

Summer thermocline dynamics drive change in microbial communities in the NW Mediterranean

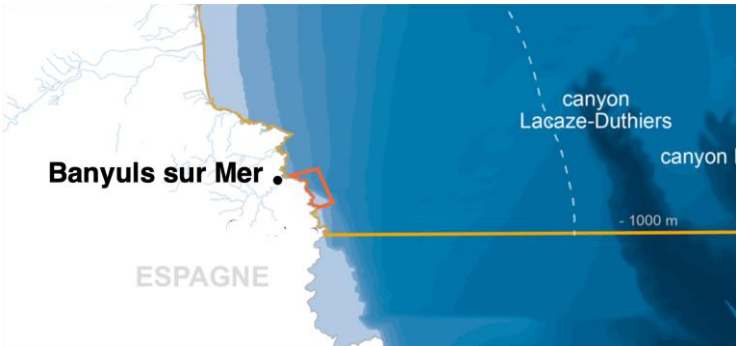
Carlota R. Gazulla, François-Yves Bouget, Pierre E. Galand
1st October 2026



BIOcean5D



First studies analysing the oceanography in the Bay of Banyuls



Production primaire au niveau de la thermocline
en zone néritique de Méditerranée Nord-Occidentale

G. CAHET, M. FIALA, G. JACQUES et M. PANOUSE

Laboratoire Arago; Banyuls-sur-Mer, France

HYDROLOGIE DANS LA ZONE NÉRITIQUE
DE BANYULS-SUR-MER (GOLFE DU LION), 1973

par M. PANOUSE, G. JACQUES et J. NEVEUX

Laboratoire Arago, 66650 Banyuls-sur-Mer

Marine Biology (1997) 128: 433–439

© Springer-Verlag 1997

J. -H. Cha · D. Martin · M. Bhaud

**Effects of temperature on oocyte growth in the Mediterranean terebellid
Eupolymnia nuebulo (Annelida: Polychaeta)**

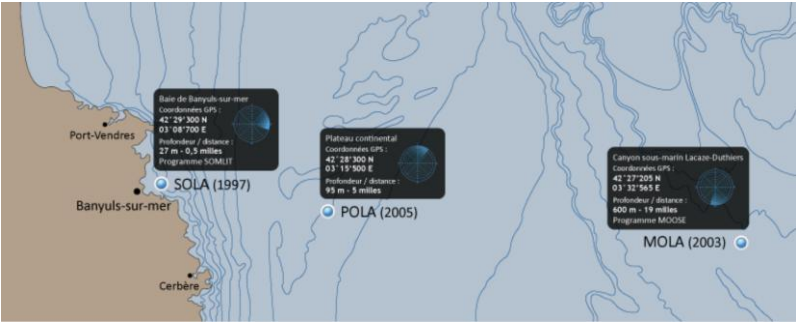
OCEANOLOGICA ACTA 1982 - VOL. 5 - N° 3

Vitamine B₁₂ et phytoplancton
au niveau de la thermocline
en Méditerranée
nord-occidentale

M. Fiala
Laboratoire Arago, 66650 Banyuls-sur-Mer, France.

Vitamine B₁₂
Dosage biologique
Diatomes
Besoin en vitamines
Thermocline
Méditerranée nord-occidentale
Vitamin B₁₂
Bioassay
Diatoms
Vitamin requirements
Thermocline
North-West Mediterranean

Banyuls Microbial Observatory



Marine Biology 14, 32–40 (1972)
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Seasonal survey of the phytoplankton biomass, composition and production in a littoral NW Mediterranean site, with special emphasis on the picoplanktonic contribution

François Charles ^{a,*}, François Lantoin ^a, Sonia Brugel ^b, Marie-Josèphe Chrétiennot-Dinet ^a, Isabel Quiroga ^a, Béatrice Rivière ^c

OCEANOLOGICA ACTA 1982 - VOL. 5 - N° 3

Vitamine B₁₂ et phytoplancton au niveau de la thermocline en Méditerranée

Vitamine B₁₂
Dosage biologique
Distances
Besoin en vitamines
Thermocline
Méditerranée nord-occidentale
Vitamin B₁₂
Biosay

Aquat. Living Resour. 20, 3–14 (2007)
© EDP Sciences, IFREMER, IRD 2007
DOI: 10.1051/alr:2007011
www.edpsciences.org/alr

Aquatic Living Resources

Nearshore dynamics of nutrients and chlorophyll during Mediterranean-type flash-floods

Katell Guizien^a, François Charles, François Lantoin and Jean-Jacques Naudin

The ISME Journal (2018) 12:2470–2478
<https://doi.org/10.1038/s41396-018-0158-1>

ARTICLE

A strong link between marine microbial community composition and function challenges the idea of functional redundancy

Pierre E. Galand ¹ • Olivier Pereira ¹ • Corentin Hochart ² • Jean Christophe Auguet ³ • Didier Debroas ²

The ISME Journal (2017) 12:200–201
<https://doi.org/10.1038/s41396-018-0281-z>

MOLECULAR ECOLOGY

Molecular Ecology (2015) 24, 5785–5795
doi: 10.1111/mec.13347

FROM THE COVER

Ecosystem productivity is associated with bacterial phylogenetic distance in surface marine waters

PIERRE E. GALAND,^{*} IAN SALTER^{†‡} and DIMITRI KALENITCHENKO^{*}

ARTICLE

Rhythmicity of coastal marine picoeukaryotes, bacteria and archaea despite irregular environmental perturbations

Stefan Lambert¹ • Margot Tragin² • Jean-Claude Lozano¹ • Jean-François Ghiglione¹ • Daniel Vaultot ² • François-Yves Bouget¹ • Pierre E. Galand ¹

Functional redundancy of seasonal vitamin B₁₂ biosynthesis pathways in coastal marine microbial communities

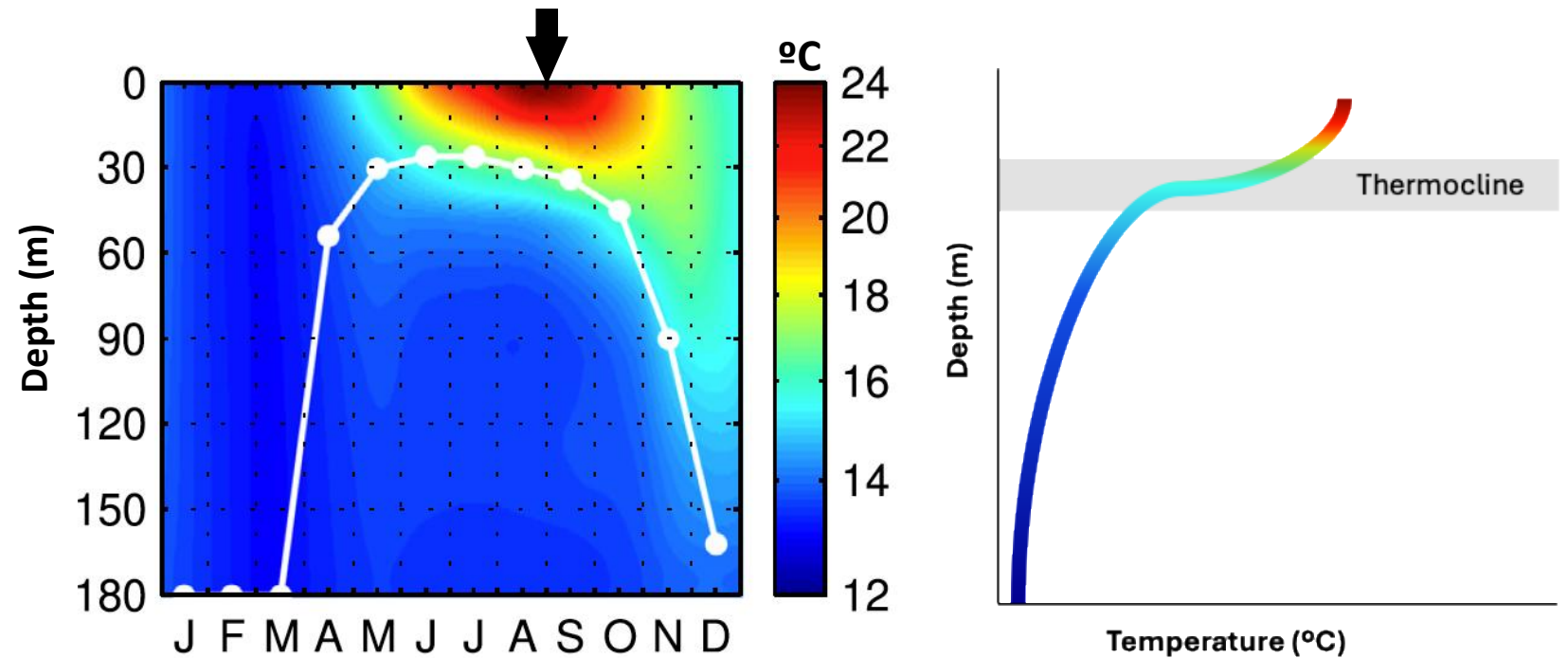
Maxime Beauvais, Philippe Schatt, Lidia Montiel, Ramiro Logares, Pierre E. Galand ✉, François-Yves Bouget ✉

First published: 30 November 2023 | <https://doi.org/10.1111/1462-2920.16545> | [VIEW METRICS](#)

Banyuls Microbial Observatory



Temperature change in the NW Mediterranean



Seawater is **stratified**
between May and October

Banyuls Microbial Observatory



1) How has the coastal environment at the Banyuls Bay changed over the last 25 years?

2) How do changes in the thermal structure of the water column generate environmental variability?

