Assessment of biogeochemical models in the NW Mediterranean

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Intro

- **<u>Final motivation</u>:**

-Promoting and providing BGC model outputs as a tool to wider community of scientist (<u>end users)</u>

Potential applications of BGC models-fisheries and climate change (H2020 Project CERES)

- Validation in **NW Mediterranean**:
- **Relevant sub-basin:** economic activities such as marine resources and tourism.

-Which variables/processess are useful and trustworthy?

<u>Focus:</u> **primary production (PP):** patterns and drivers

What drives PP variability??

- **Photosynthesis** of phytoplankton as a f(): Light & Nutrients

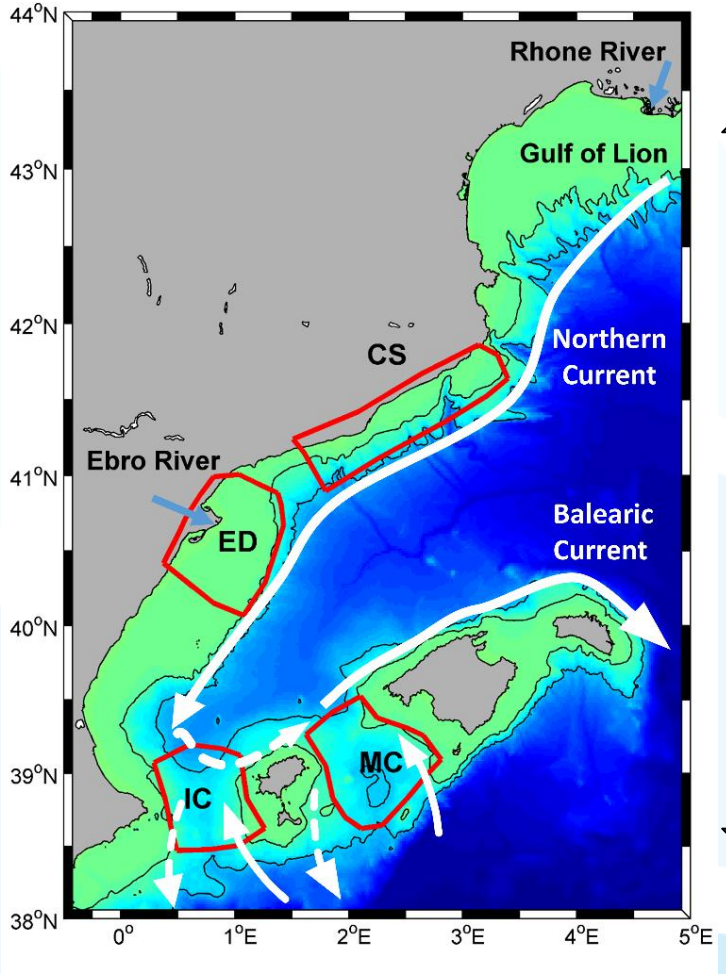
- Simulating **PP** in the ocean:
- **Water column**:

-**mixing/stratification** seasonal cycle drives Light & Nutrients availability

-fronts/mesoscale processess

- **Coastal areas**-**riverine inputs** (nutrients)

Balearic Sea: NW Mediterranean



- Ecoregions with different **BGC seasonal patterns** and **trophic regime** (productivity):

- **Catalan shelf (CS):** intense winter mixing (Gulf of Lion).
- **Ebro Delta:** shallow and eutrophic
- **Balearic Channels** (IC/MC): dominated by stratification

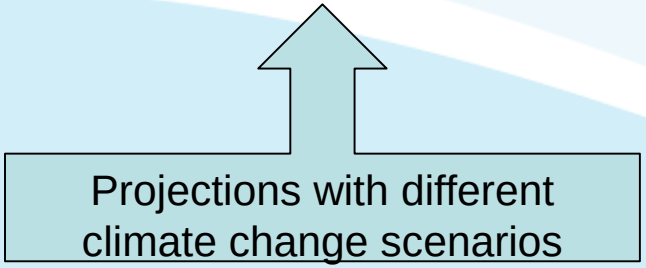
- **Inflowing Atlantic Waters influence**: southernmost area

Balearic Channels:
IC-Ibiza Channel, **MC**-Mallorca Channel,
ED-Ebro Delta
CS-Catalan Shelf.

(Lavigne et al.,2013; Siokou-Frangou et al., 2010; D´Ortenzio and Ribera d´Alcala 2009)

Reanalysis: Coupled-BGC model

- Physical Reanalysis (2000-2016)
- (i) NEMO-**BFM**: Mediterranean region, which assimilates **physical data** (SST,SSH) and **chlorophyll** (CMEMS product)
- (ii) NEMO-**PISCES**: IBI-W Mediterranean which assimilates only **physical data** (SST,SSH) (CMEMS product)
- (iii) POLCOMS-**ERSEM:** IBI-Mediterranean domain, which does not include any data assimilation.



