

# Formation of thin layers of phytoplankton in the upwelling region off NW Iberia: biological growth versus physical accumulation

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Universidade de Vigo

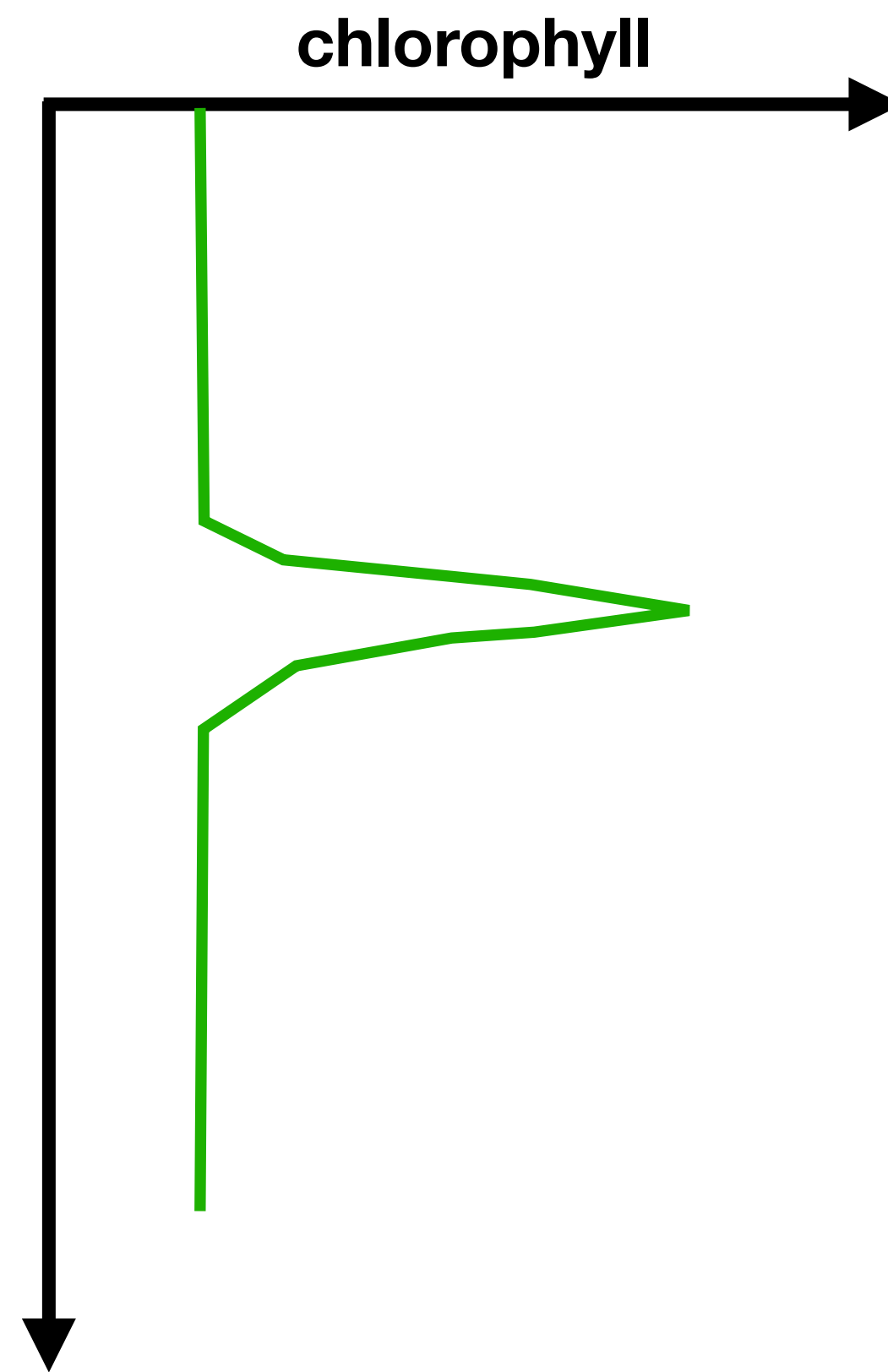
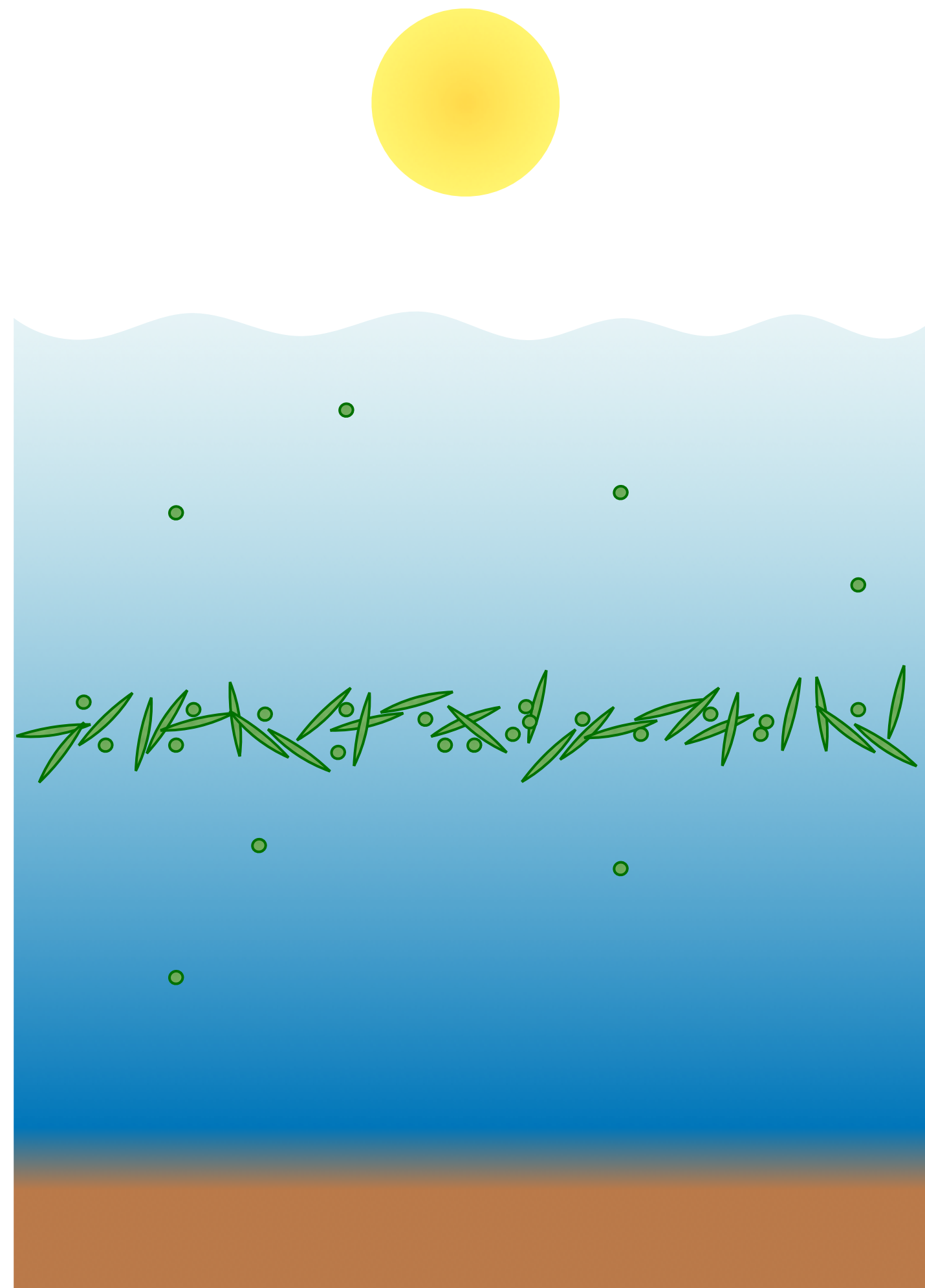
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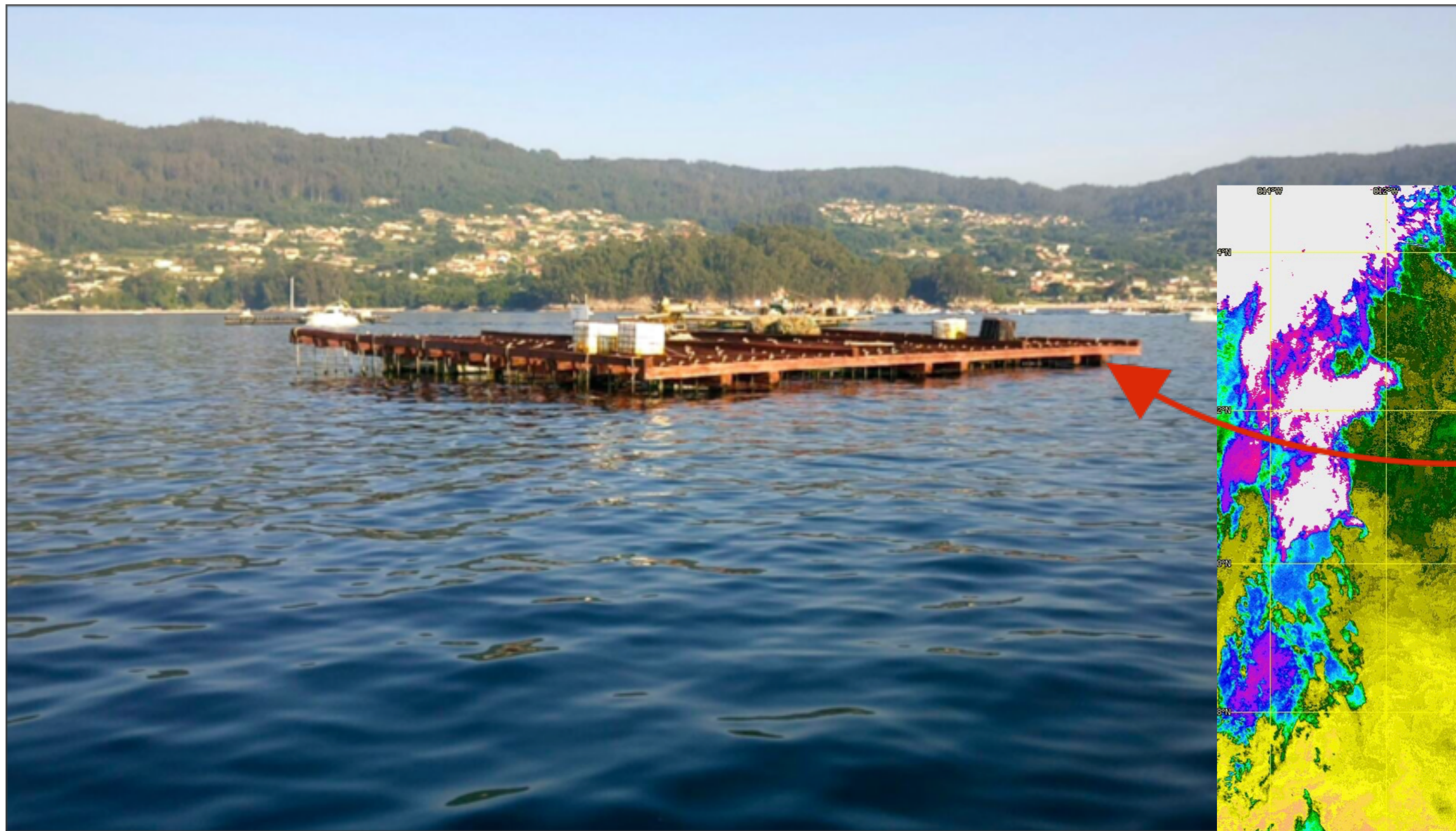
Ocean Sciences Meeting 2020

