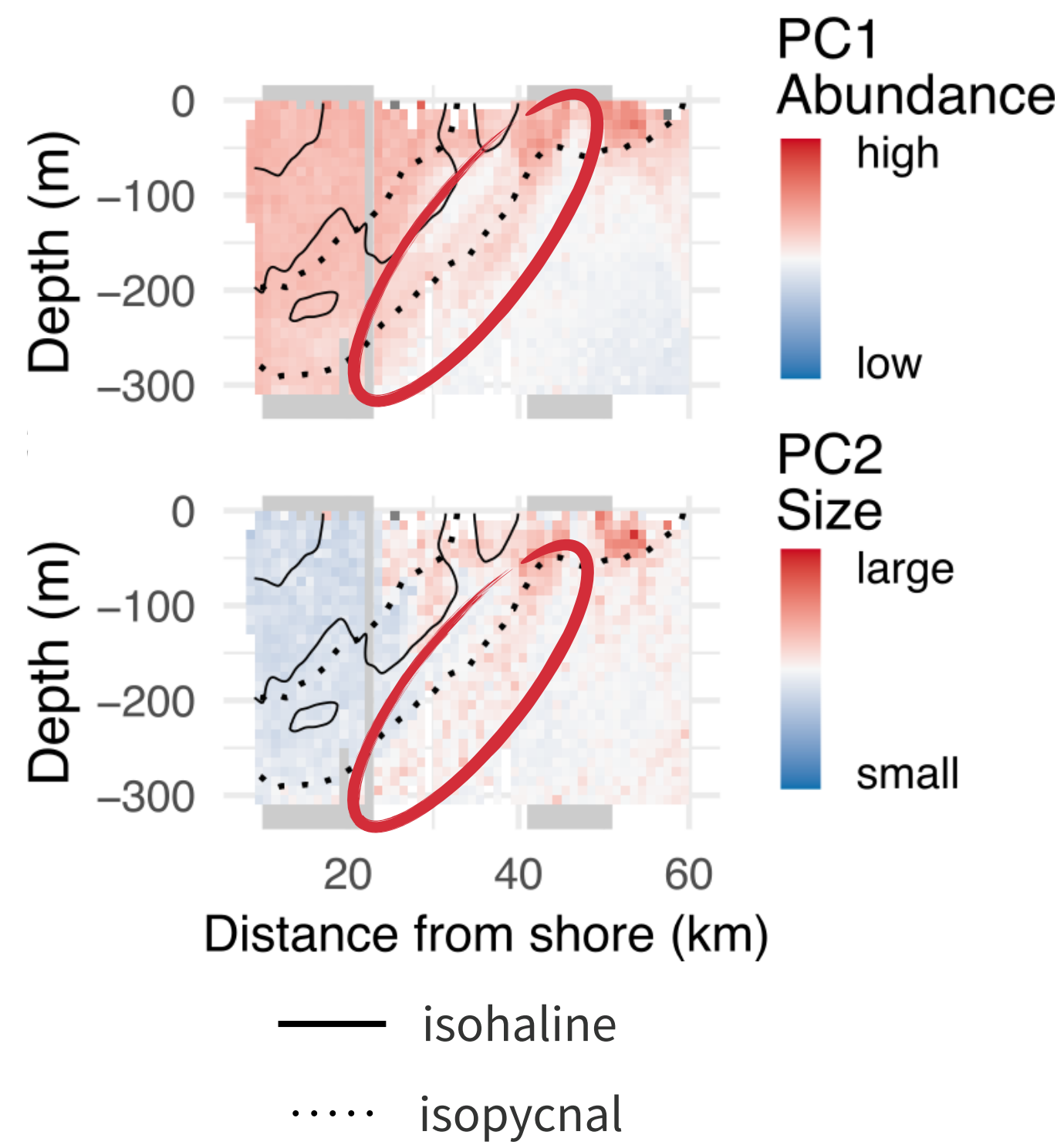
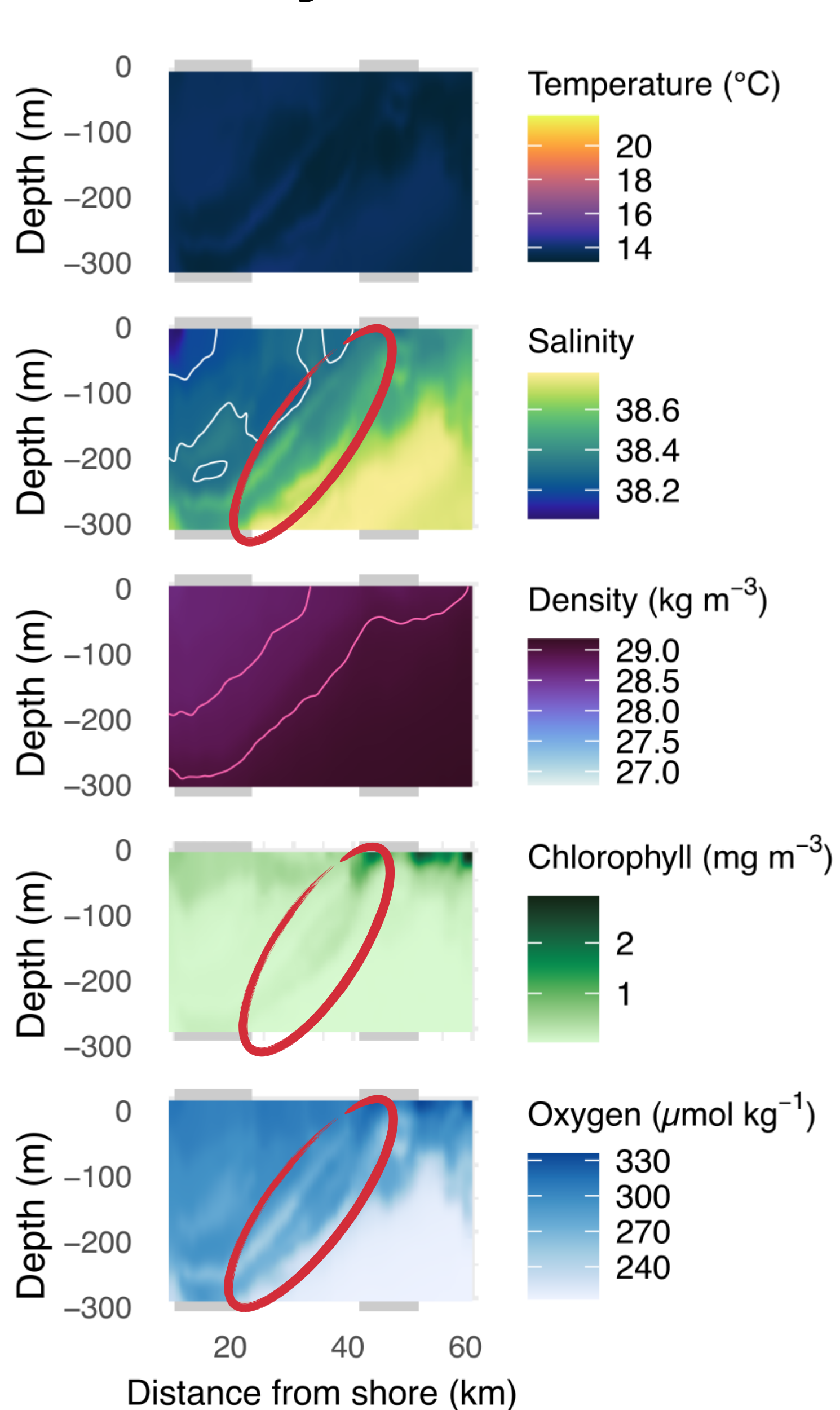
1: Early bloom



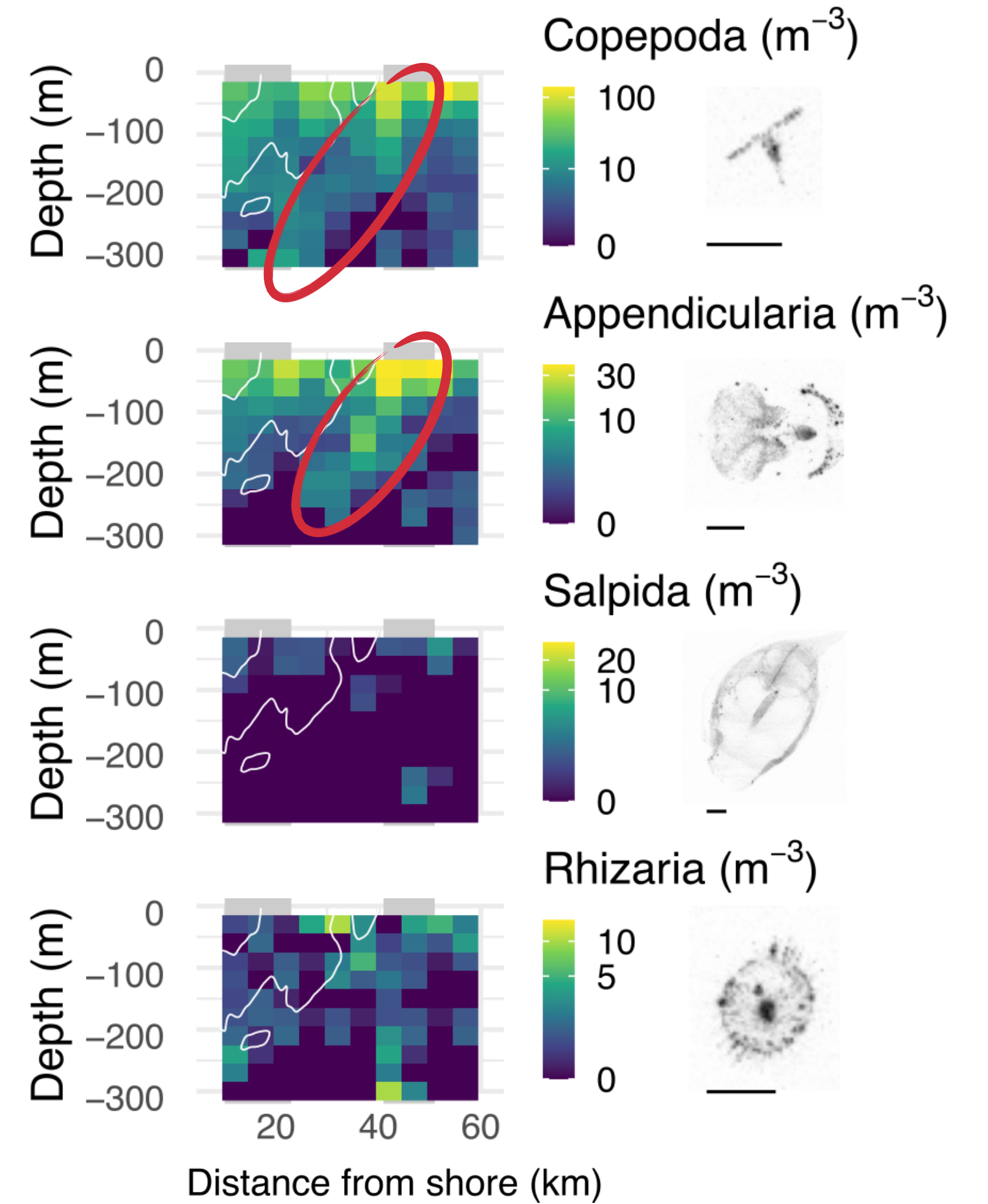
1: Early bloom



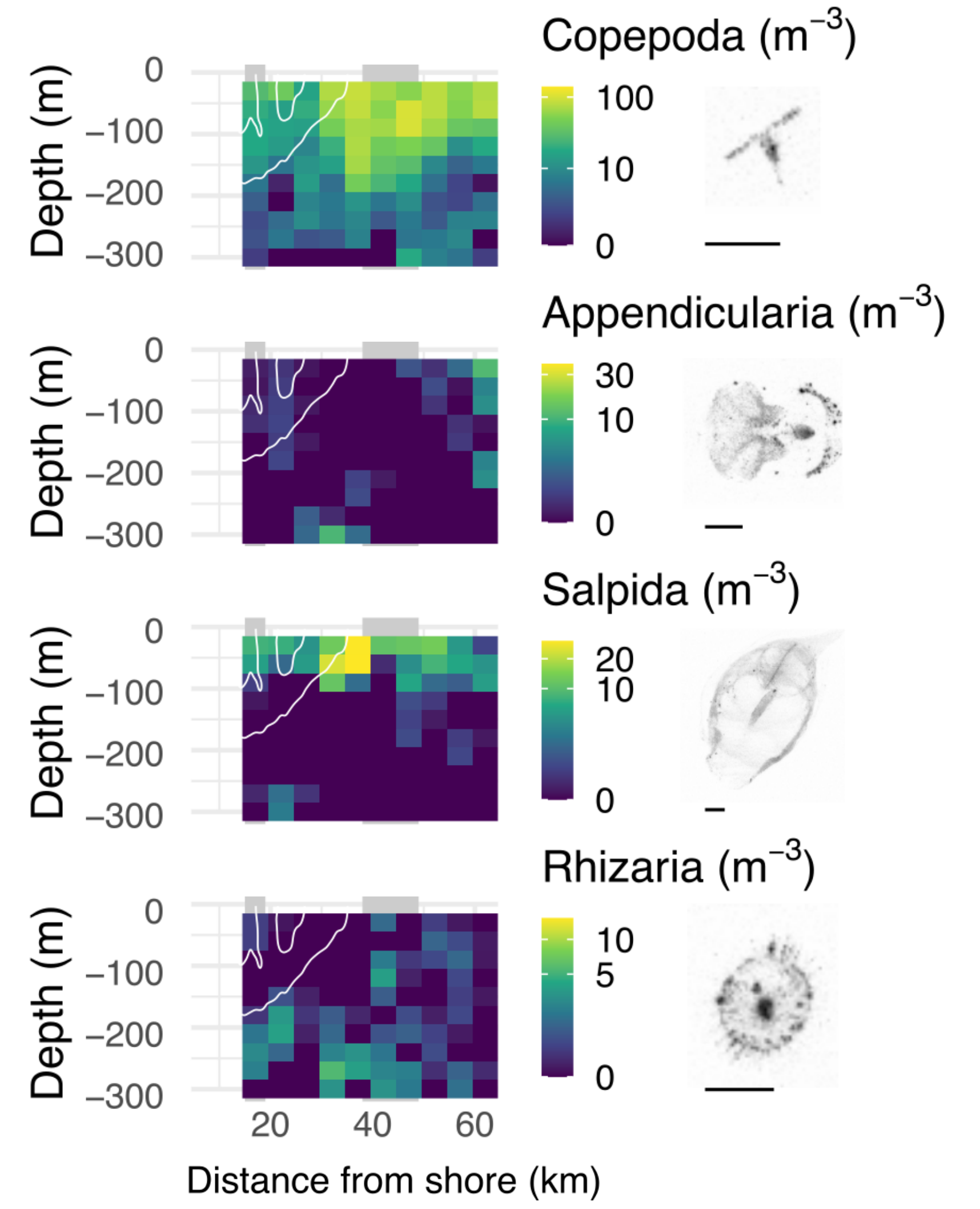
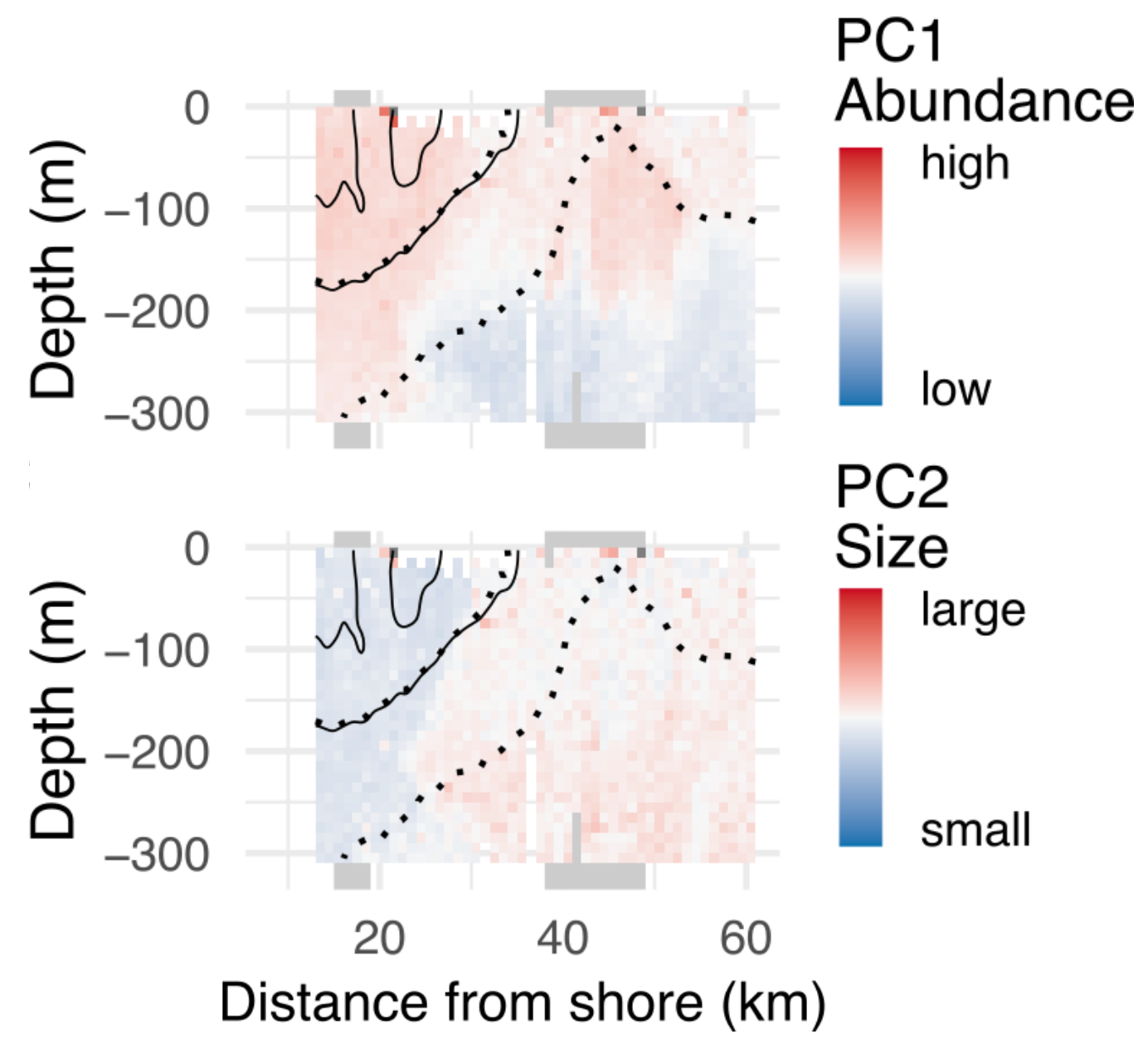
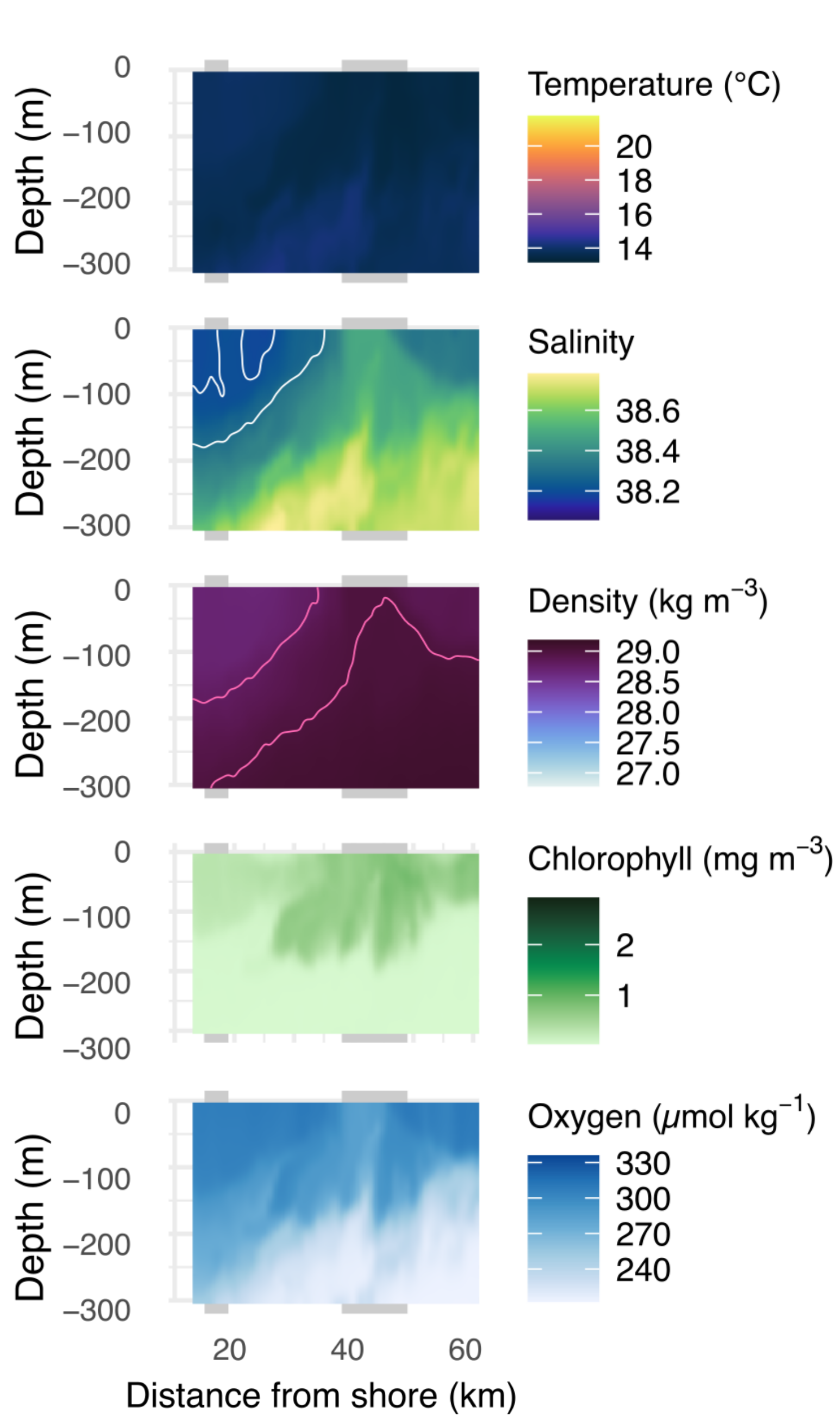
1: Early bloom