Physical Reanalysis: main features

	BFM	PISCES	ERSEM
Equations	NEMO-OPA	NEMO-v3.4 model	POLCOMs
Domain (open boundary)	Mediterranean Sea (Atlantic side)	IBI area (Atlantic and Mediterranean Sea)	IBI-Mediterranean
Horizontal Resolution/vertical levels	1/16º (5-6 Km) / 72 **z-levels**	1/12º(7-8 km)/ 75 **z-levels**	1/10º (9-10 km)/ 40 **sigma levels**
Atmospheric forcing	**ERAInterim ECMWF**	**ECMWF ERA-Interim**	**ERWAInterim ECMWF Model**
Rivers runoff	monthly mean datasets: the Global Runoff Data Centre dataset (Fekete et al., 1999)	Merge of daily SMHI & PREVIMER & Monthly climatology (GRDC)	second version of Global NEWS

BGC models: main features

-**Plankton Functional Type models:** different groups within e.g. Phytoplankton
-**Different elements:** Carbon, Nitrogen, Phosphorus…

BGC model	BFM	PISCES	ERSEM
Simulated elements and variables (phytoplankton)	C,N,P,Si, Chl, Fe	C,N,P,Si, Chl, Fe	C,N,P,Si,Fe
Phyto. groups	diatoms, flagellates, picophytoplankton and dinoflagellates	Nanoflagellates, diatoms	diatoms, nanoflagellates, picophytoplankton, and dinoflagellates
Nutrient uptake/assimilation	Monod/Droop	Monod	Lineal/Droop
Phytoplankton Stoichometry	Flexible. ½ to 2x Refield ratio (N/P)	Redfield fixed C/N/P = 122/16/1	Flexible. ½ to 2x Refield ratio (N/P)
Nutrient inputs: Rivers	Monthly scale from direct observations (Ludwig et al., 2009). All other inputs are treated as constants	DOC, DIC from Ludwig et al. (1996) and transformed to N/P/Si with constant ratios	Global NEWS database

Observations

- **Satellite data**

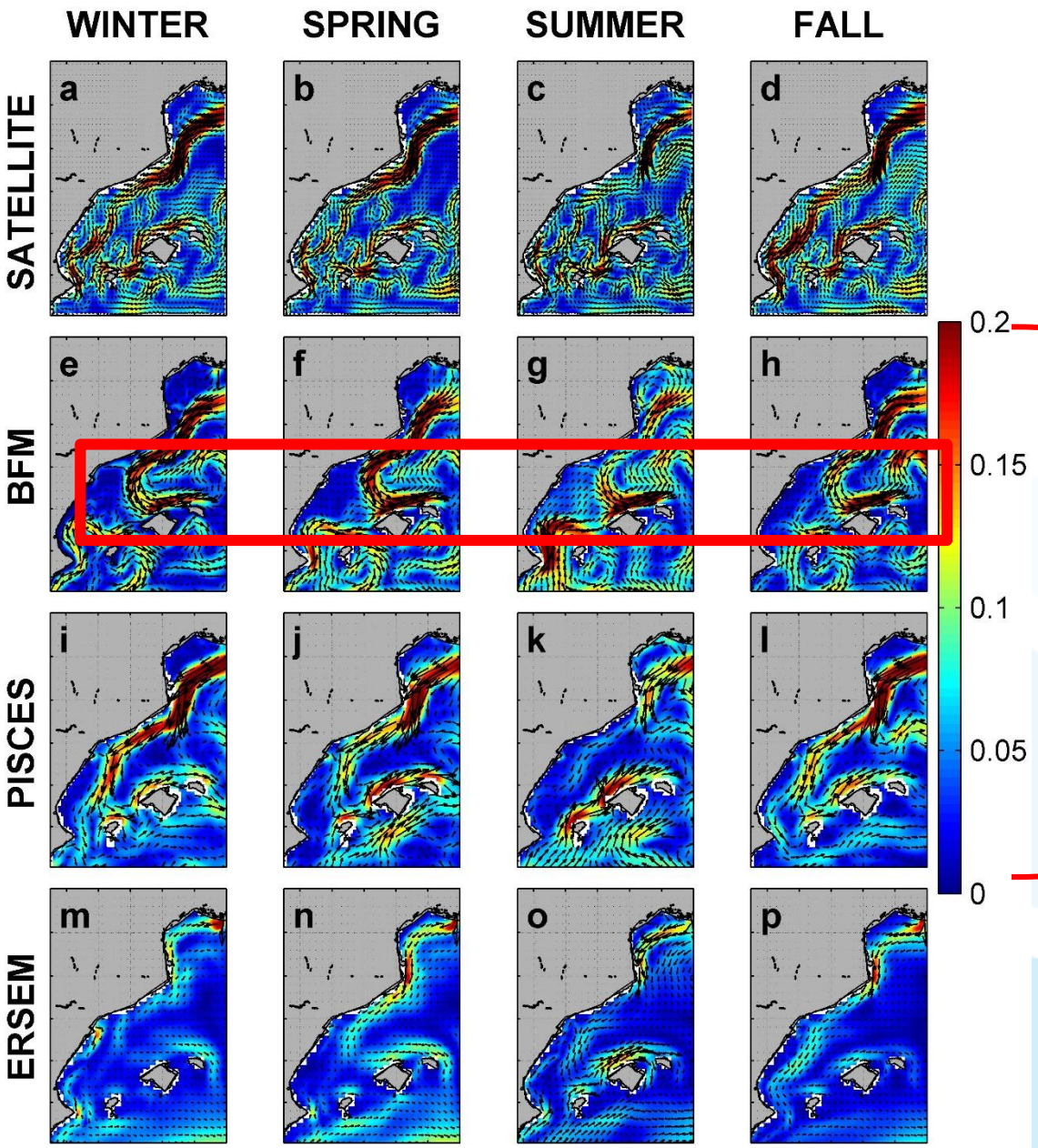
-from CMEMS platform including **SST**, **chlorophyll** and geostrophic currents (**u,v**) from SLA.

