



# living planet symposium | BONN

23-27 May 2022



TAKING THE PULSE  
OF OUR PLANET FROM SPACE



## Assimilating Satellite and BGC-Argo data into operational modelling of the Mediterranean Sea biogeochemistry



**OGS**  
Istituto Nazionale  
di Oceanografia  
e di Geofisica  
Sperimentale

Anna Teruzzi, Stefano Salon, Laura Feudale, Giorgio Bolzon, Gianpiero Cossarini

25 May 2022

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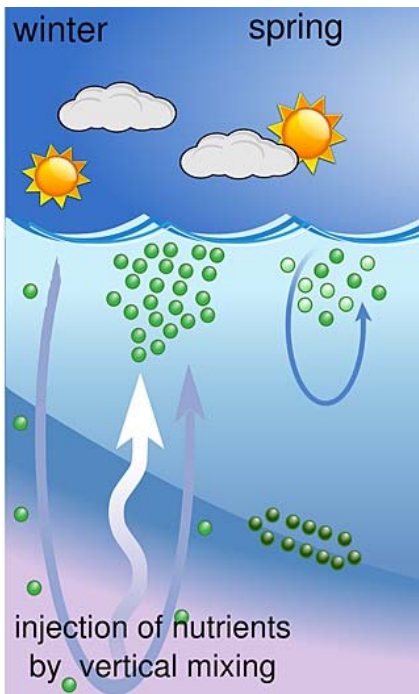
→ THE EUROPEAN SPACE AGENCY

# Seasonality of the Mediterranean Sea biogeochemistry

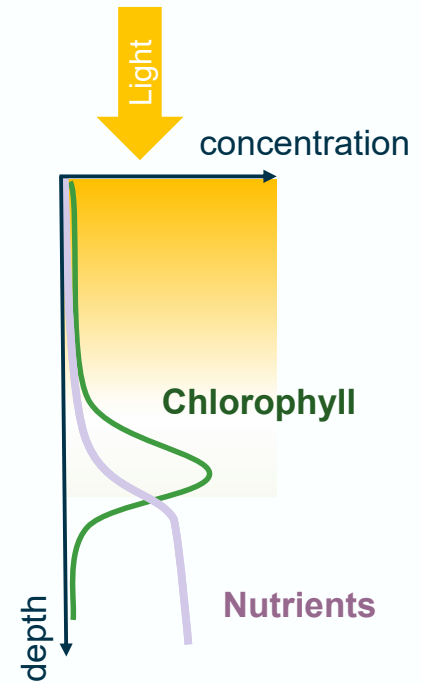
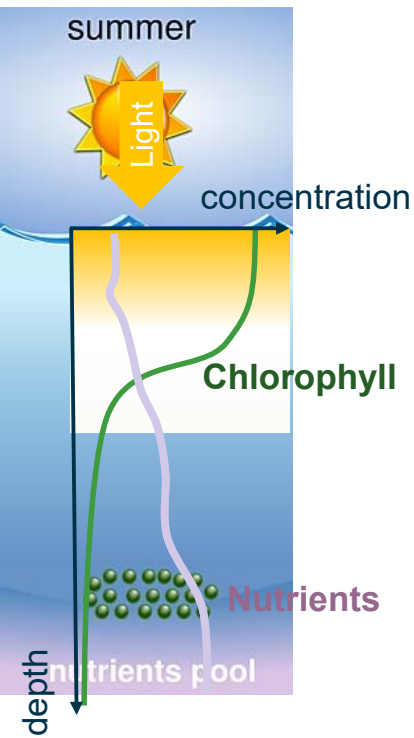


