Can pCO_2 observations help constrain predator-prey interactions in a biological model?

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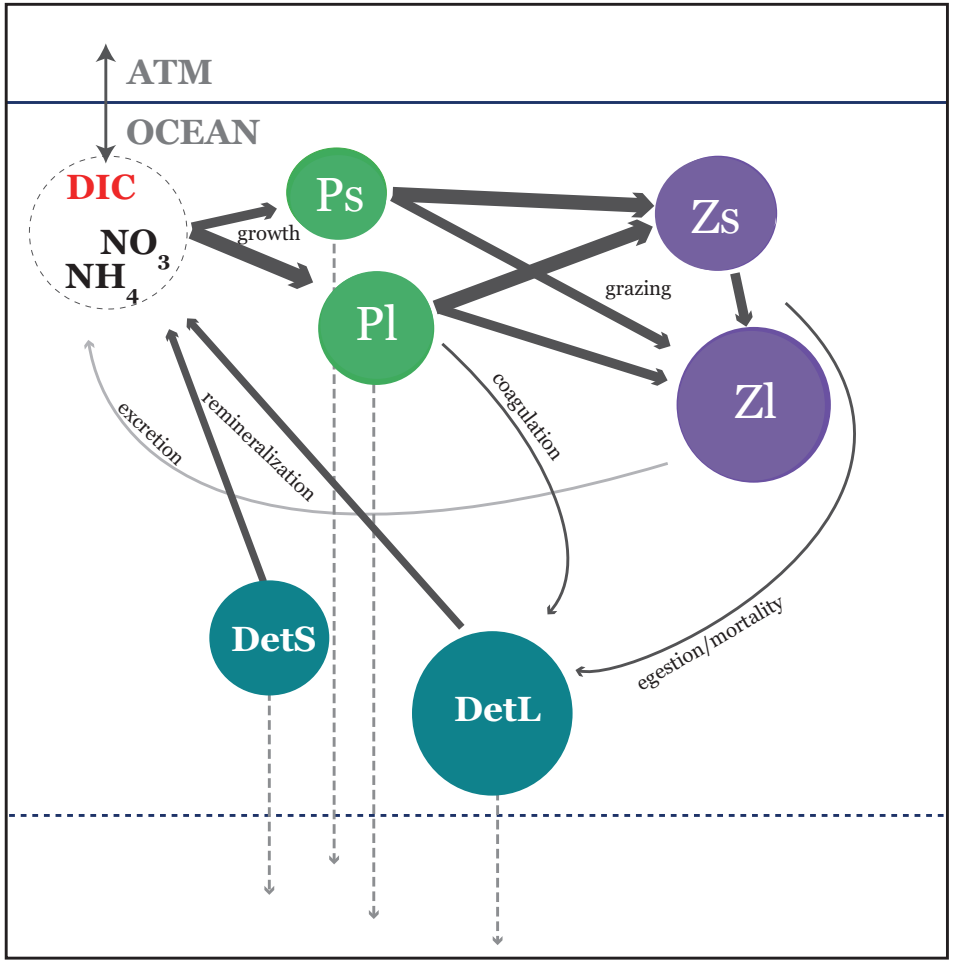
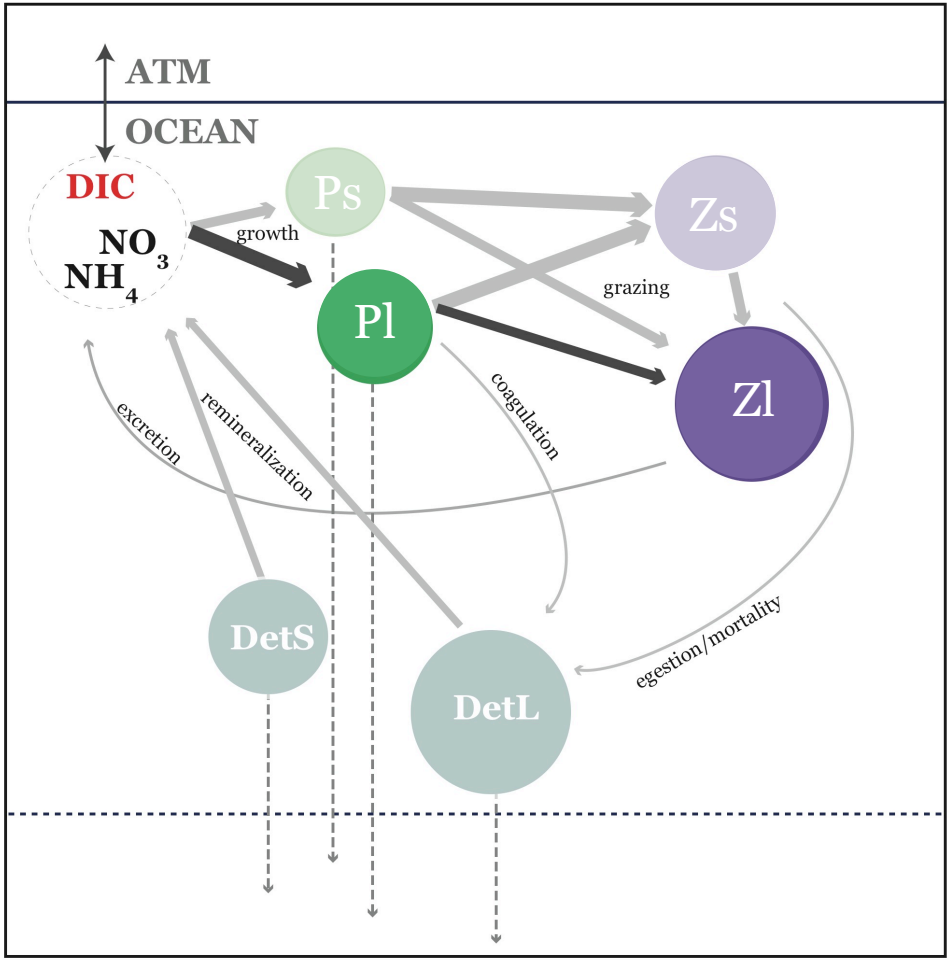

ATM
OCEAN
DIC
