Contrasting mixing conditions in adjacent upwelling bays influence the occurrence of harmful algae blooms

Esperanza Broullón[1,2,*], Bieito Fernández Castro[3], Carlos Souto[4], Beatriz Mouriño-Carballido[1]

[1]Centro de Investigación Mariña da Universidade de Vigo (CIM-UVIGO), Vigo, Spain
[2]Instituto Investigaciones Marinas (IIM-CSIC), Vigo, Spain
[3]Ocean and Earth Science, University of Southampton, Southampton, UK
[4]Applied Physics Department, University of Vigo, Vigo, Spain
*ebroullon@gmail.com

Motivation

Upwelling bays are one of the most productive ecosystems in the global ocean, where harmful algae blooms (HAB) often threaten fishing and aquaculture activity. Factors responsible for this toxic episodes remain enigmatic. Elusive thin layers of phytoplankton (TLP), where high-cell densities are located within a narrow depth interval, have been related to the formation and occurrence of HAB, which hinder our capacity to anticipate and react early to their occurrence.

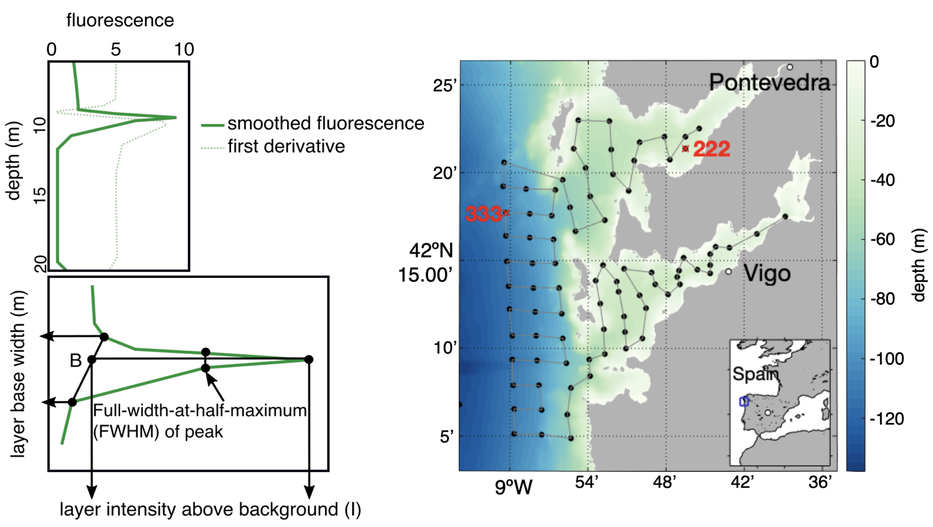
Hypothesis

TLP play an important role in the formation of harmful algae blooms in the Galician Rías

Objectives

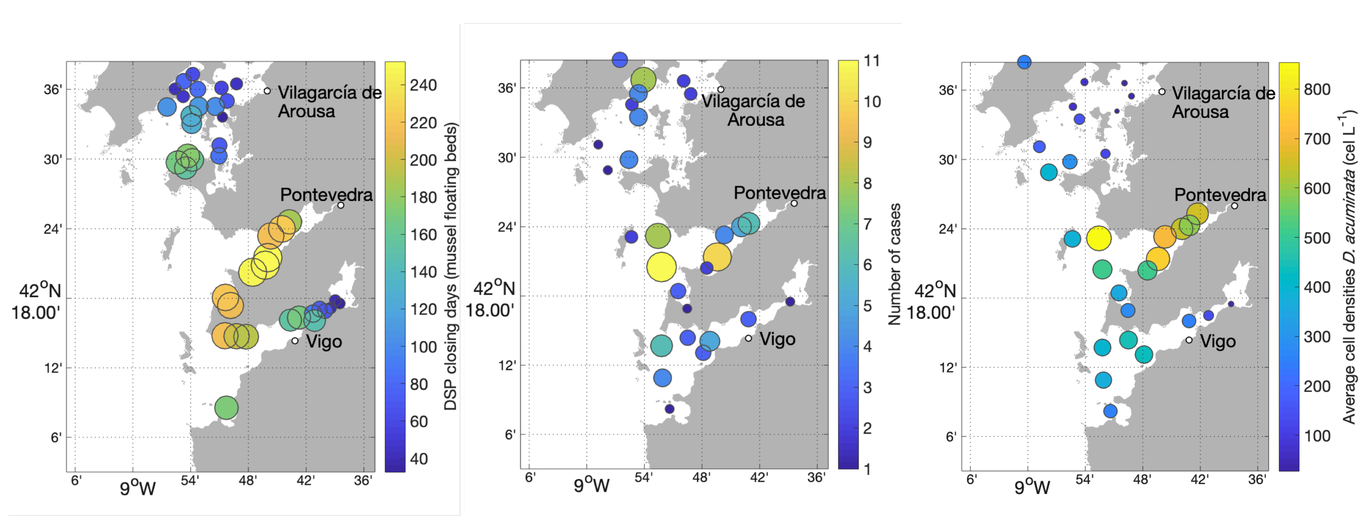
To discern the role of TLP in differences in toxicity between consecutive bays and elucidate the physical drivers