Adapted from  
Mignot et al., 2014

## Winter bloom

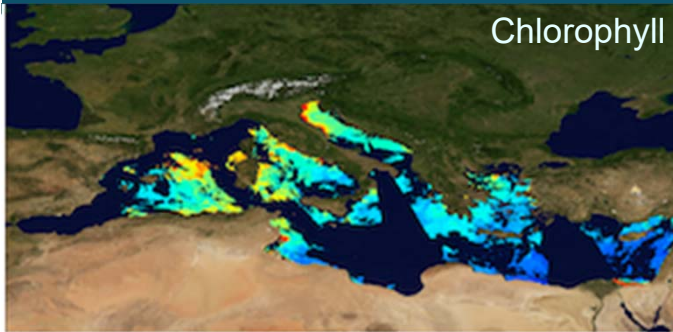


## Deep chlorophyll maximum (DCM)

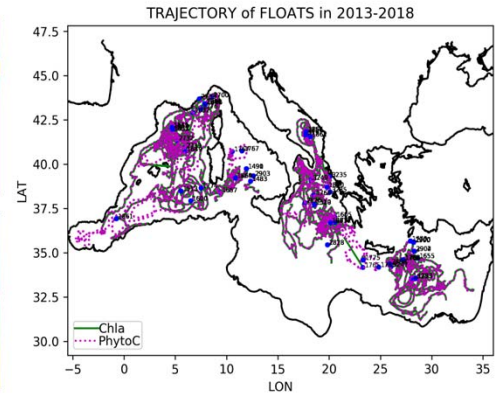
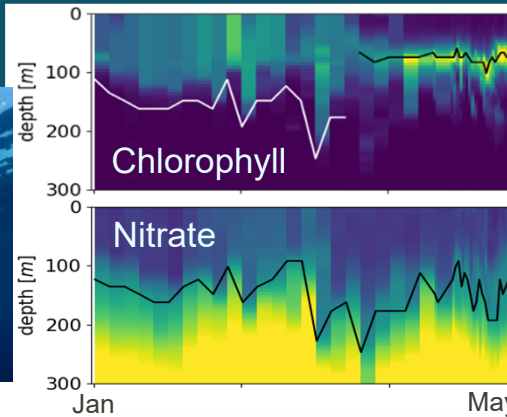


# Data assimilation

## Satellite

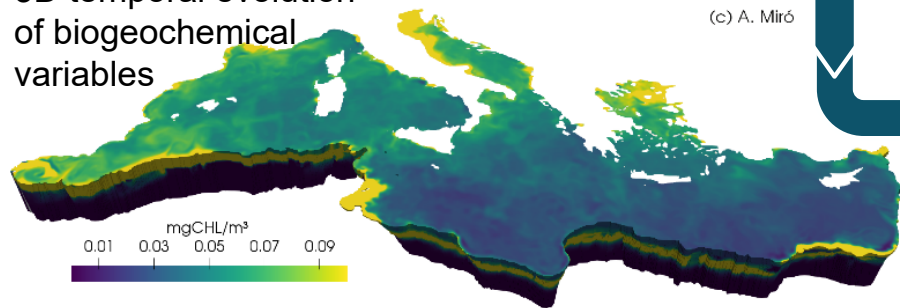


## BGC-Argo floats



## Models

3D temporal evolution of biogeochemical variables



(c) A. Miró

## Data assimilation

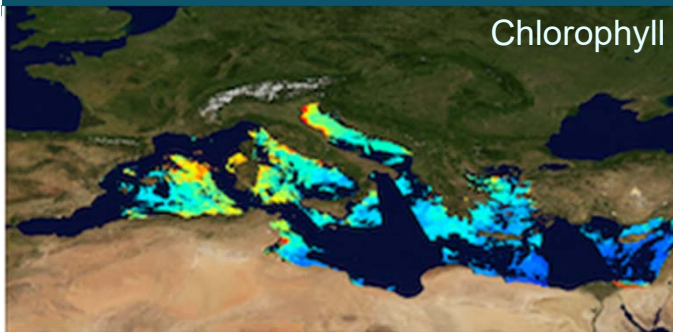
Combines observations and model with their uncertainties to provide a better representation of reality