- ***In situ***

-public databases from **oceanographic surveys**: IBAMAR, MEDAR-MEDATLAS, CMEMS *in situ* products monitoring station (OOCS) and **high spatial resolution glider data** from SOCIB

-**T,S, density, chlorophyll, nutrients (nitrate, phosphate)**

-Monthly averaged obs vs. monthly output



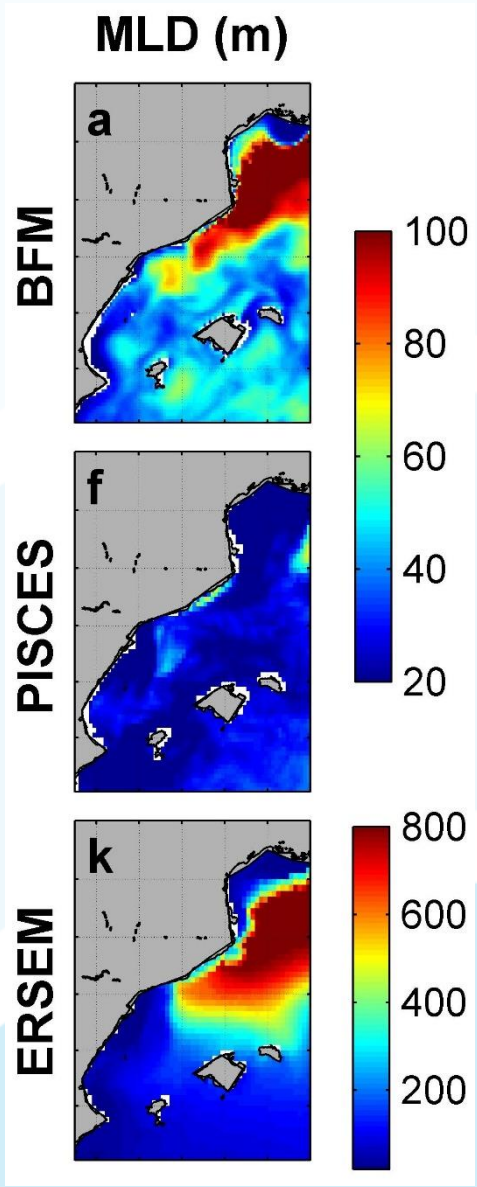
Circulation patterns (m/s)

-Well captured: **Northern Current** and Balearic Current (SLH assimilation)

- **BFM: N Currenct connected to Balearic C.**
- **Atlantic influence in South side**