# What are thin layers of phytoplankton?

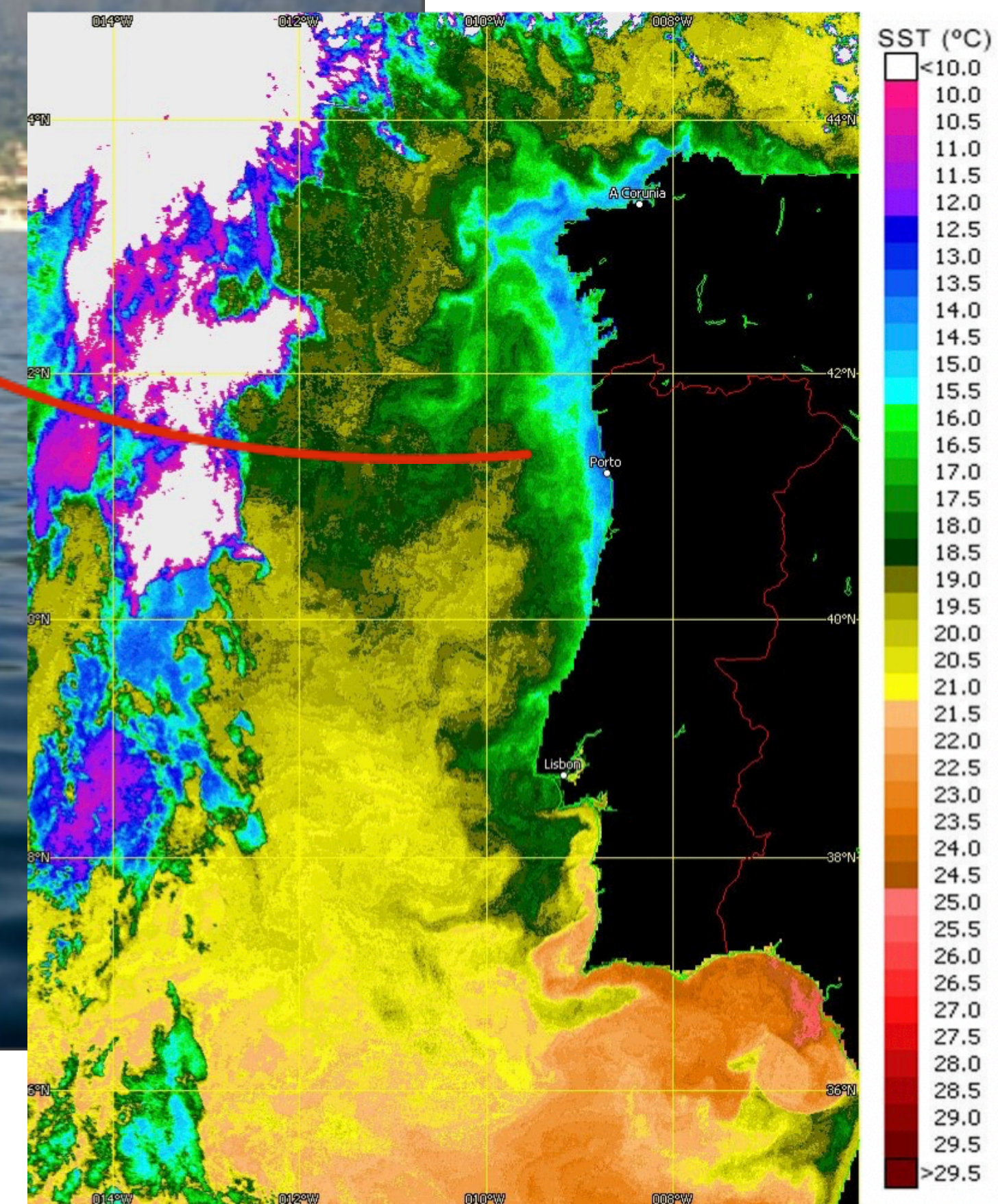


- \* Thickness  $< 3$  m
- \* Intensity  $> 2 \times$  Background
- \* TL can extent horizontally over several km and persist for several days

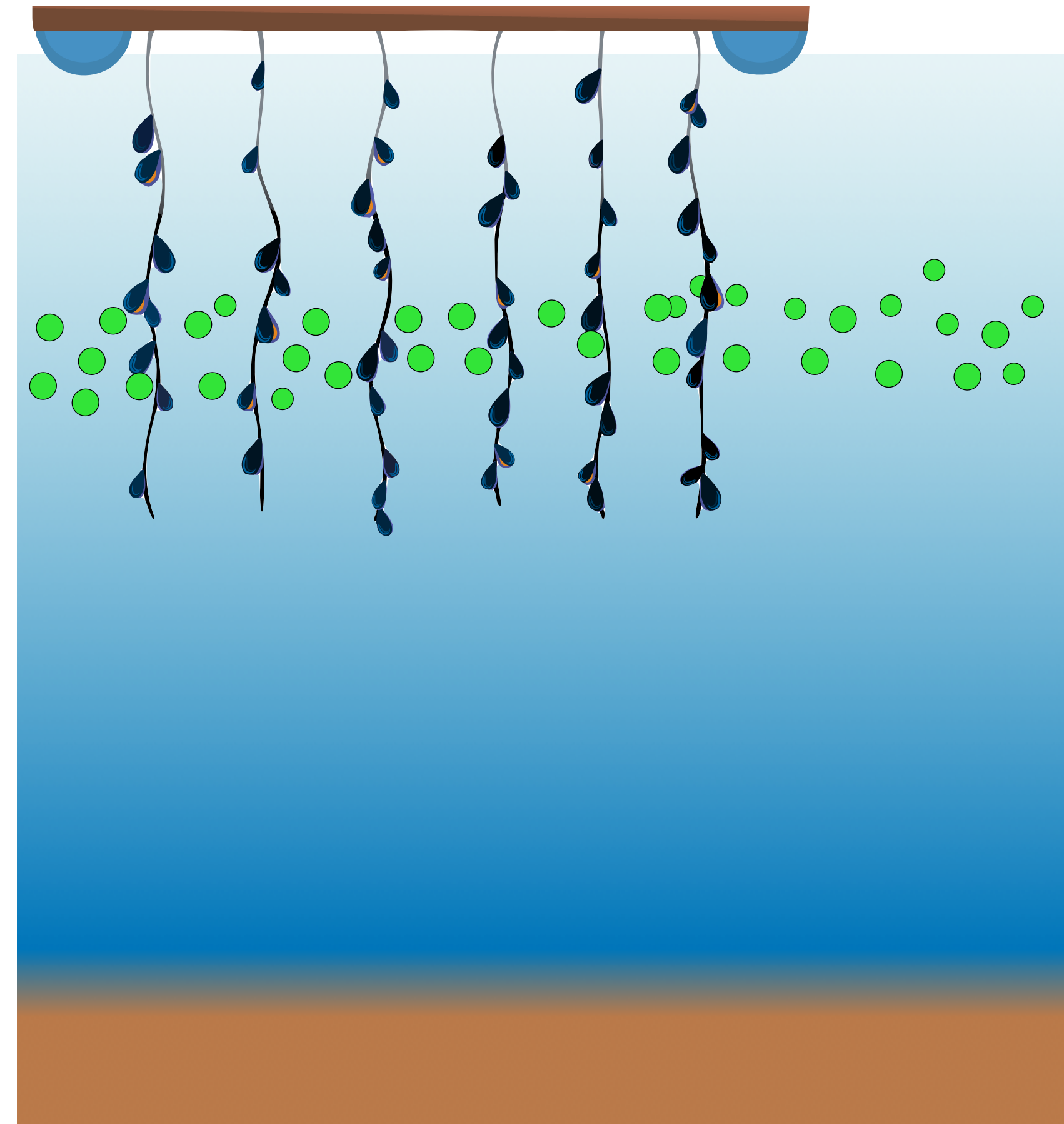
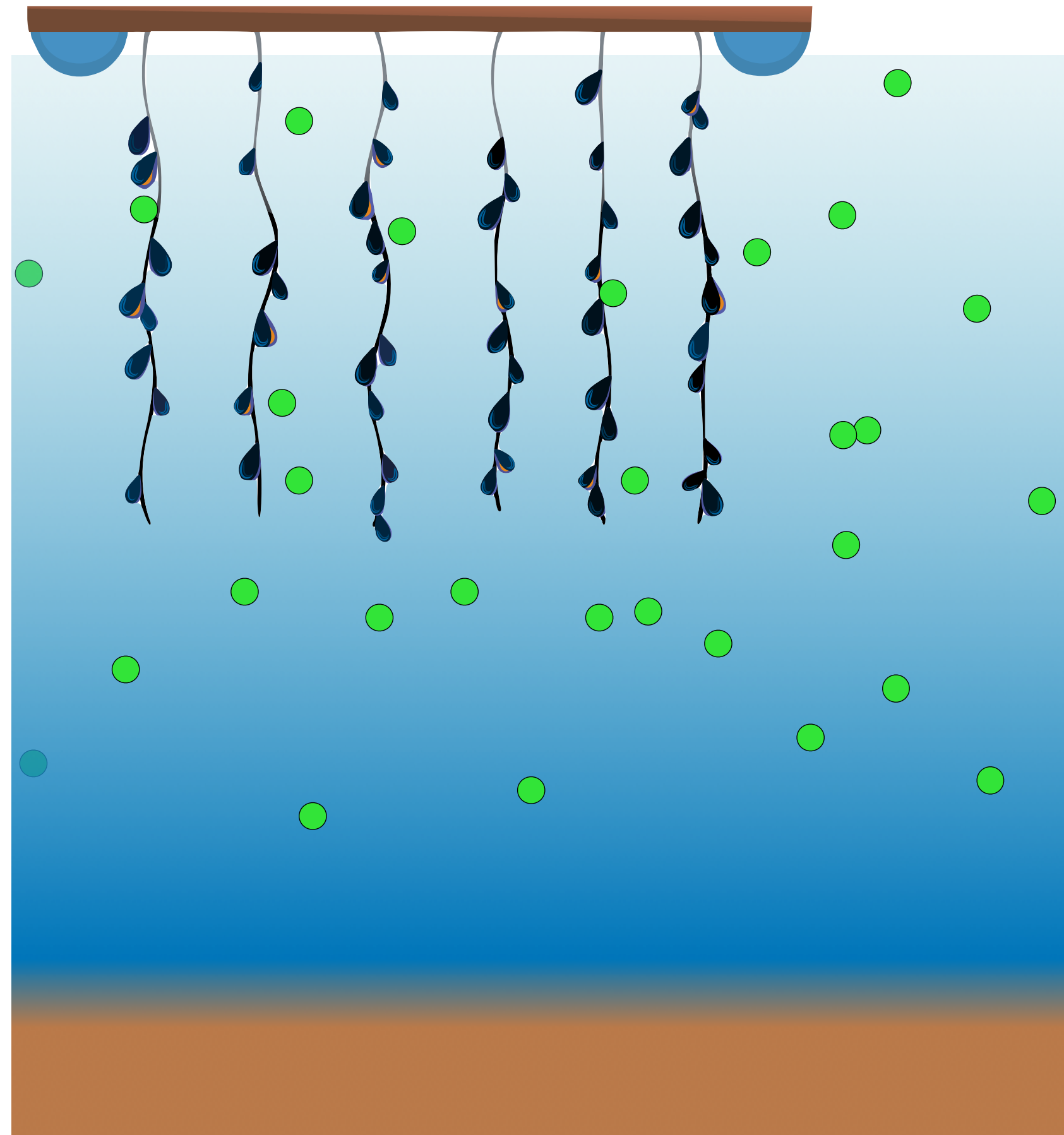
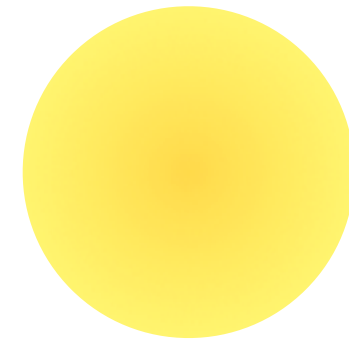
# Motivation