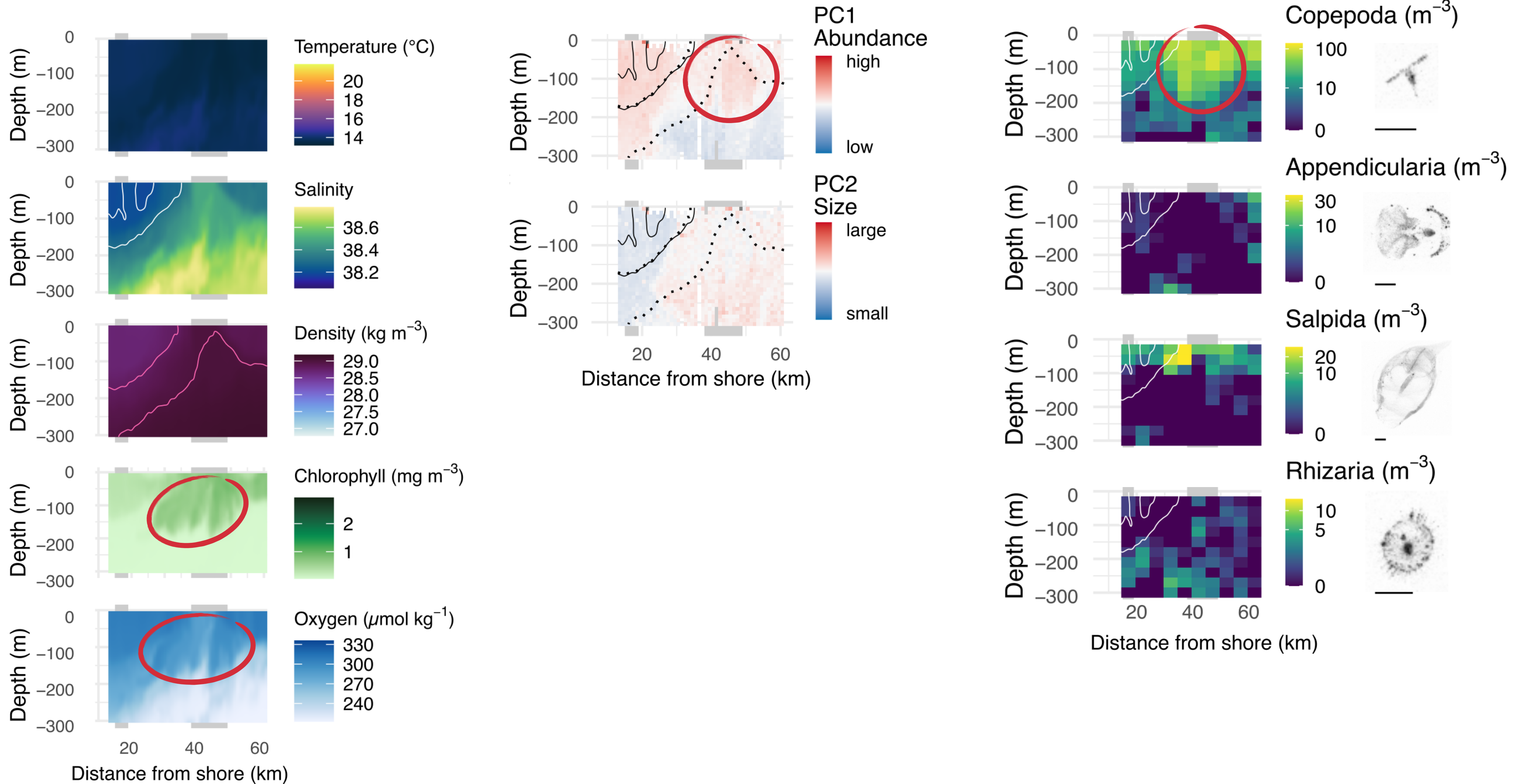
*Subducting waters
... affecting particles,
Copepods and Appendicularia
Discarded houses*



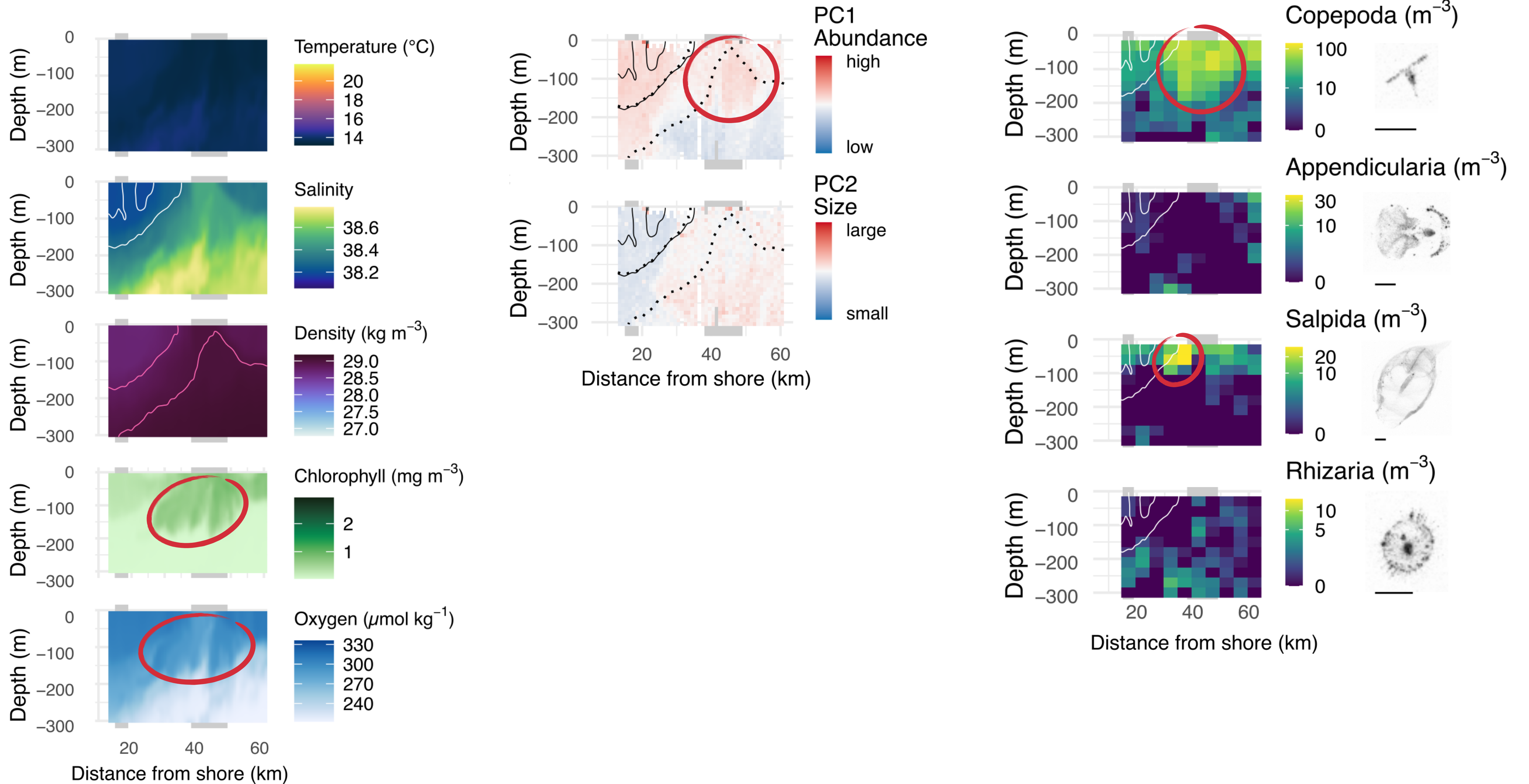
2: Mid bloom



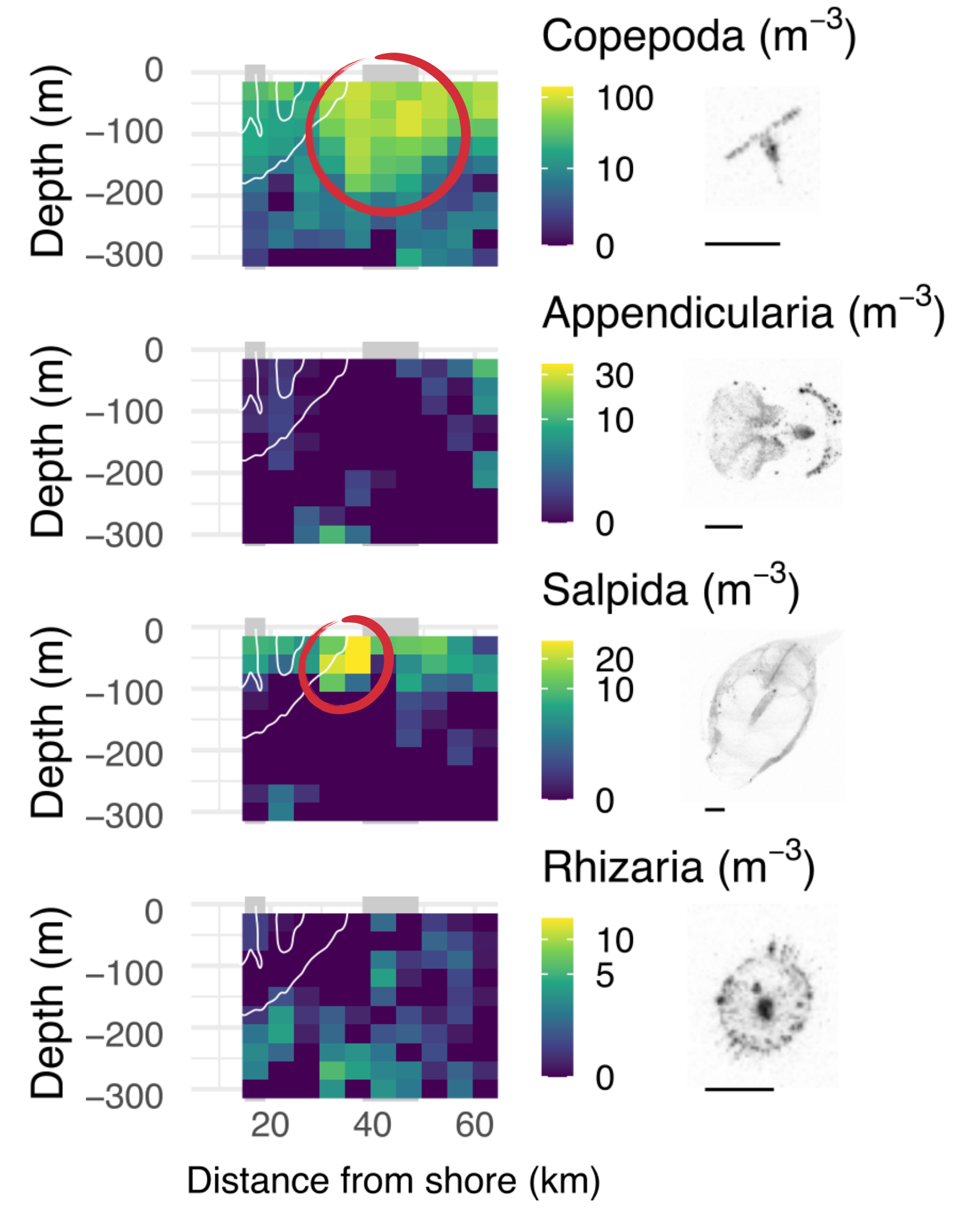
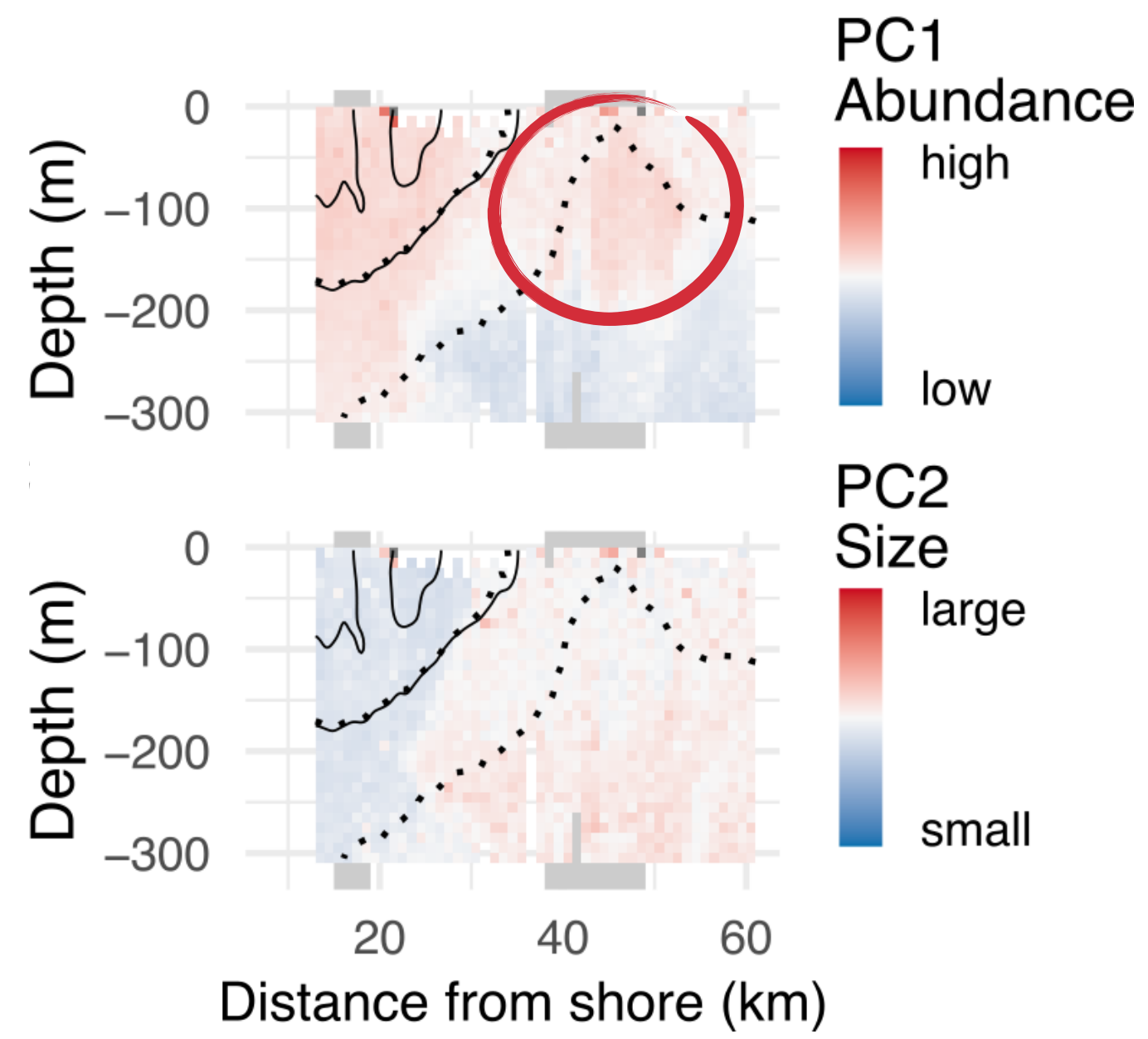
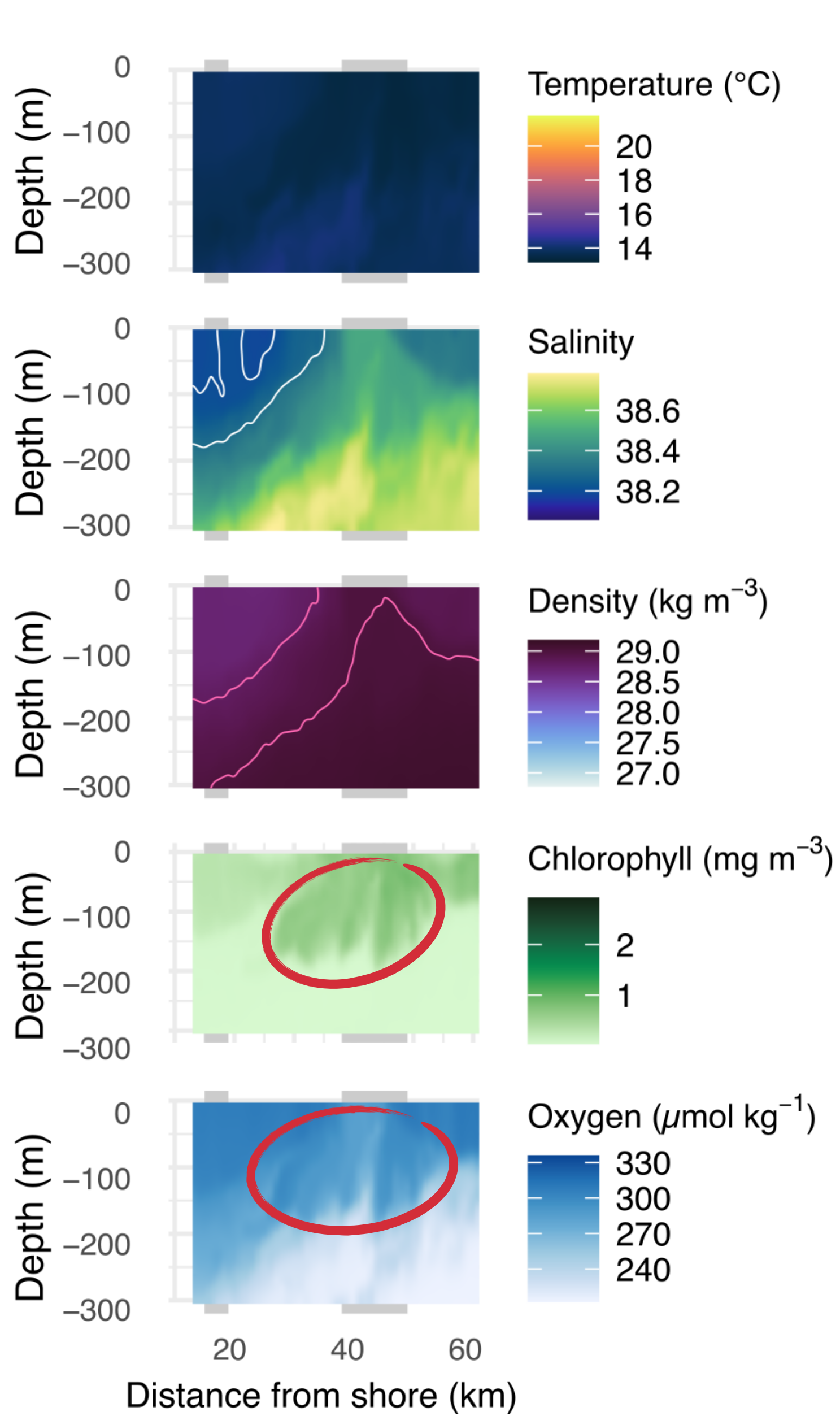
2: Mid bloom



