Challenges and Opportunities for biogeochemical prediction

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Inspiring Minds

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Motivation for biogeochemical prediction

- Climate projections
- Hindcasts/reanalyses
- Short-term and seasonal forecasts
- Scenarios

Clear need!

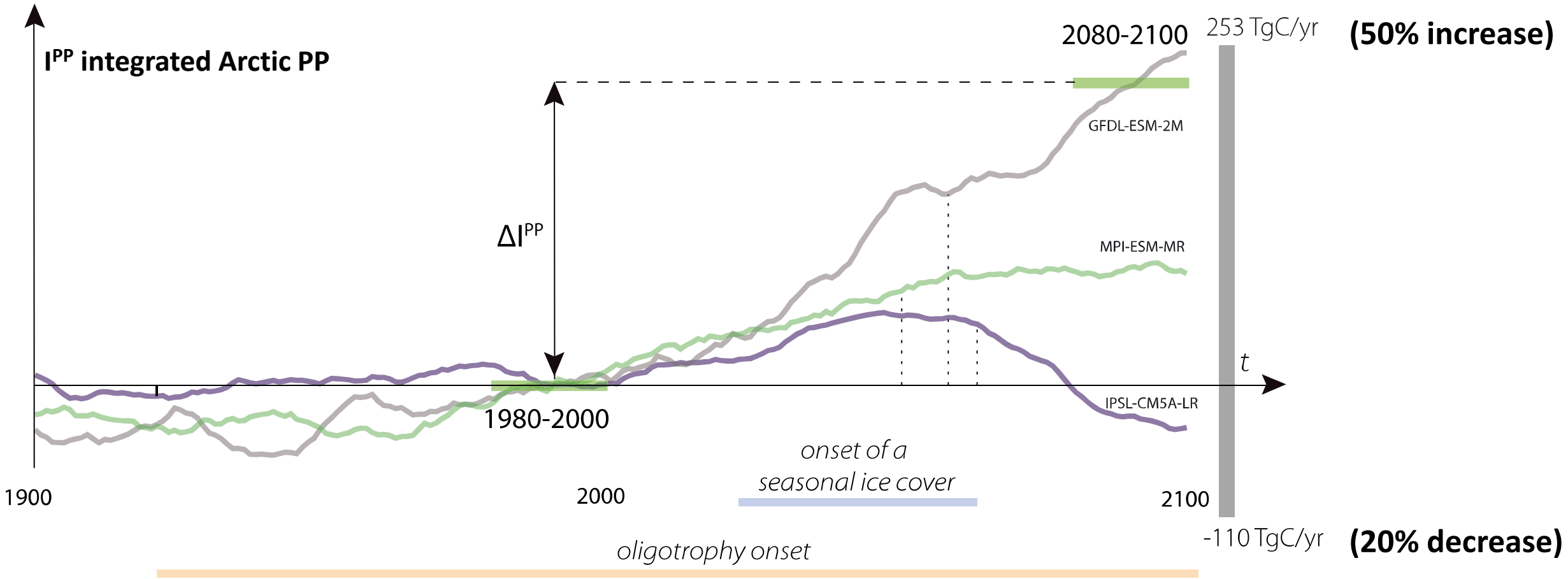
Scientific and societal applications:

1) Carbon cycle research, carbon accounting
- Quantification of carbon uptake, sequestration
- National carbon accounting
- Sensitivity of carbon fluxes to climate forcing, shifting baselines
- Climate projections