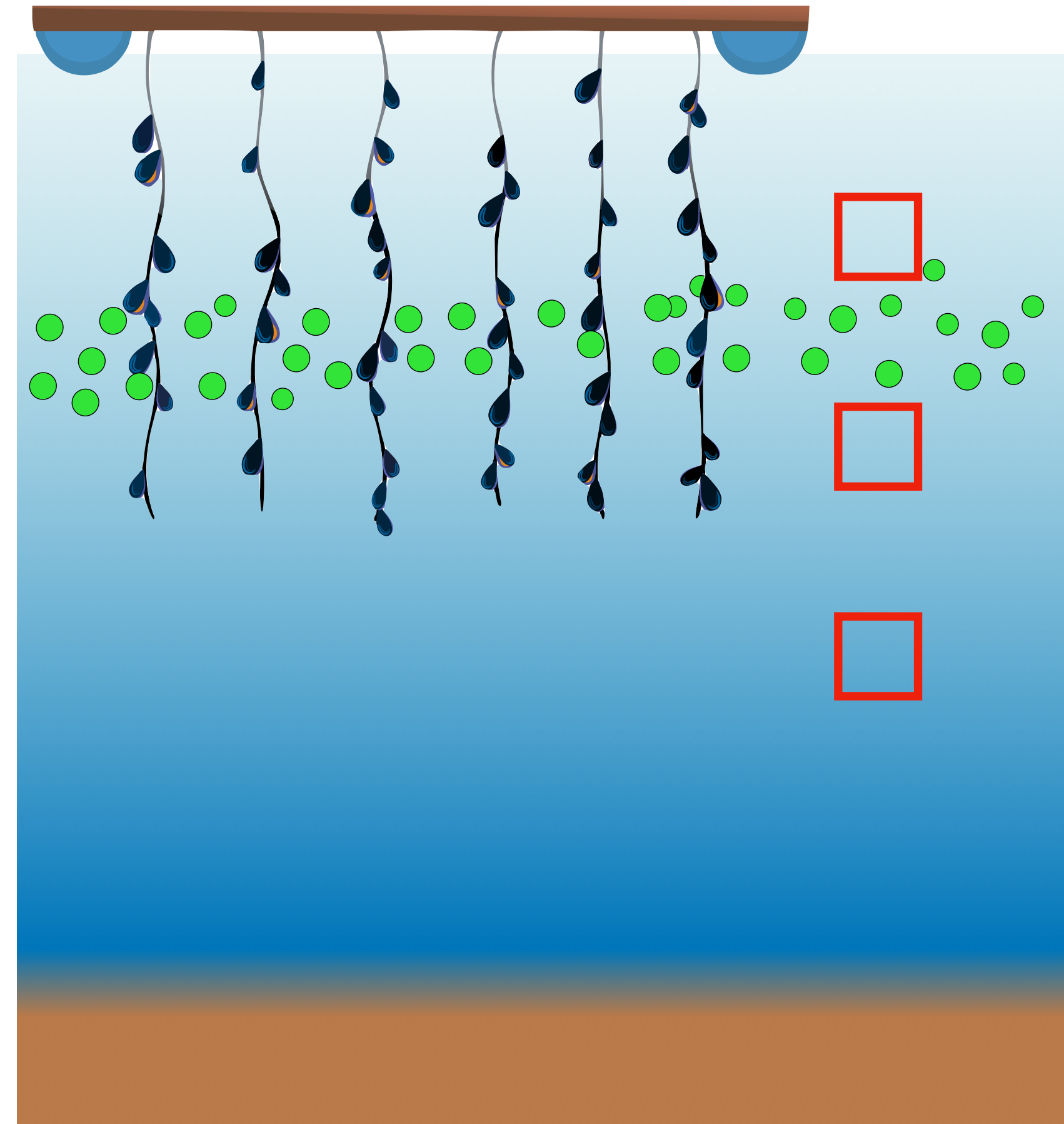
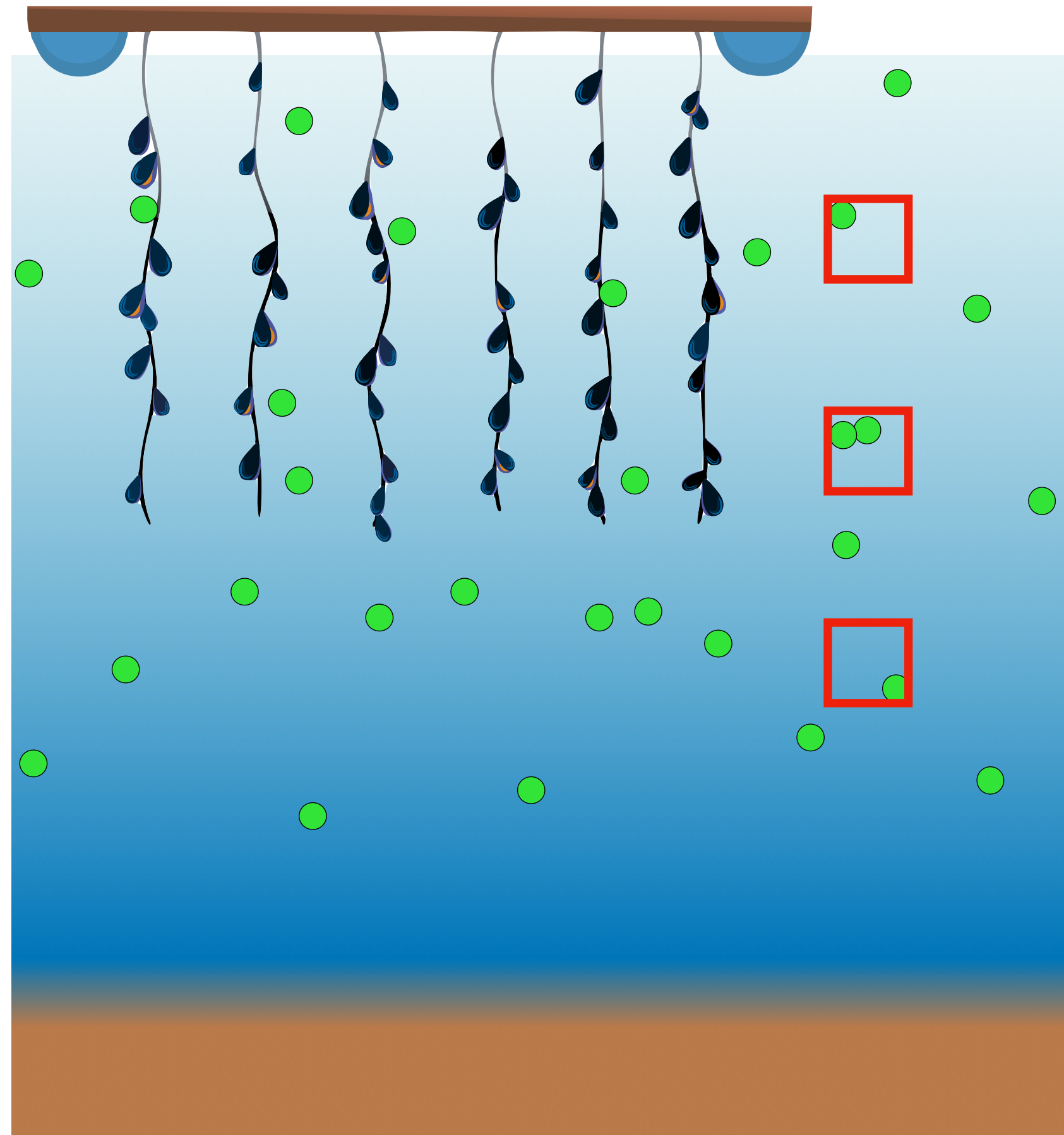
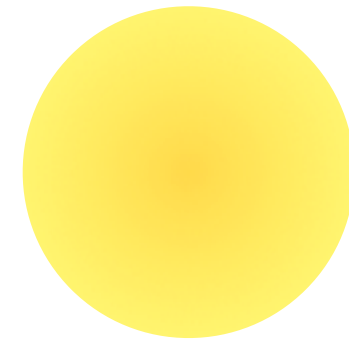
Mussel raft, Ría de Pontevedra



# Motivation



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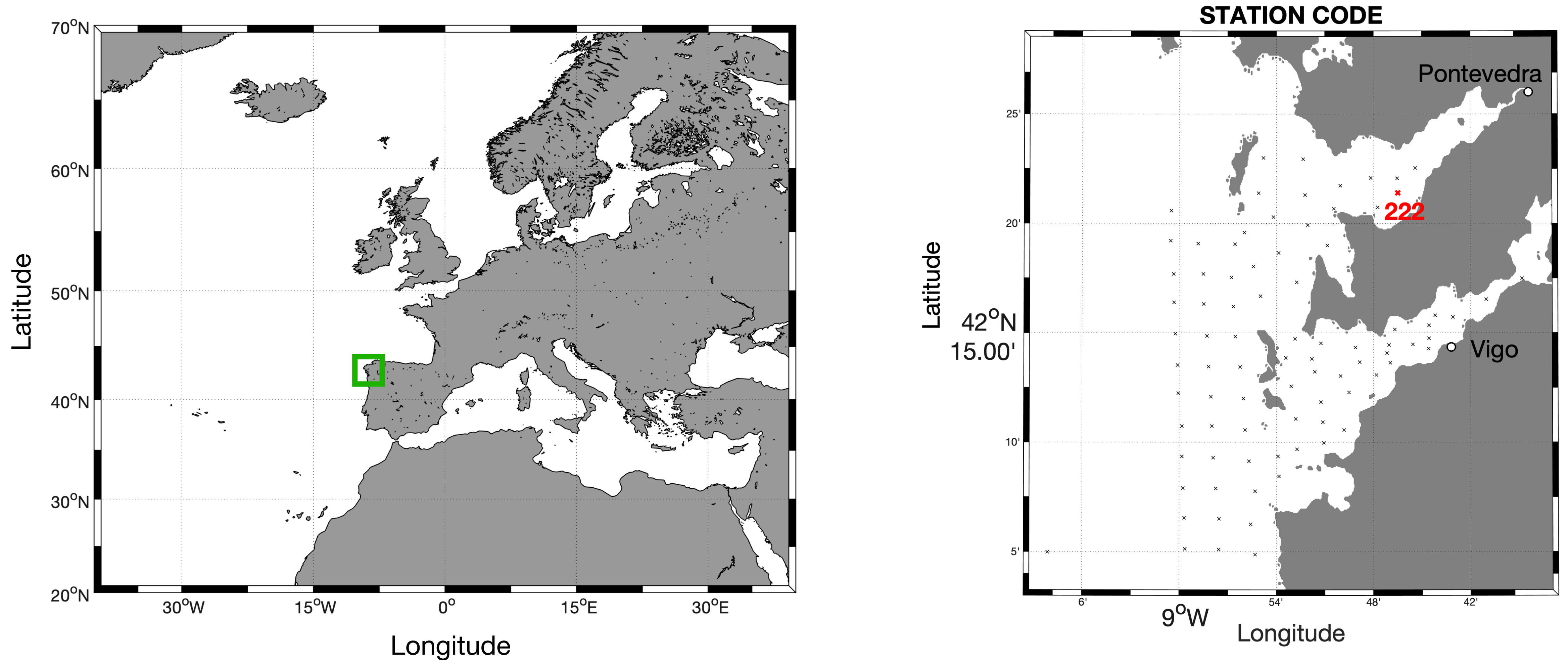


# Questions

- \* What are the **dynamics** of a thin layer of phytoplankton?
- \* What is the **spatial extent**?
- \* What is the contribution of **physical and biological processes** to their formation?