Thin layers of phytoplankton in the Galician Rías



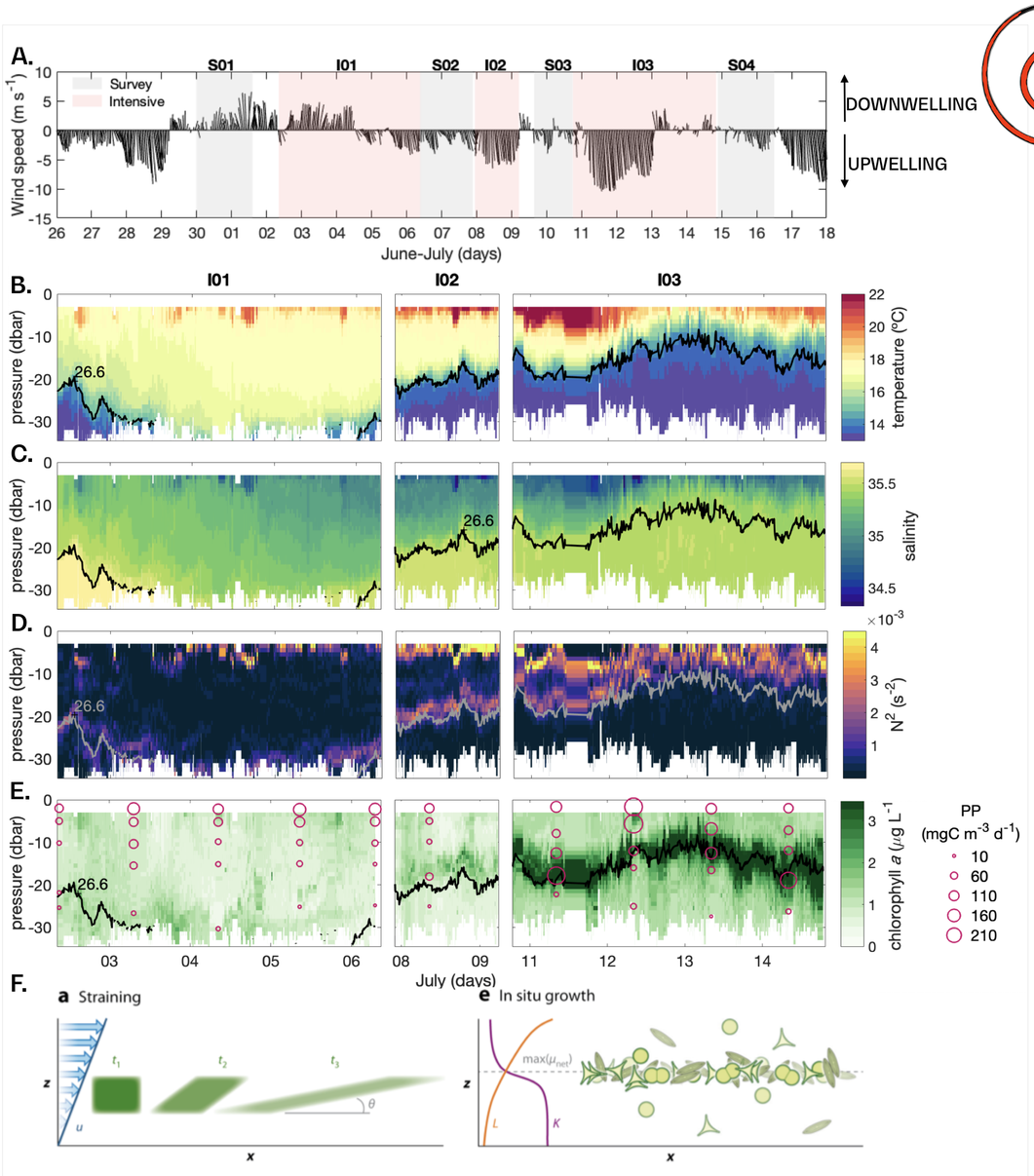
Characteristics of a TLP (left), tipically FWHM<3 m and I/B>2. Bathymetry map of the REMEDIOS-TLP cruise in the two southermost Galician Rías (right). Line indicates the sampling path. The intensive sampling station 222 is marked with a red cross in ría de Pontevedra.