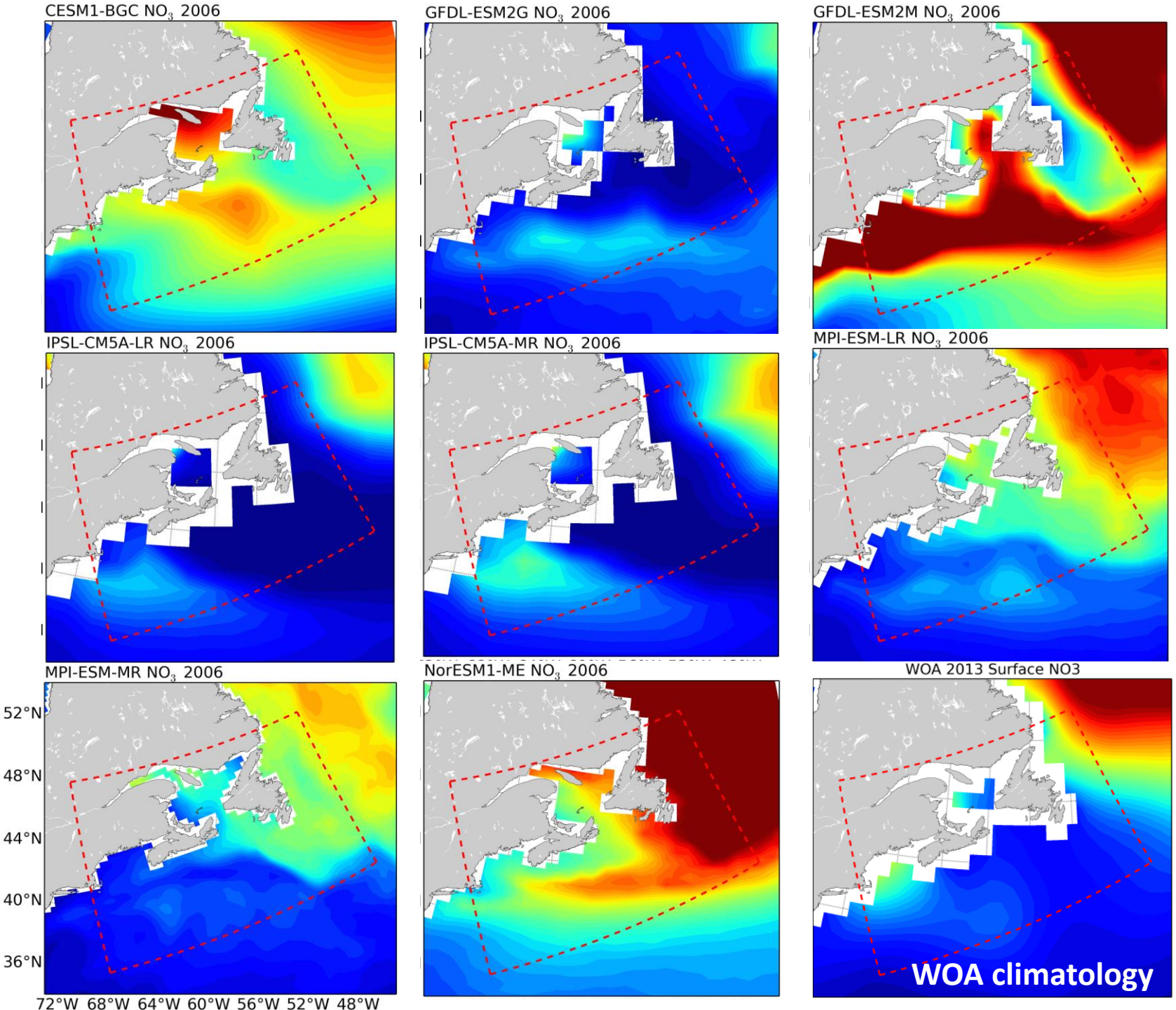
2) Marine productivity/ecosystems
- Fisheries management
- Conservation of endangered species
- Design of MPAs
- Future projections for ecosystems

<u>Problem:</u> Large-scale biogeochemical models at present not properly validated, constrained by observations (satellite chl is not enough).
Especially problematic because these models are not based on first principles, highly non-linear, and have many poorly known parameters.

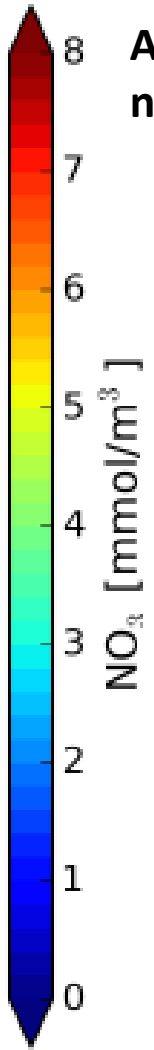
Vancoppenolle et al., *Global Biogeochem. Cycles* (2013)



Average Primary Production anomalies in the Arctic Ocean
Ranges are from 11 CMIP5 models, trajectories from three selected models