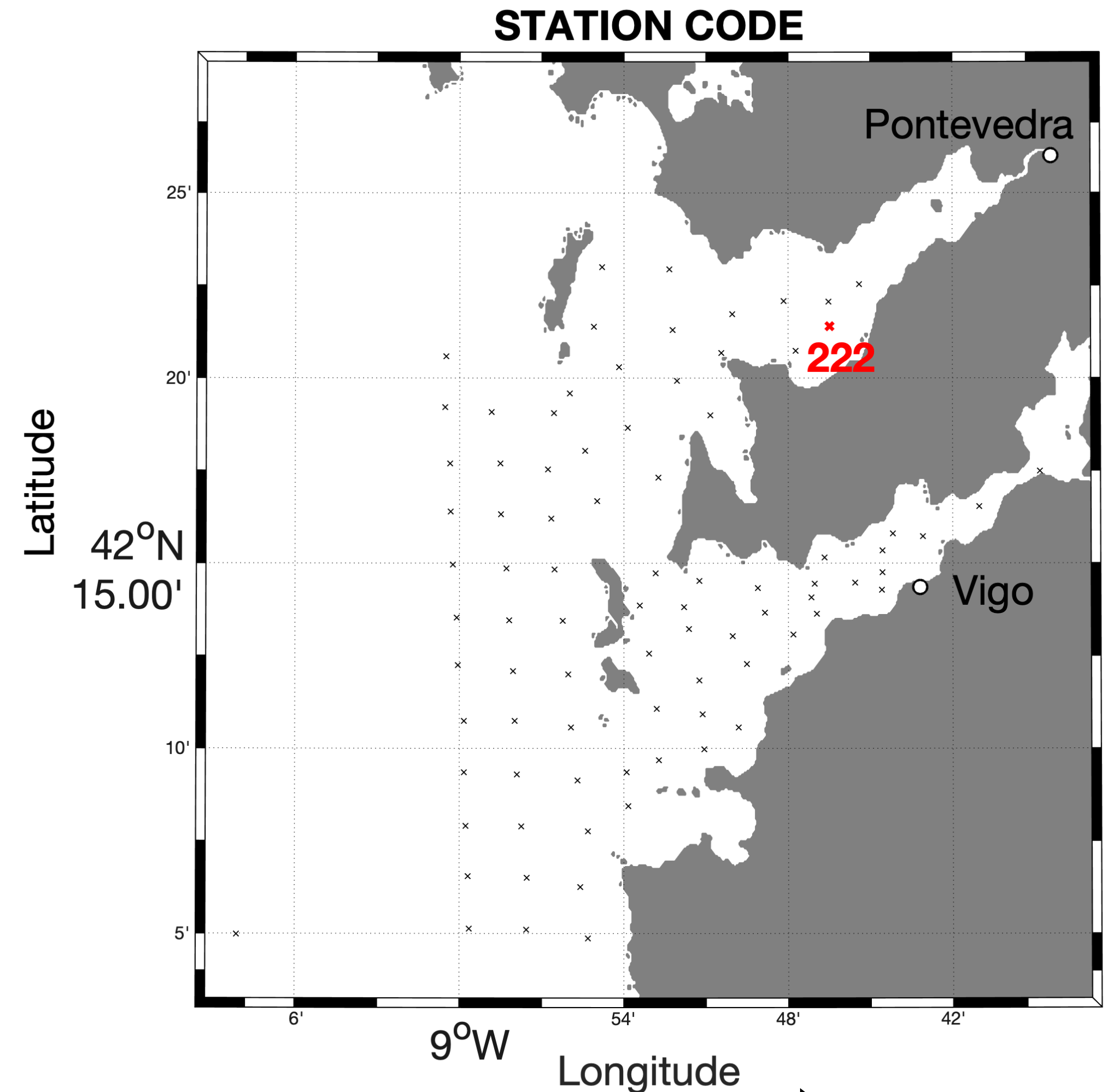
# Research design

REMEDIOS-TLP cruise, July 2018



# Research design

- \* 4 SURVEY samplings through the 84 stations
  - \* 1 CTD cast per station (total = 225 profiles)
- \* 3 INTENSIVE samplings at station **222**
  - \* 5 high resolution CTD profiles every 30 minutes (total = 1674 profiles)
  - \* 1 sampling with Niskin bottles at different depths every 6 hours





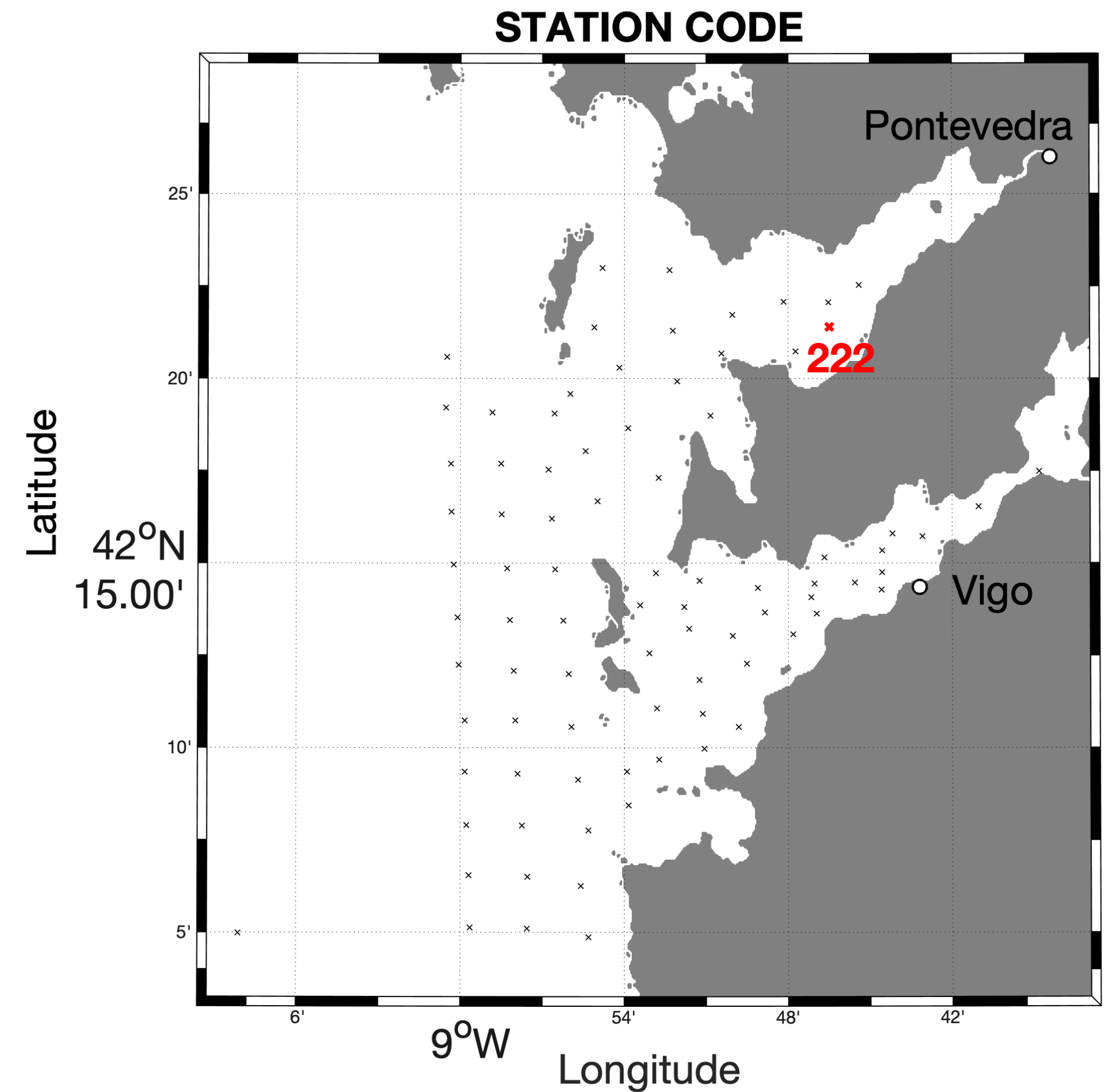
# Variables

## INTENSIVE SAMPLINGS (222)

- High resolution CTD
  - \* **Temperature**
  - \* **Chlorophyll *a* (from fluorescence)**
- Niskin bottles
  - \* **Nitrate**
  - \* **Chlorophyll *a***
  - \* **Primary production <sup>14</sup>C**

## SURVEY SAMPLINGS

- 1 CTD cast per station
  - \* **Fluorescence** profiles -> thin layers detection



# Main goals

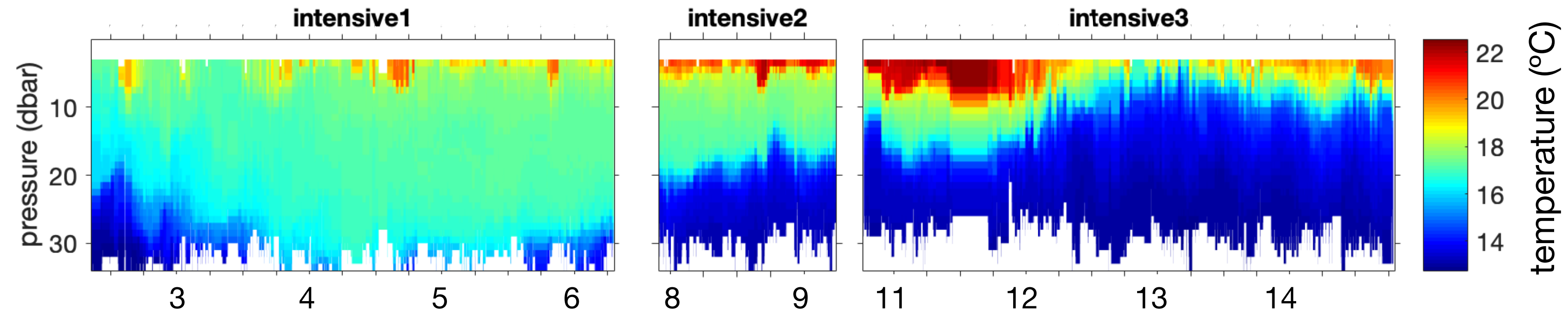
- \* What are the **dynamics** of the thin layer detected during the REMEDIOS-TLP cruise?
- \* What is the **spatial extent** of the thin layer of phytoplankton?
- \* What is the contribution of **physical and biological processes**?

# Main goals

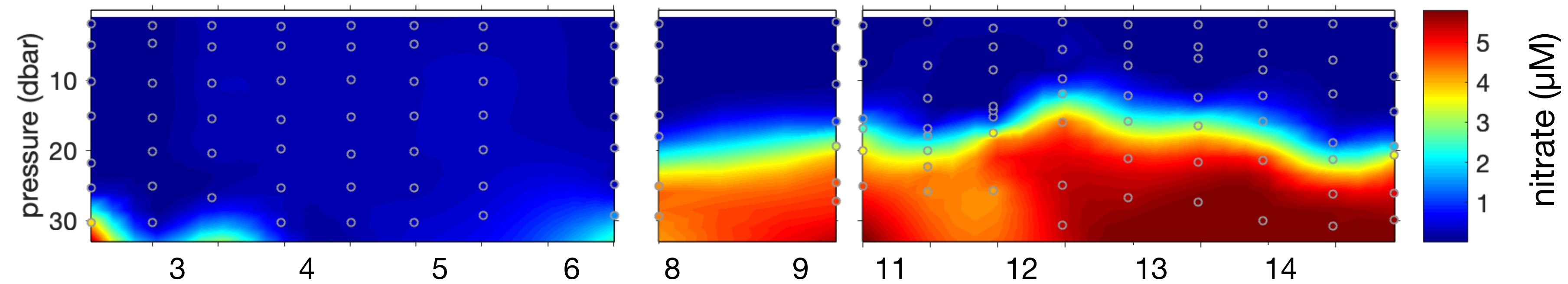
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# What is the temporal variability?