2: Mid bloom



2: Mid bloom

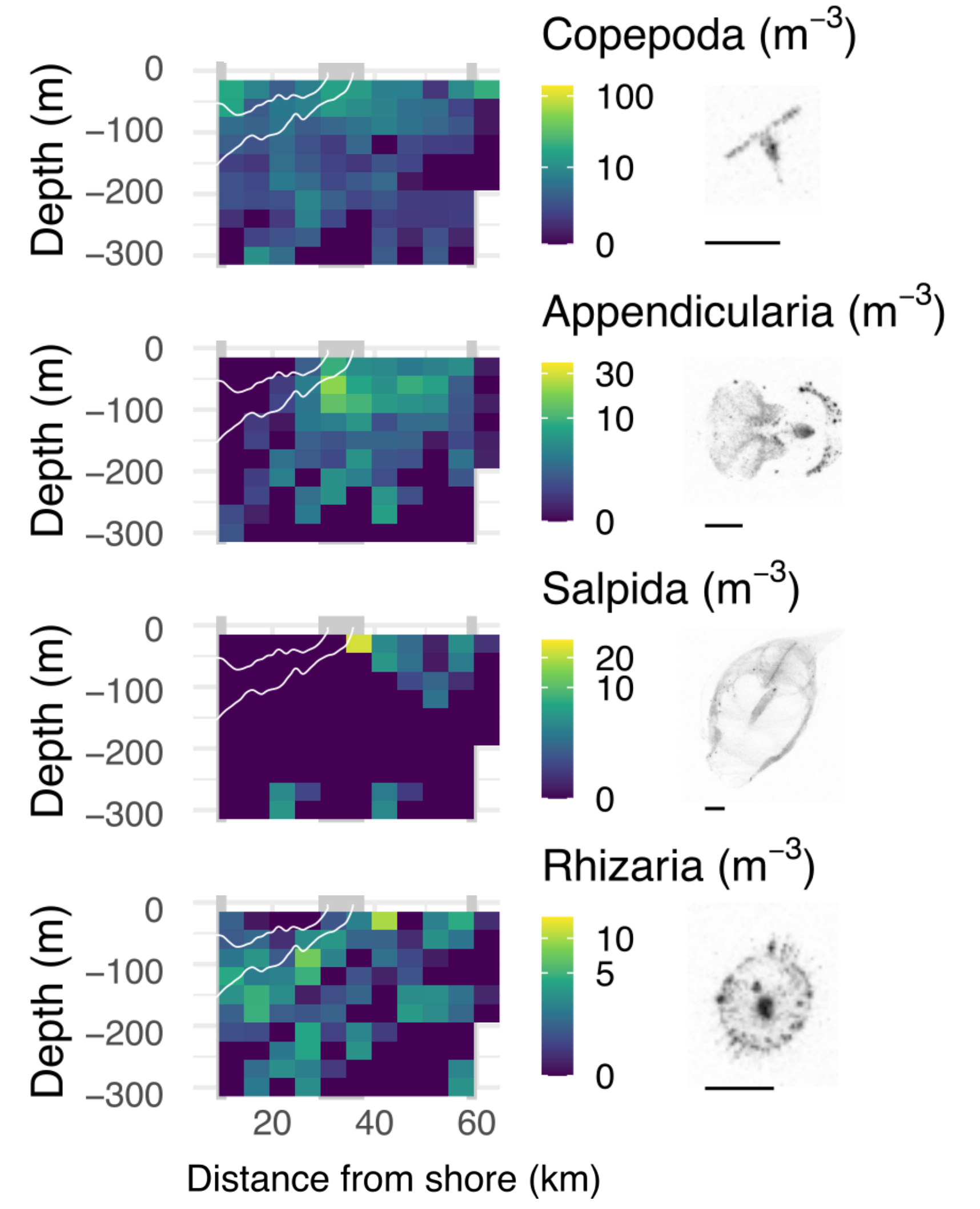
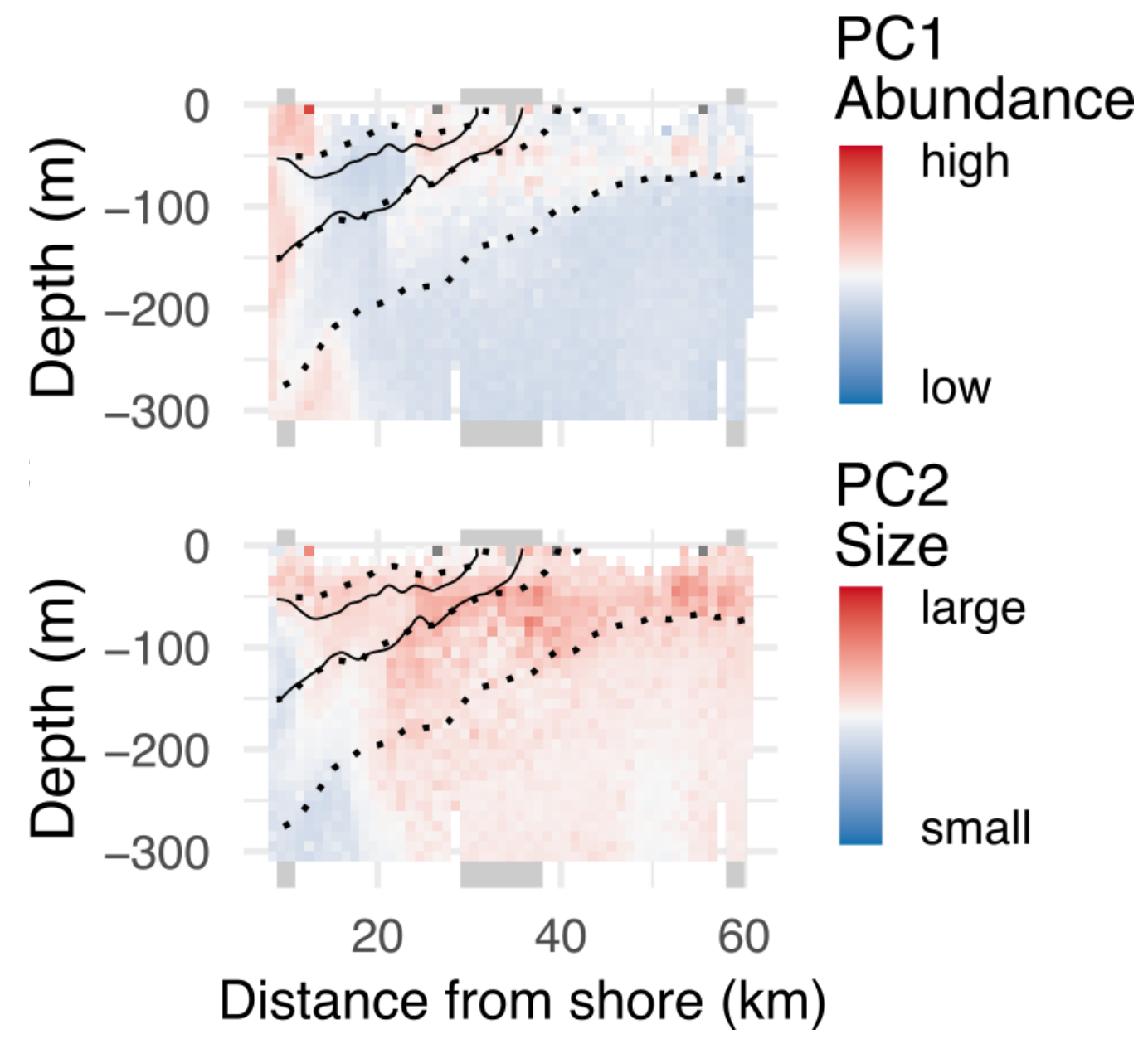
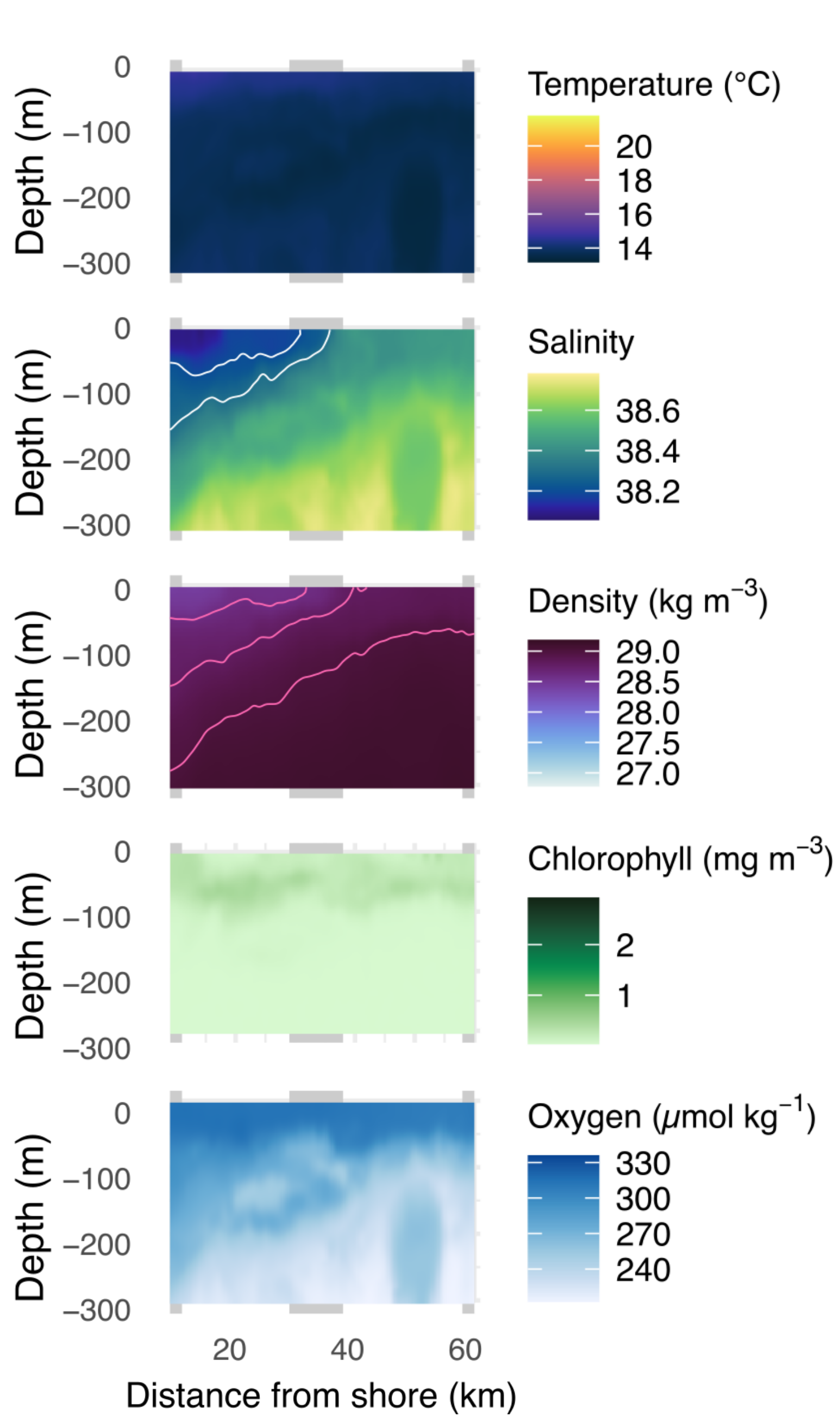