-Less intense patterns

Density patterns



Mixed Layer Depth (MLD)-February

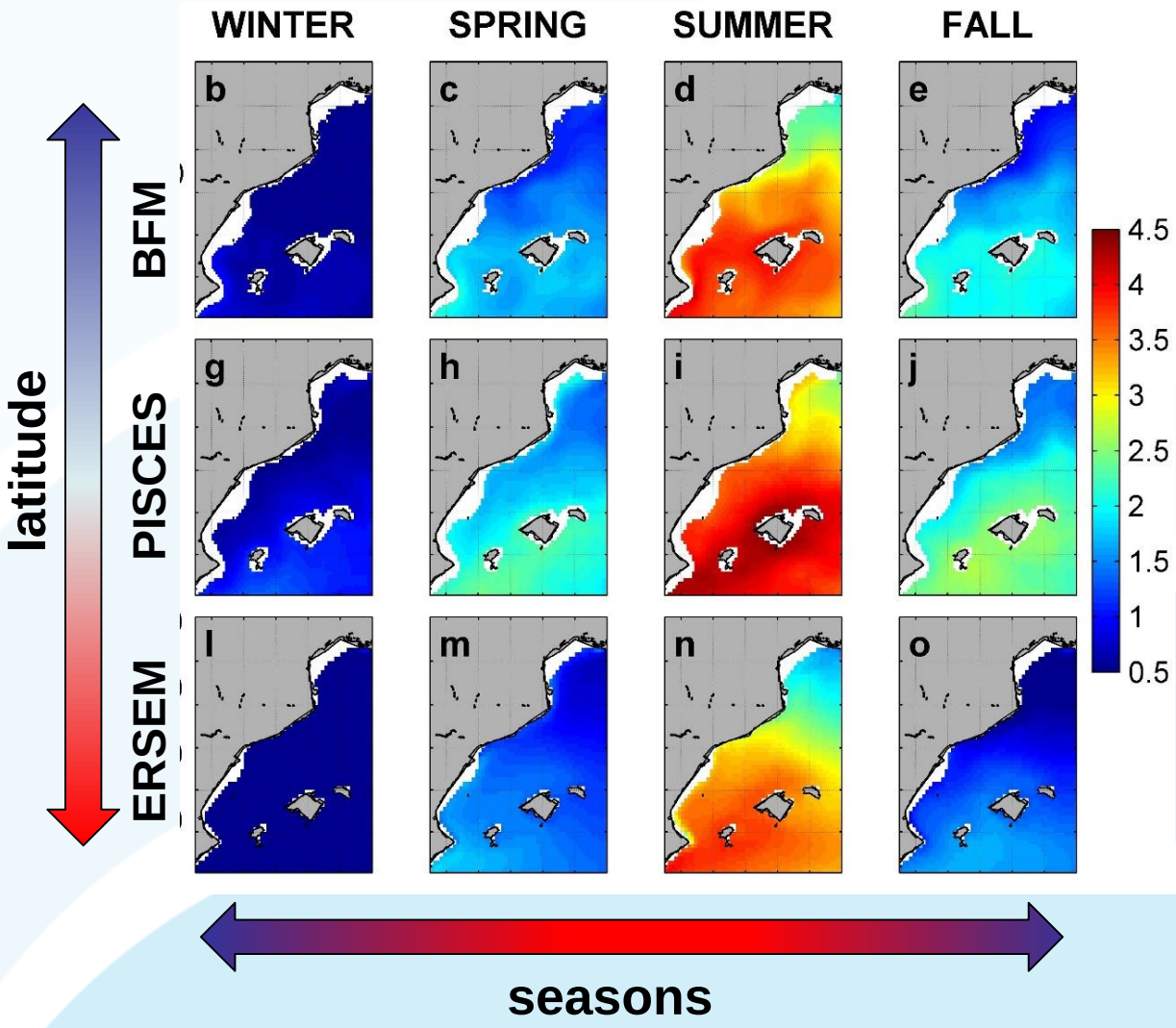
-density threshold criterion-0.03 Kg m^{-3}

- Climatology (e.g. Lavigne et al., 2013) :

-50 m (No bloom-Algerian subbasin, Balearic Channels), 85 m (Intermittent bloom-NW, CS), and 100 m (Bloom region, Gulf of Lion).

- Unrealistic intense mixing in **ERSEM**
- Input of nutrients and timing and strength of **late Winter/Spring bloom**