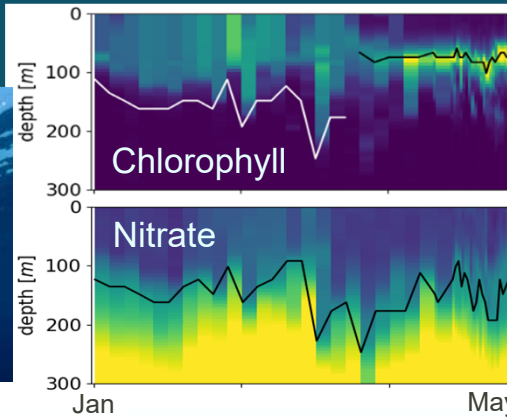
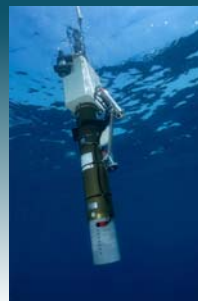
# Data assimilation



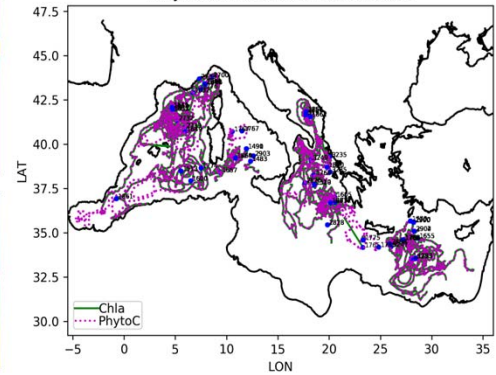
## Satellite



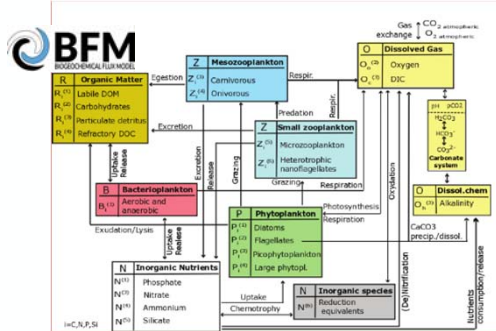
## BGC-Argo floats



TRAJECTORY of FLOATS in 2013-2018



## Models



1/16° horizontal resolution

70 levels

One year simulation 2015

## Data assimilation

Daily assimilation of BGC-Argo chlorophyll and nitrate

Weekly assimilation of BGC-Argo chlorophyll and nitrate

Updates of phytoplankton and nutrient variables



# Results – Assimilation impact on nitrate

Simulation WITH data assimilation (DAsim)

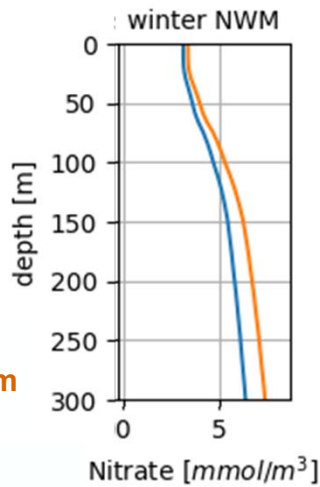
REF simulation WITHOUT data assimilation

$$\text{Impact indicator } 0 - 200 \text{ m } I_{xy}(t) = \frac{|ScFcn(t) - REF(t)|_{200}}{REF(t)_{200}}$$