Ocurrence and toxicity



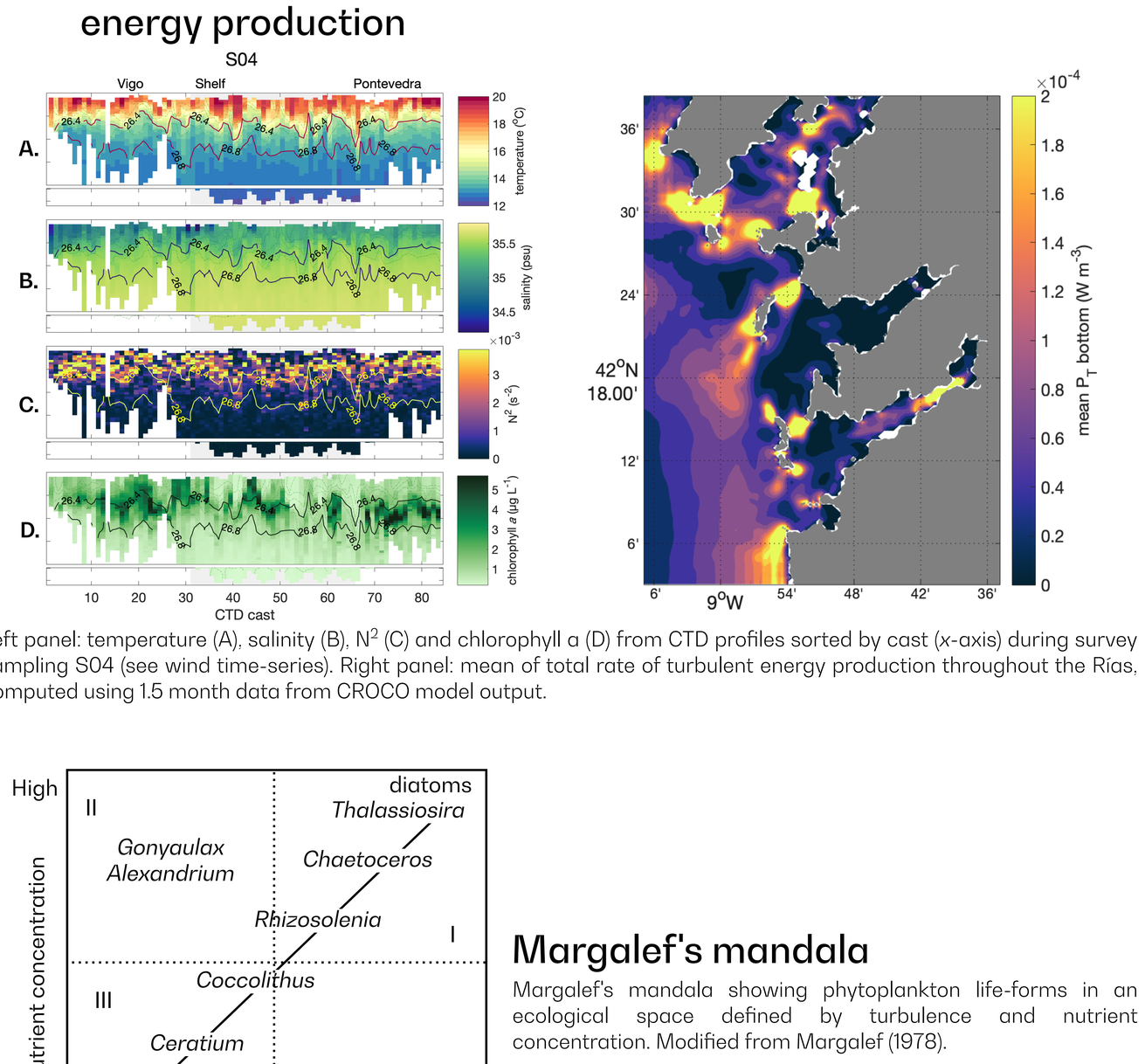
Mussel harvesting closures (average number of days per station and year) due to lipophilic toxins (left), number of TLP cases (center) and average cell densities of *Dinophysis acuminata* (right), during 2012-2015 in the Galician Rías.