Environmental data collected over 25 years

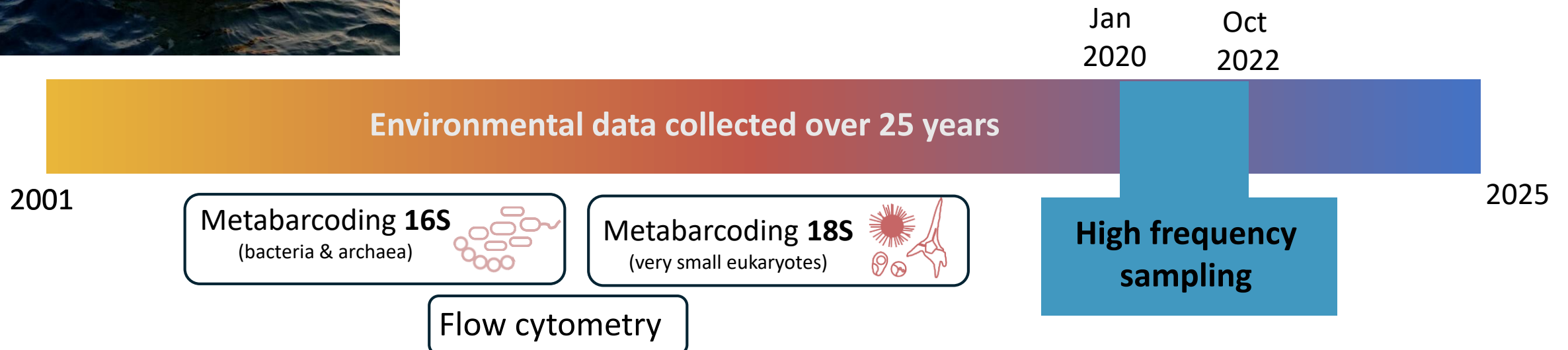
2001

2025

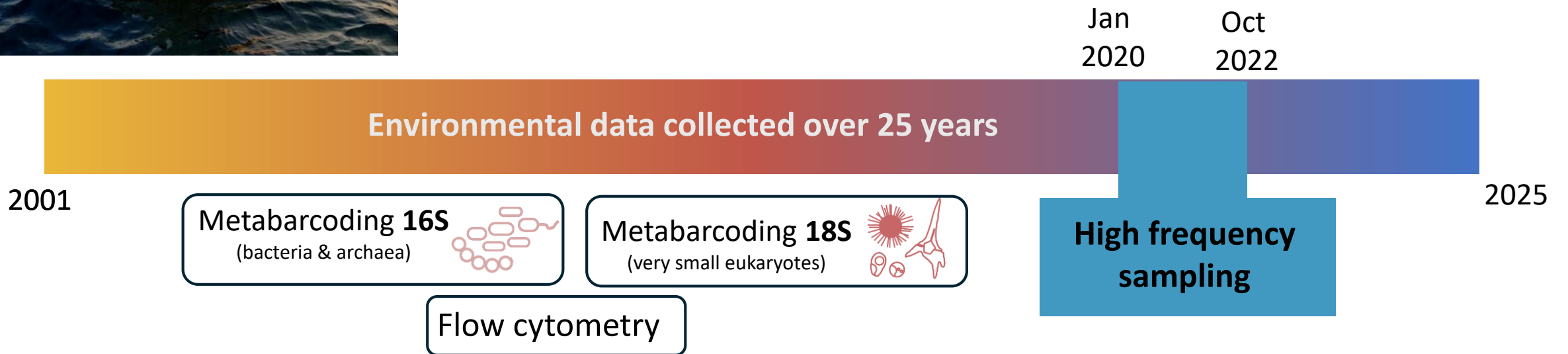
Banyuls Microbial Observatory



- 1) How has the coastal environment at the Banyuls Bay changed over the last 25 years?
- 2) How do changes in the thermal structure of the water column generate environmental variability?
- 3) What are the consequences of this environmental variability for phytoplankton and microbial communities?



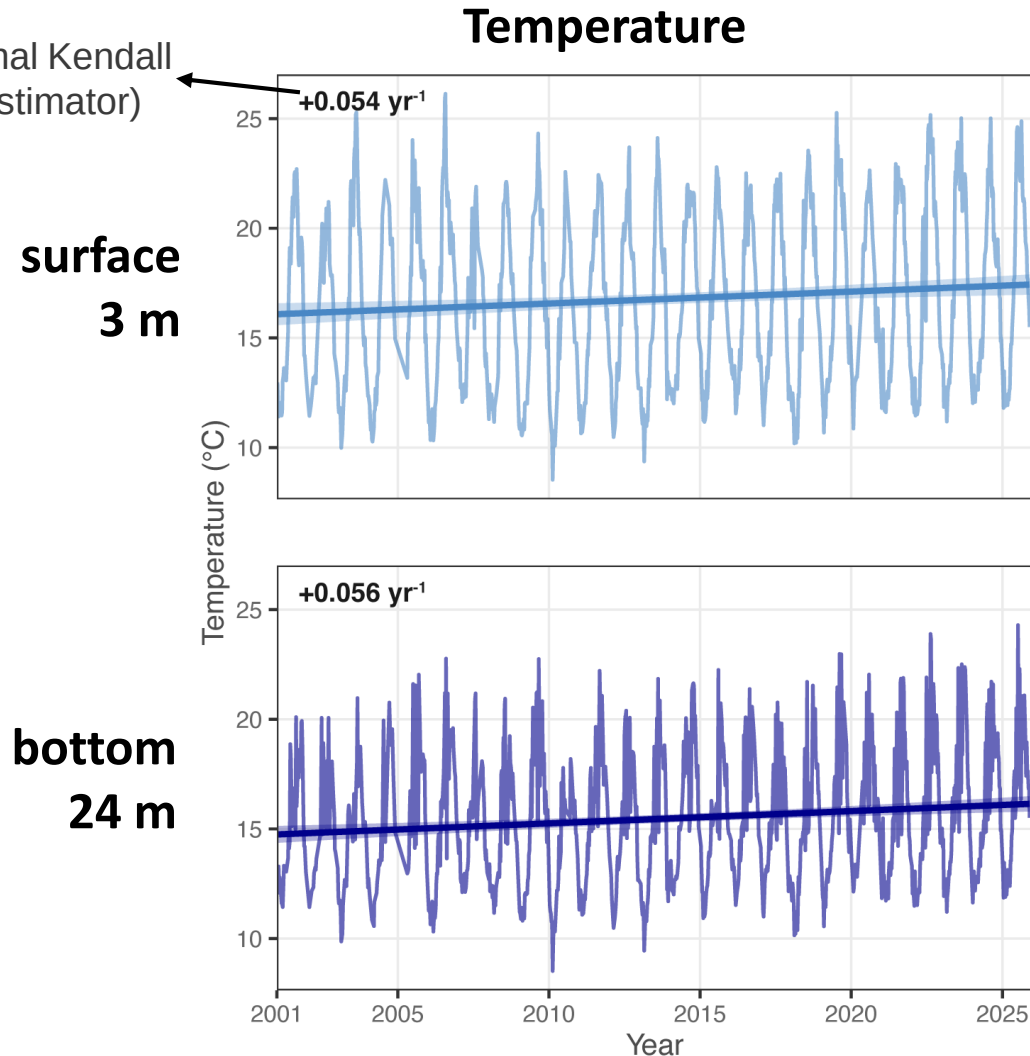
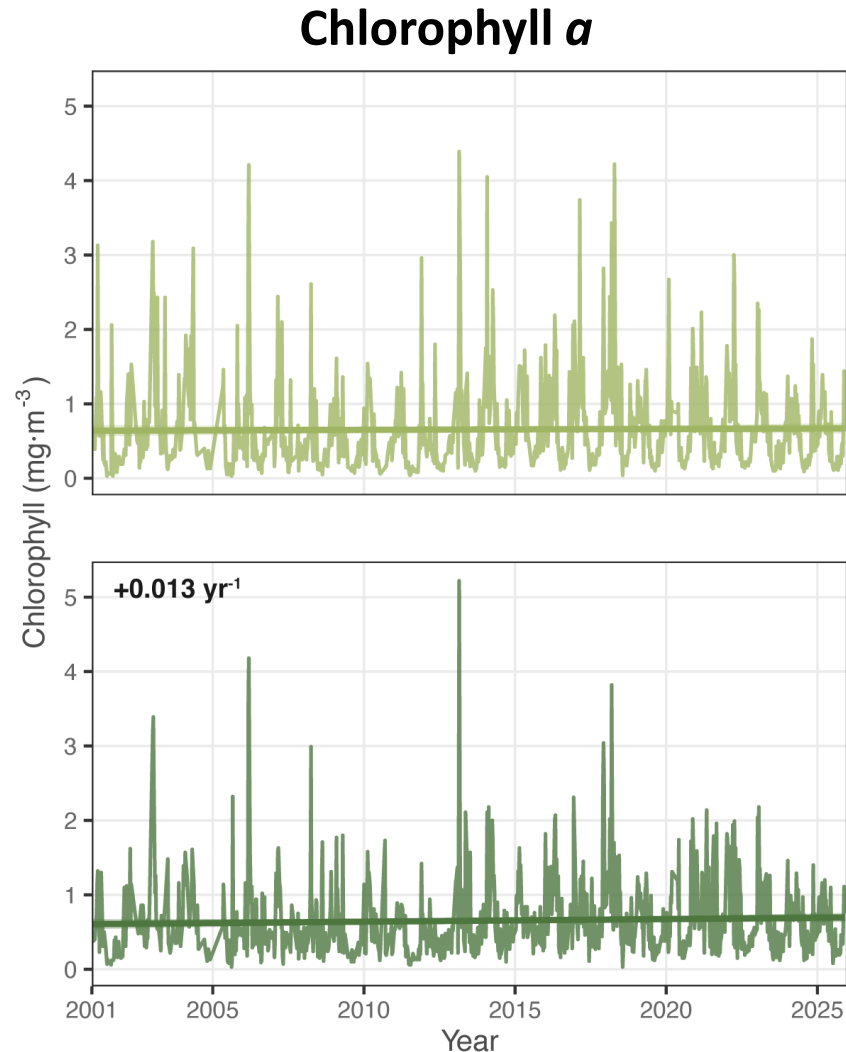
Banyuls Microbial Observatory



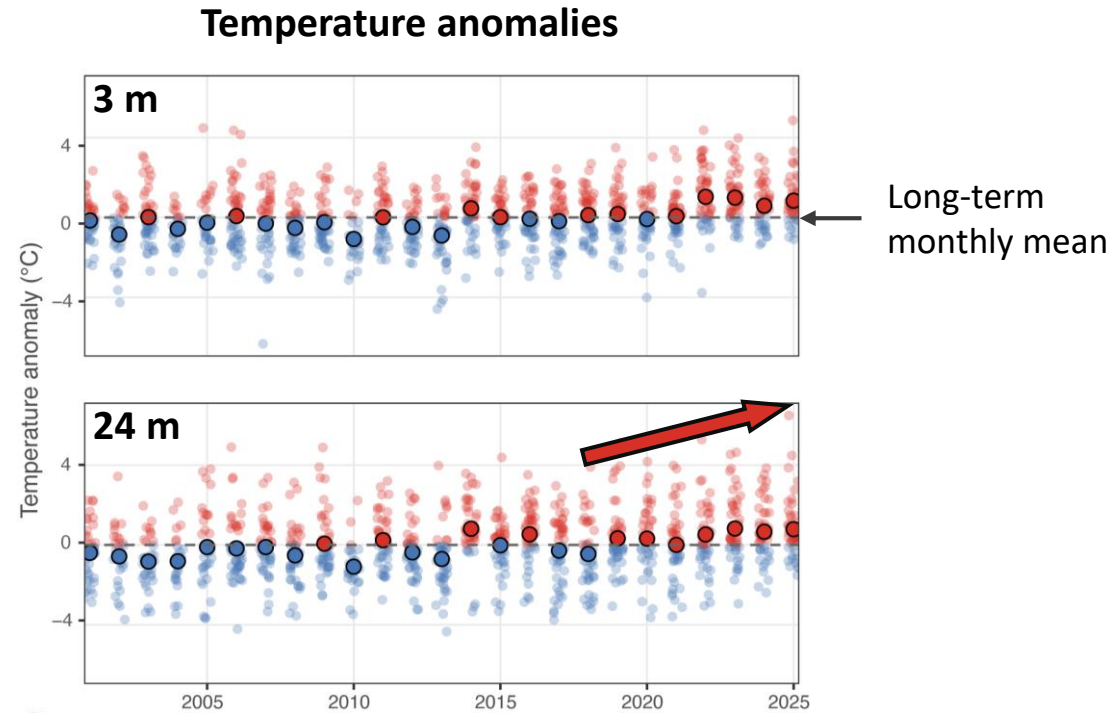
1 How has the coastal environment at the Banyuls Bay changed over the last 25 years?