Density patterns



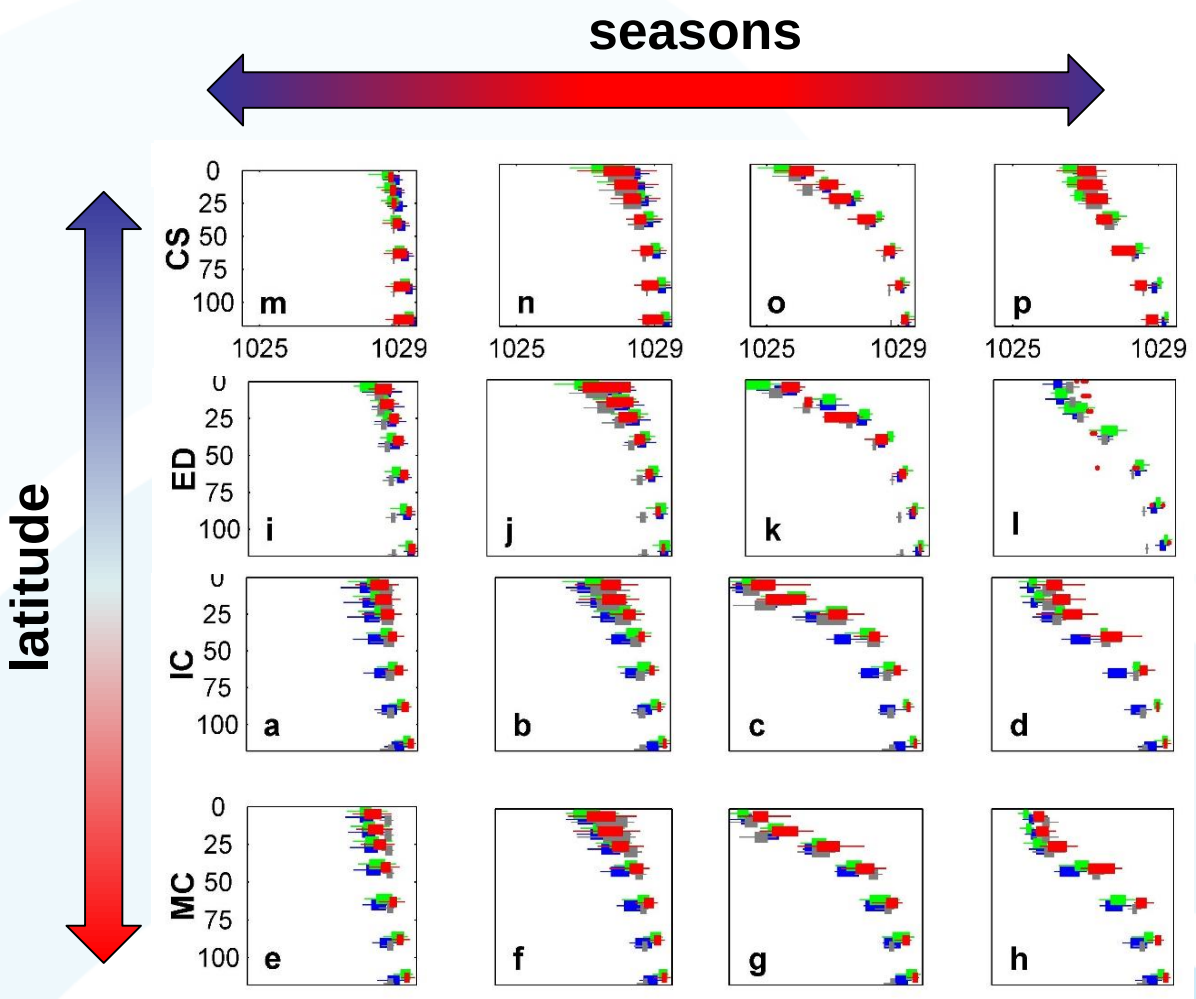
Density gradient

(10-90 m) (kg m^{-3}):

proxy of **stratification**

- seasonal cycle (warming/mixing)
- North-South gradient (less clear in ERSEM)

Density profiles: seasonal climatology



-seasonal cycle (warming/mixing)

-North-South gradient

-small discrepancies among models

Observations BFM PISCES ERSEM

Nutrient patterns: Nitrate

<u>Nutrient inputs</u>:

- **Riverine discharge:**

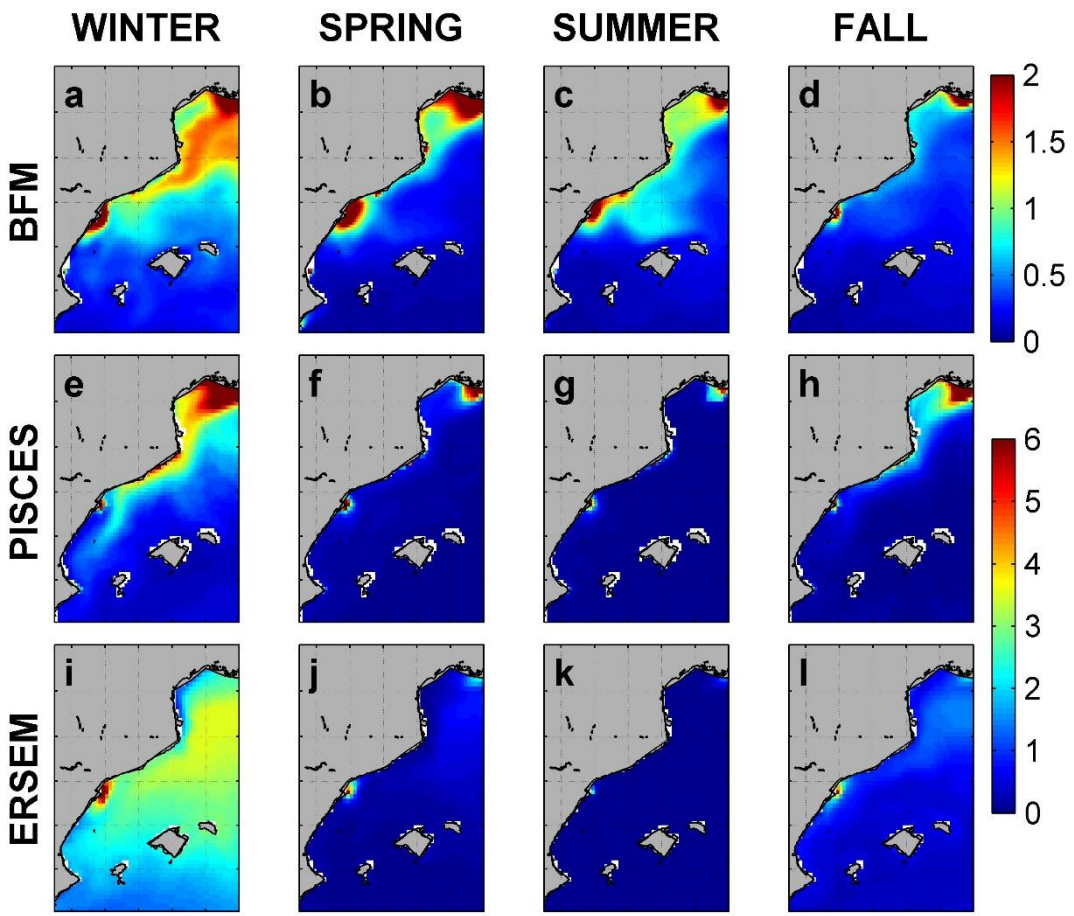
Ebro river

Rhone river

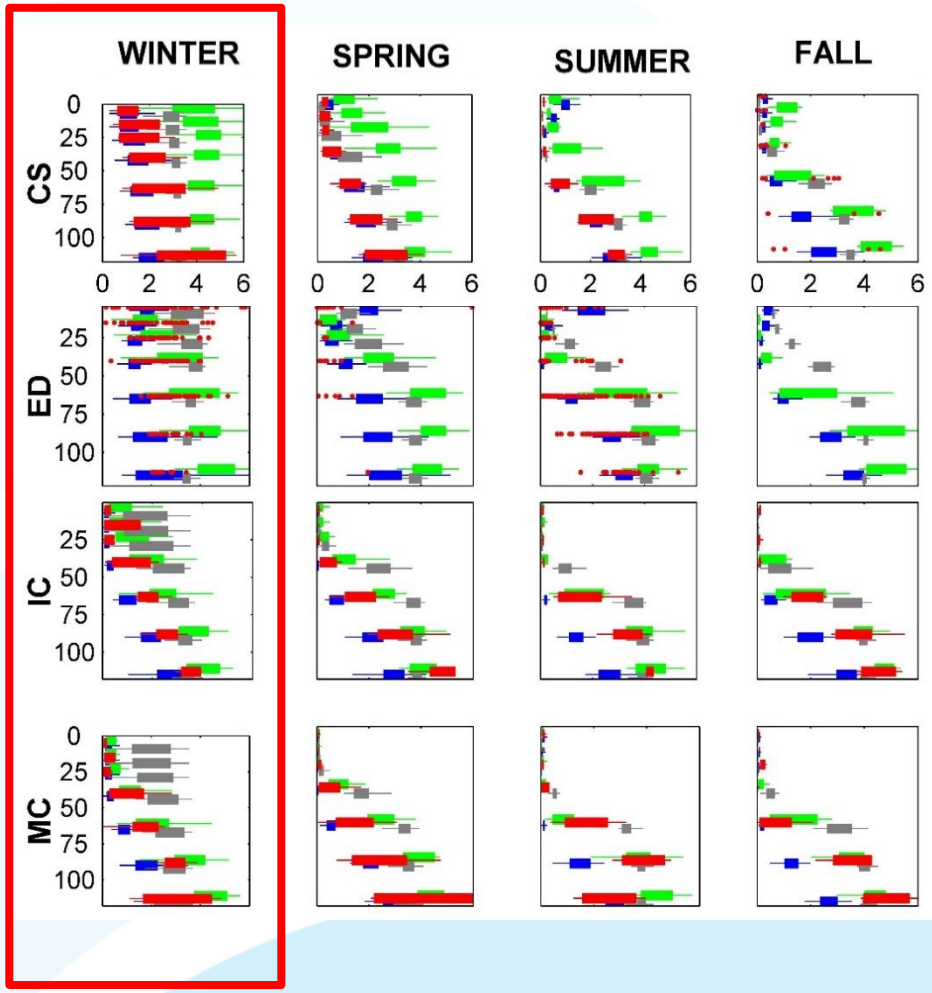
- **Overall Overestimation in PISCES**
- **Summer in BFM**
- **Ebro in PISCES**