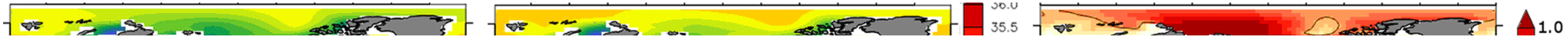


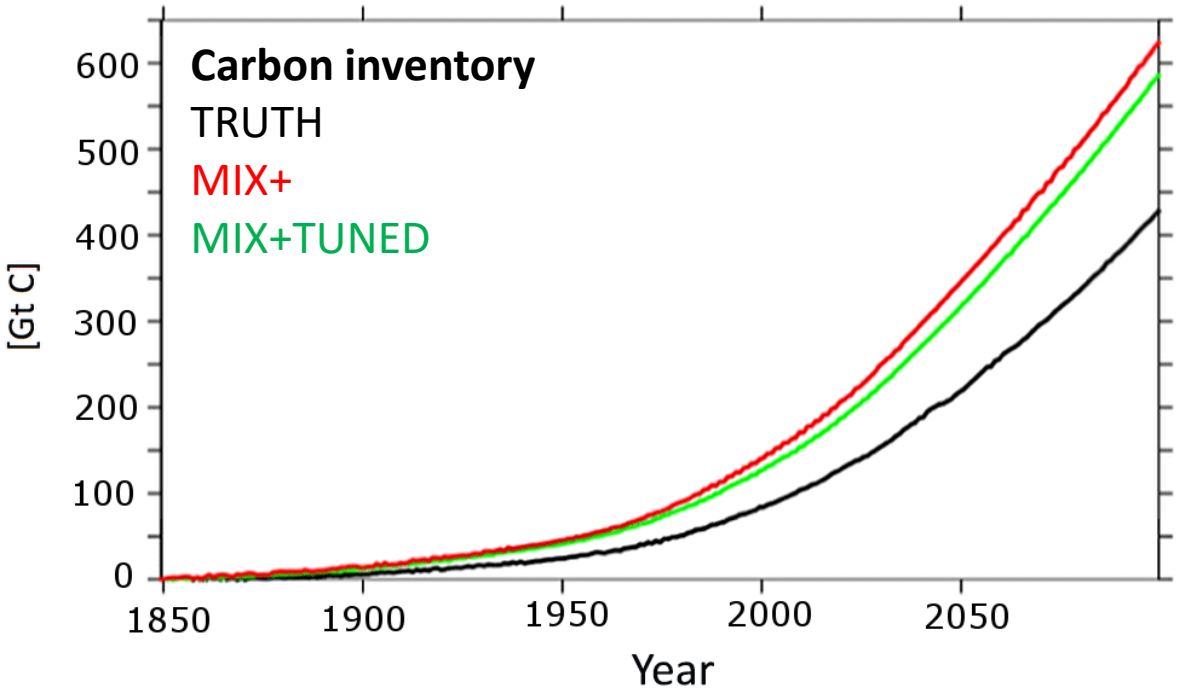
Regional comparison of CMIP5 models in the northwestern North Atlantic