Over the last **25 years**, we detected an **increase in temperature** at 3 and 24 m, and an **increase in chlorophyll *a*** at 24 m

(seasonal Kendall slope estimator)



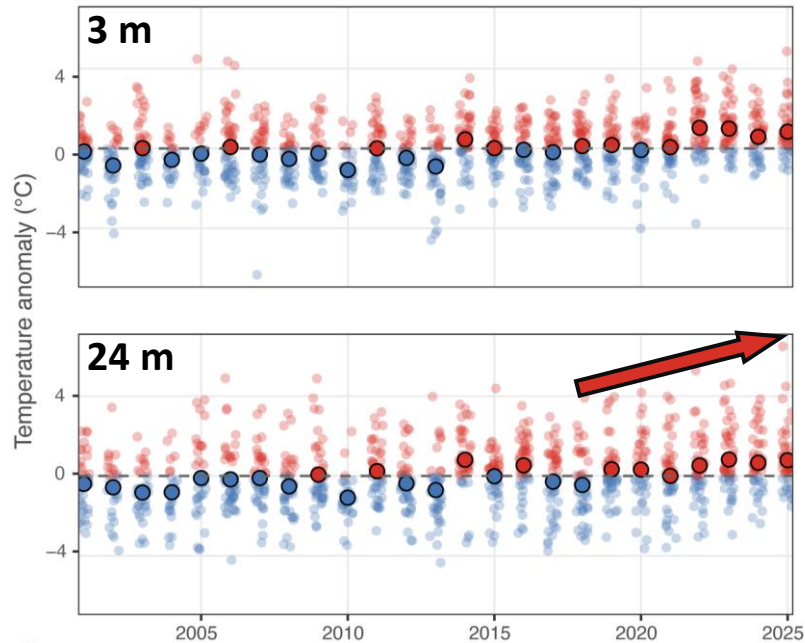
1 How has the coastal environment at the Banyuls Bay changed over the last 25 years?



At 24 m, temperature anomalies have become **positive for the last seven years**. Also, the anomalies at this depth were both **more frequent and of higher intensity**.

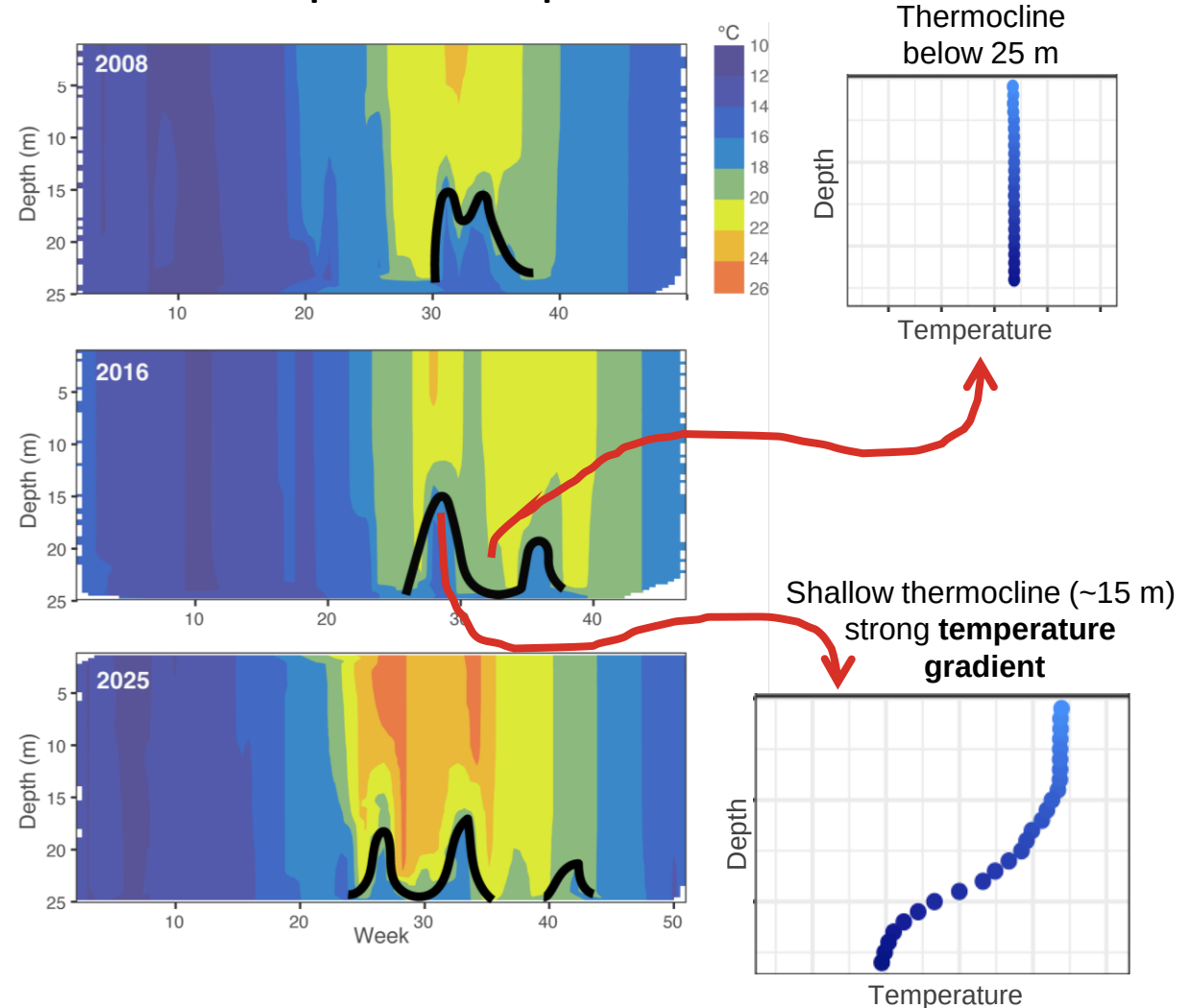
1 How has the coastal environment at the Banyuls Bay changed over the last 25 years?

Temperature anomalies

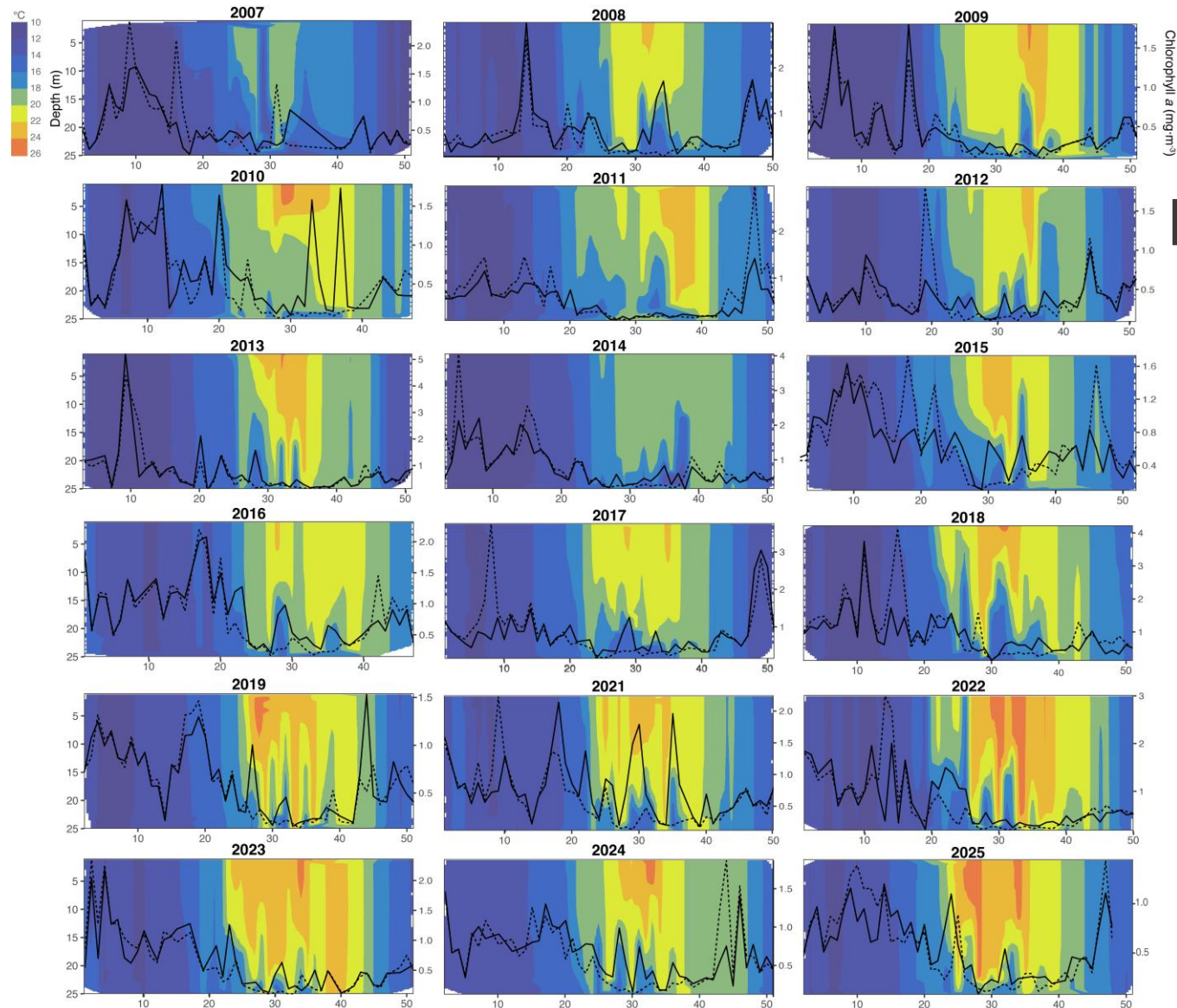


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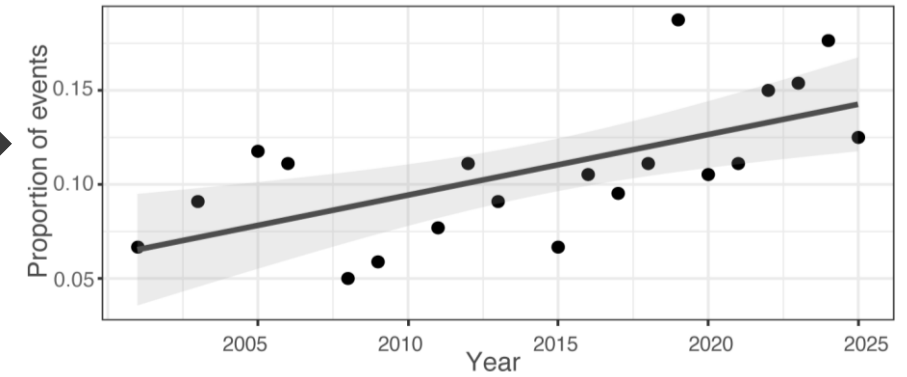
Annual vertical profile of temperature