- **Winter mixing**

Overestimation in ERSEM



Nitrate profiles



- **Riverine nutrient:**

-Overestimated in **PISCES**

-Summer in **BFM**

-Ebro in **ERSEM**

- **Winter mixing:**

-Overestimated in **ERSEM**

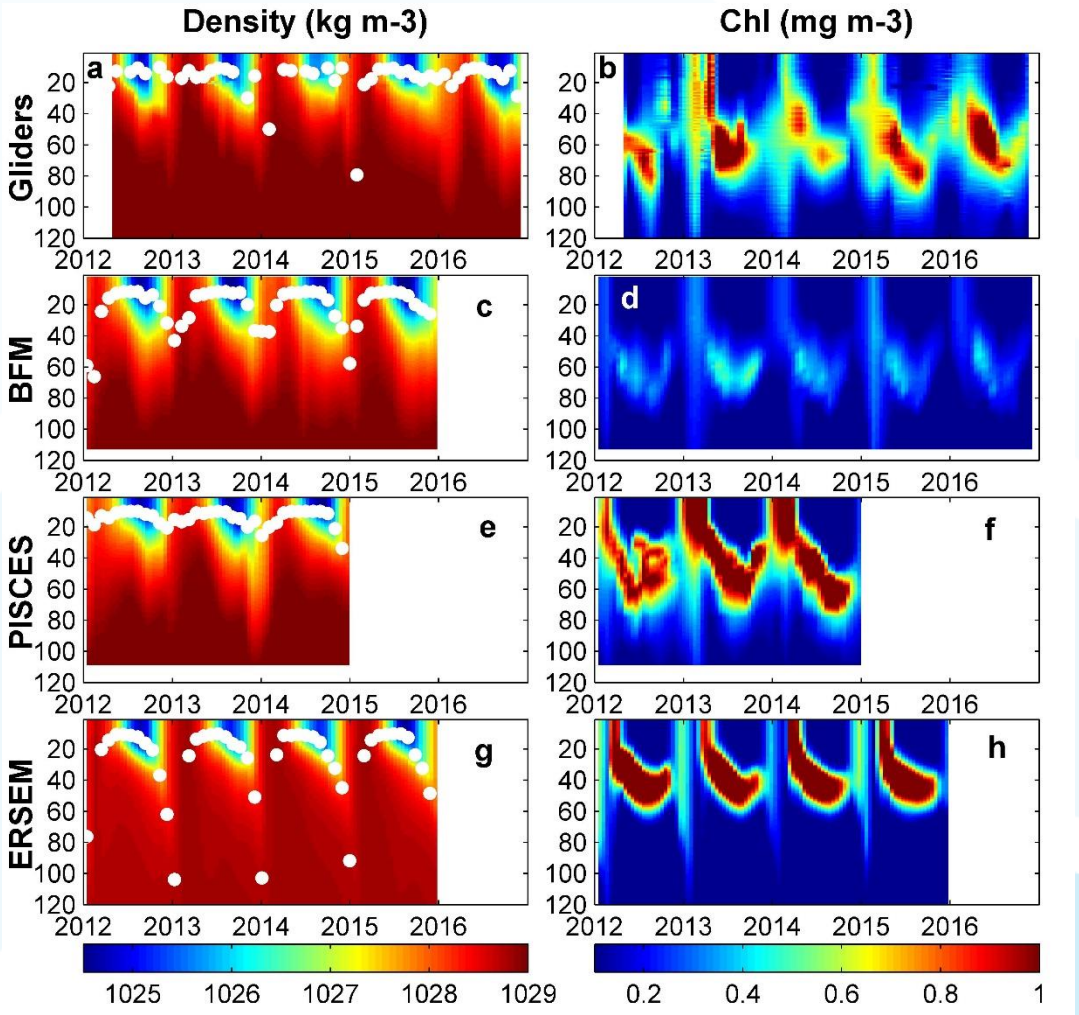
- **Balearic Channels:**

Constant nutricline (stratification)

-overestimation in deep layers **PISCES/ERSEM**

Observations BFM PISCES ERSEM microM

Temporal series of density/chlorophyll: Ibiza Channel



White dots-Mixed Layer Depth

Gliders data

-late winter bloom during less intensified stratification

-Deep Chlorophyll Maximum

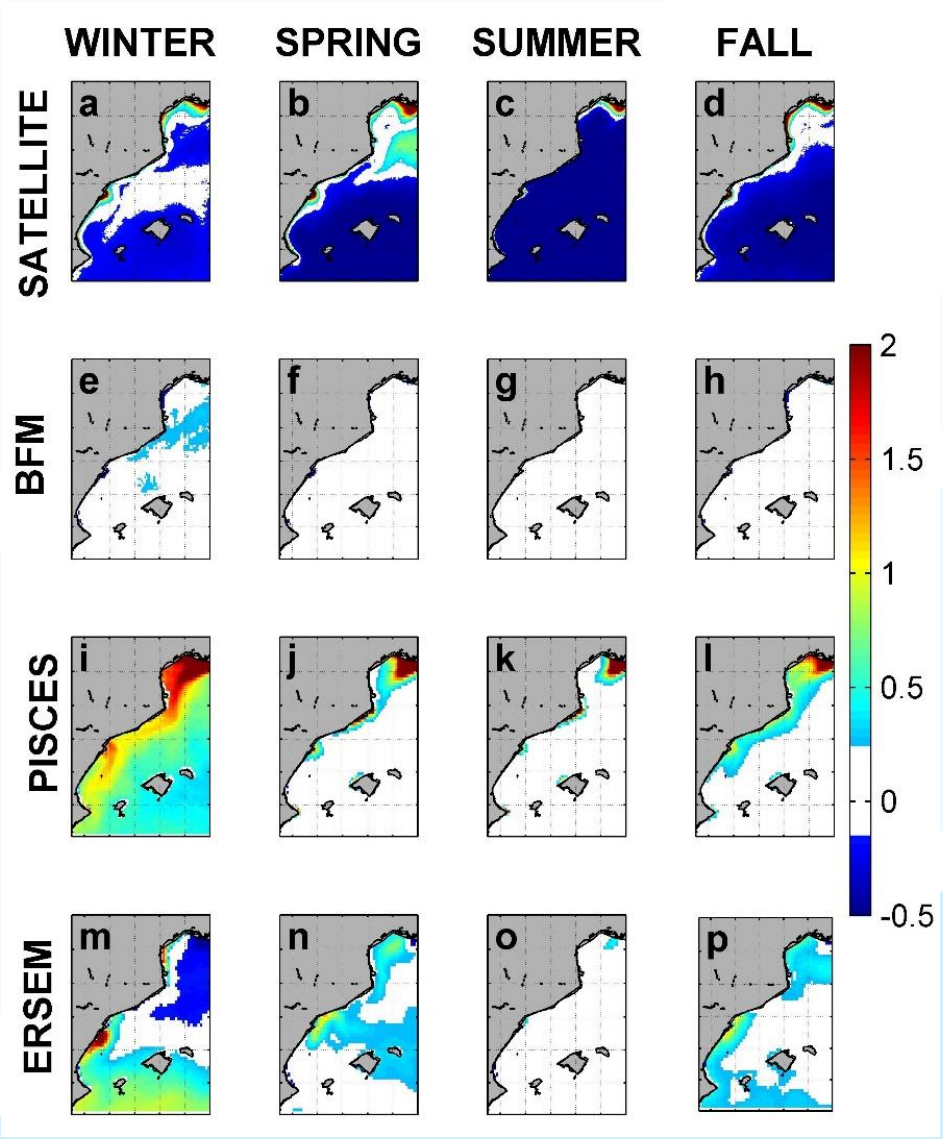
(deepening along spring-summer)