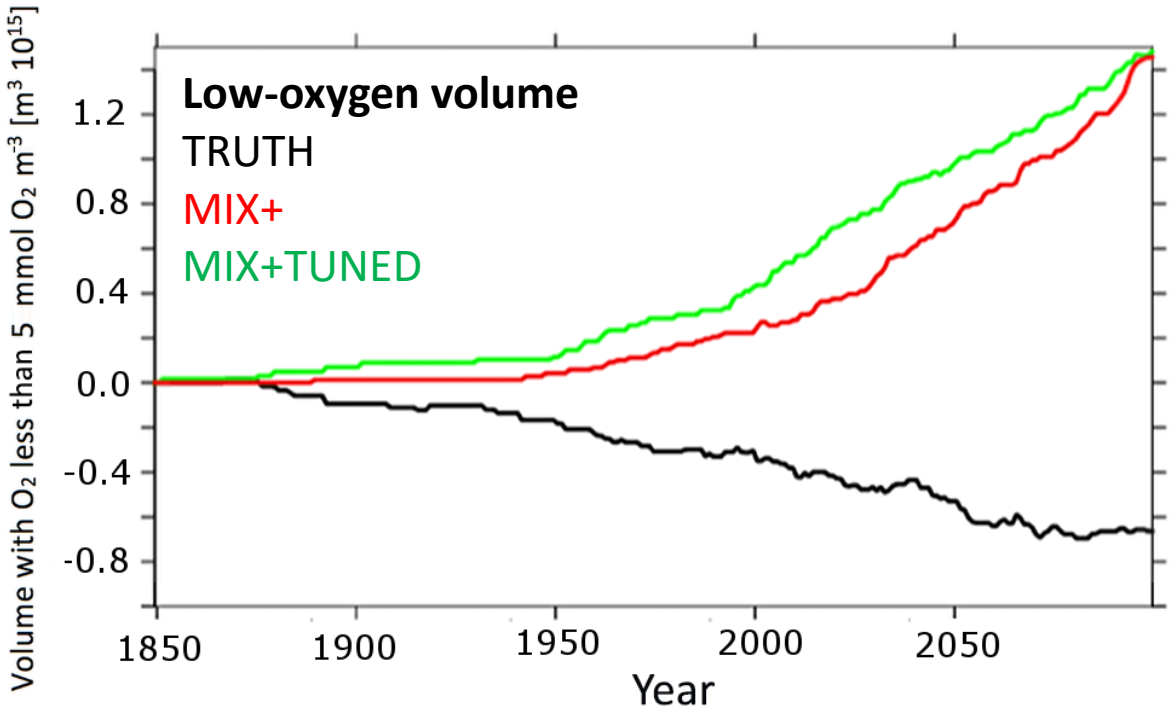


Annual average surface nitrate concentration

Löptien and Dietze, *Biogeosciences* (2019)







UVic Earth System Model
Defined one model configuration as TRUTH
Increased vertical mixing in a twin: MIX+
Retuned bgc model parameters: MIX+TUNED

Ran for historical and RPC8.5 emissions

Opportunities Global Biogeochemical Float Array

Number of floats: ~1000

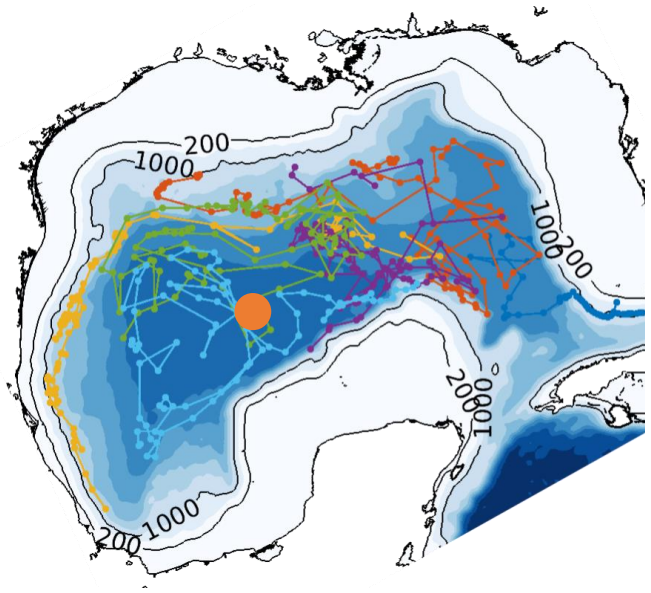
Schedule: 250 new floats per year (assuming lifetime of 4 years)

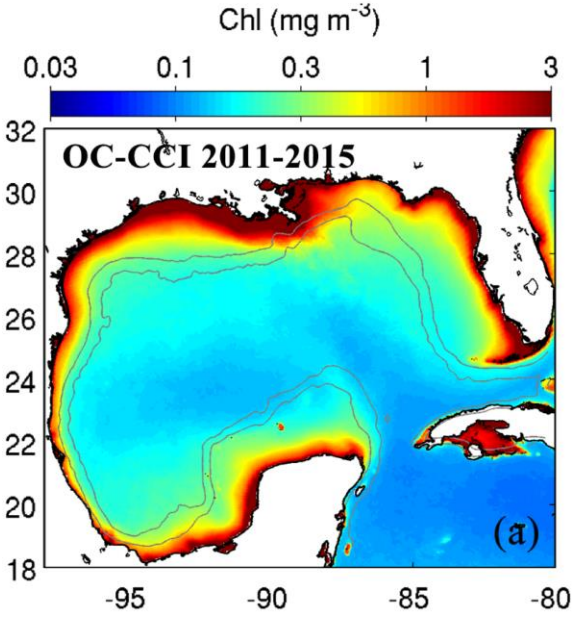
Cost: US$100,000 per float, US$25M total per year