1 How has the coastal environment at the Banyuls Bay changed over the last 25 years?



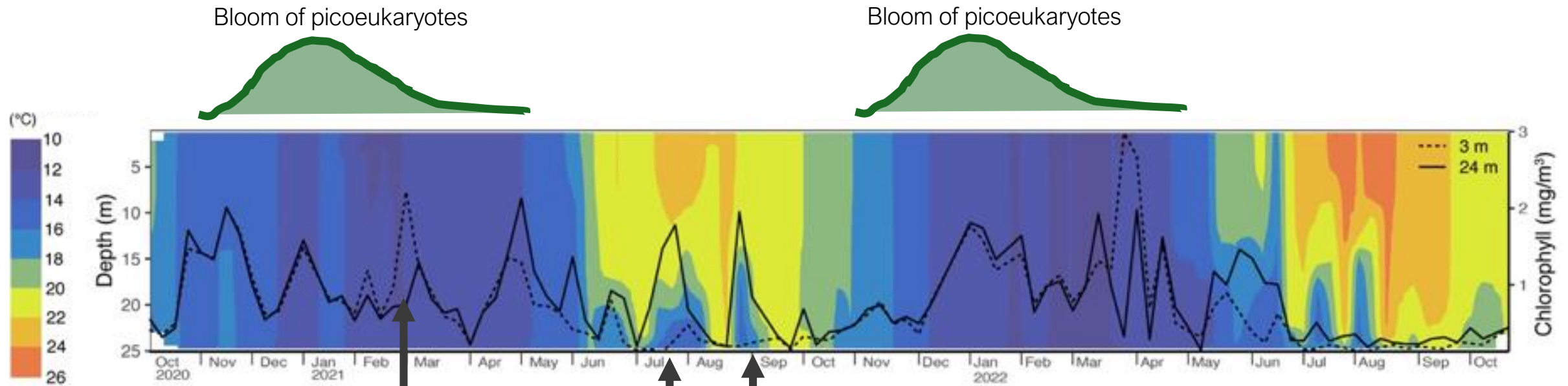
Thermocline vertical oscillations



When the thermocline is shallow, deep water at SOLA have

- ↑ Chlorophyll *a*
- ↑ Nitrite & Nitrate
- ↑ Phosphate
- ↑ Salinity
- ↑ Oxygen

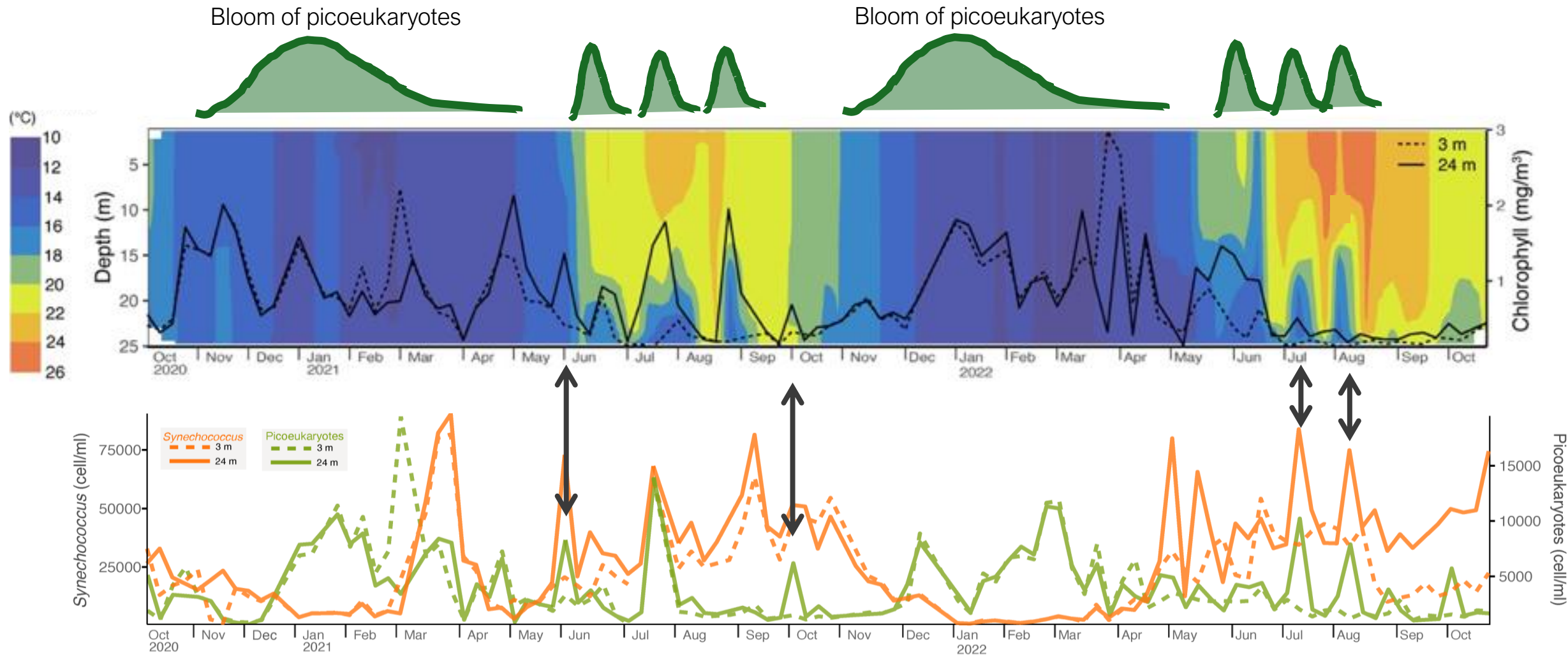
How do changes in the thermal structure of the water column generate environmental variability?



High winter **chlorophyll a**
at all depths driven by
picoeukaryotic blooms

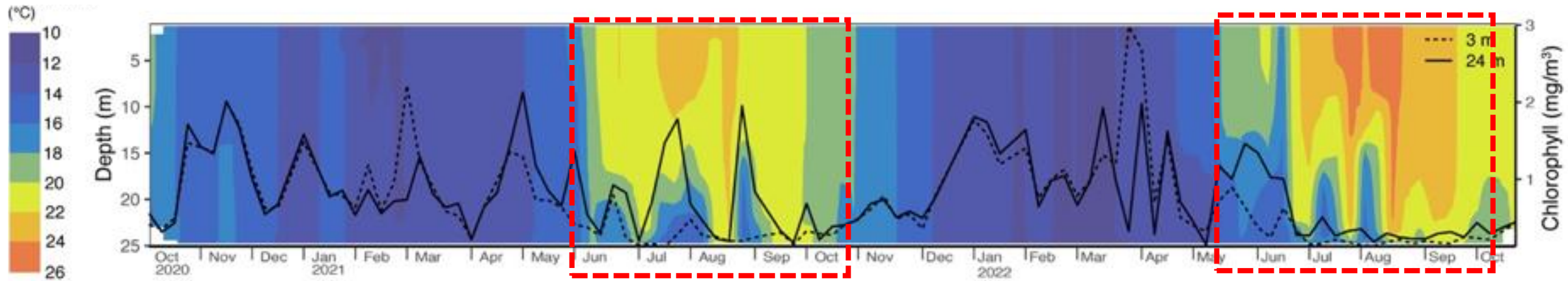
Chlorophyll concentrations
are elevated at 24 m when the
thermocline is shallow

How do changes in the thermal structure of the water column generate environmental variability?

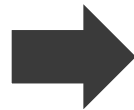
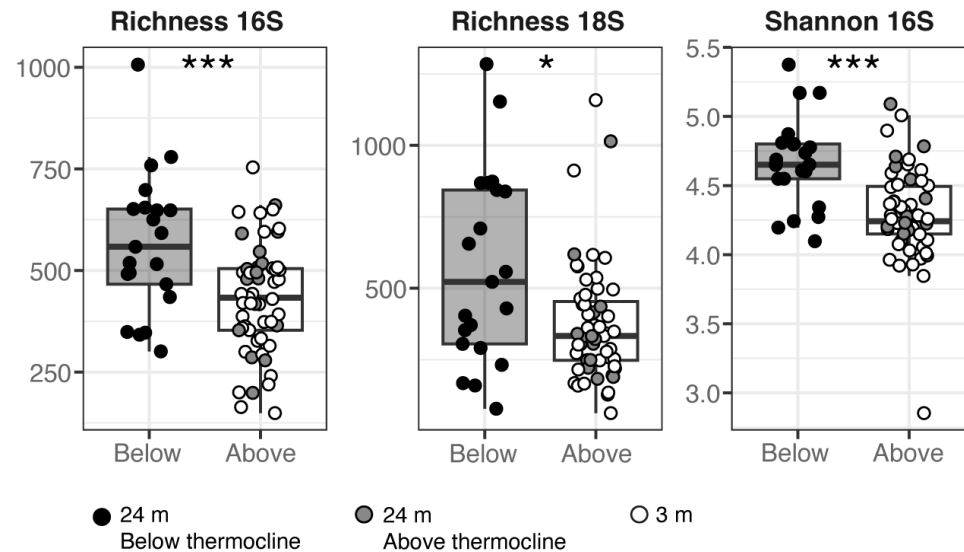


Vertical oscillations of the thermocline promote blooms of phytoplankton at the near bottom of SOLA during spring and summer

How do changes in the thermal structure of the water column generate environmental variability?