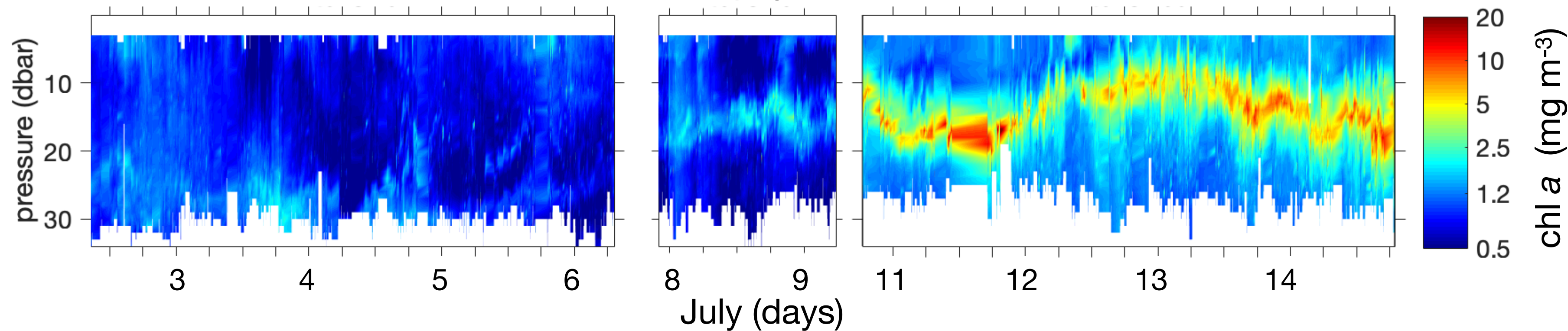
Temperature 222 st



Nitrate 222 st



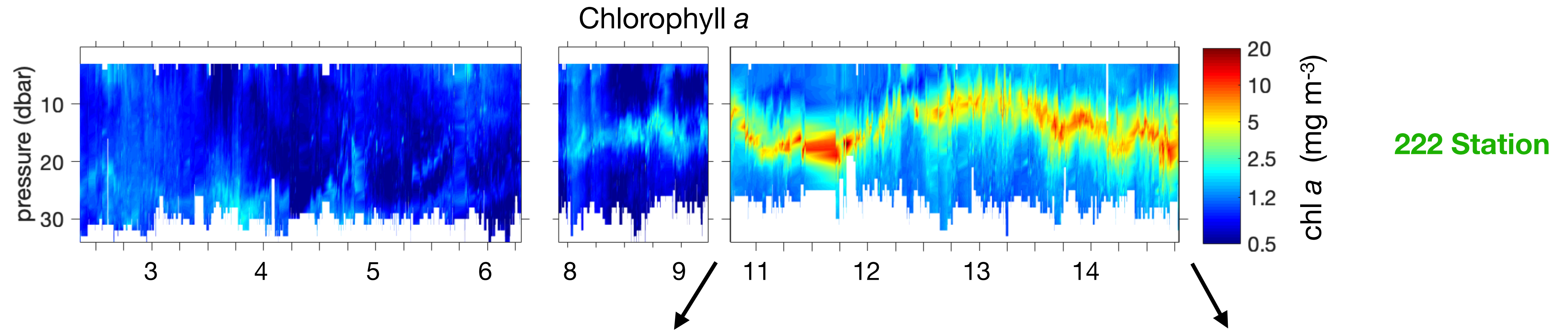
Chlorophyll a 222 st



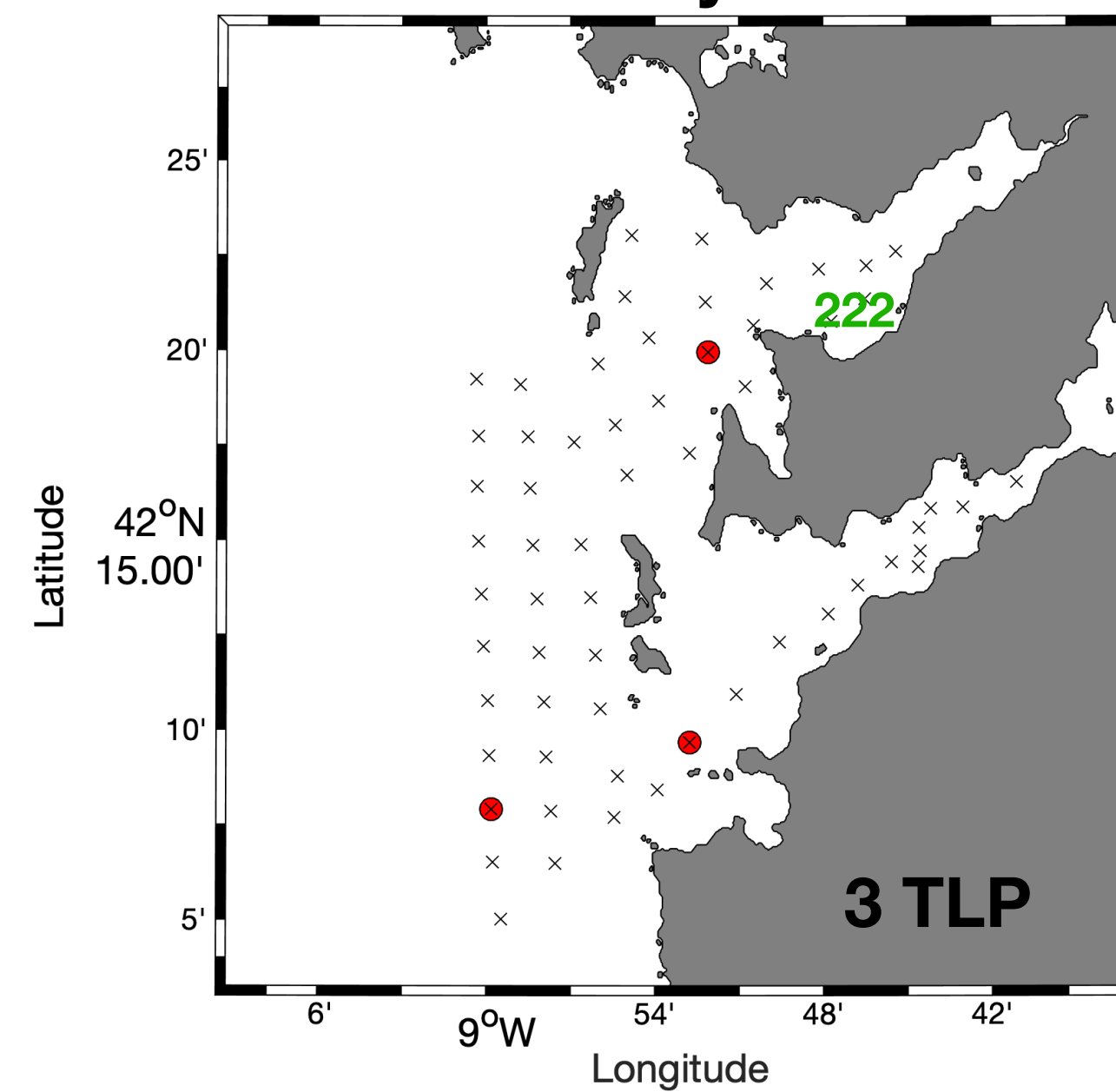
# Main goals

- \*What are the **dynamics** of the thin layer detected during the REMEDIOS-TLP cruise?
- \*What is the **spatial extent** of the thin layer of phytoplankton?
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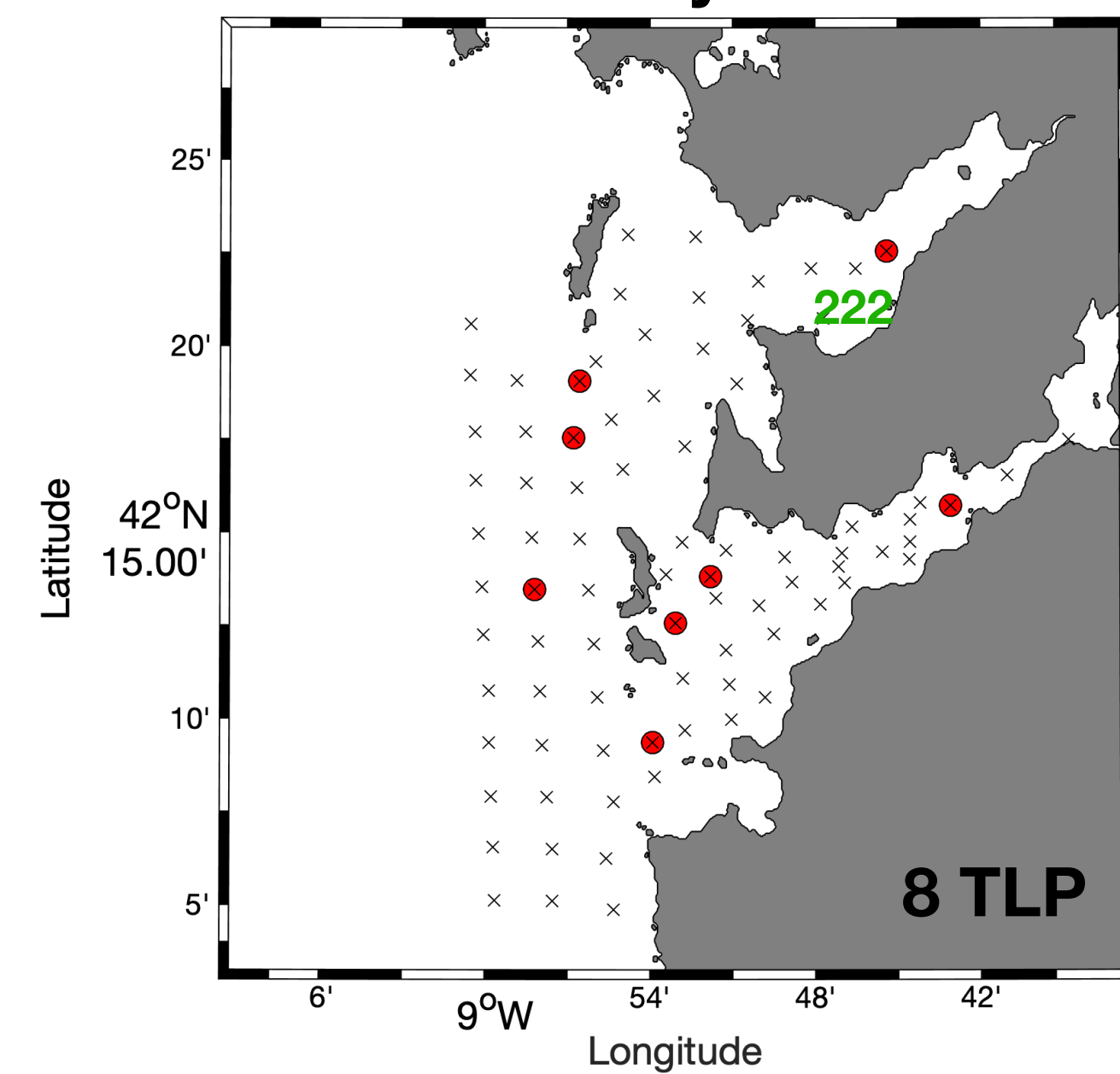
# Spatial extent



survey 3



survey 4



# Main goals

- \*What are the **dynamics** of the thin layer detected during the REMEDIOS-TLP cruise?
- \*What is the **spatial extent** of the thin layer of phytoplankton?
- \*What is the contribution of **physical and biological processes**?