Mixing event affecting particles and plankton

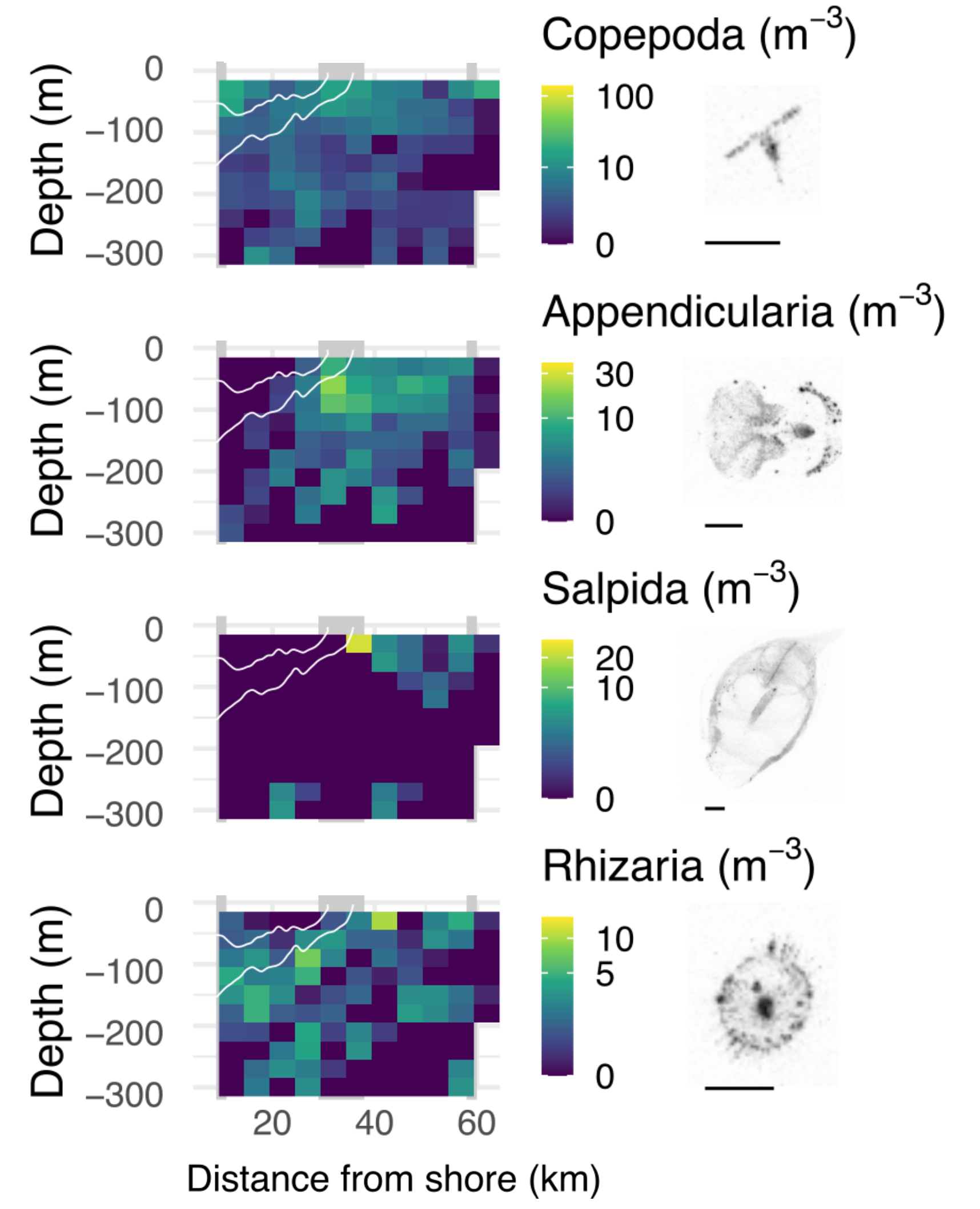
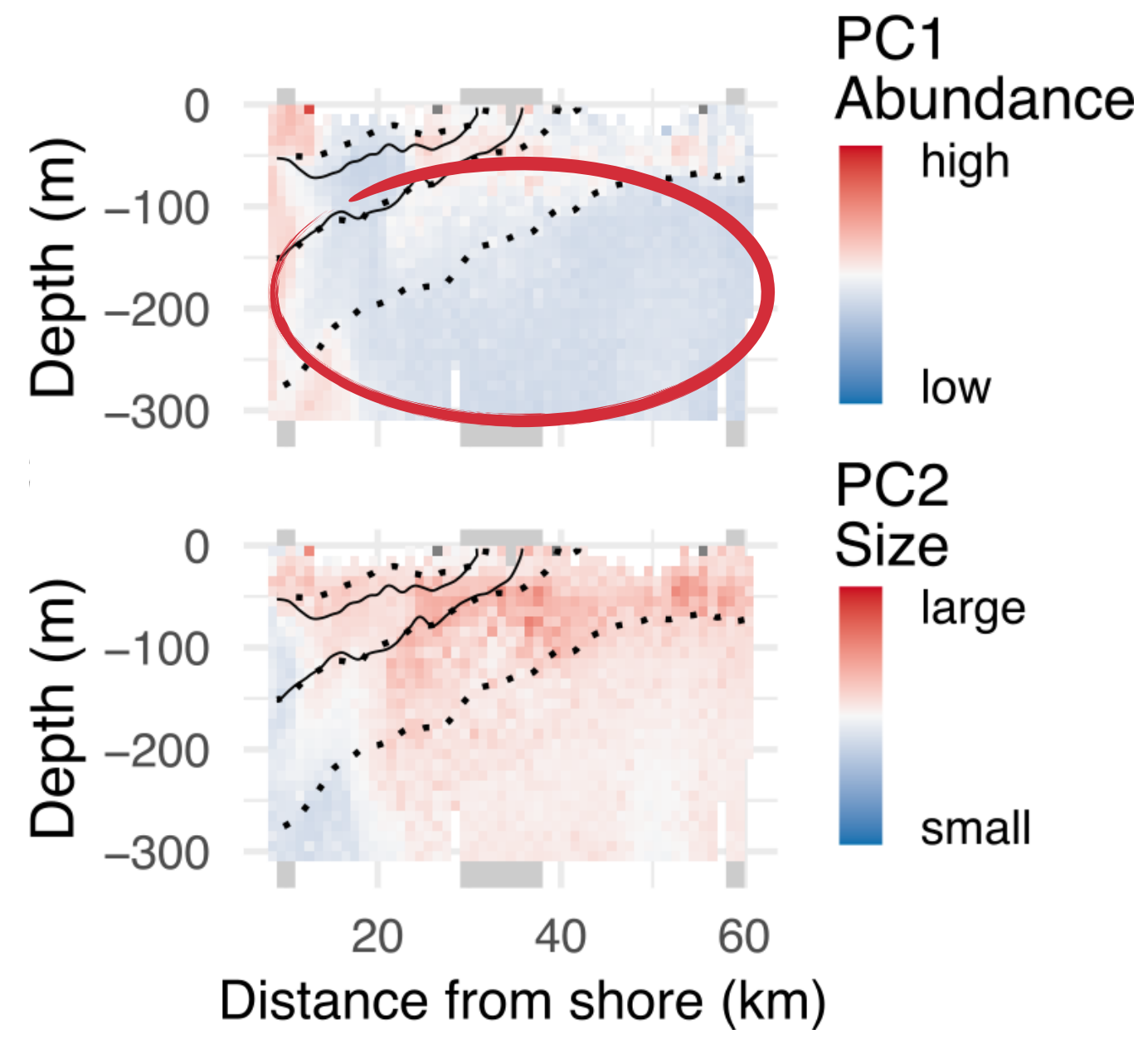
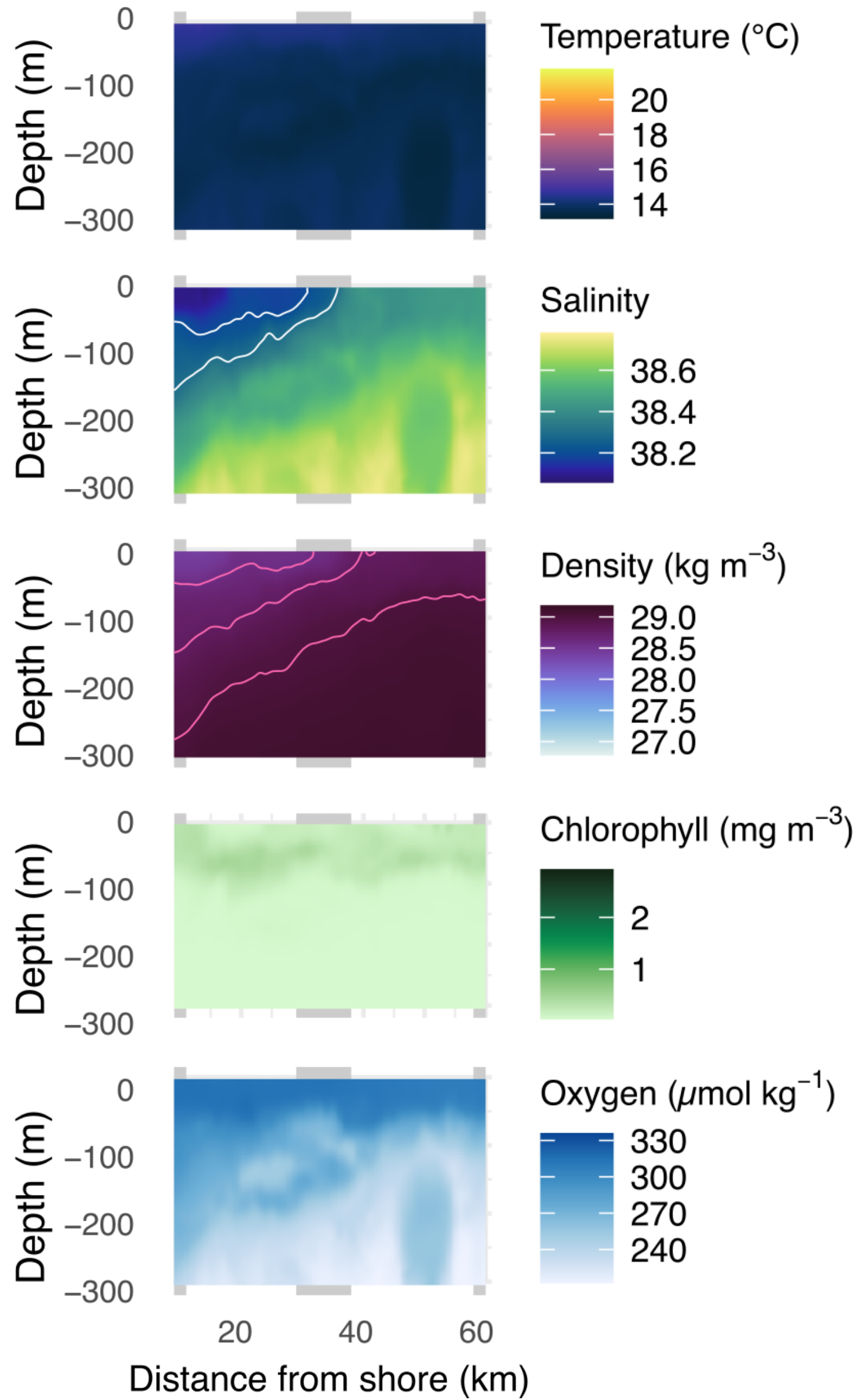
Appendicularians \rightarrow Salps

Concentration increase at front

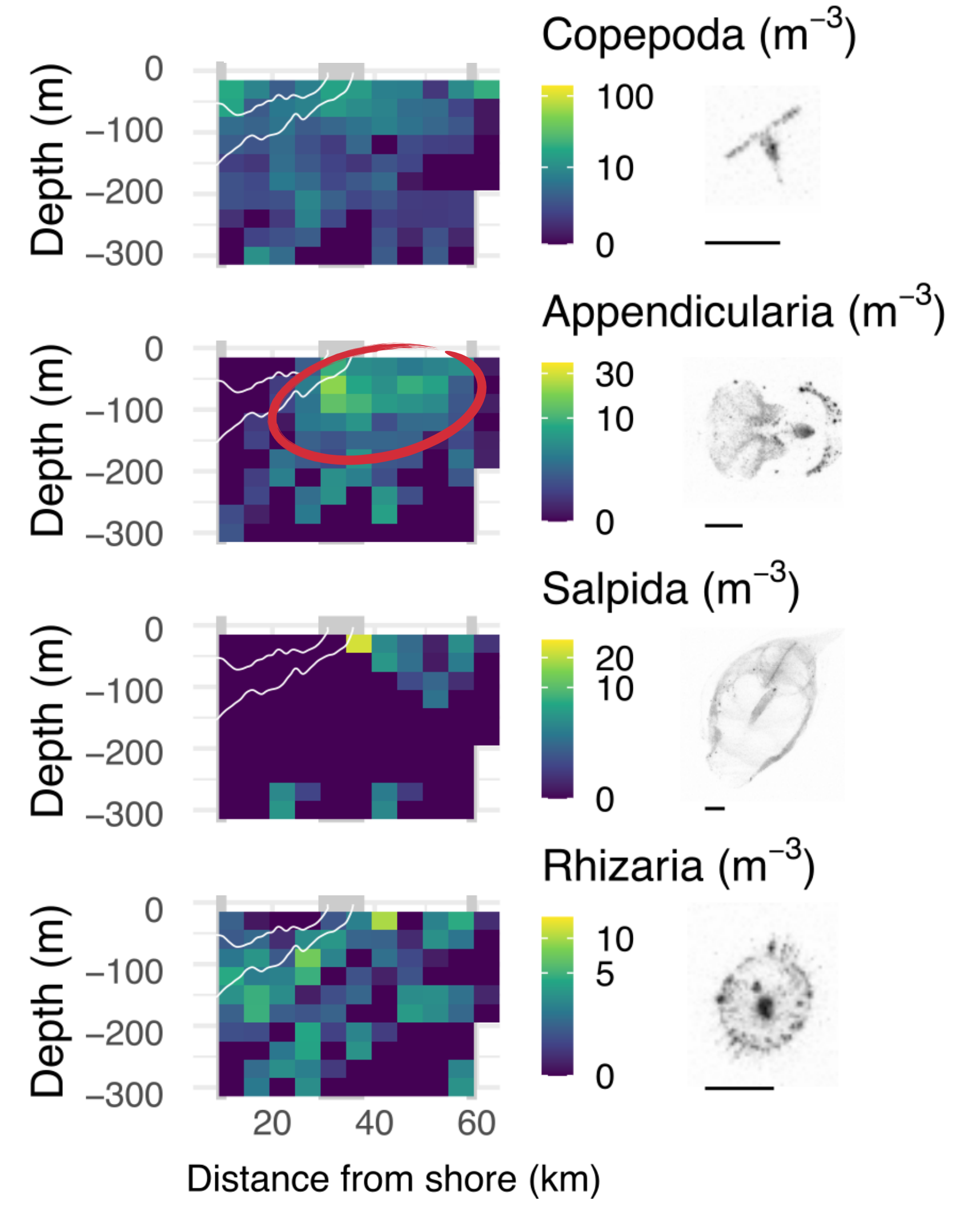
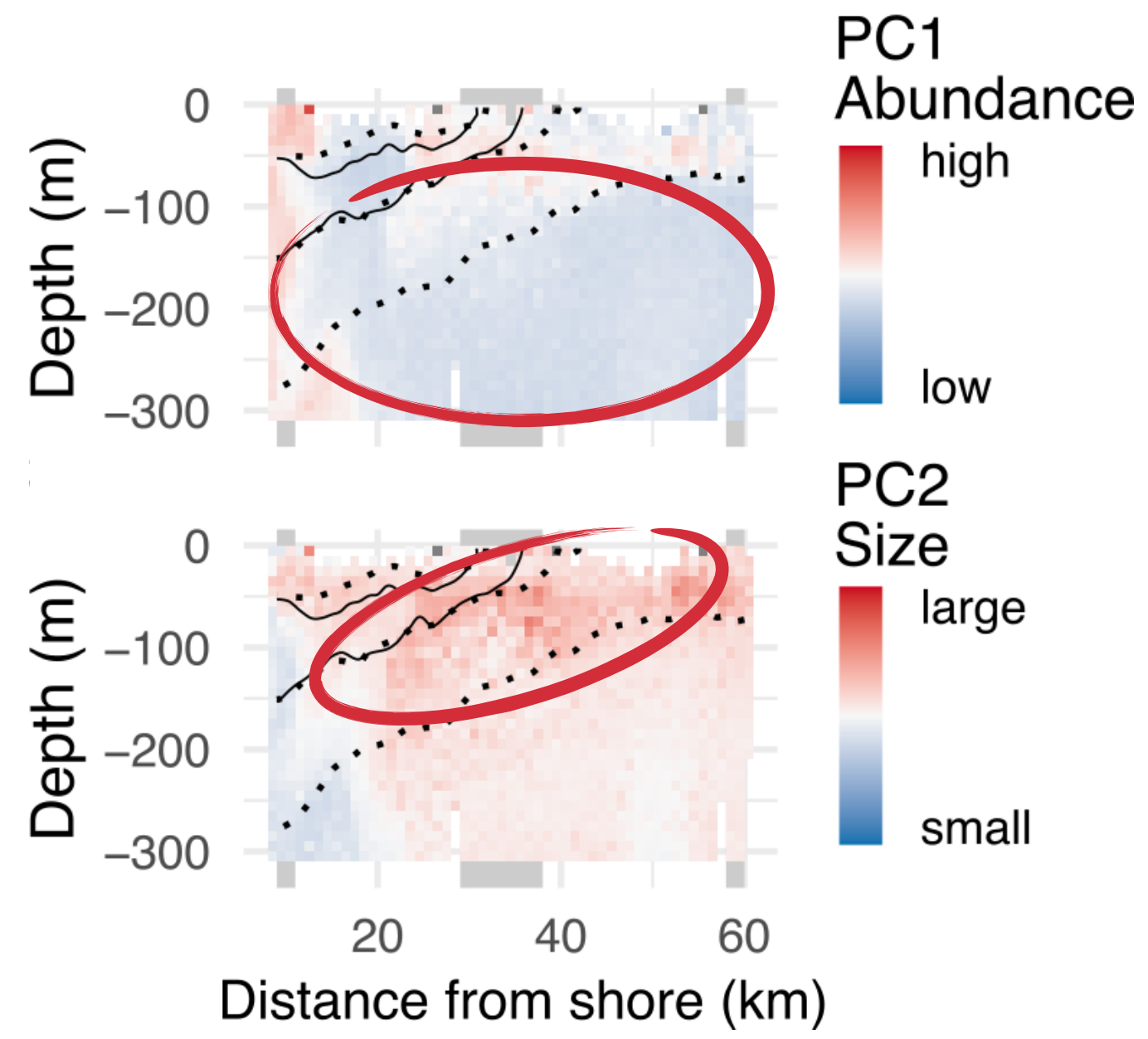
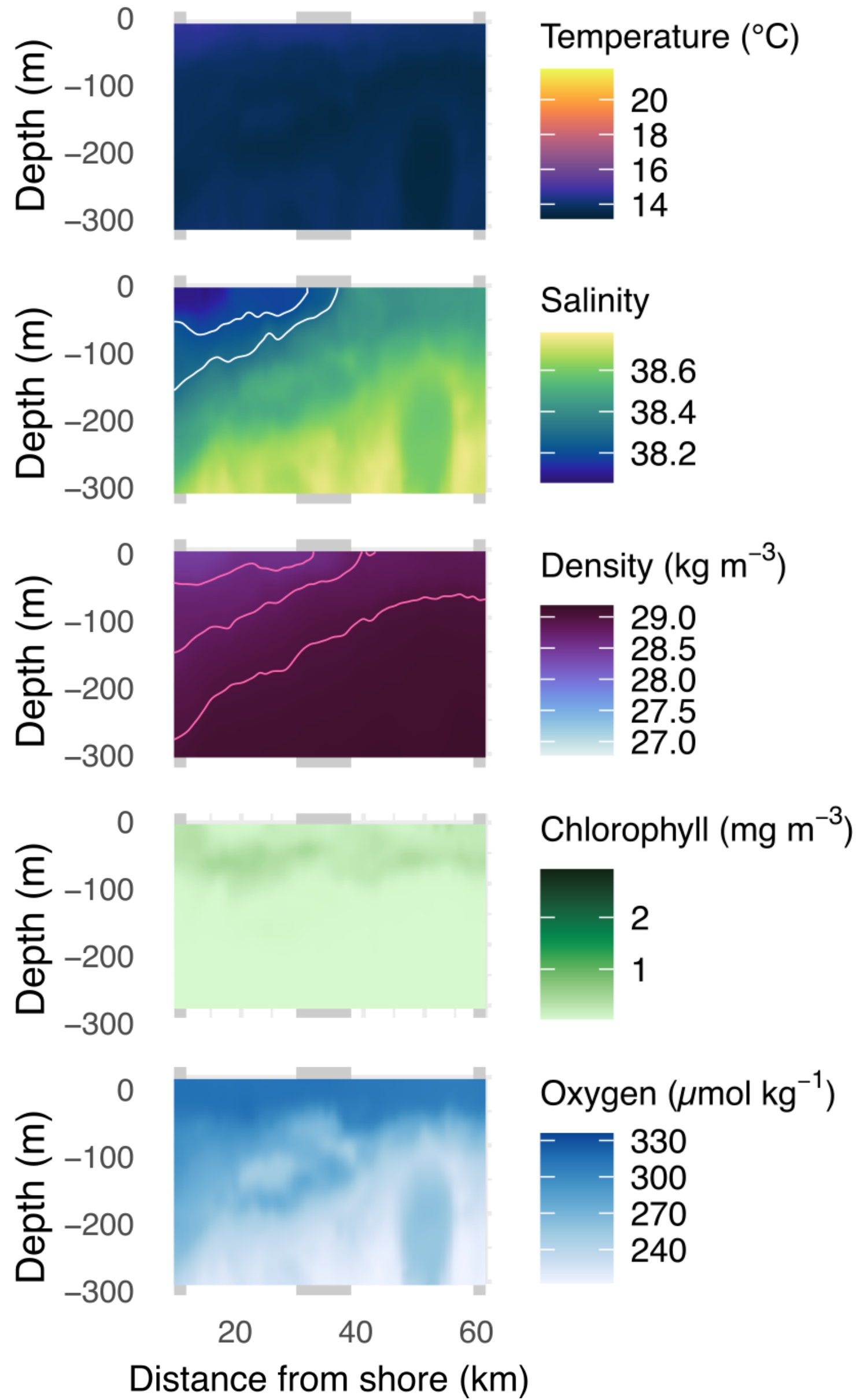
3: Late bloom