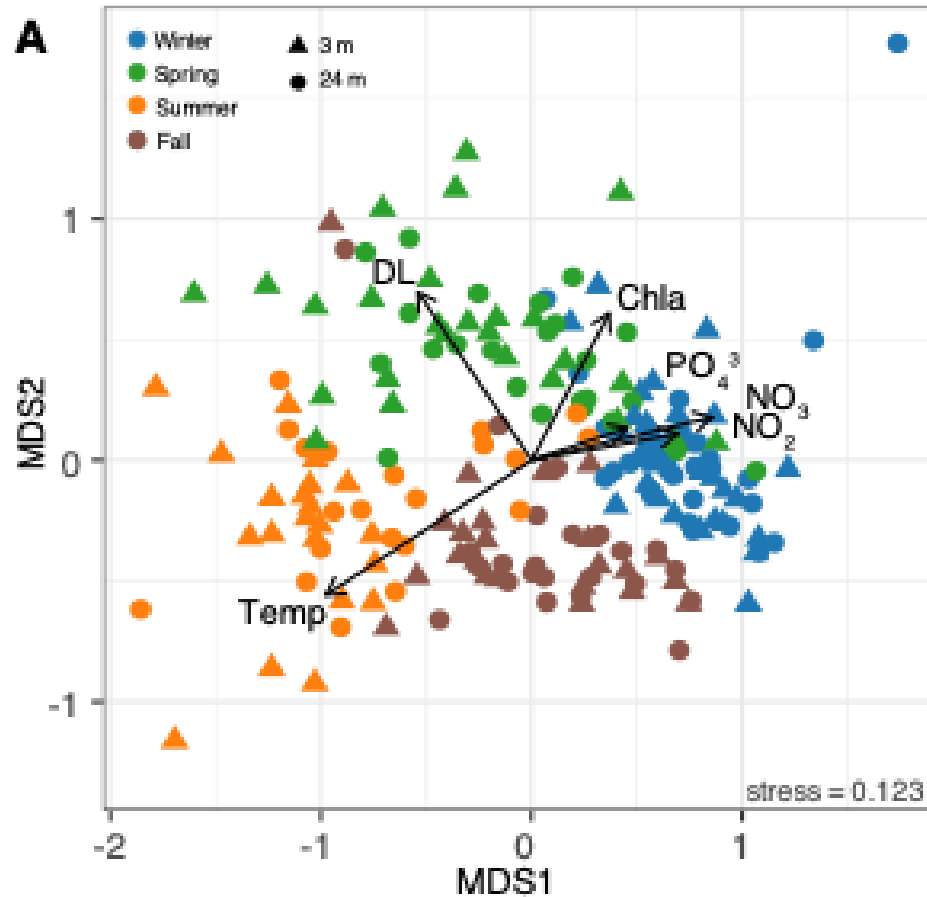


↑ Chlorophyll *a*
 ↑ Nitrite & Nitrate
 ↑ Phosphate
 ↑ Salinity
 ↑ Oxygen



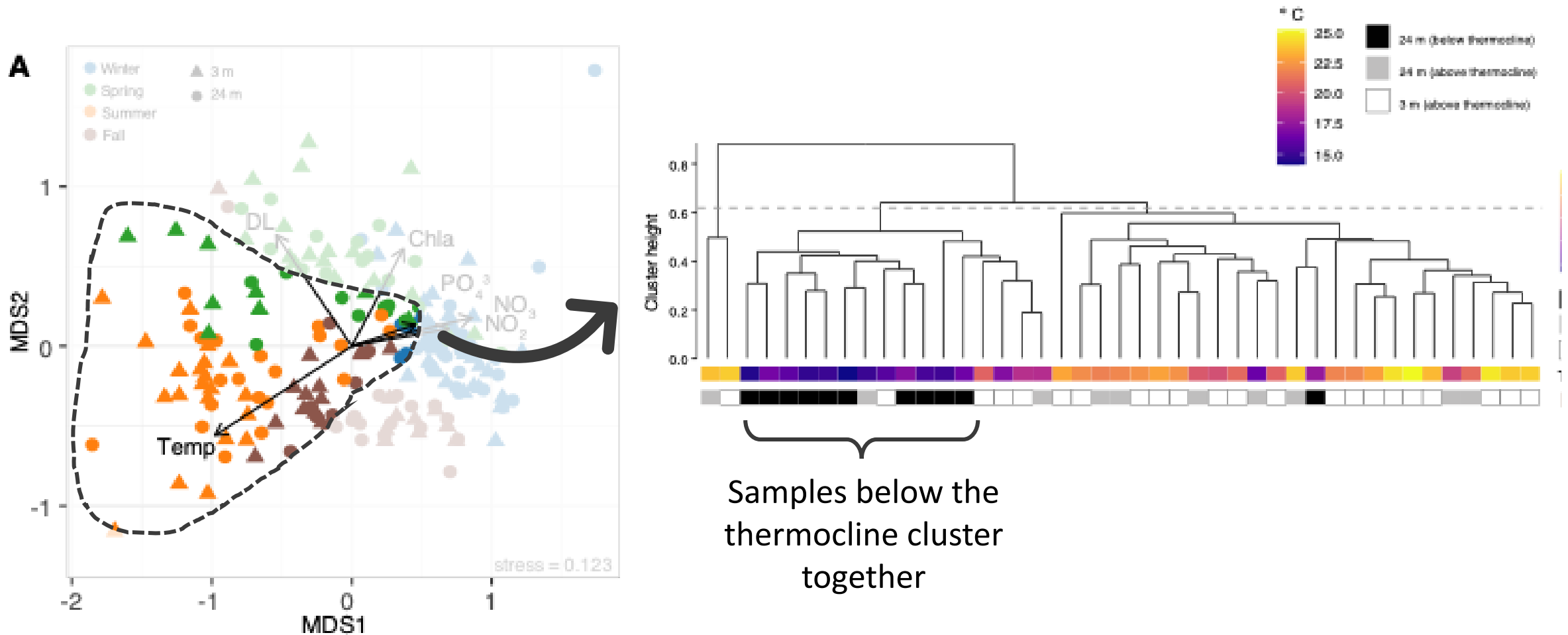
Thermocline oscillations
 drive **environmental**
variability across the water
 column that and promote
changes in the diversity of
 microbial communities at
 SOLA

What are the consequences of this environmental variability for phytoplankton and microbial communities?

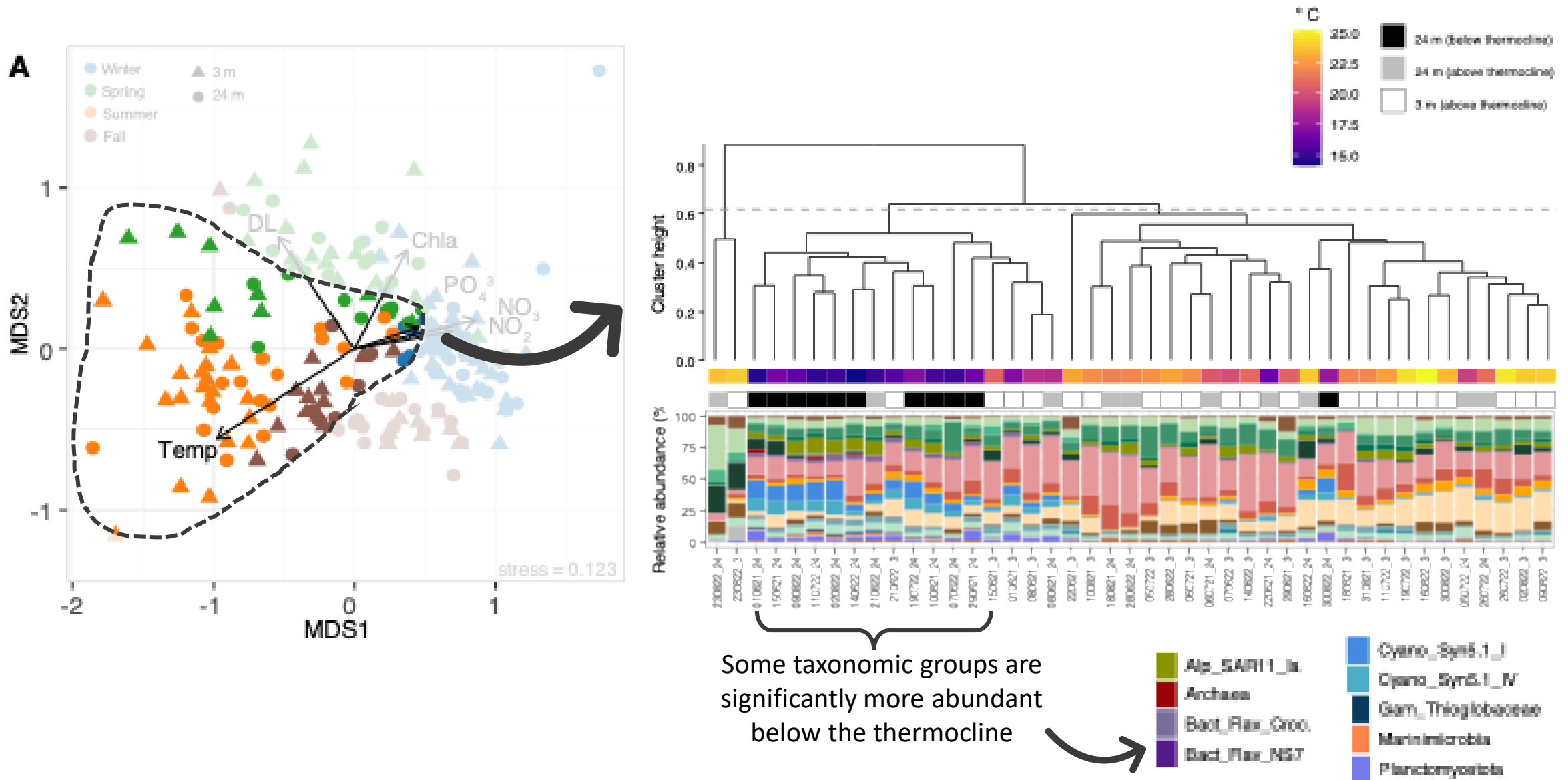


Ordination based on Bray-Curtis
dissimilarity for the 16S

What are the consequences of this environmental variability for phytoplankton and microbial communities?