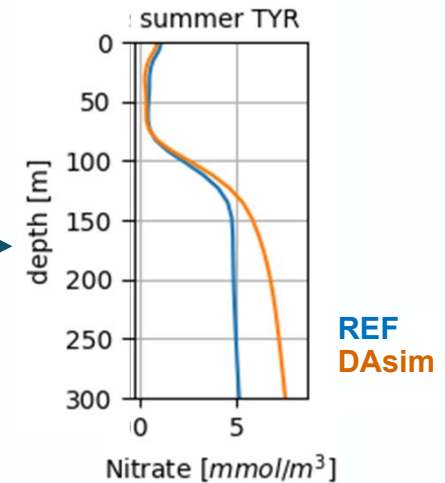
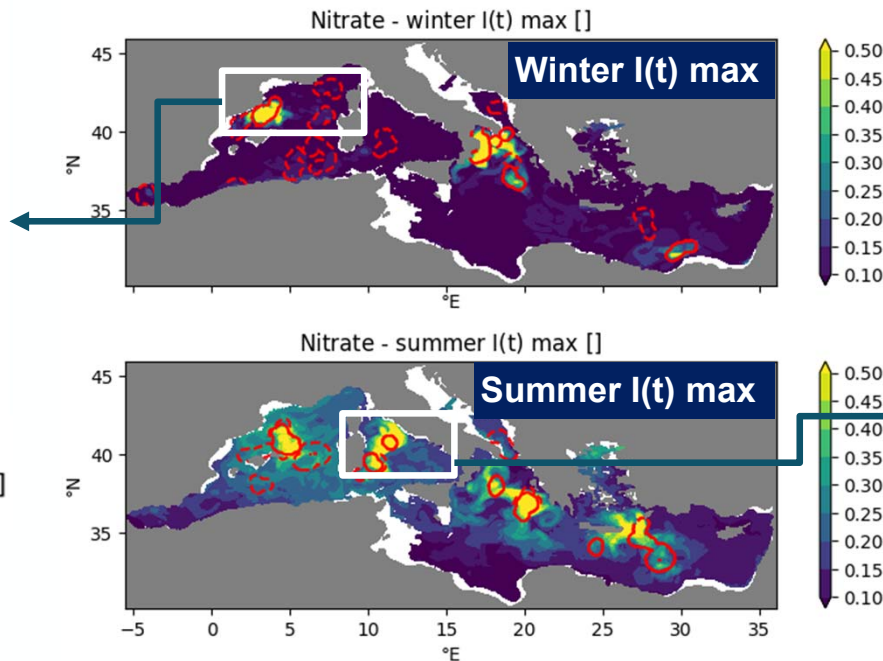


BGC-Argo chlorophyll

BGC-Argo chlorophyll and nitrate



REF  
DAsim



REF  
DAsim

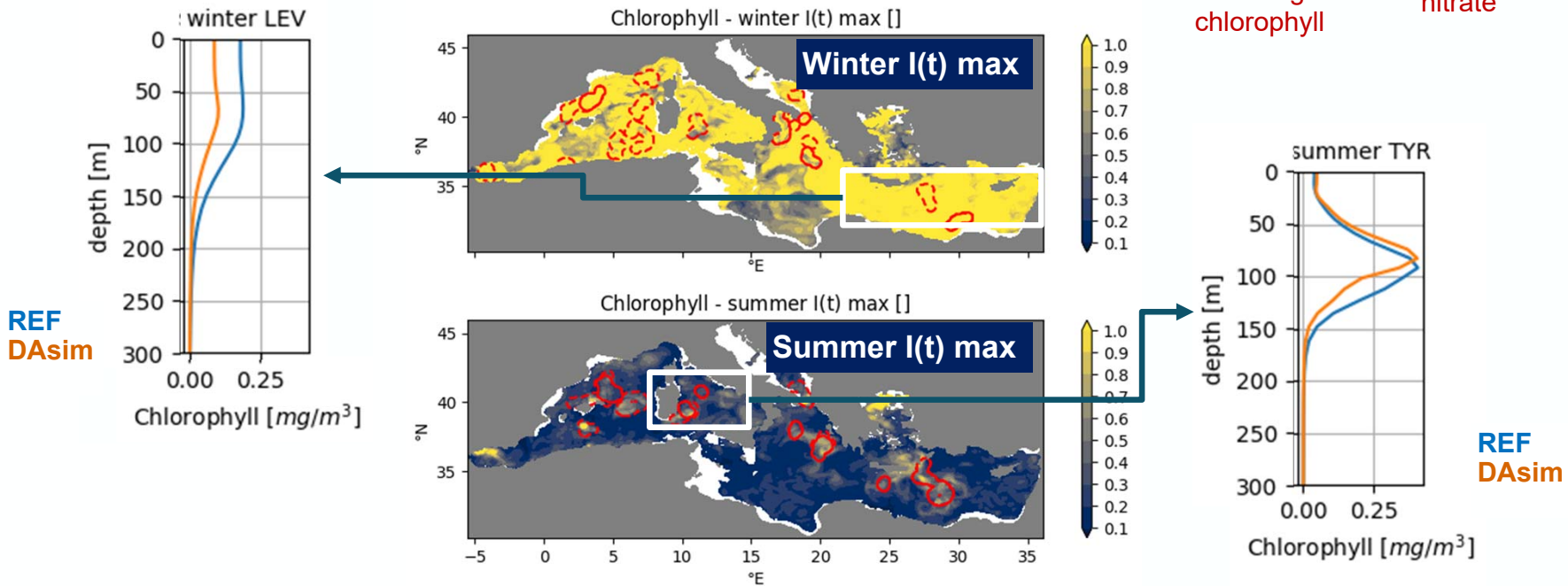
# Results – Assimilation impact on chlorophyll