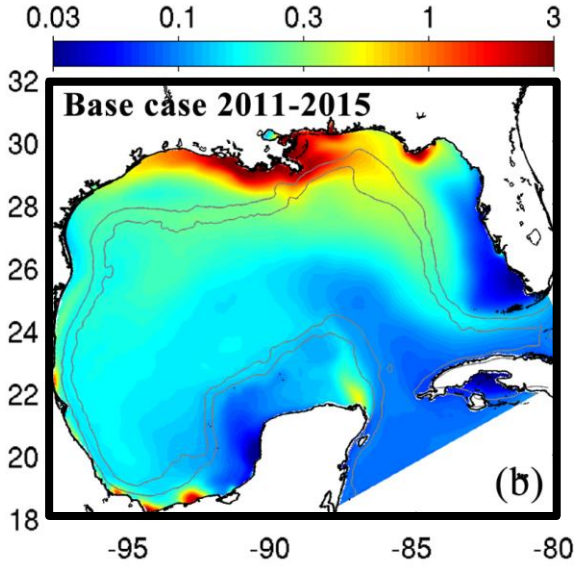
Parameters	EOV type
oxygen	1, 3, 4
nitrate	1, 4
pH	1, 4
chlorophyll (fluorometer, radiometer)	2, 3, 4
suspended particles (backscatter)	3
downwelling irradiance	3, 4

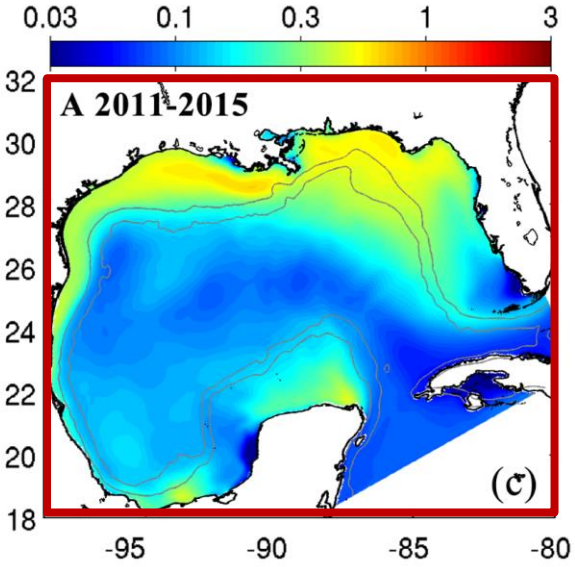
1 Essential Ocean Variable (EOV)
2 Essential Ecosystem Variable (eEOV)
3 Biogeochemical EOV
4 Essential Climate Variable (ECV)
(see Table 1 in Science & Implementation Plan for more details)

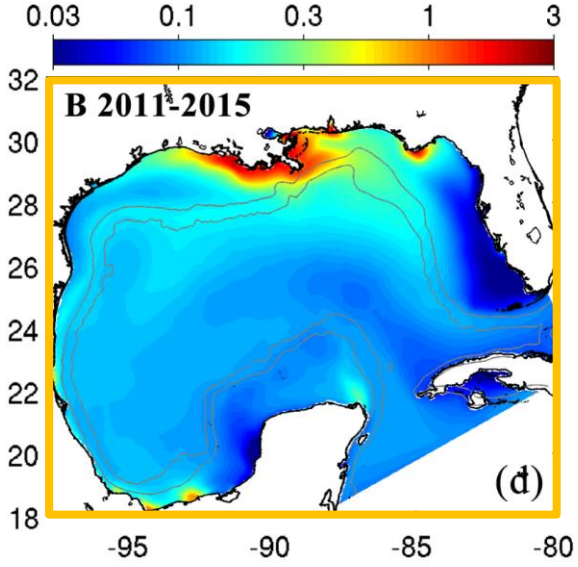
Biogeochemical model optimization using BGC Argo float observations