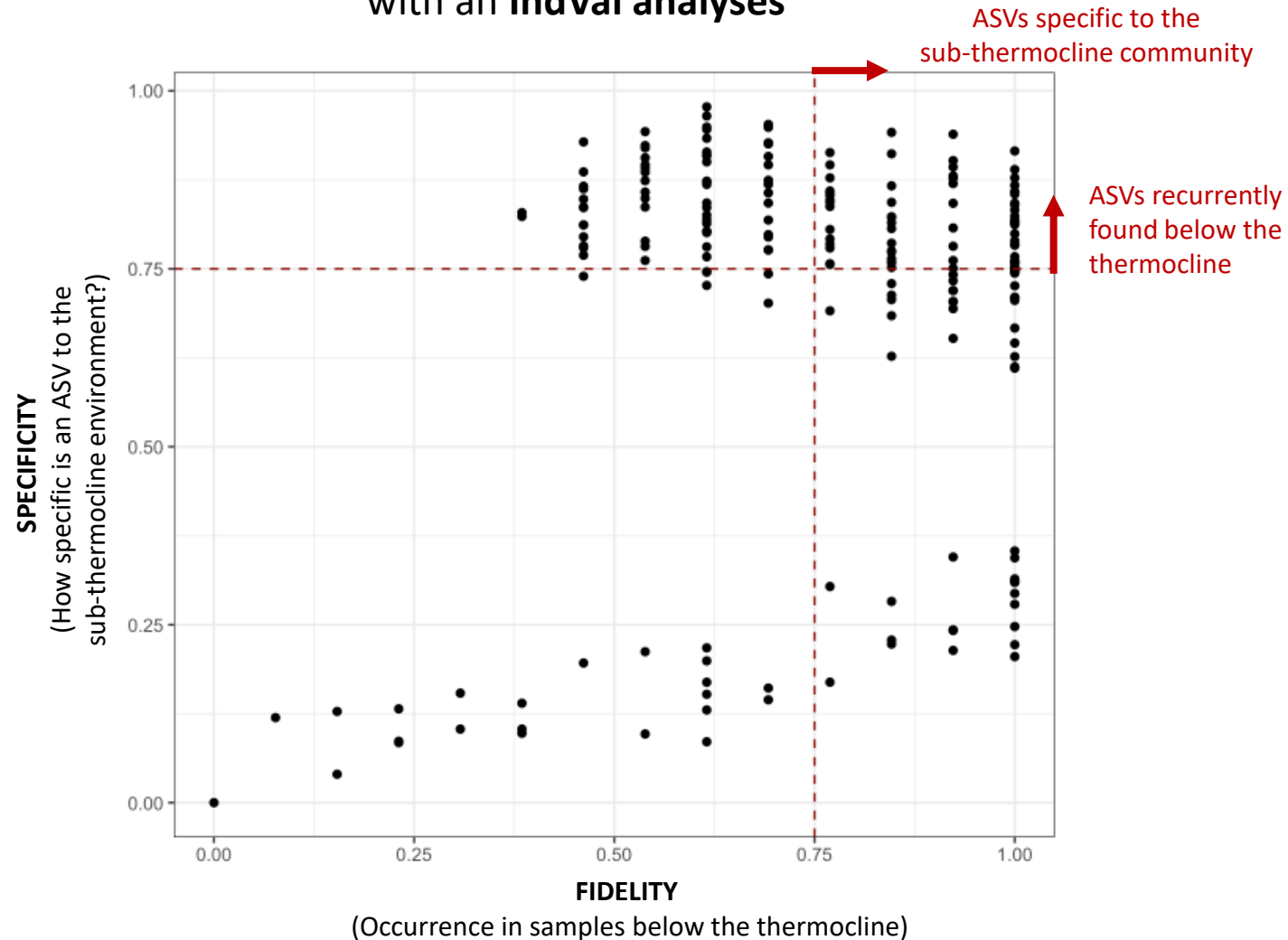


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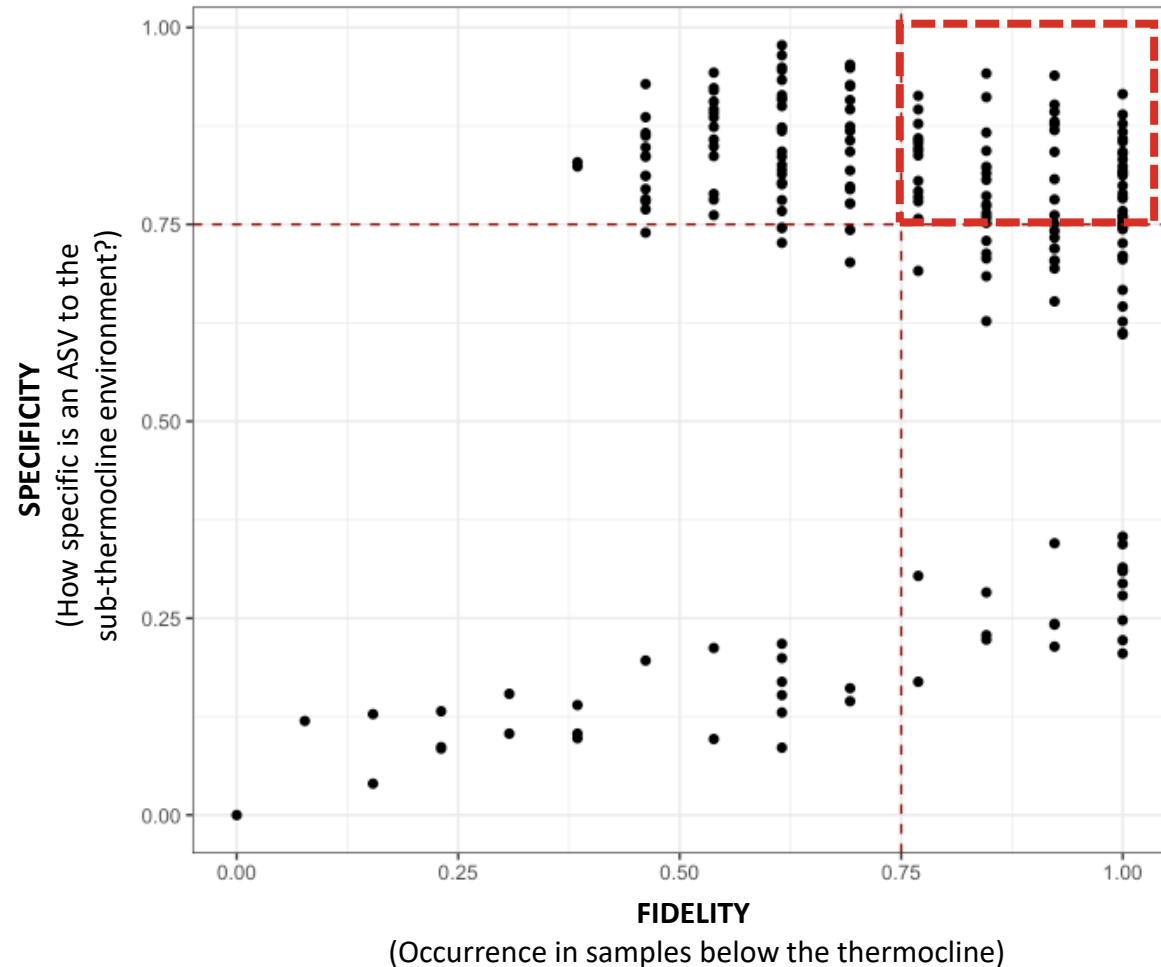
What are the consequences of this environmental variability for phytoplankton and microbial communities?

We identified ASVs that were **specific and recurrent** in samples **below the thermocline** with an **IndVal** analyses

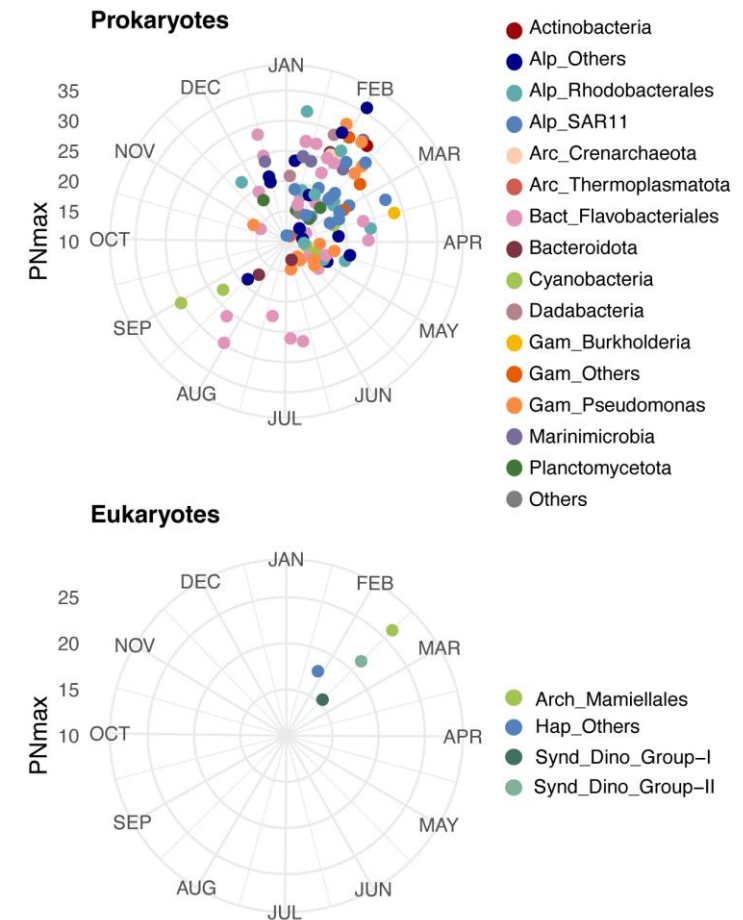


What are the consequences of this environmental variability for phytoplankton and microbial communities?

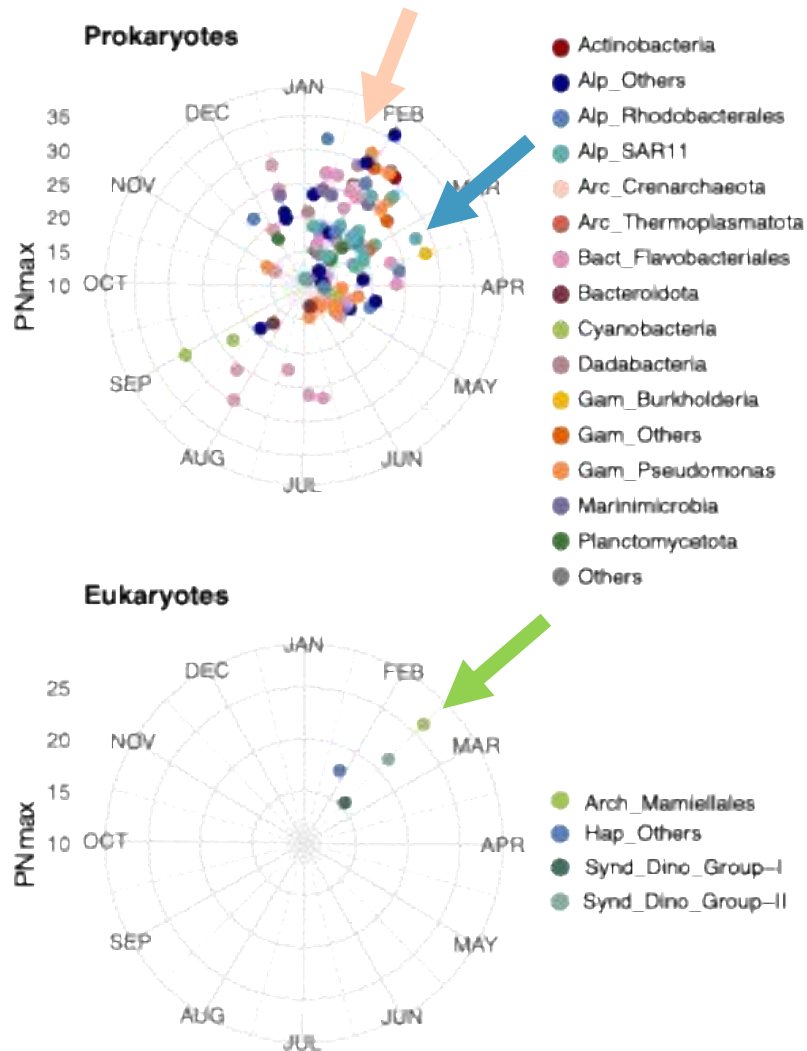
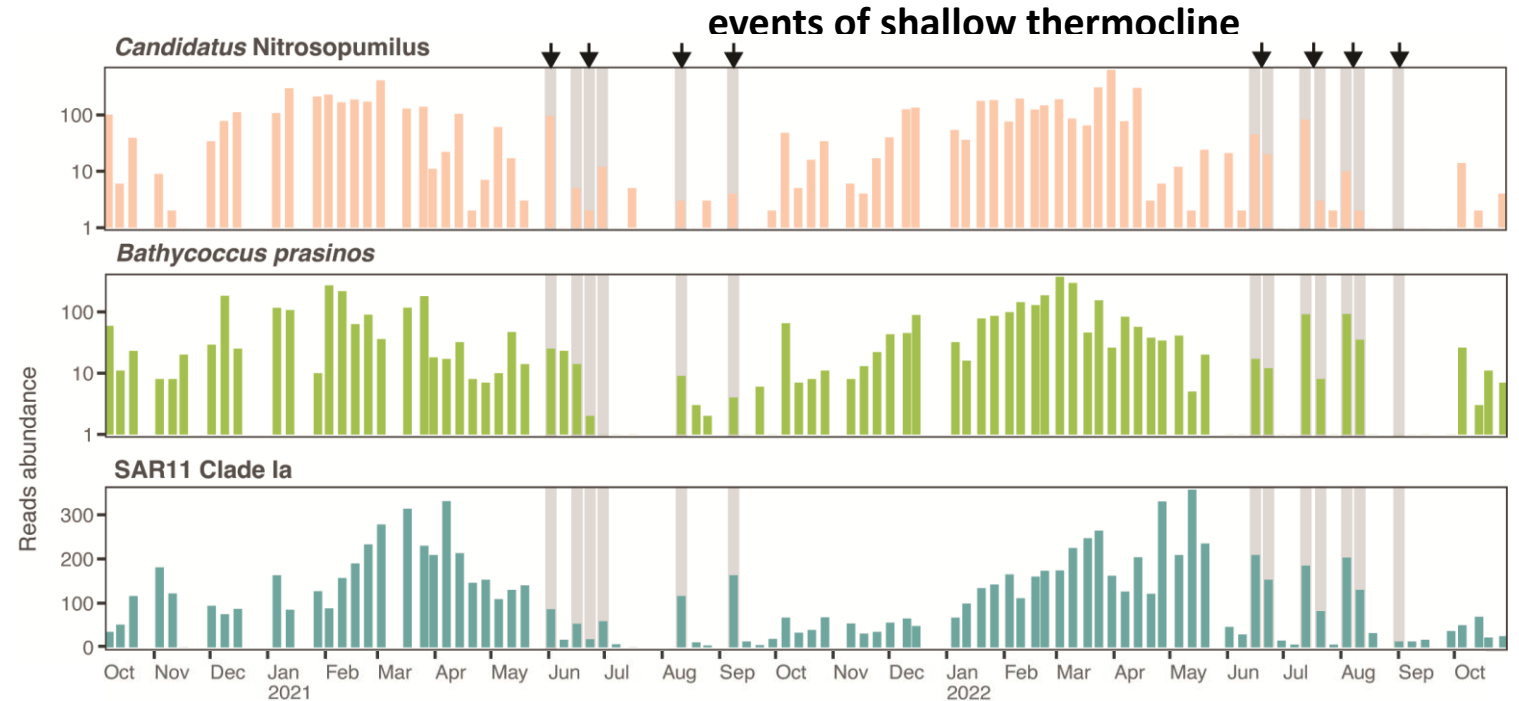
We identified ASVs that were **specific and recurrent** in samples **below the thermocline** with an **IndVal analyses**