Simulation WITH data assimilation (DAsim)

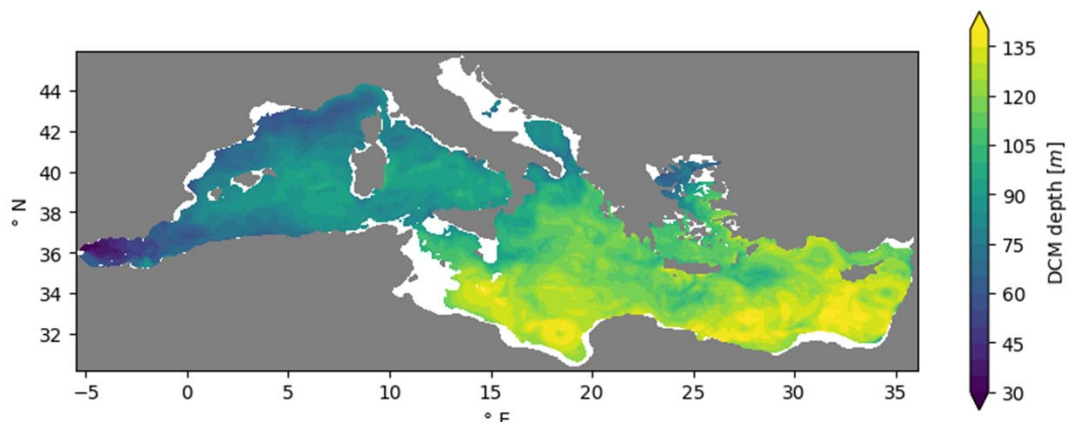
REF simulation WITHOUT data assimilation

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BGC-Argo chlorophyll  
BGC-Argo chlorophyll and nitrate



# DCM in the assimilated simulation

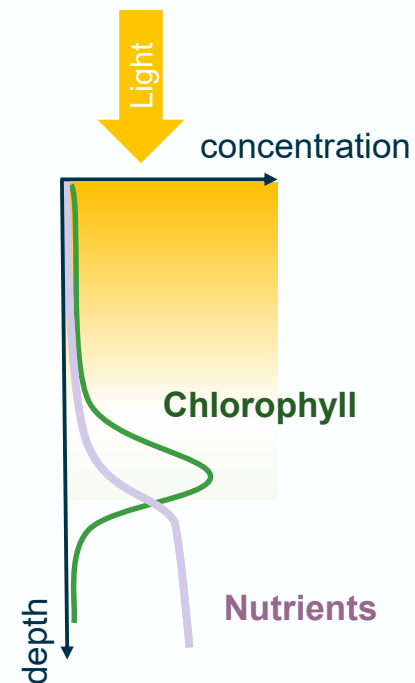
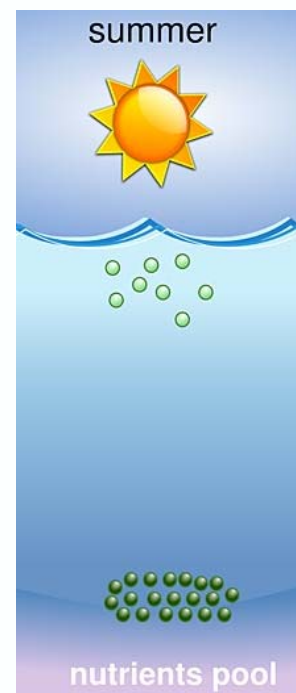


DCM depth west-east gradient  
(Barbieux et al., 2019; Mignot et al., 2014)