# How did it form?

$$\frac{\partial chl\ a}{\partial t} = \left( \frac{\partial chl\ a}{\partial t} \right)_{gains} - \left( \frac{\partial chl\ a}{\partial t} \right)_{losses}$$

$$\frac{\partial chl\ a}{\partial t} = \left( \frac{\partial chl\ a}{\partial t} \right)_{biological} + \left( \frac{\partial chl\ a}{\partial t} \right)_{physical} - \left( \frac{\partial chl\ a}{\partial t} \right)_{biological} - \left( \frac{\partial chl\ a}{\partial t} \right)_{physical}$$



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**Net rate**

# How did it form?

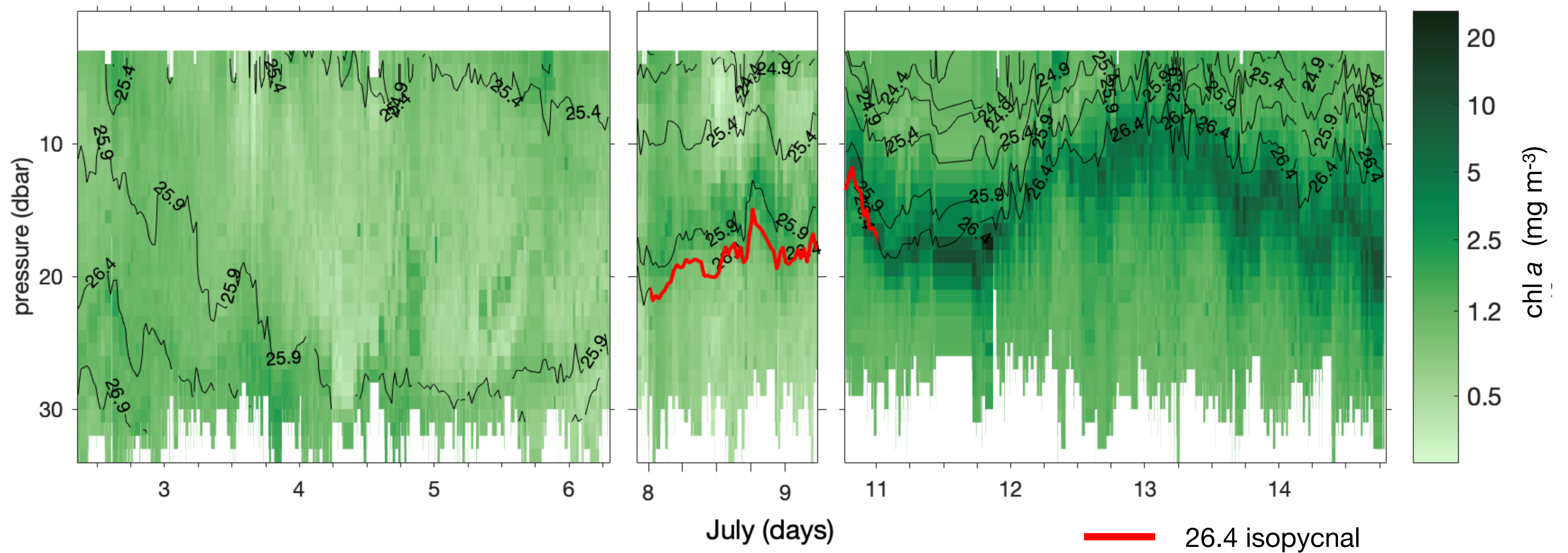
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**Growth rate**

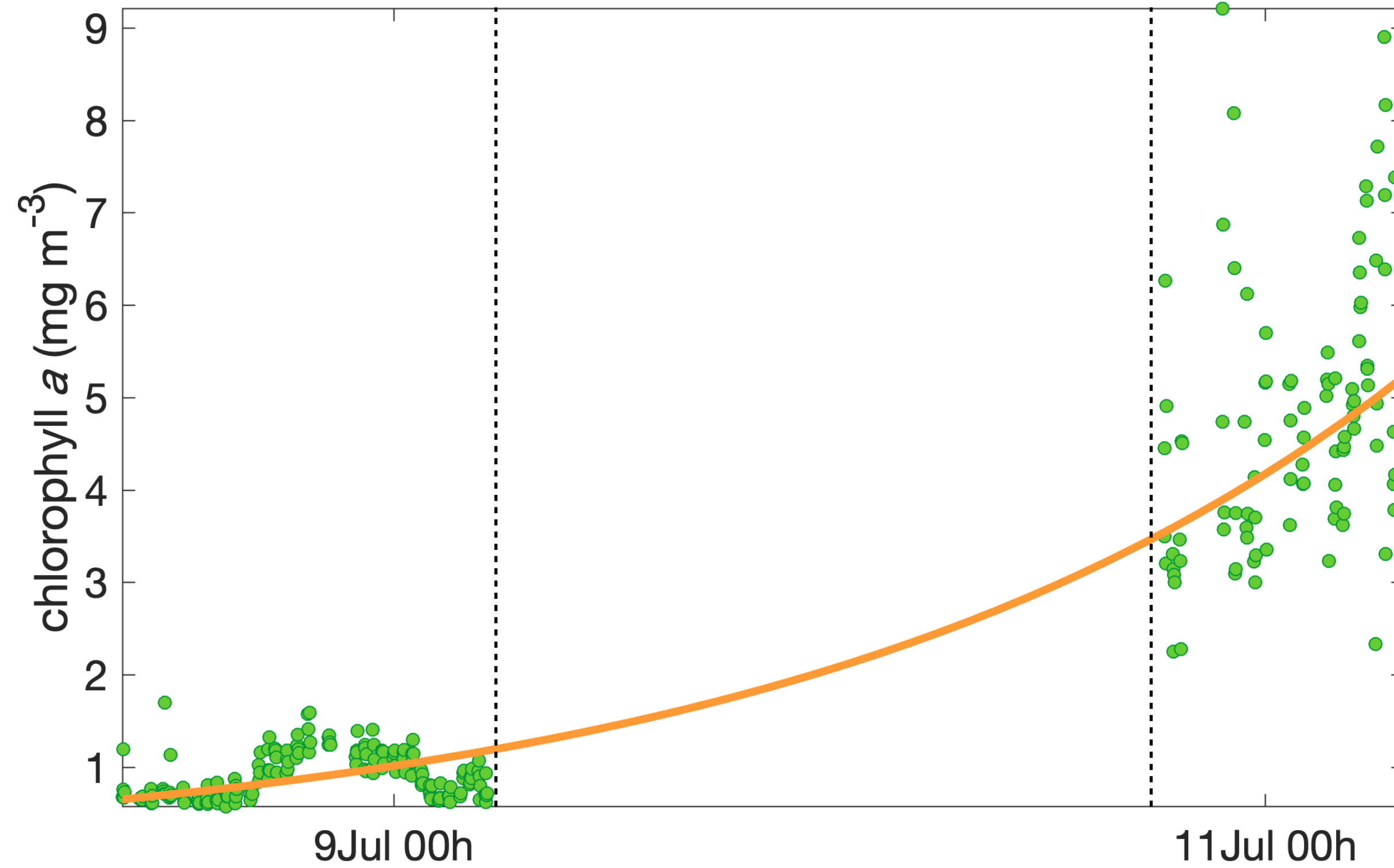
# Net rate

Chlorophyll values at 26.4 isopycnal  
between PP experiments



# Net rate

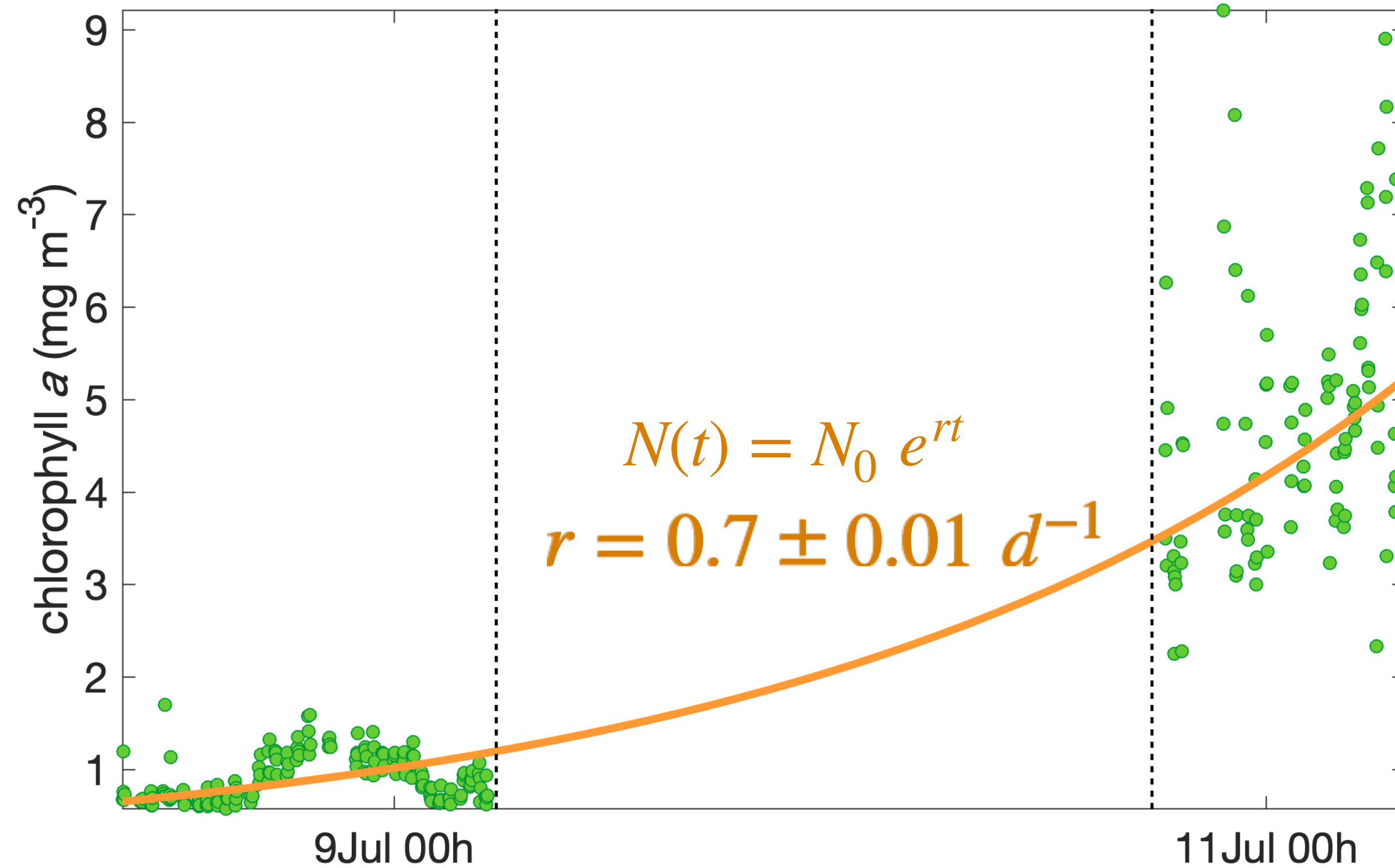
**Chlorophyll *a*** values at **26.4 isopycnal**  
between PP experiments