And analysed their abundance patterns and seasonality using **Lomb-Scargle Periodogram**:



What are the consequences of this environmental variability for phytoplankton and microbial communities?



The main components of the sub-thermocline community are species typical from winter and spring

Where does the sub-thermocline community come from?

H1: DISPERSAL

Present below the thermocline offshore



Appear at SOLA through dispersal

H2: LOCAL SELECTION

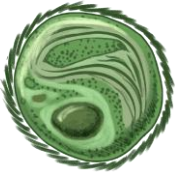
Rare/absent below the thermocline offshore



Increase at SOLA under favorable conditions

What are the consequences of this environmental variability for phytoplankton and microbial communities?

Where does the sub-thermocline community come from?



H1: DISPERSAL

Present below the thermocline offshore



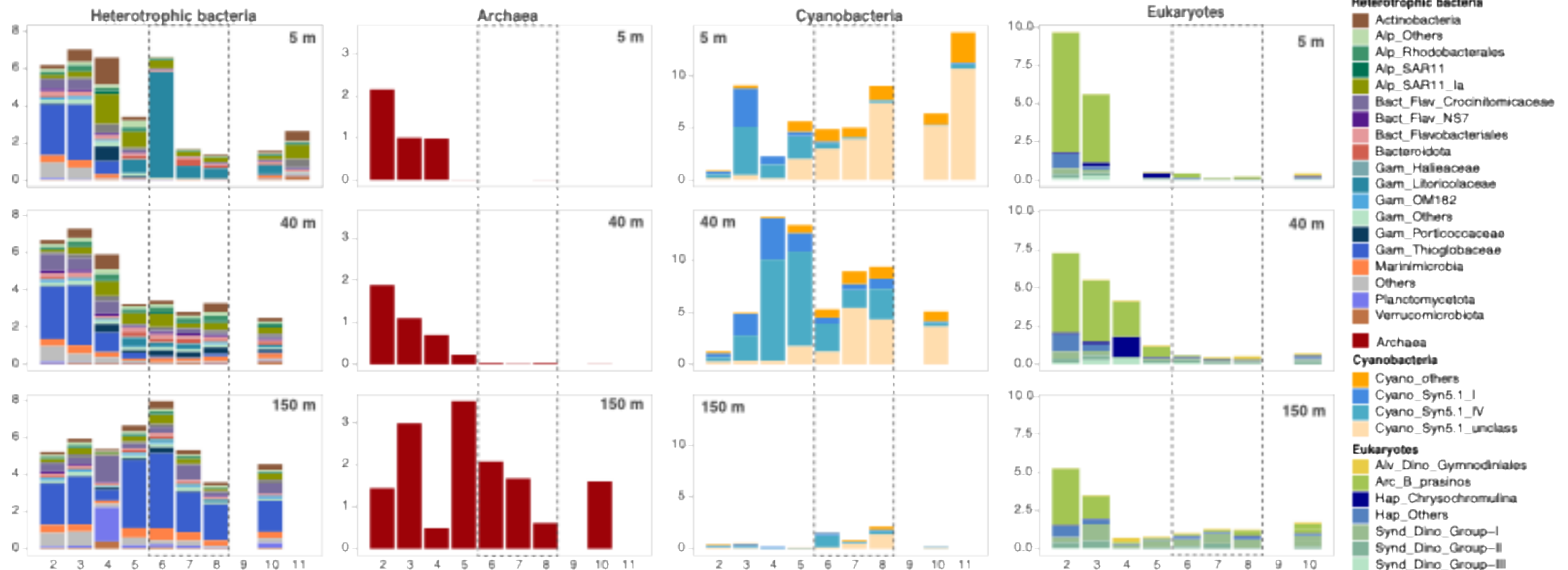
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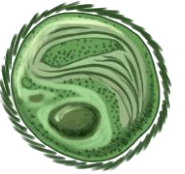
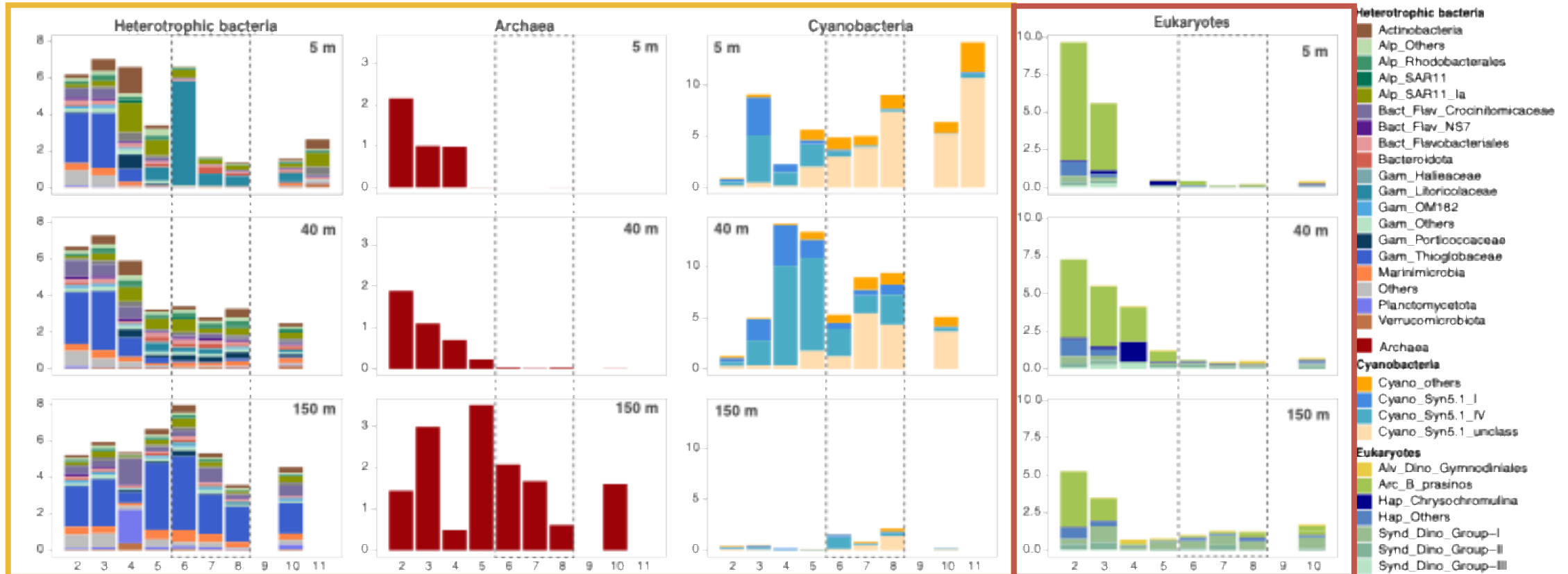
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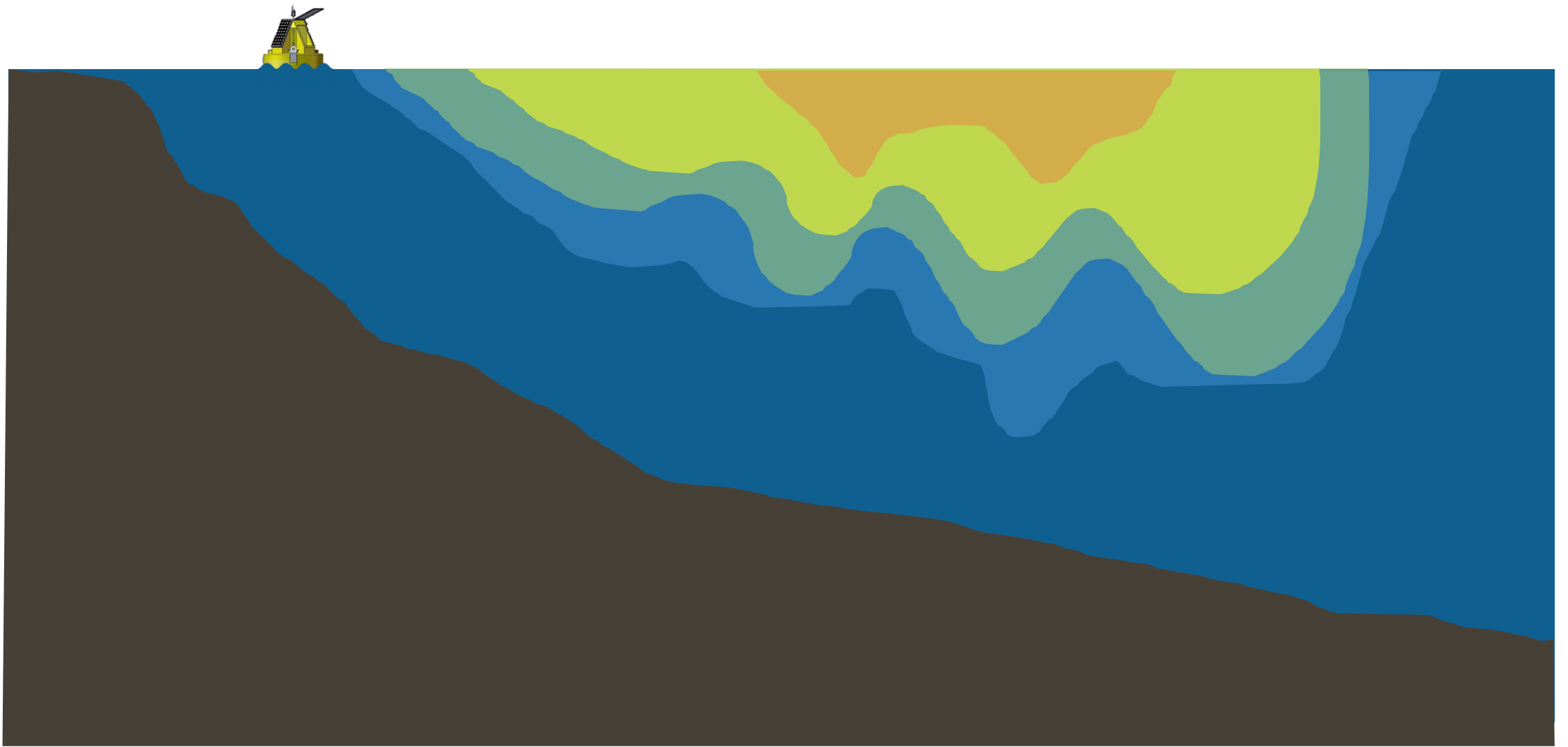
Rare/absent below the thermocline offshore