DCM features in the western and eastern Mediterranean

## Deep chlorophyll maximum (DCM)

Adapted from Mignot et al., 2014

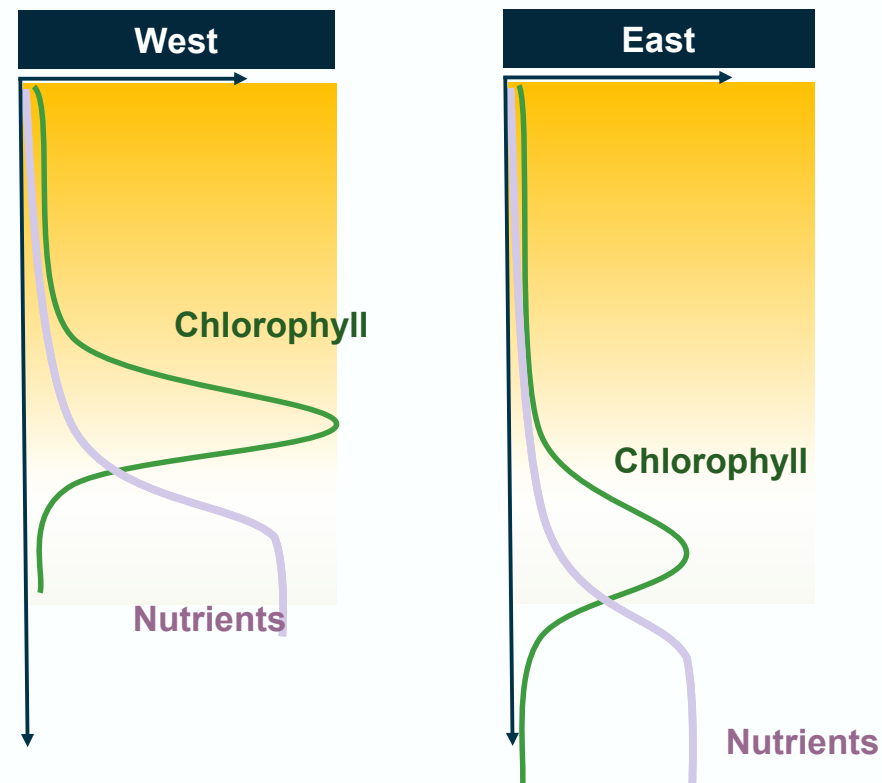


# DCM west-east differences

| DCM   | West     | East    |
|---|----------|---------|
| DCM depth [m]   | 75-90    | 100-125 |
| Chlorophyll at DCM [mg/m <sup>3</sup> ]                     | 0.4-0.48 | 0.3-0.4 |
| DCM thickness [m]<br>(chlorophyll > 0.5 chlorophyll at DCM) | 40-50    | 50-70   |

| Nitracline<br>(depth of maximum nitrate variation)           | West      | East      |
|--|-----------|-----------|
| Nitracline depth [m]   | 80-100    | 125-150   |
| Nitracline slope [mmol/m <sup>4</sup> ]                      | 0.08-0.10 | 0.03-0.05 |
| Nitrate concentration below DCM layer [mmol/m <sup>3</sup> ] | 6-7.5     | 4.5-5     |