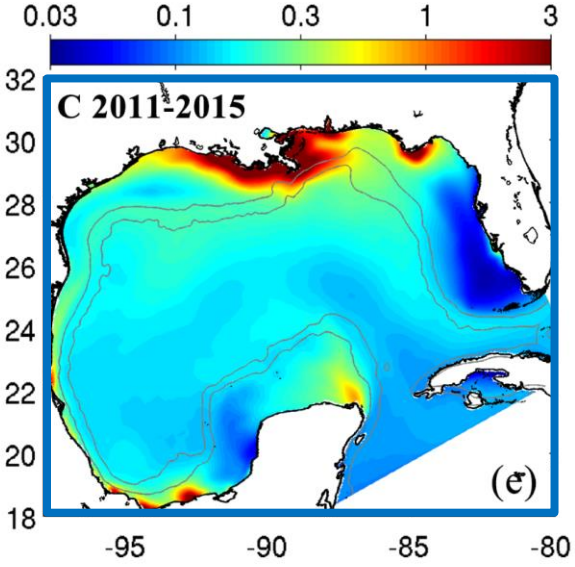












Baseline & obs.

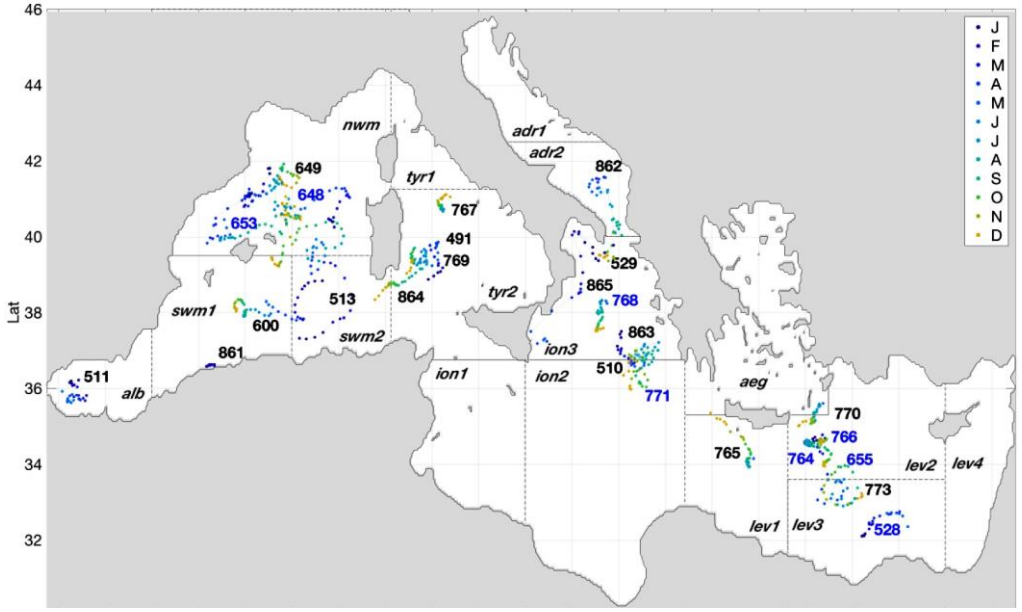
A: satellite chl

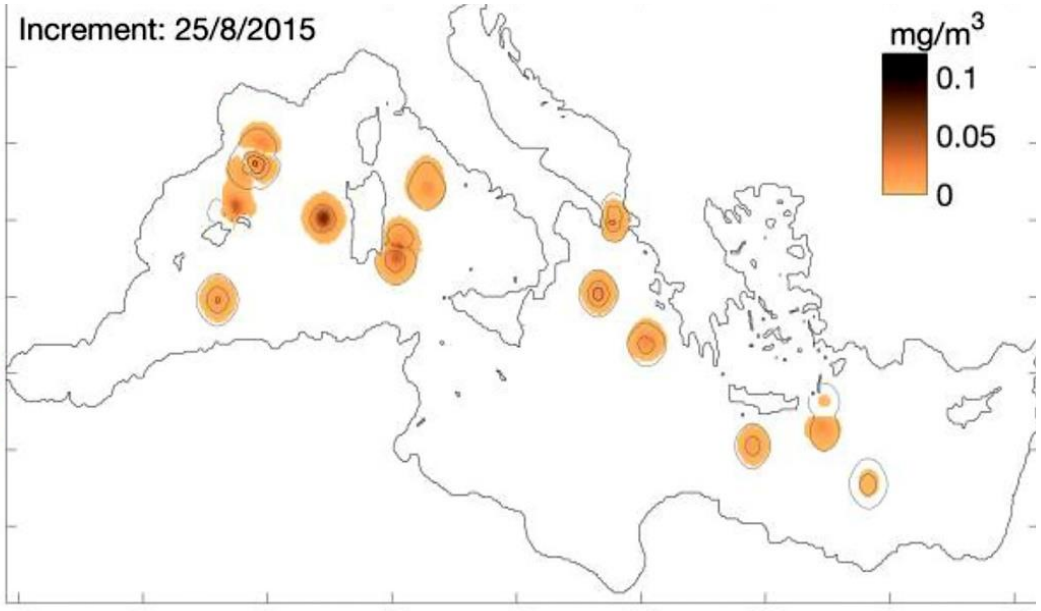
B: satellite chl + float ch

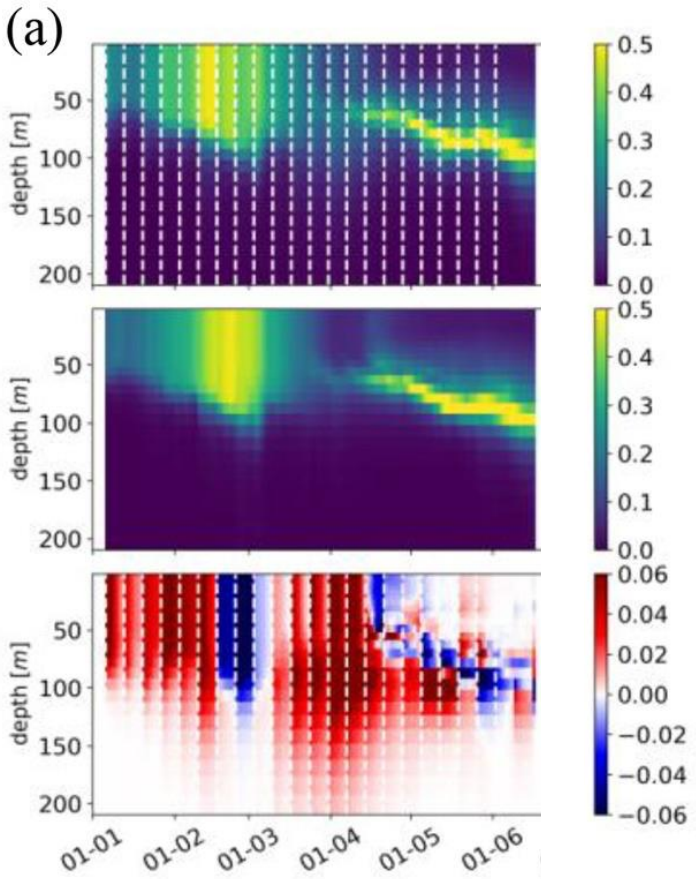
C: satellite chl + float ch
phy/POC

Talk by Bin Wang today at 12:00 in room 507

Cossarini et al., *Ocean Modelling* (2019)







Assimilation of BGC Argo profiles in operation model of the Mediterranean Sea

Talk by Gianpiero Cossarini was yesterday

Opportunities

GODAE OceanView's Marine Ecosystem Analysis and Prediction (MEAP) Task Team (TT)

>20 members from operational agencies and academia

Working with other TTs as appropriate (DA TT & OseVal TT)

See Mini Review in OceanObs SI for more details

frontiers in Marine Science

MINI REVIEW
published: 13 March 2019
doi: 10.3389/fmars.2019.00089

Check for updates

Advancing Marine Biogeochemical and Ecosystem Reanalyses and Forecasts as Tools for Monitoring and Managing Ecosystem Health

Katja Fennel[1], Marion Gehlen[2], Pierre Brasseur[3], Christopher W. Brown[4], Stefano Ciavatta[5], Gianpiero Cossarini[6], Alessandro Crise[6], Christopher A. Edwards[7], David Ford[8], Marjorie A. M. Friedrichs[9], Marilaure Gregoire[10], Emlyn Jones[11], Hae-Cheol Kim[4,12], Julien Lamouroux[13], Raghu Murtugudde[14], Coralie Perruche[13] and the GODAE OceanView Marine Ecosystem Analysis and Prediction Task Team*

Talk by Marion Gehlen today at 2:30 in room B3

Take home points

- **Clear need for biogeochemical predictions & projections**
- **Need biogeochemical observation streams (BGC Argo!) – our community needs to engage**
- **GODAE OceanView provides framework for information exchange, coordination & collaboration; Propose MEAP activity on BGC Argo assimilation (talk to me if interested!)**