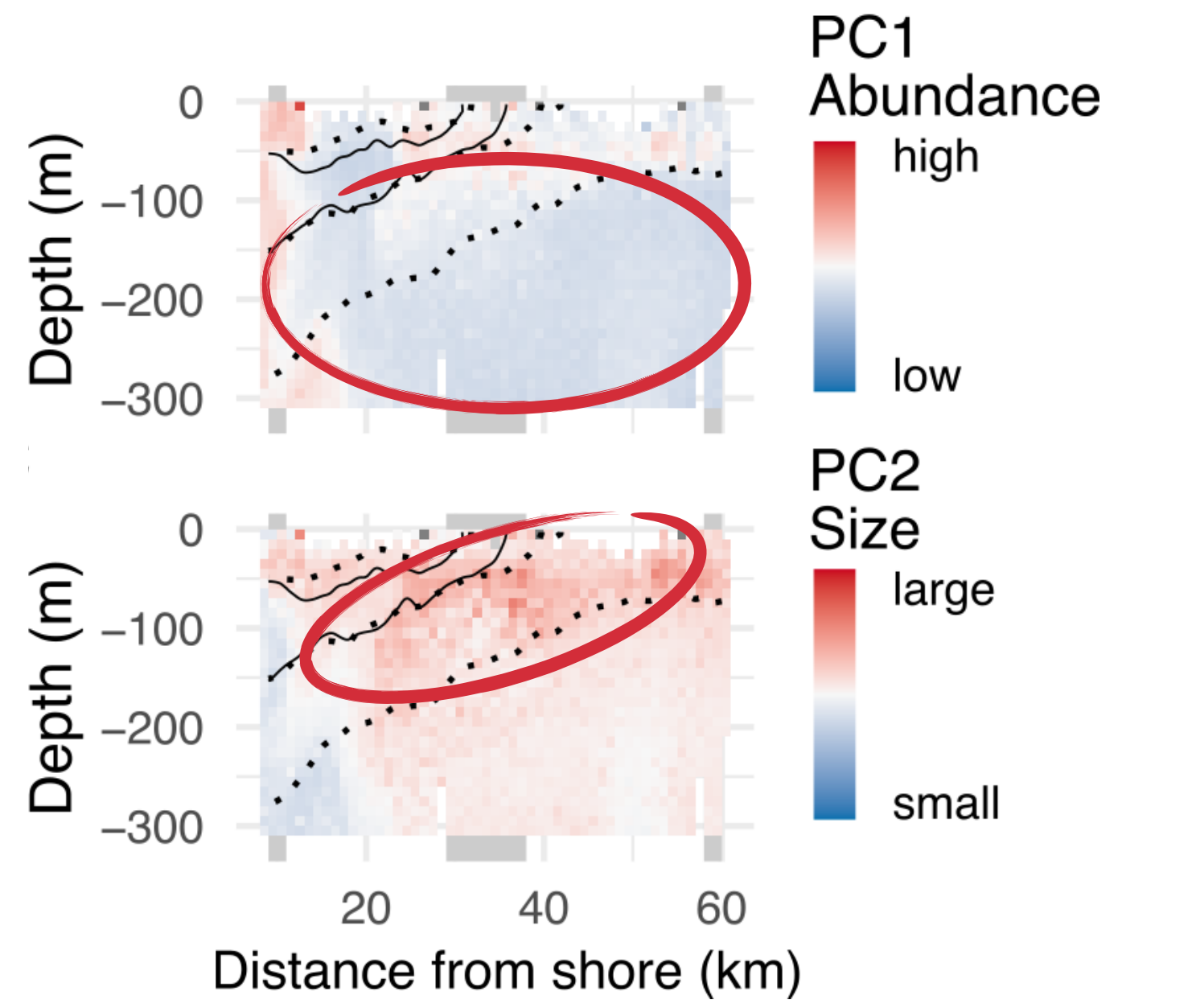
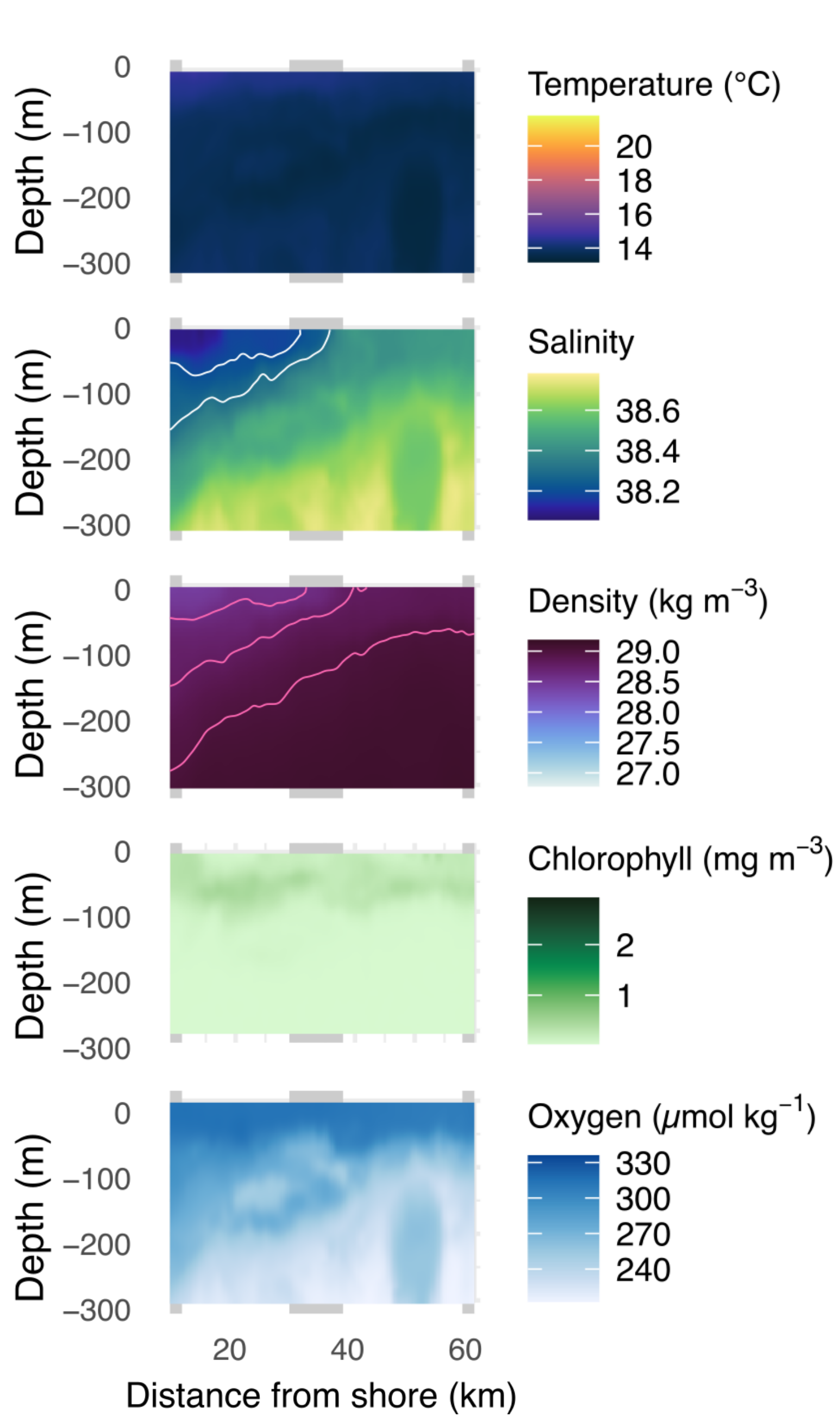
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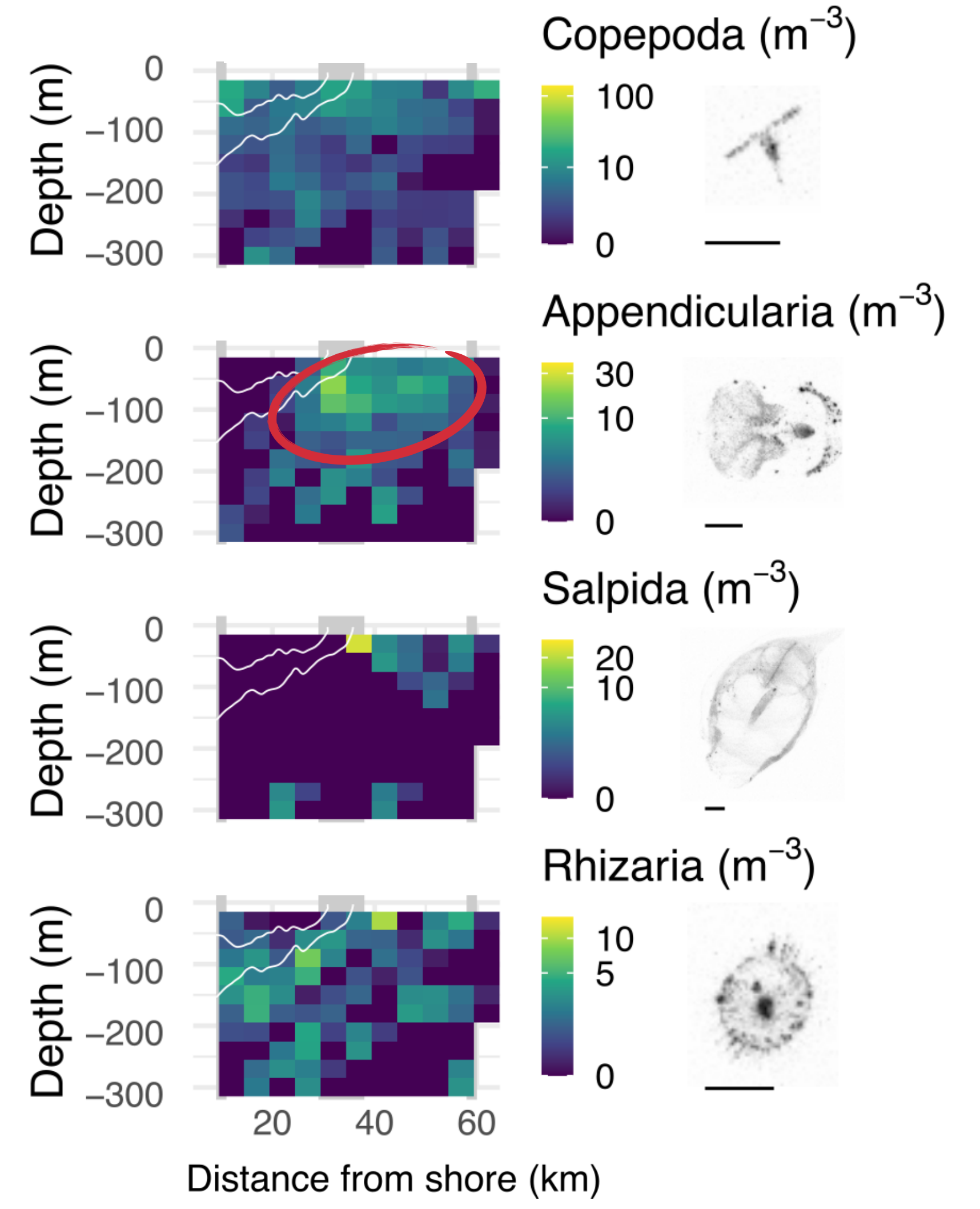
3: Late bloom