Increase at SOLA under favorable conditions



Take home messages



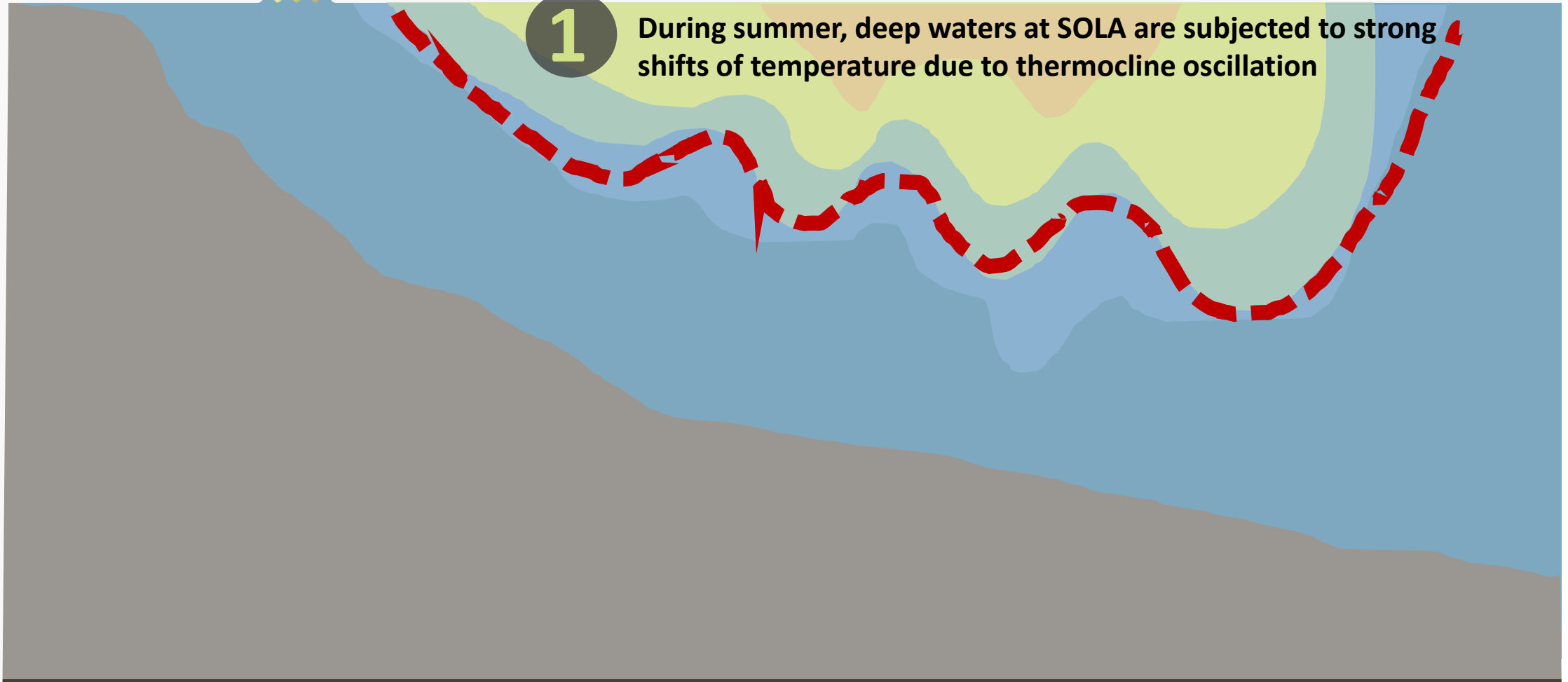
Take home messages

TIME

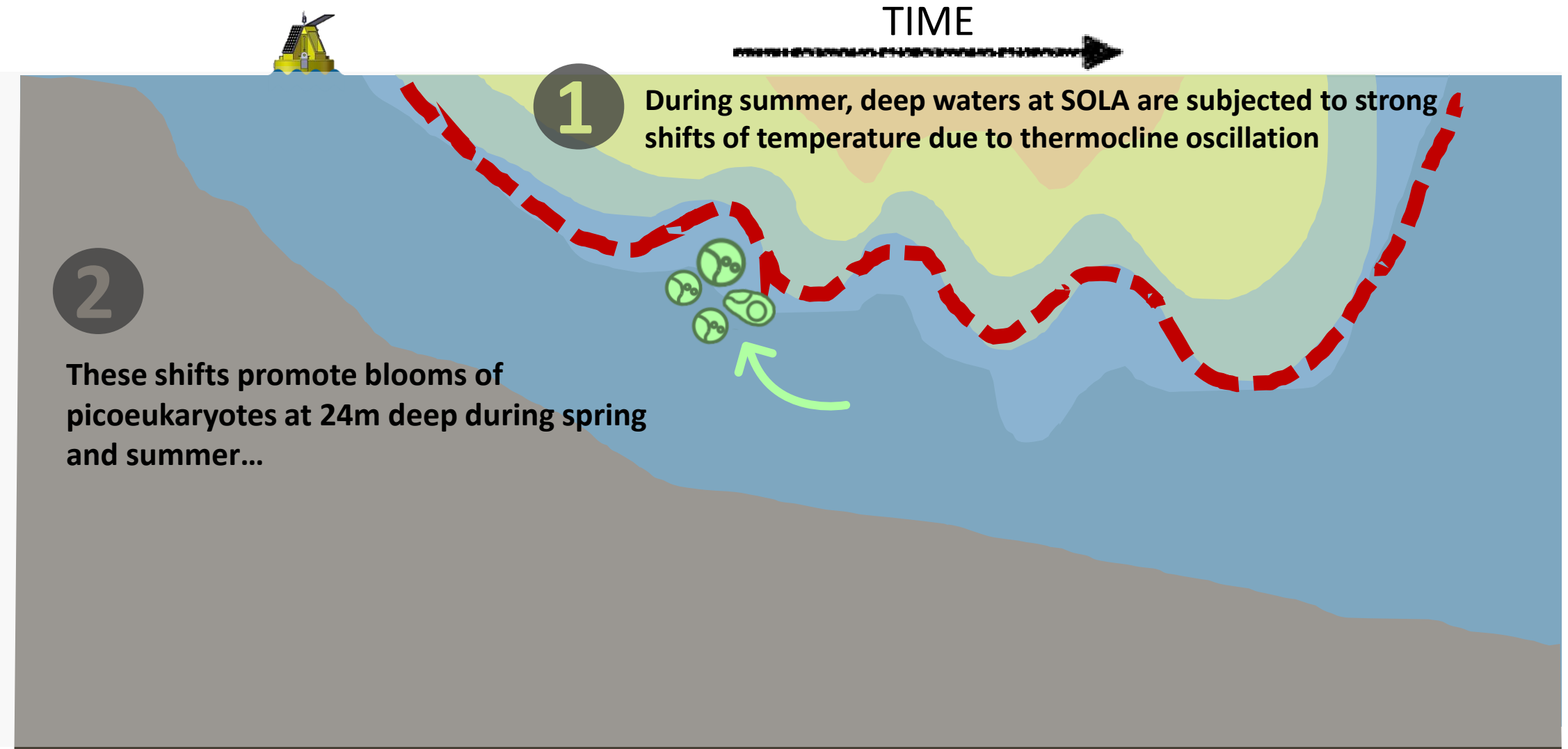


1

During summer, deep waters at SOLA are subjected to strong shifts of temperature due to thermocline oscillation



Take home messages



Take home messages

TIME →

1

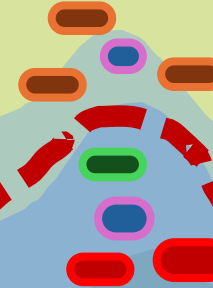
During summer, deep waters at SOLA are subjected to strong shifts of temperature due to thermocline oscillation

2

These shifts promote blooms of picoeukaryotes at 24m deep during spring and summer...

3

...and increases the differences between surface and near-bottom communities during spring and summer



Take home messages

TIME →

1

During summer, deep waters at SOLA are subjected to strong shifts of temperature due to thermocline oscillation

2

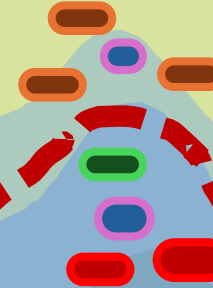
These shifts promote blooms of picoeukaryotes at 24m deep during spring and summer...

3

...and increases the differences between surface and near-bottom communities during spring and summer

4

These processes are recurrent, they appear every year, and they seem to have increase their frequency over time.



Merci!



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