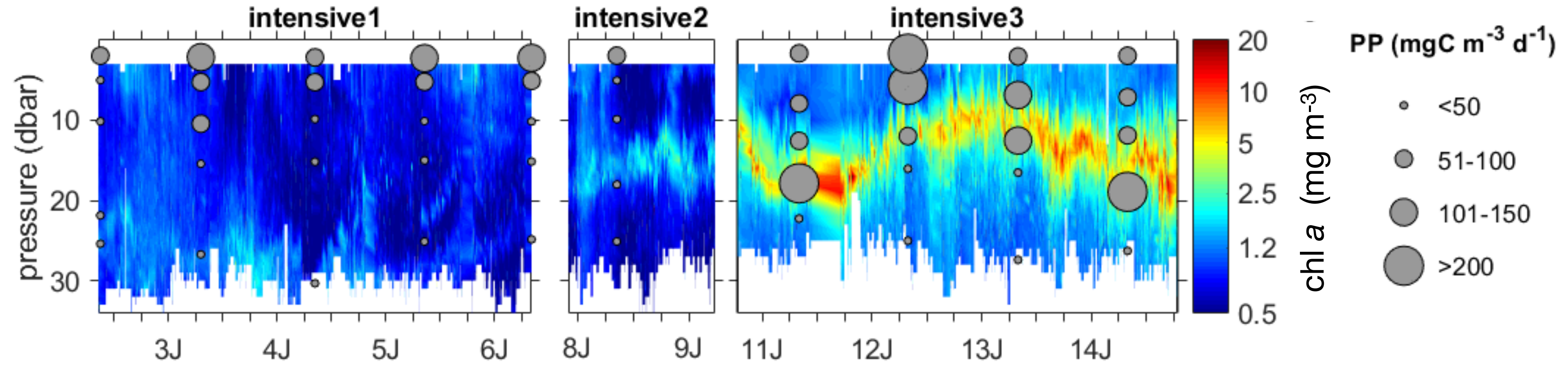
# Net rate

physical + biological

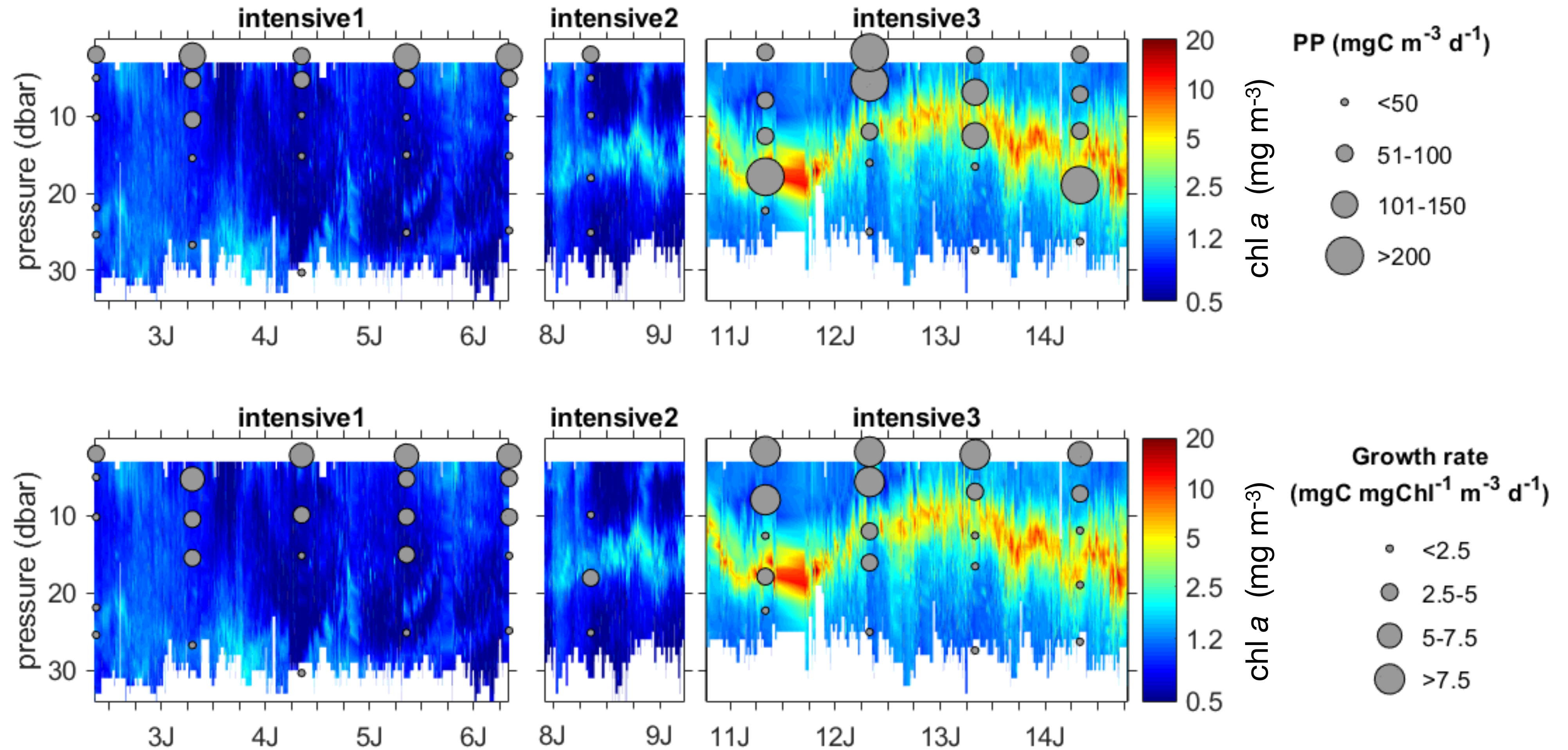
**Chlorophyll *a*** values at **26.4 isopycnal**  
between PP experiments