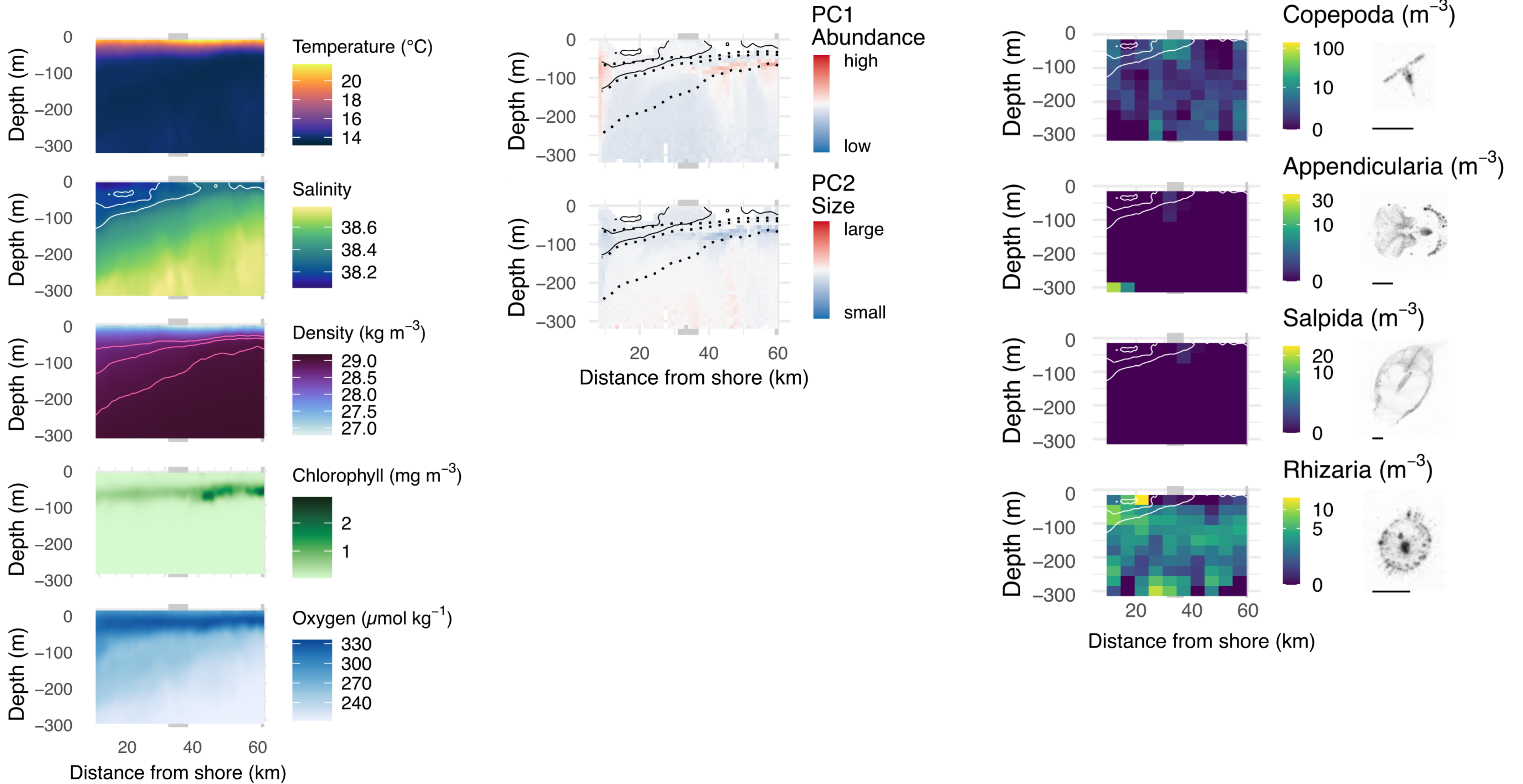
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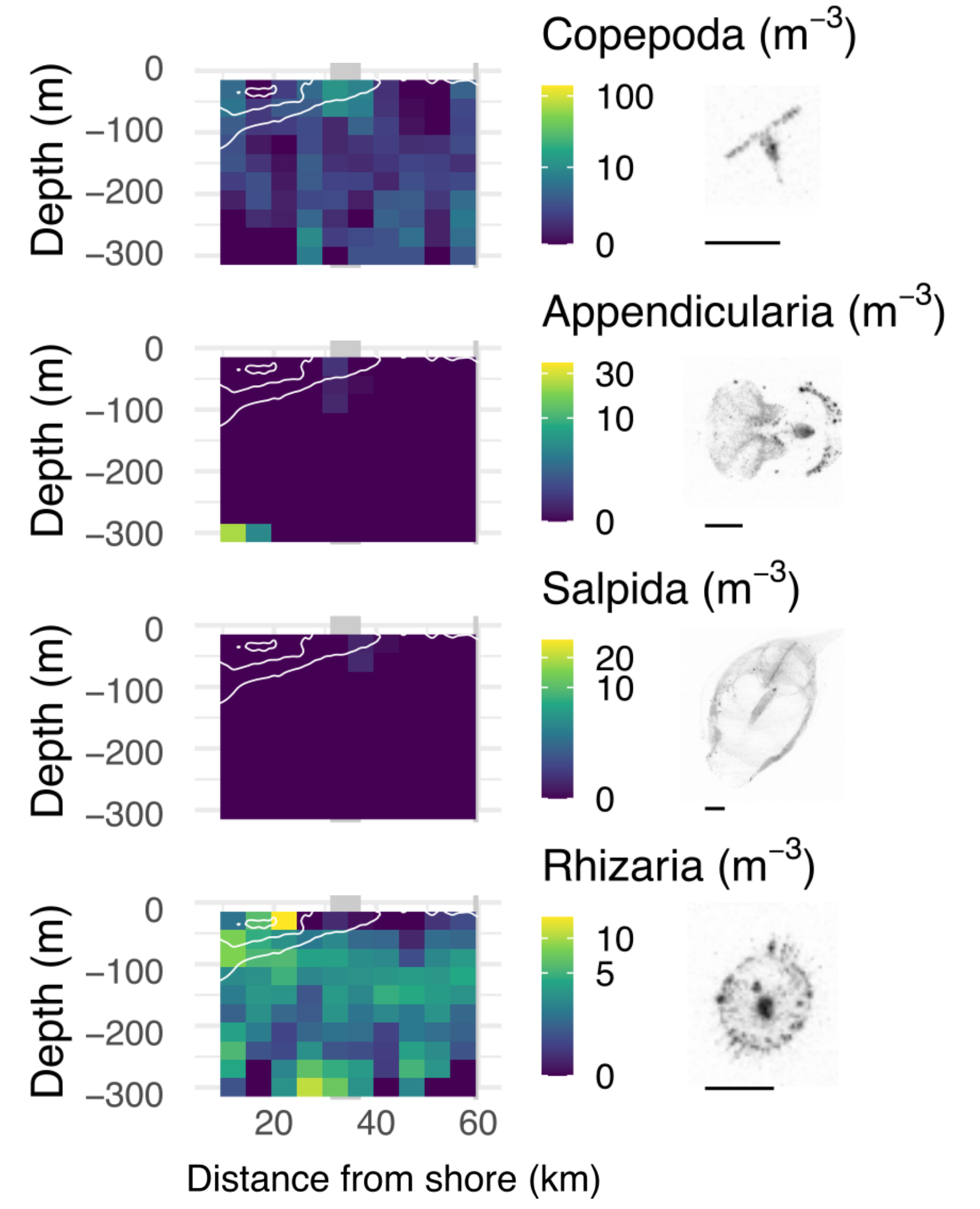
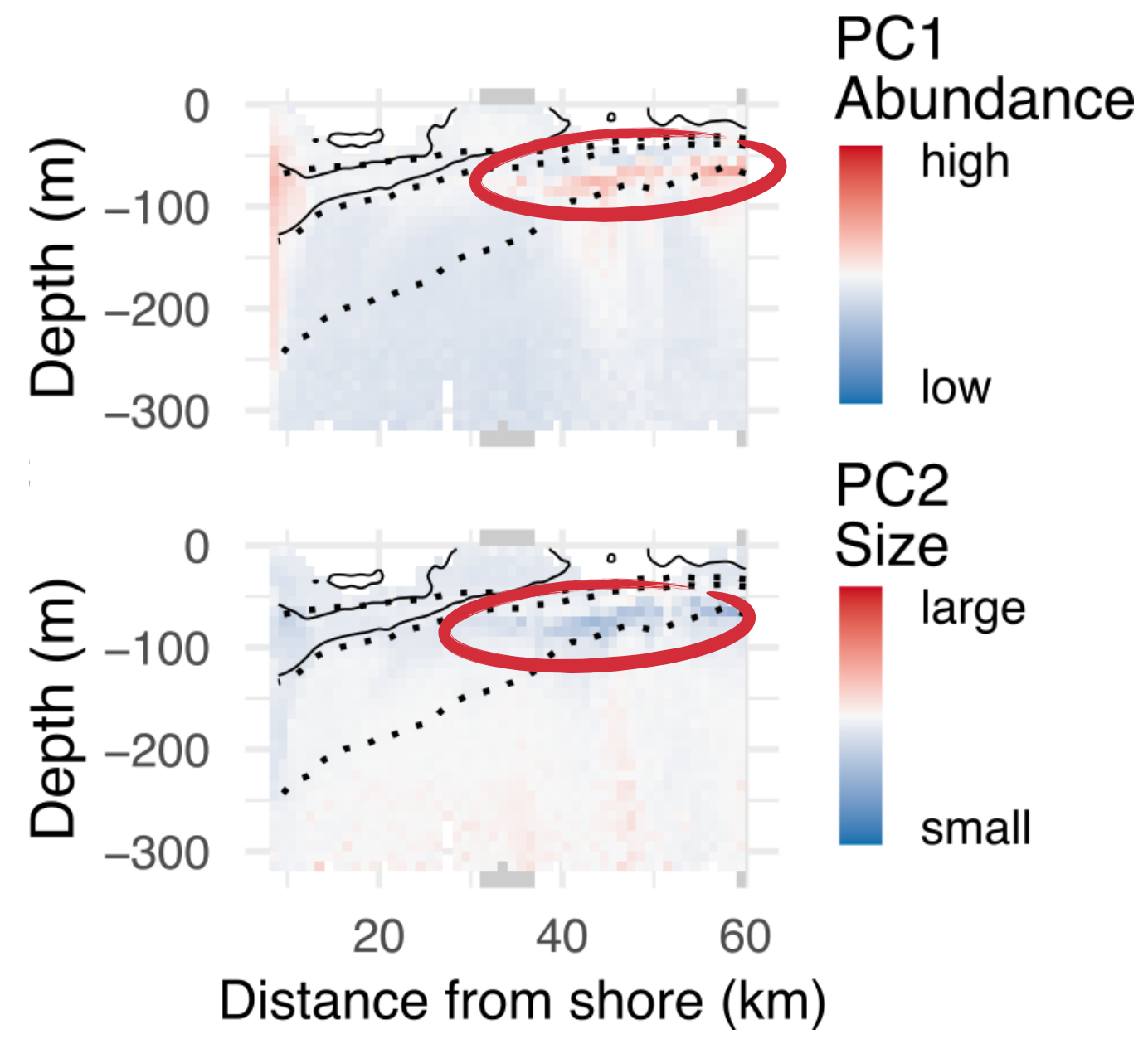
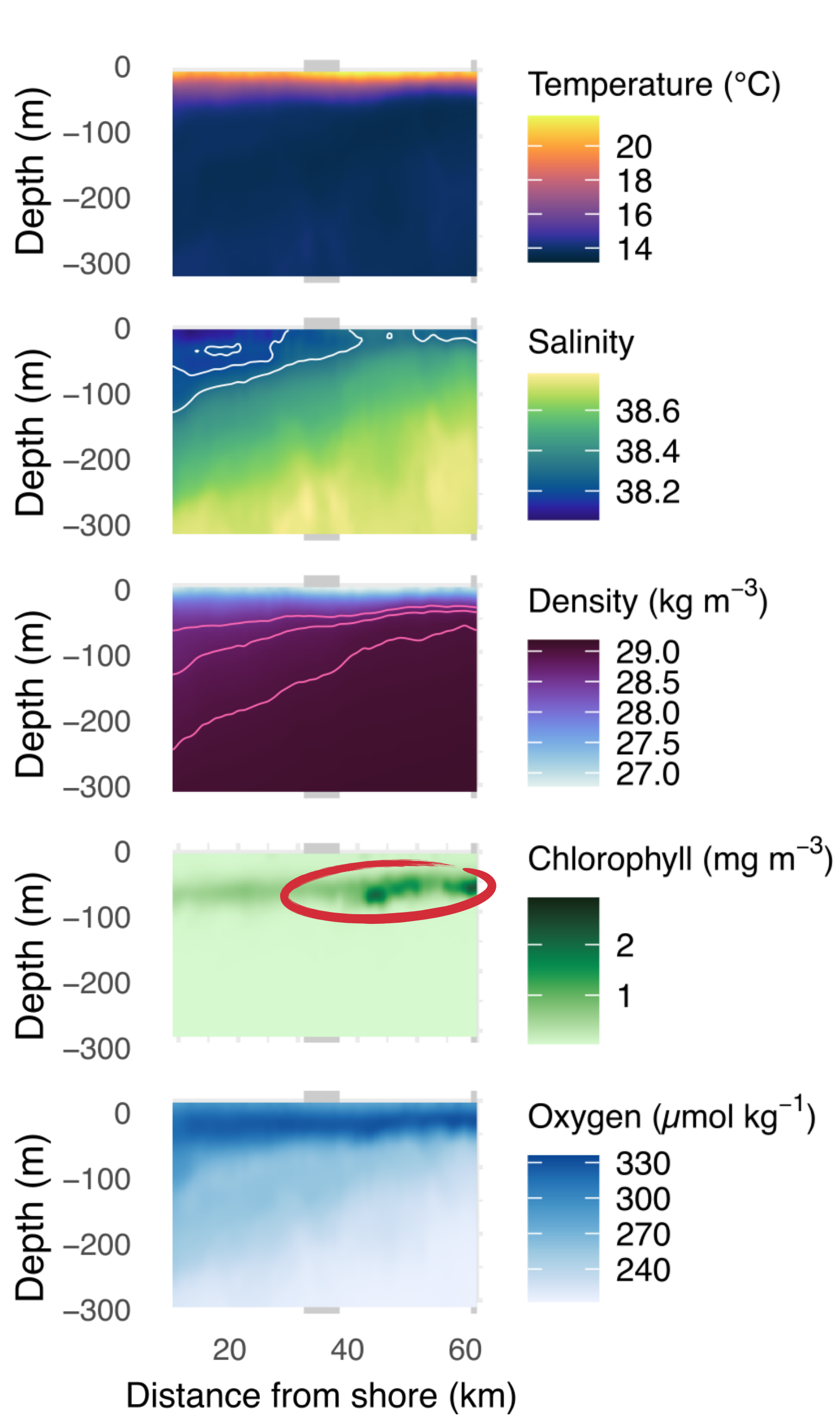
Very few particles
 Salps → Appendicularians
 Discarded houses



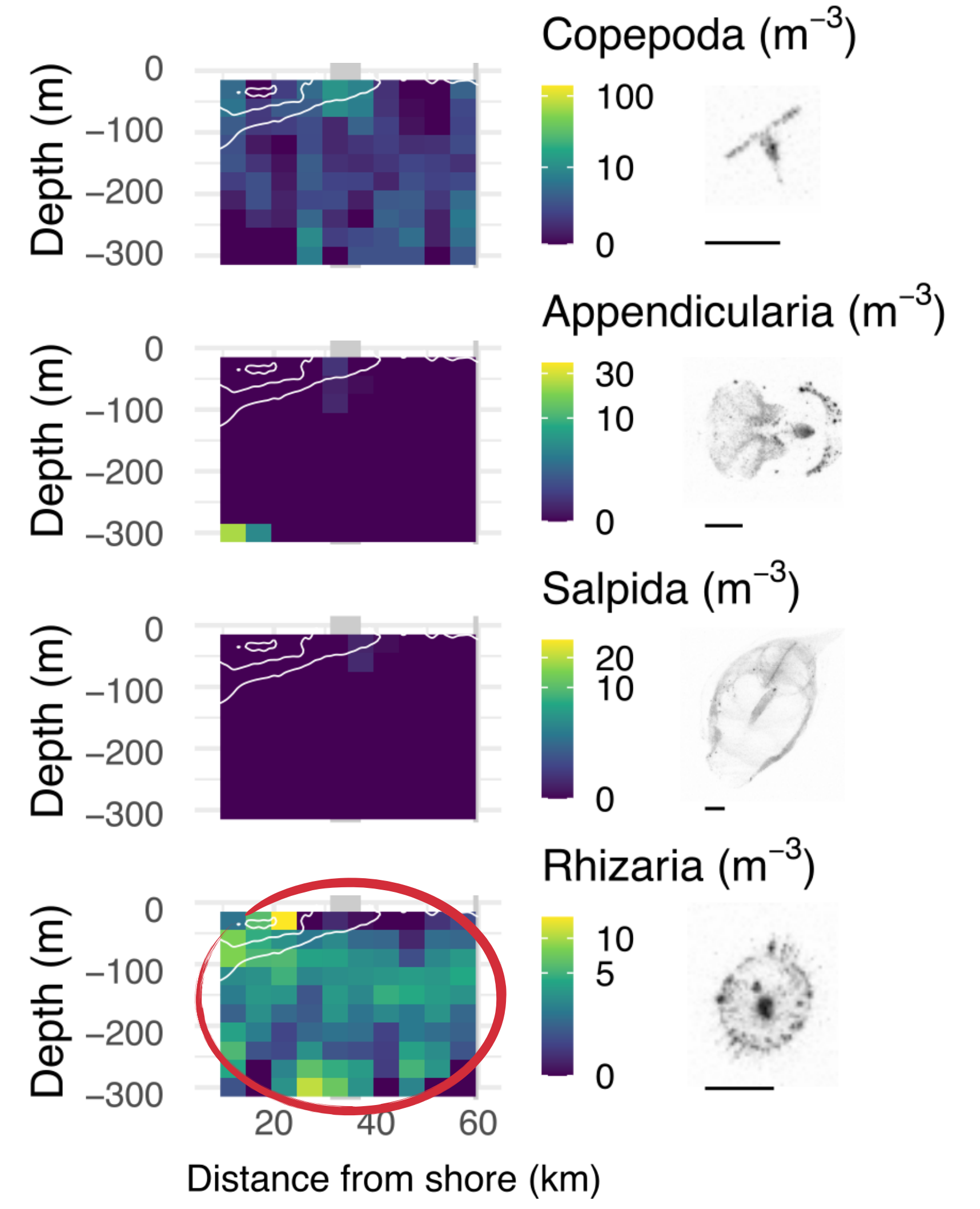
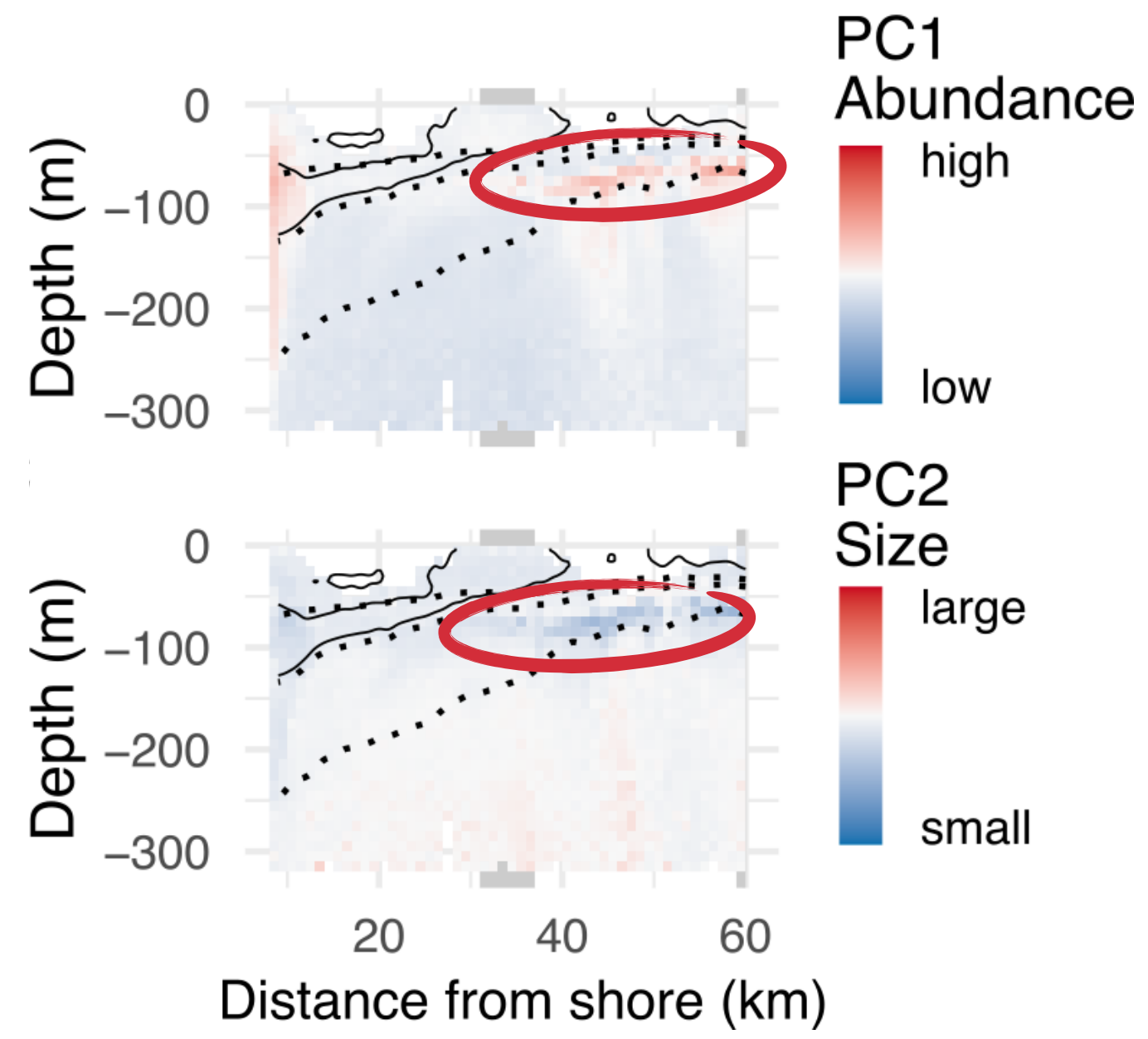
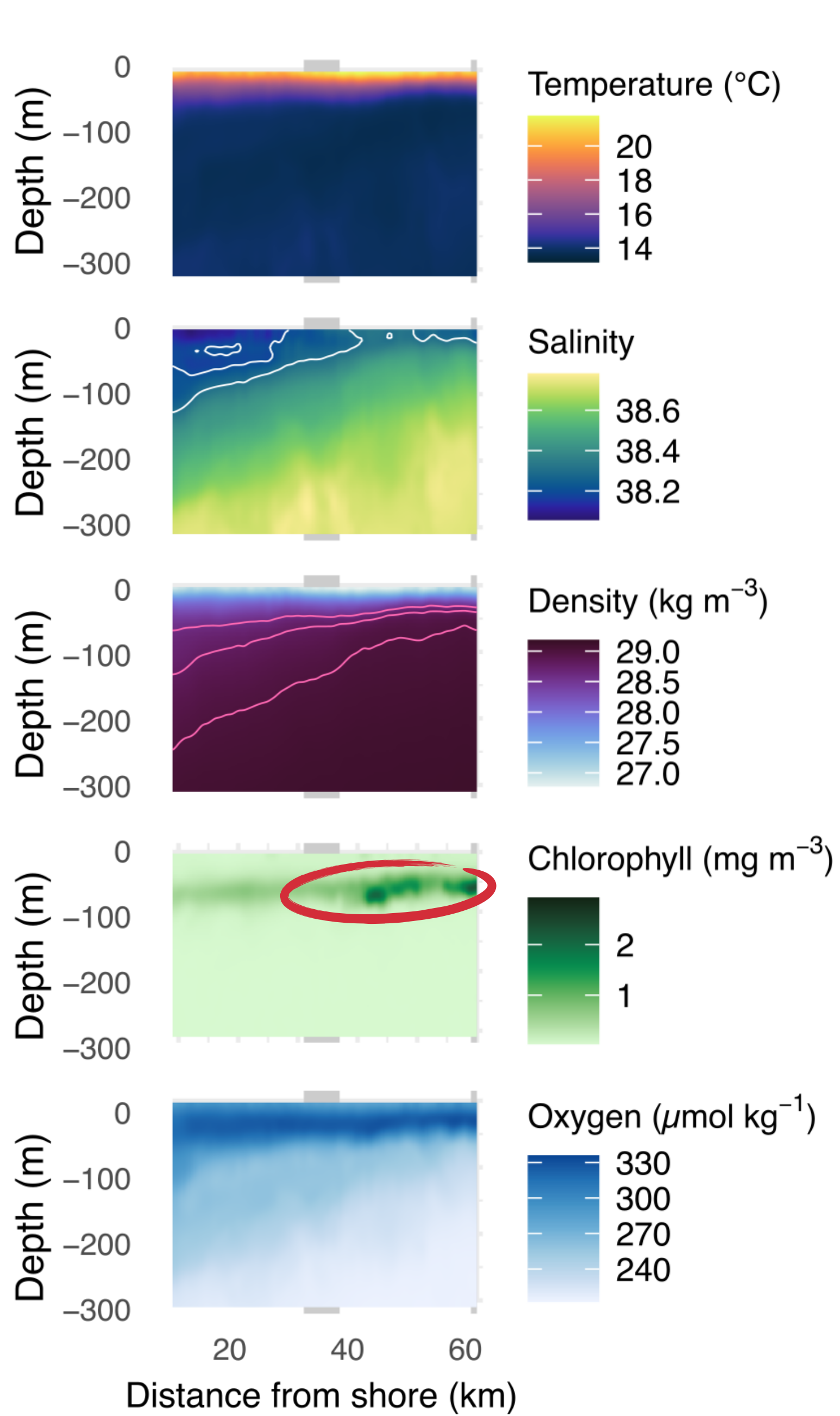
4: Post bloom