Mechanisms of thin layers formation

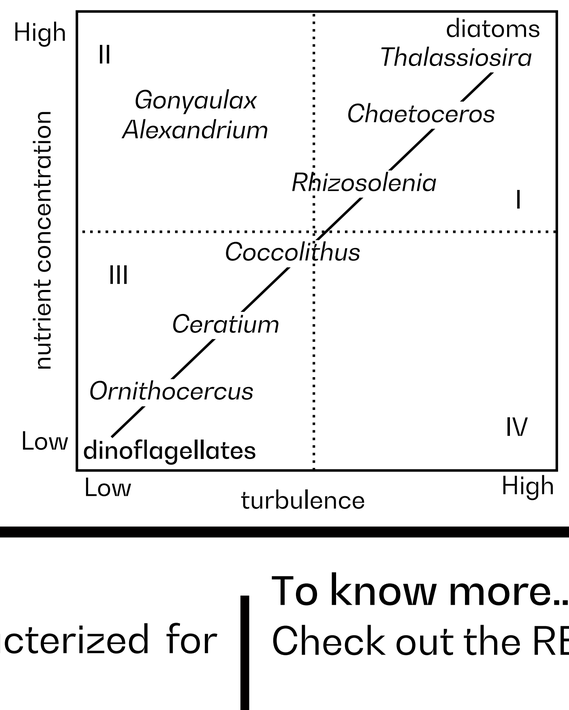


(A) Time-series of shelf-wind vectors throughout the cruise. Gray shaded areas indicate survey samplings (CTD stations), whereas red shaded areas indicate intensive samplings (high-res CTD at st. 222). Time-series of high-resolution temperature (B), salinity (C), N^2 (D) and chlorophyll *a* (E), at st. 222. (F) Mechanisms of thin layers formation (modified from Durham & Stocker (2012)).

Vertical chlorphyll *a* differences and turbulent energy production



Left panel: temperature (A), salinity (B), N^2 (C) and chlorophyll a (D) from CTD profiles sorted by cast (*x*-axis) during survey sampling S04 (see wind time-series). Right panel: mean of total rate of turbulent energy production throughout the Rías, computed using 1.5 month data from CROCO model output.



Margalef's mandala

Margalef's mandala showing phytoplankton life-forms in an ecological space defined by turbulence and nutrient concentration. Modified from Margalef (1978).

Conclusions

1. TLP were frequently observed in Ría de Pontevedra, characterized for longer toxicity episodes due to *Dinophysis* species.
2. A combination of straining and *in situ* growth could explain the TLP formation.
3. The lower rate of turbulent energy production in Ría de Pontevedra could explain the higher occurrence of TLP and HAB.

To know more...

Check out the REMEDIOS YouTube channel!

Acknowledgments

This research was funded by project REMEDIOS (CTM2016-75451-C2-1-R) to BM-C from the Spanish Ministry of Economy and Competitiveness. E.B. acknowledges a predoctoral fellowship (ED481A-2019/288) from Xunta de Galicia, co- funded by FSE Galicia (2014–2020).