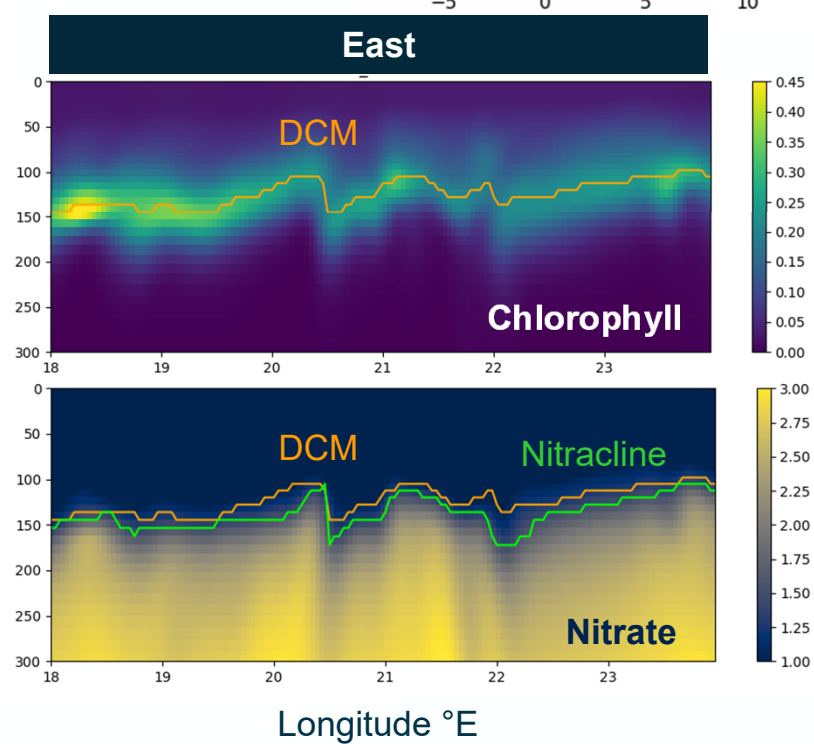
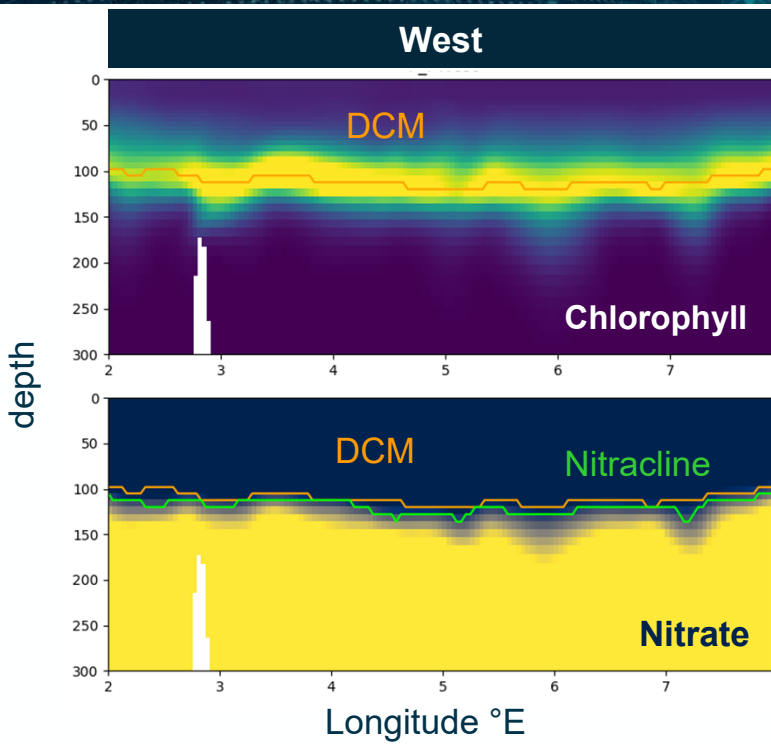
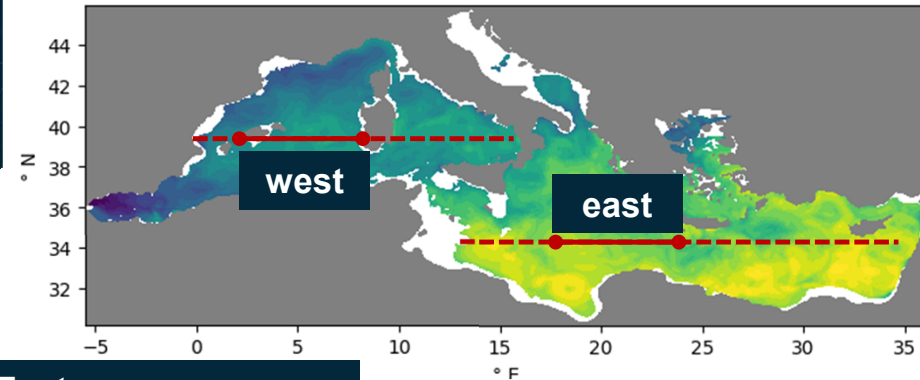
| PAR   | West  | East  |
|---|-------|-------|
| PAR at DCM [mol quanta/m <sup>2</sup> /d <sup>1</sup> ] | 1.5-2 | 0.6-1 |