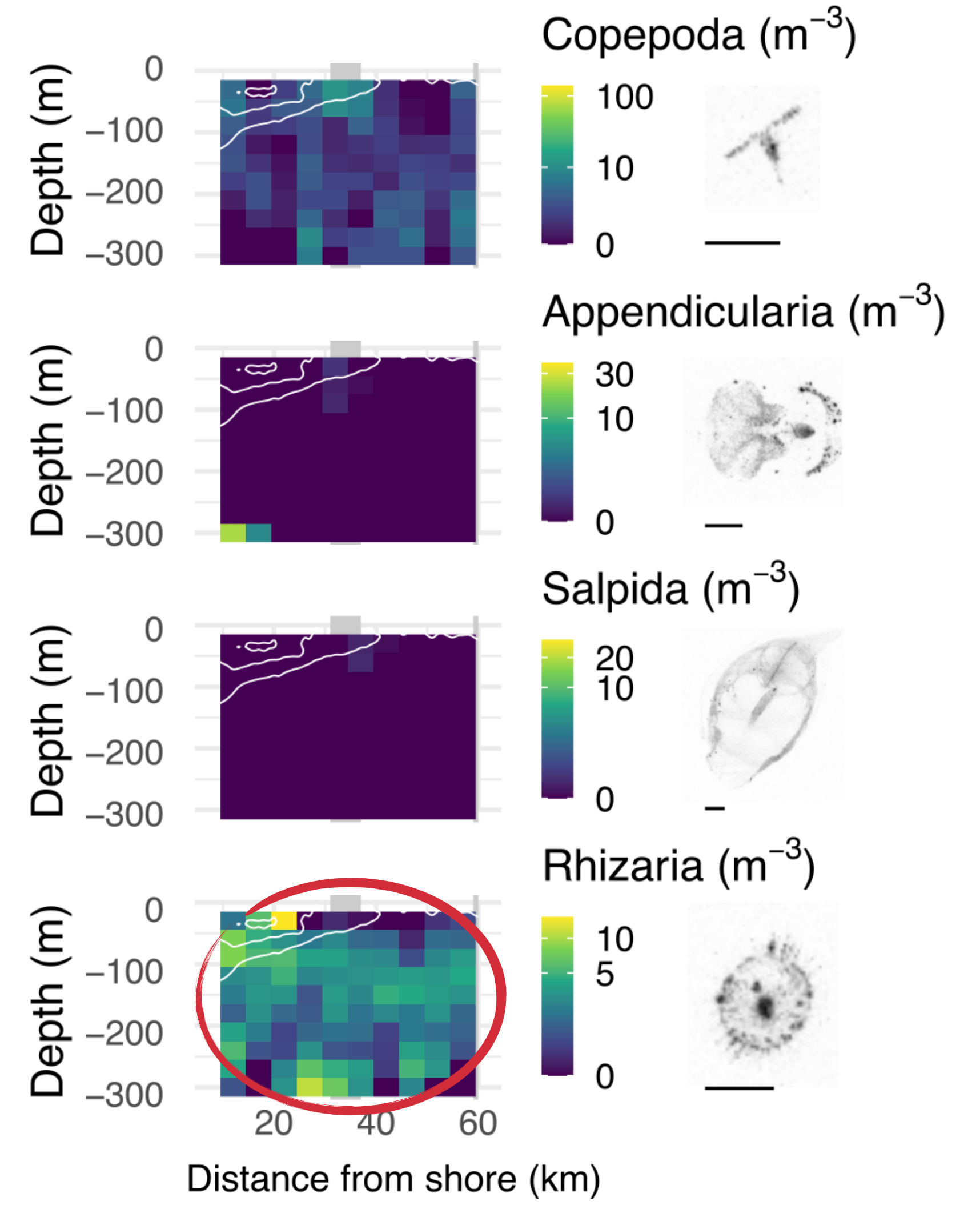
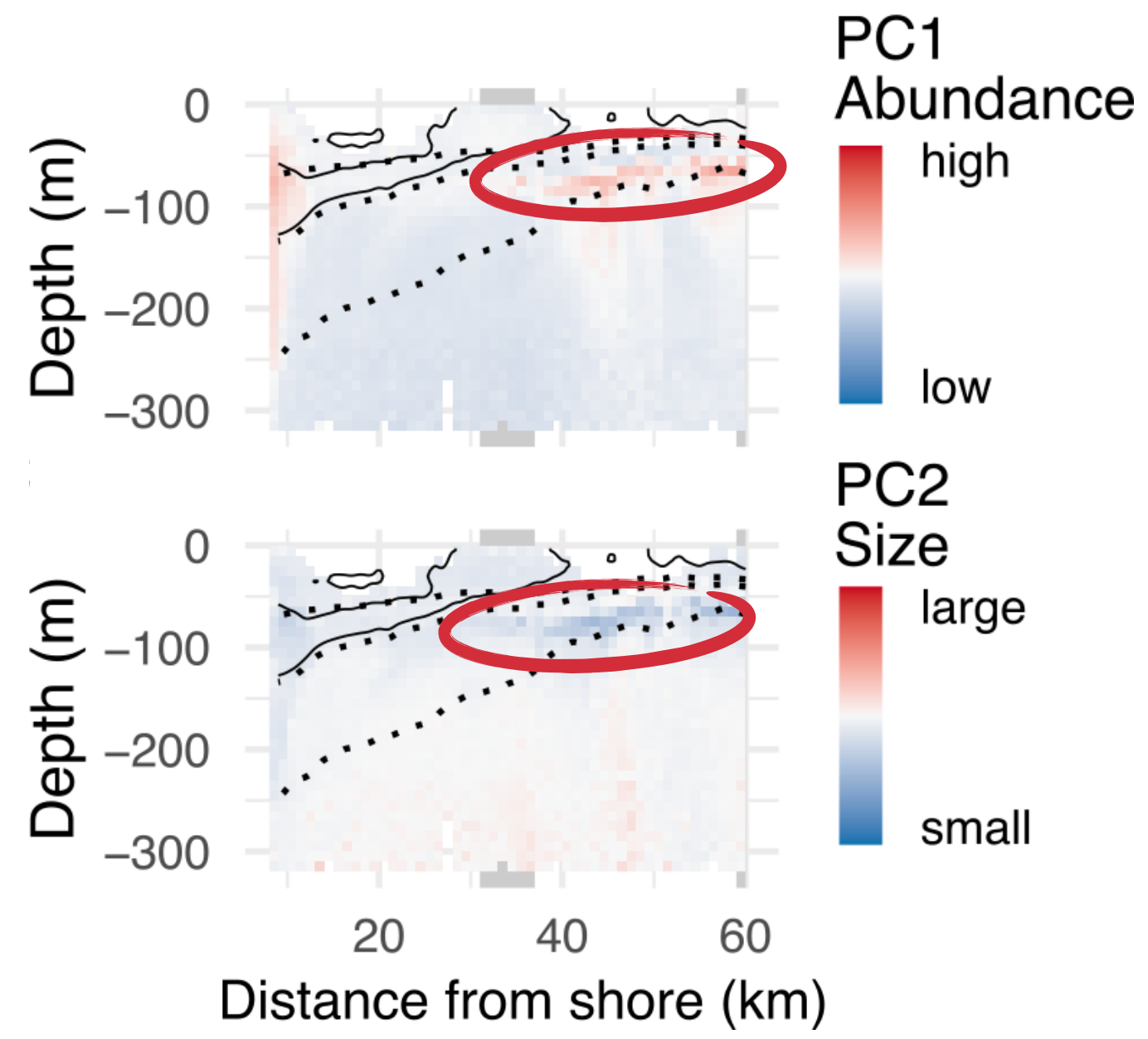
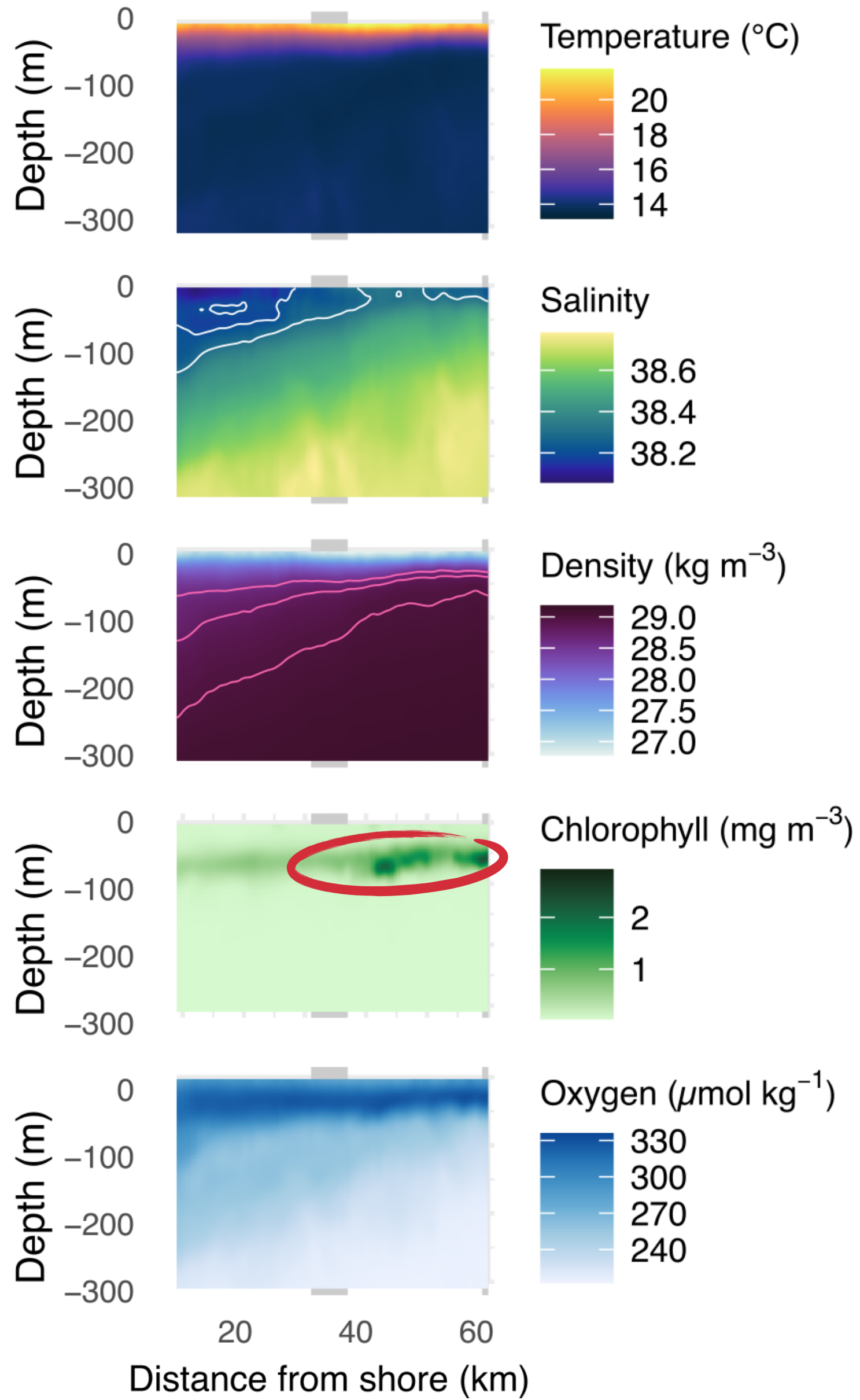
4: Post bloom



4: Post bloom



4: Post bloom



Effect of DCM on particle distribution

Rhizaria

Limitations

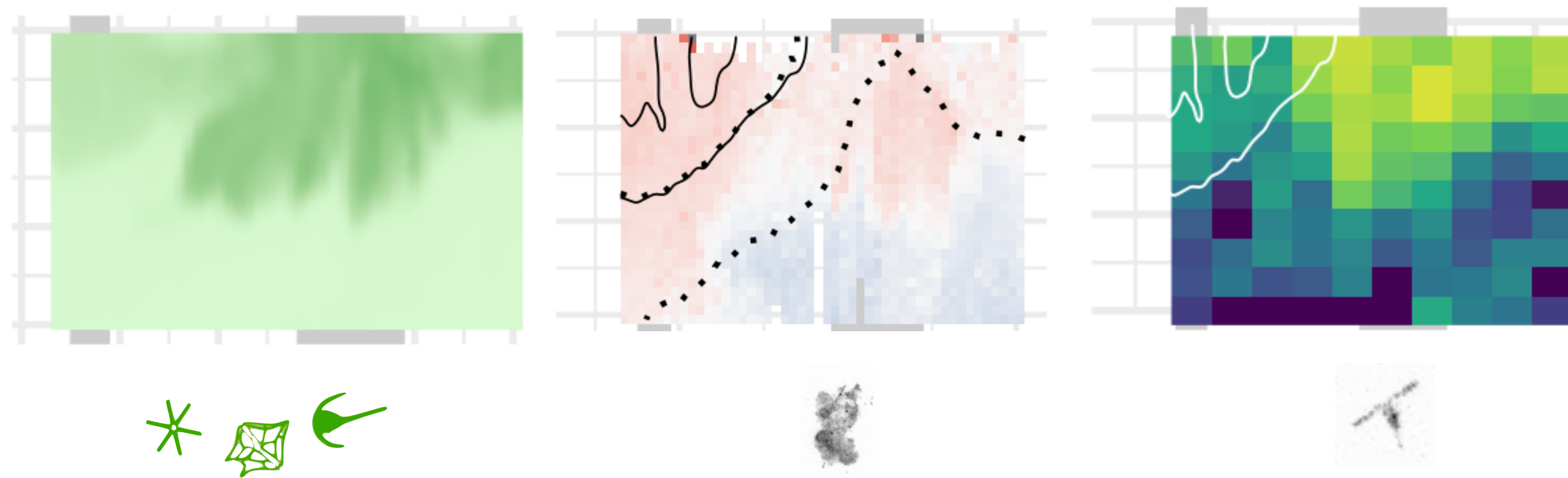
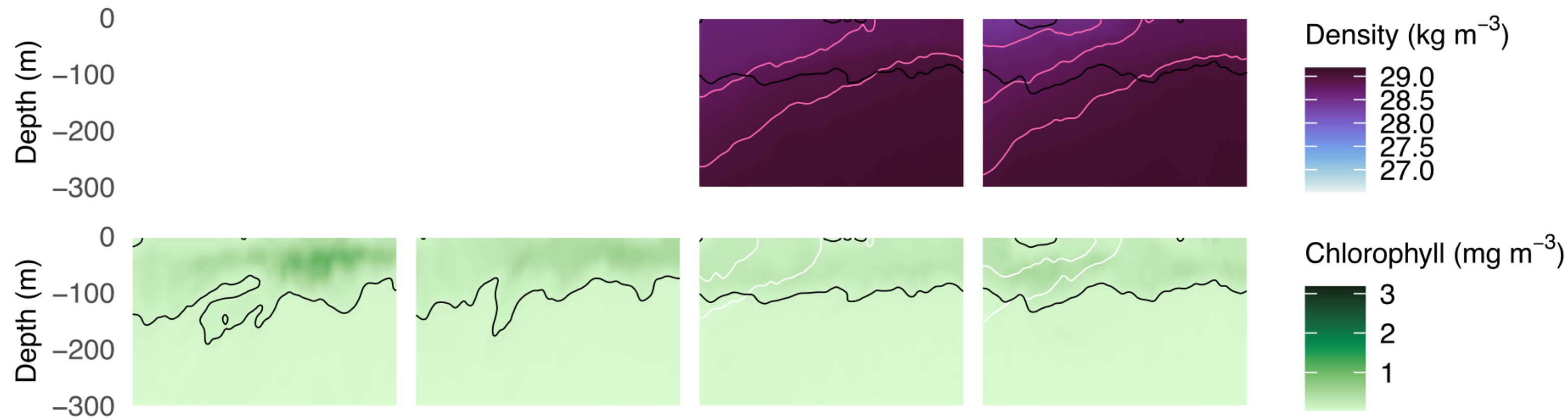
Some **instrument failure** (e.g. no CTD for ~15 days)