ERSEM: winter mixing (light limitation)

Southside basin:

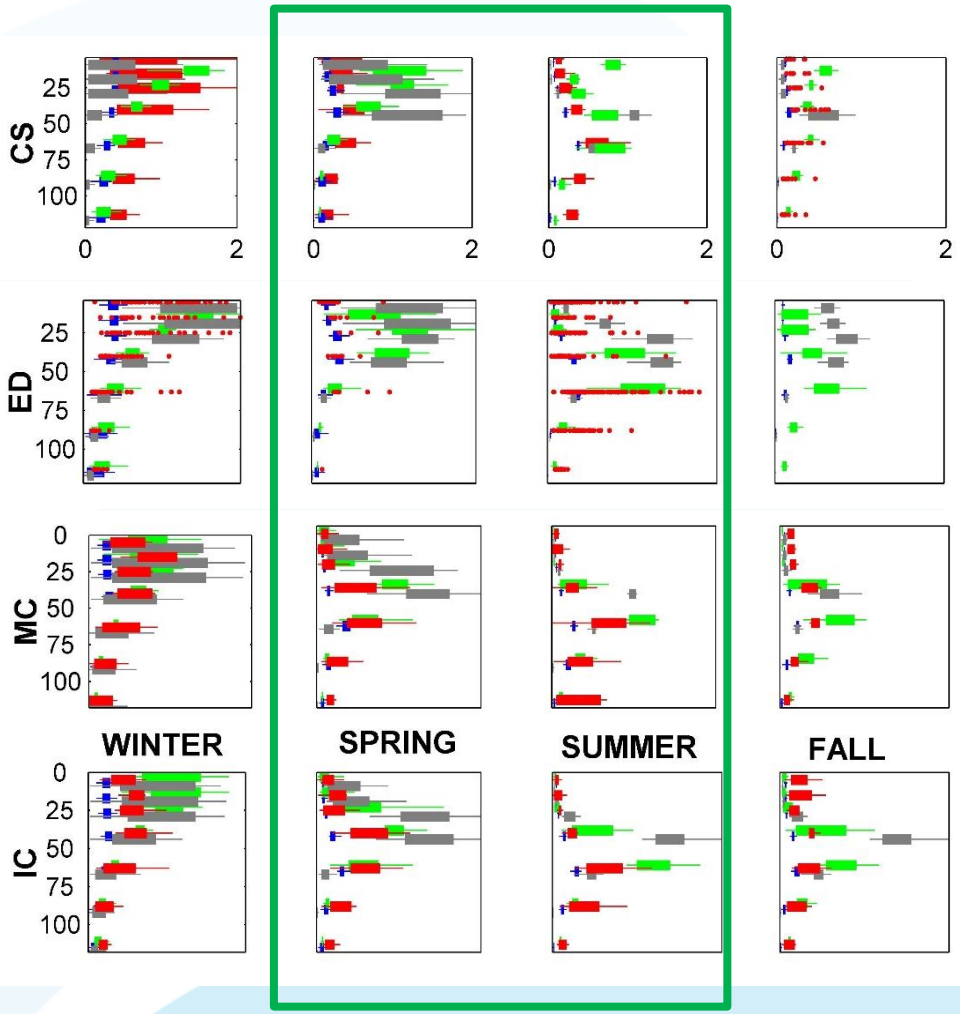
Stratification domines

Surface chlorophyll patterns



- **<u>Surface chlorophyll</u>** from satellite
- **<u>Absolute difference</u>** with models (mg m^{-3})
- **BFM**: assimilation
- **PISCES:** riverine input overestimated
- **ERSEM:** winter mixing, riverine input and Atlantic inflowing waters

Chlorophyll profiles: **DCM**



- **BFM:** subestimation

(lower deep nutrient levels and assimilation)

- **PISCES:** slight overestimation
- **ERSEM:** shallower and overestimated-lower stratification

Observations BFM PISCES ERSEM

mg m^{-3}

Conclusions

- **Circulation patterns:** proper performance with assimilation (**BFM**,**PISCES**)
- **Density patterns:** proper performance (**BFM**,**PISCES**)

excepting **ERSEM**: **winter mixing and less stratification-improper timing and magnitude bloom/DCM**)

- **Riverine nutrient input:** overestimated in all simulations but outstanding in **PISCES** (masking several processes)

- **DCM:**

-underestimated in **BFM** **(**lower deep nutrients and assimilation**)**

Thanks for your attention and questions!

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