DCM more productive in the western Mediterranean



# DCM west-east differences



# Summary and conclusion



- **Implementation of satellite chlorophyll and BGC-Argo data assimilation**

Operational in Copernicus Marine Service using OC TAC and BGC-Argo

+ Oxygen data assimilation in November 2022

Further development of multi-platform data assimilation in SEAMLESS H2020 project

- **West-east differences in Mediterranean Sea DCM**

More productive western DCM

The screenshot shows the article page on the Biogeosciences website. The article title is "Deep chlorophyll maximum and nutricline in the Mediterranean Sea: emerging properties from a multi-platform assimilated biogeochemical model experiment". The authors listed are Anna Teruzzi, Giorgio Bolzon, Laura Feudale, and Gianpiero Cossarini. The article is dated 30 Nov 2021. The page includes a search bar, navigation tabs (Article, Assets, Peer review, Metrics, Related articles), and a sidebar with sections like Abstract, Introduction, Methods, Results, Discussion, Conclusions, Code and data availability, Author contributions, Competing interests, Disclaimer, Special issue statement, Acknowledgements, Financial support, Review statement, and References. A "Special issue" section is also visible, titled "Biogeochemistry in the BGC-Argo era: from process studies..."

Teruzzi, A., Bolzon, G., Feudale, L., and Cossarini, G., Biogeosciences 2021 <https://doi.org/10.5194/bg-18-6147-2021>



## BGC-Argo valuable sources of information

View of the ocean interior

Several observed variables

Used in a near time framework → assimilation and validation

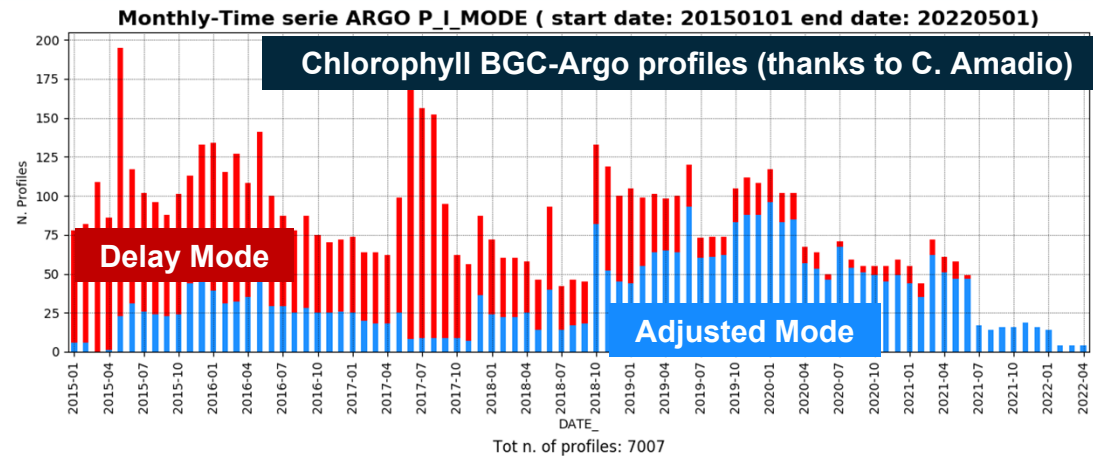
Use of more variable in the future (optics)

Consistency with other data sets → satellite

Quality control in near real time

Good coverage should include at least 2 fully equipped BGC-Argo in the eastern and western Mediterranean

Quality or coverage degradation → impact on Copernicus Marine Service Analysis and Forecast products





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## TAKING THE PULSE OF OUR PLANET FROM SPACE



# THANK YOU



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Sperimentale

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DCM and  
nutricline depth

Chlorophyll at  
DCM and  
nutricline slope

Light at DCM and  
bottom nutrient  
concentration