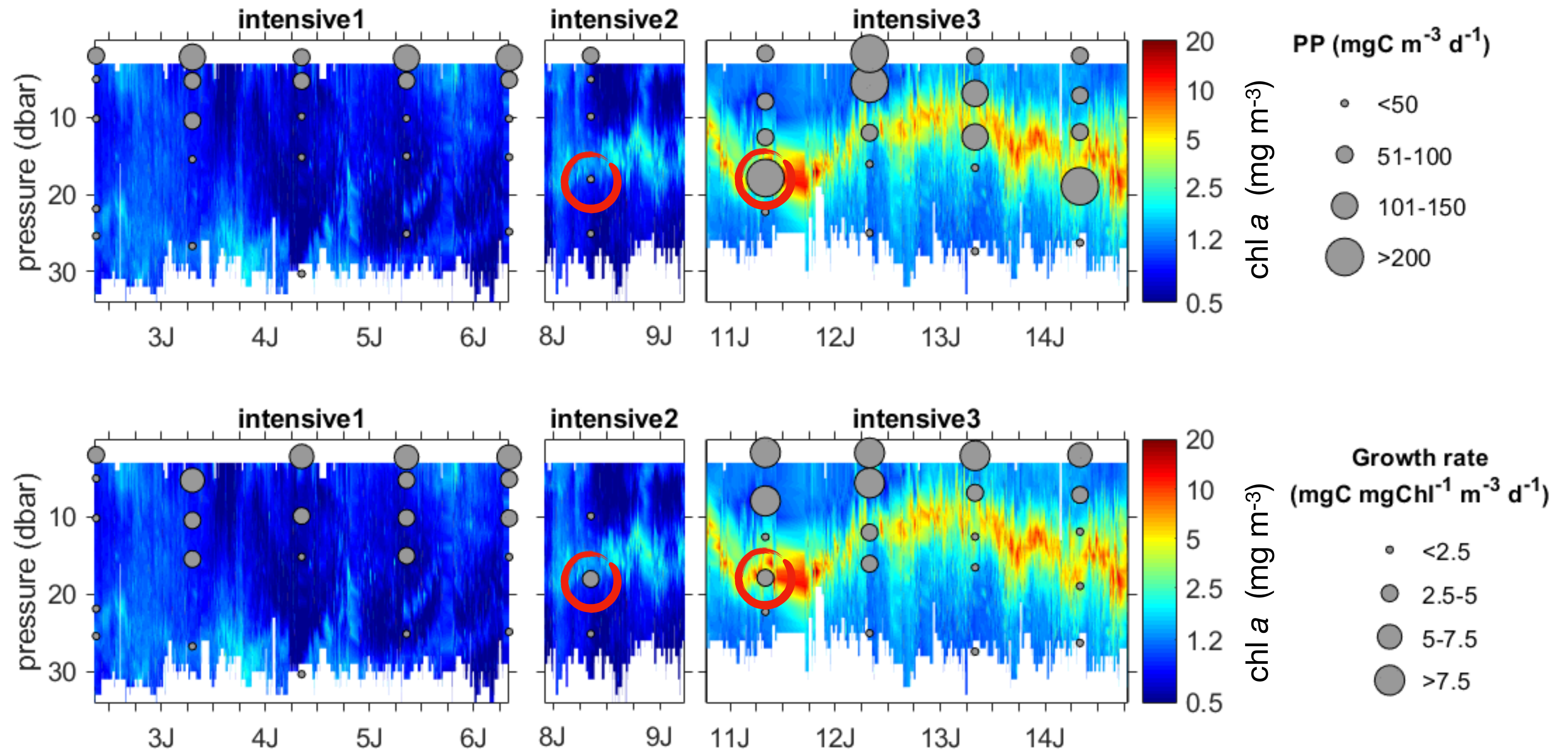
# Biological processes



# Biological processes

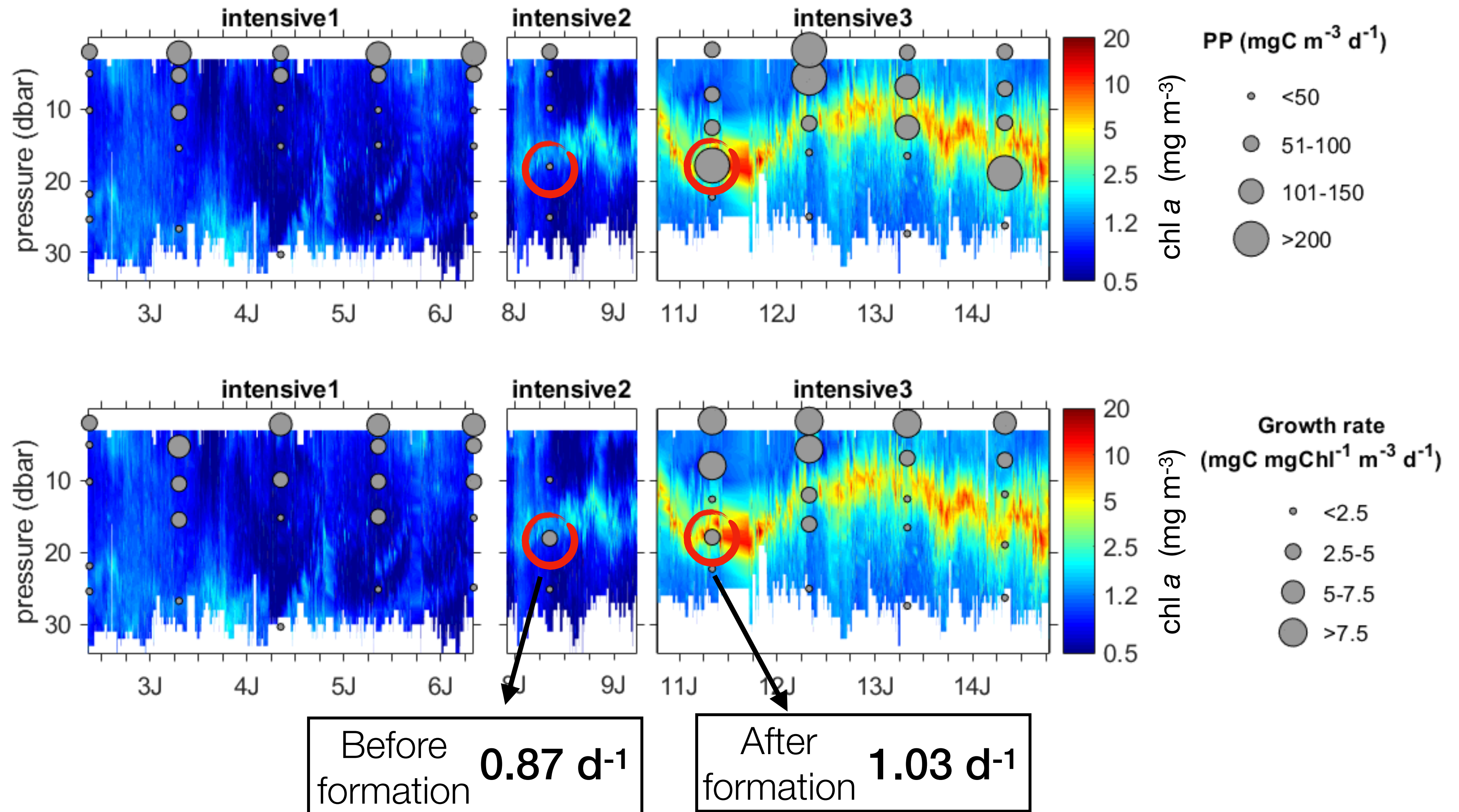


# Biological processes





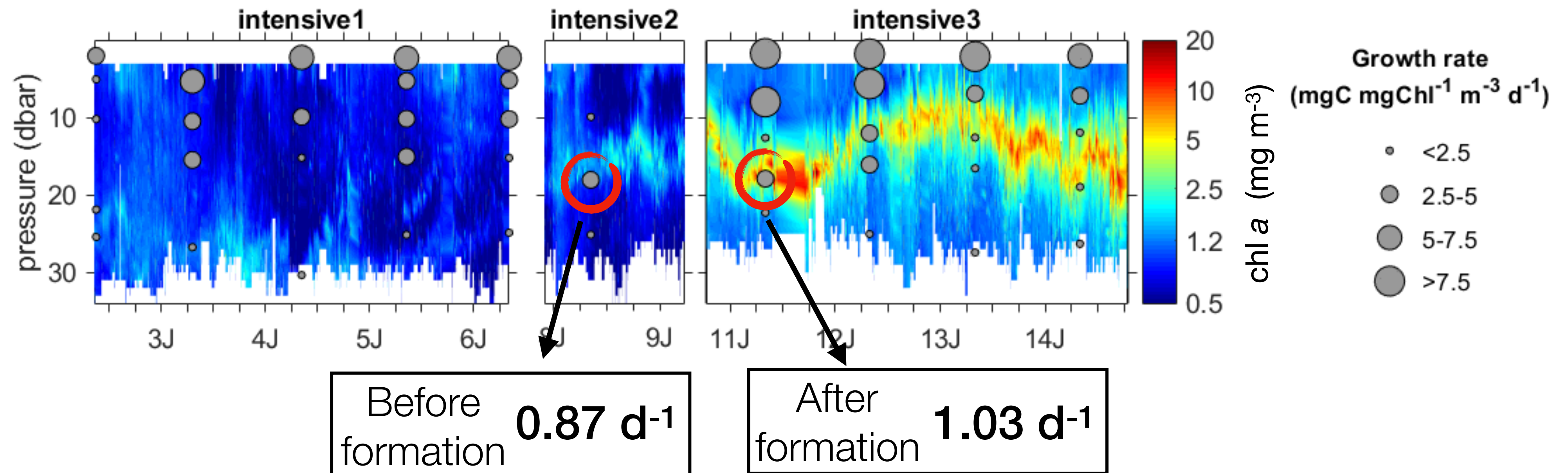
# Growth rate



# Growth rate

$$\text{Growth rate} = \frac{0.87 \text{ d}^{-1} + 1.03 \text{ d}^{-1}}{2}$$

$$\text{Growth rate} = 0.95 \pm 0.11 \text{ d}^{-1}$$



# What was the contribution of physical and biological processes?

$$\frac{\partial chl\ a}{\partial t} = \left( \frac{\partial chl\ a}{\partial t} \right)_{biological} + \left( \frac{\partial chl\ a}{\partial t} \right)_{physical} - \left( \frac{\partial chl\ a}{\partial t} \right)_{biological} - \left( \frac{\partial chl\ a}{\partial t} \right)_{physical}$$

## Net rate vs Growth rate

- If... Growth rate = Net rate → Biological processes could explain net accumulation
- If... Growth rate < Net rate → Both combination
- If... Growth rate > Net rate → Physical processes are decreasing concentration

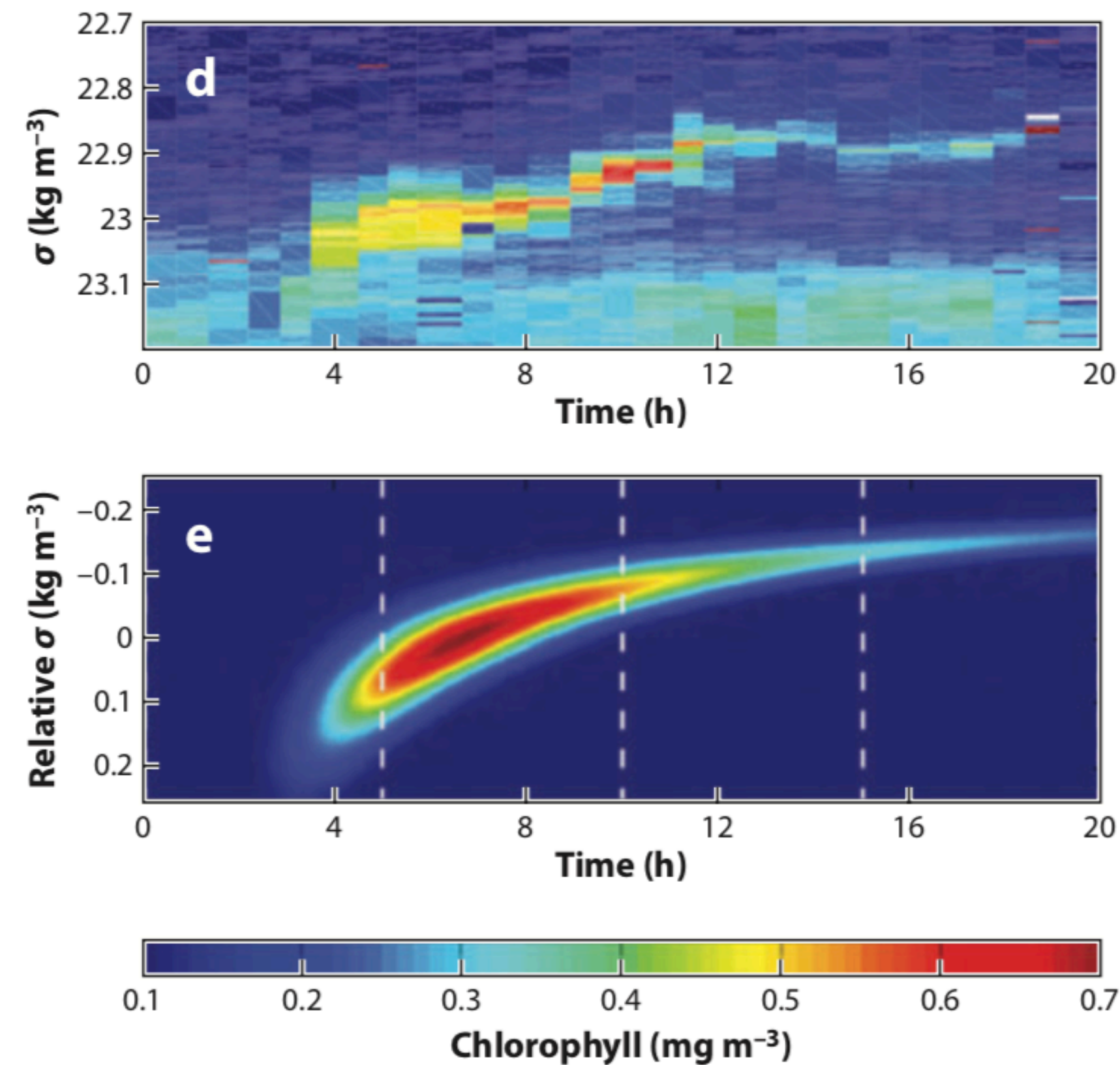
$$Growth\ rate = 0.95 \pm 0.11\ d^{-1} > Net\ rate = 0.7 \pm 0.01\ d^{-1}$$

# Conclusions

1. Thin layer was formed during the **transition from downwelling to upwelling** over a period less than two days
2. It was a **local feature** present in only one station
3. Our analyses are not enough to explain which processes were the main responsible of the thin layer formation

# Next step

To apply a model that can reproduce the thin layer to know what mechanisms are forming this features in this region



# Acknowledgments

Grant «Programa de axudas á etapa predoutoral da Xunta de Galicia» **XUNTA DE GALICIA**  
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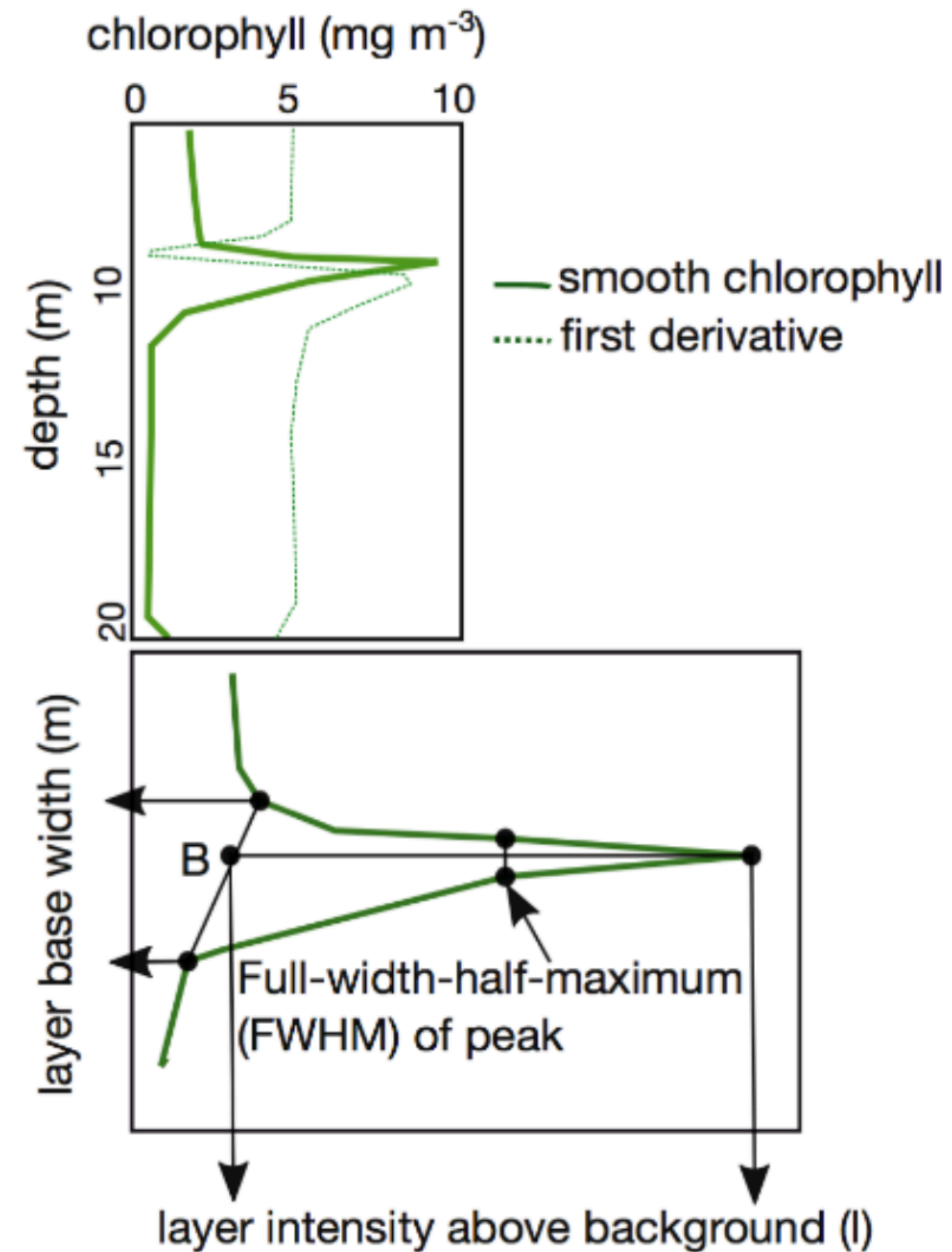
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Competitiveness to B. Mouriño-Carballido

<http://proyectoremedios.com>

**CONTACT: [ebroullon@gmail.com](mailto:ebroullon@gmail.com)**



## Thin layers detection:



- \* Thickness  $< 3$  m
- \* Intensity  $> 2 \times$  Background

## Growth rate calculations:

$$\text{Growth rate} = \frac{PPnet \times 0.8}{\text{extracted chl } a \times (C : \text{chl } a \text{ ratio})}$$