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

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

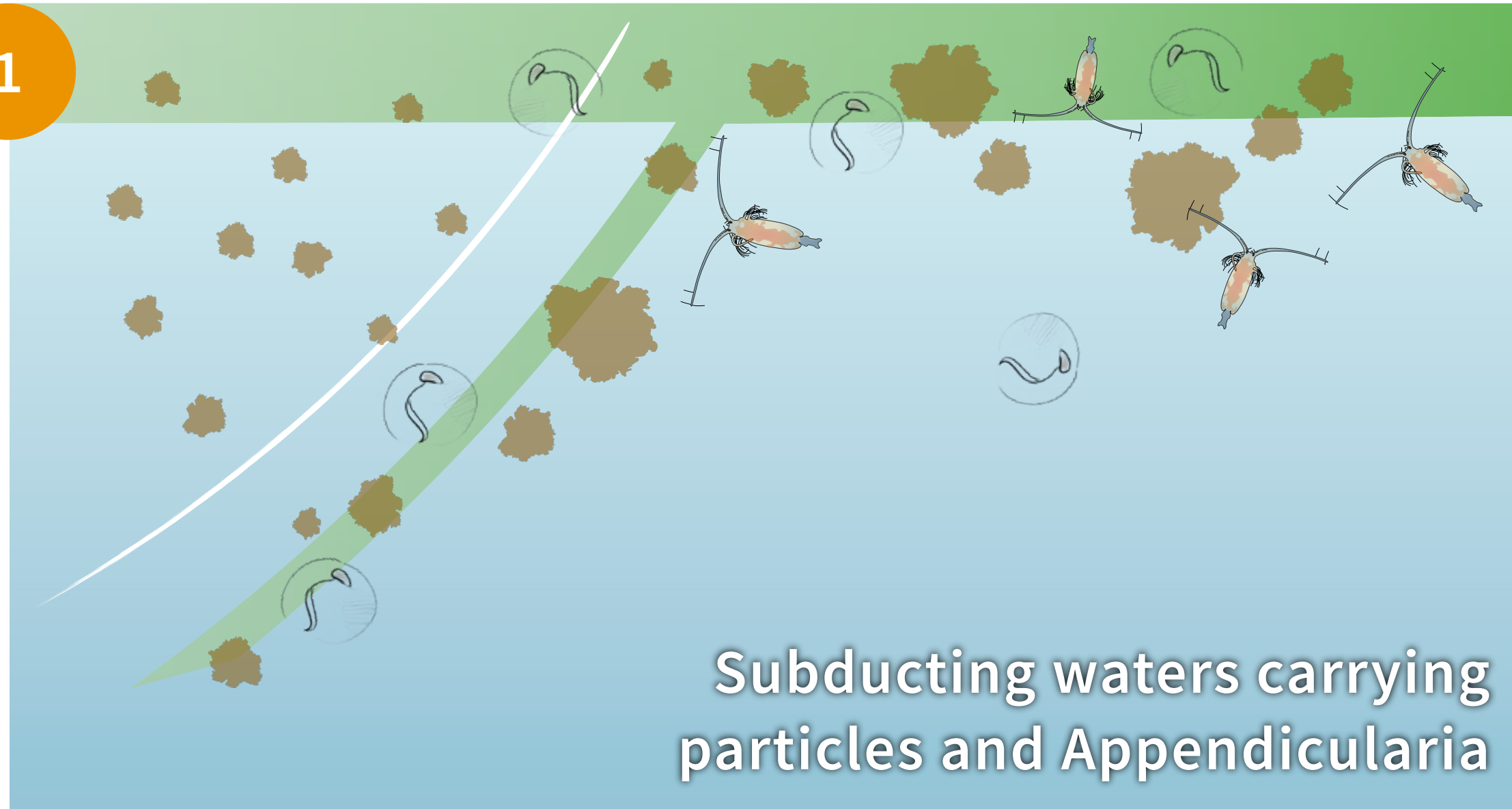
sampling rate of 0.25L/s but oligotrophic area

solution: UVP6 HF = less autonomy but higher sampling rate

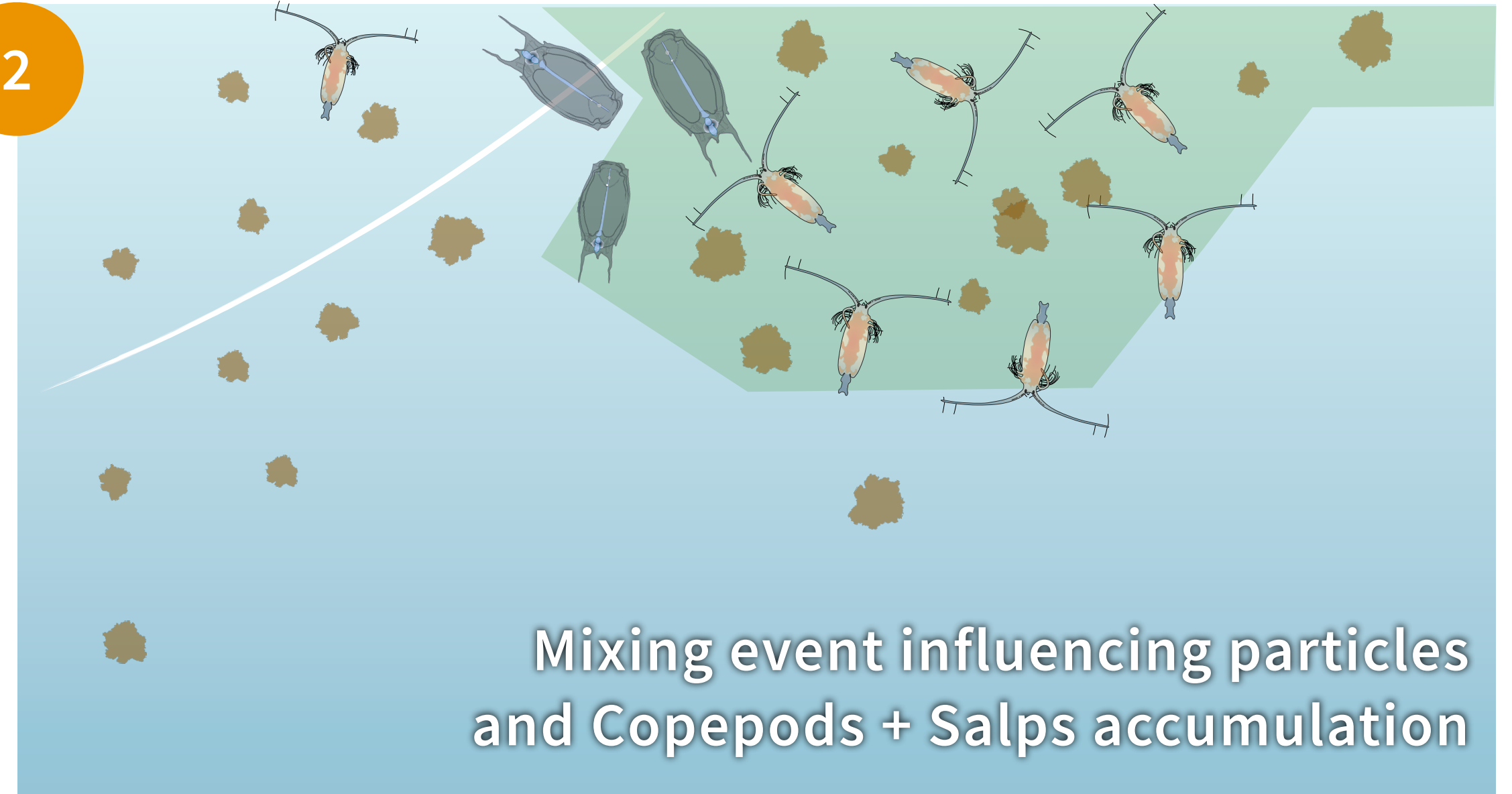


Summary: bloom dynamics

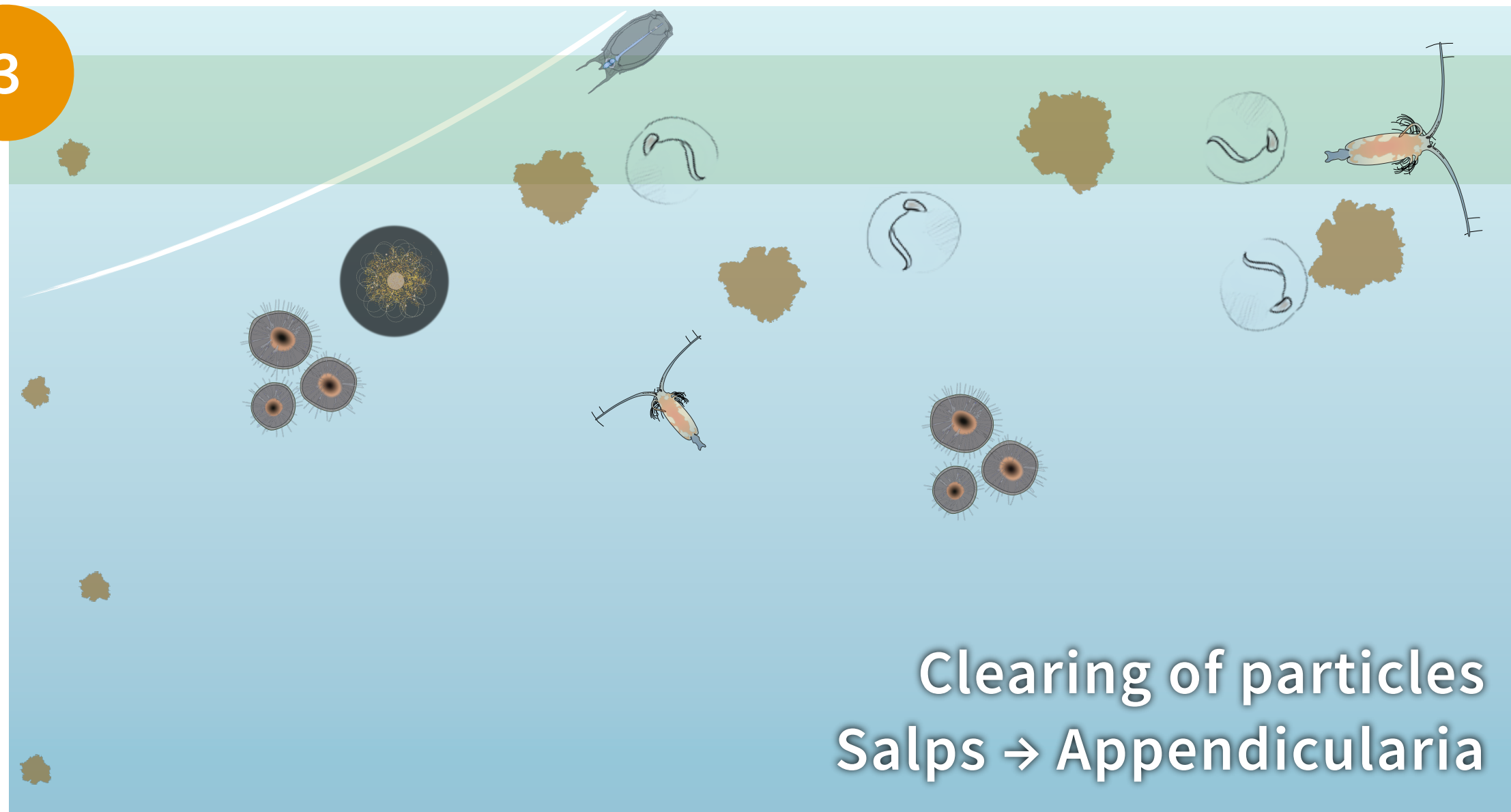
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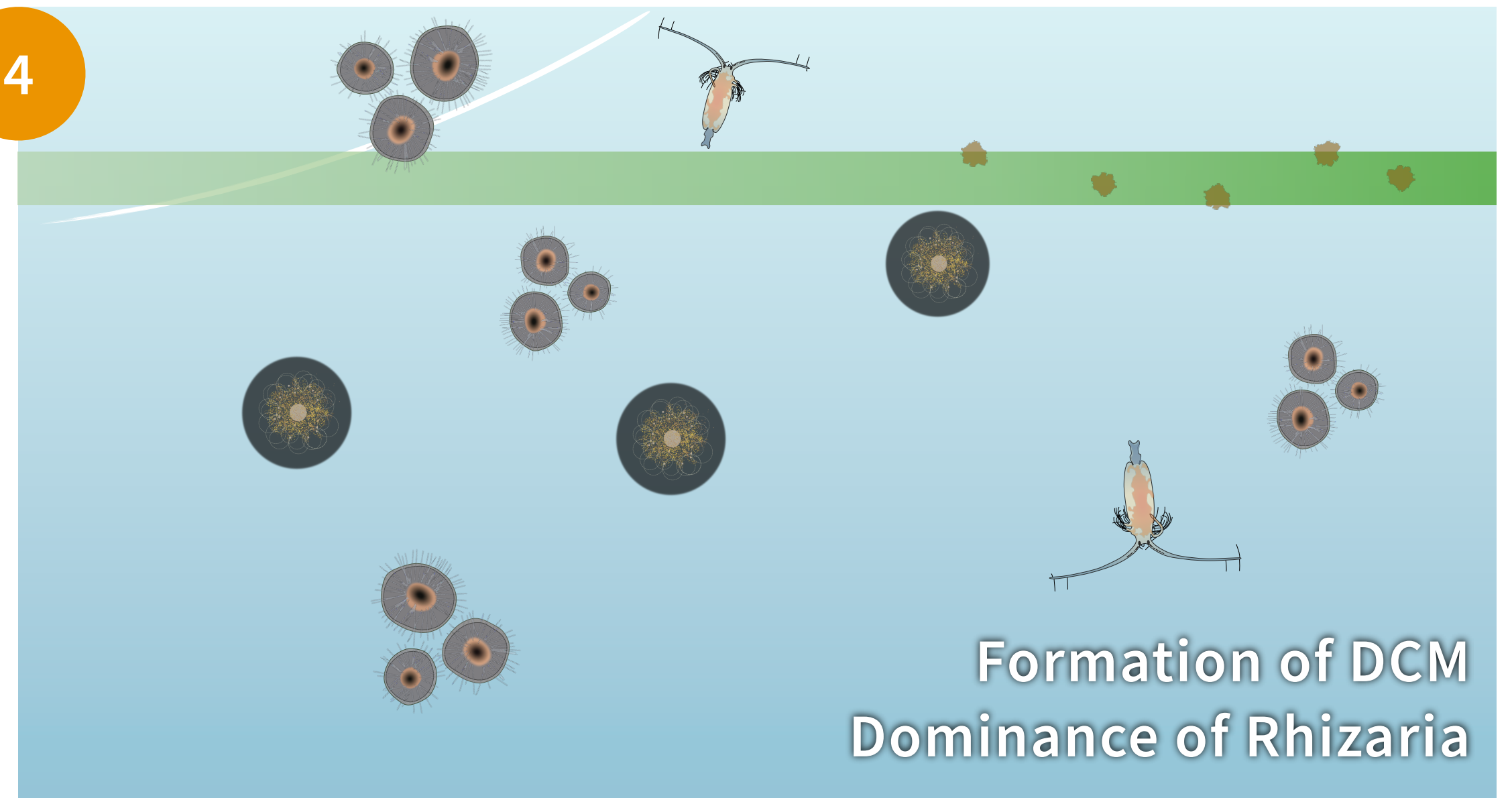
2



3



4



Summary: bloom dynamics

1



2



ent influencing particles
ds + Salps accumulation

3



Clearing of particles
Salps → Appendicularia



Formation of DCM
Dominance of Rhizaria

Bloom signal rapidly carries over to large zooplankton, temporally and spatially

thelma.panaiotis@imev-mer.fr



Thank you

IMMERIC



LABORATOIRE
D'OcéANOGRAPHIE
DE VILLEFRANCHE

BELMONT
F O R U M



SCIENCES
SORBONNE
UNIVERSITÉ