NO3
NH4
Ps
Pl
Zs
Zl
growth
grazing
excretion
remineralization
coagulation
egestion/mortality
DetS
DetL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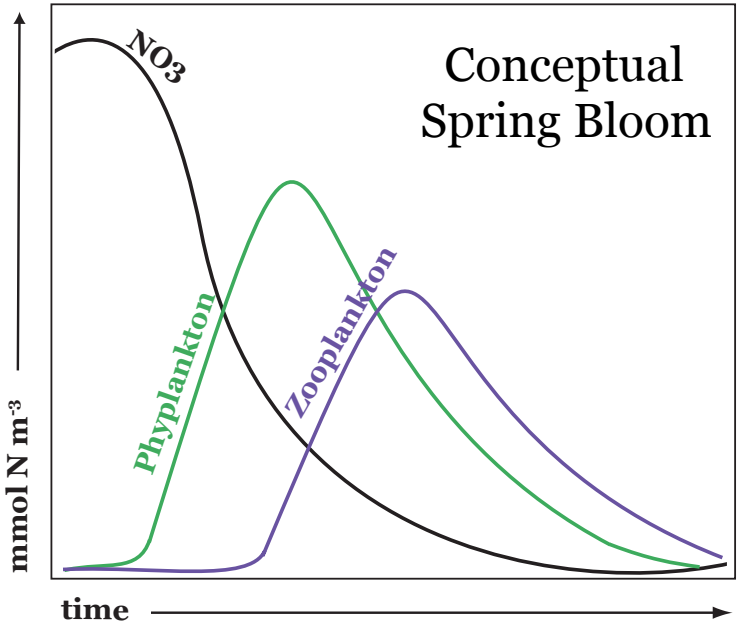
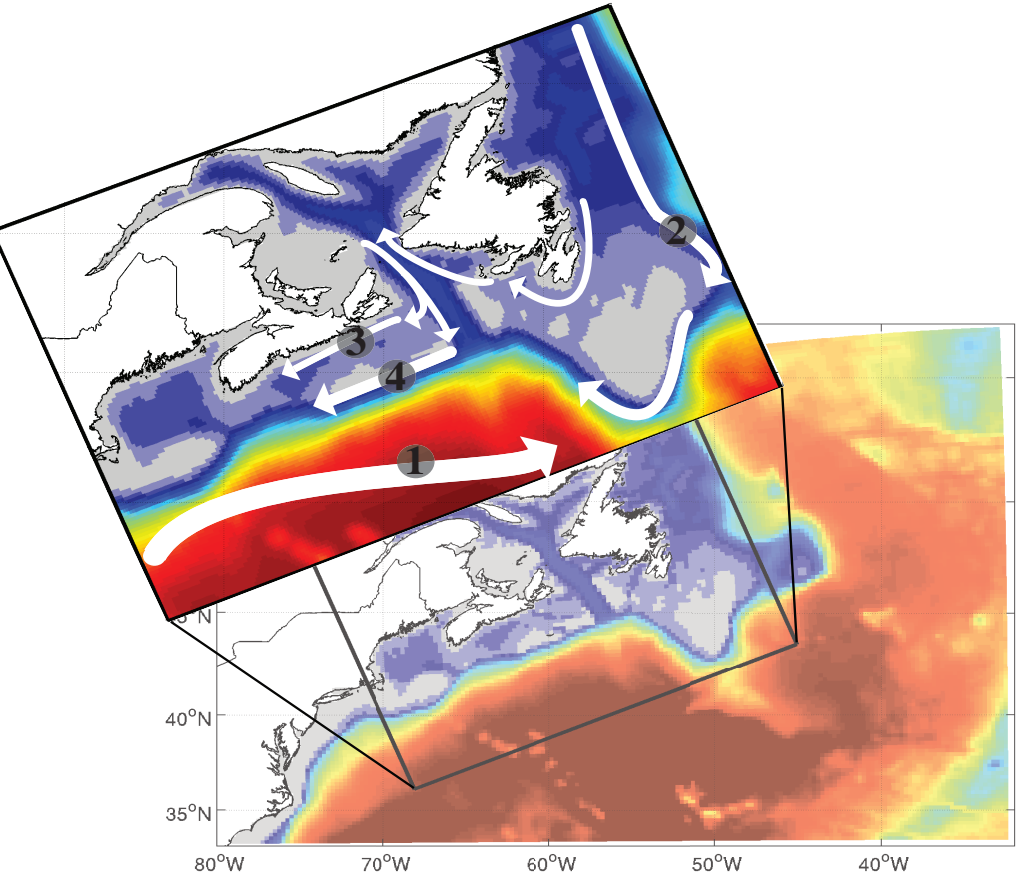
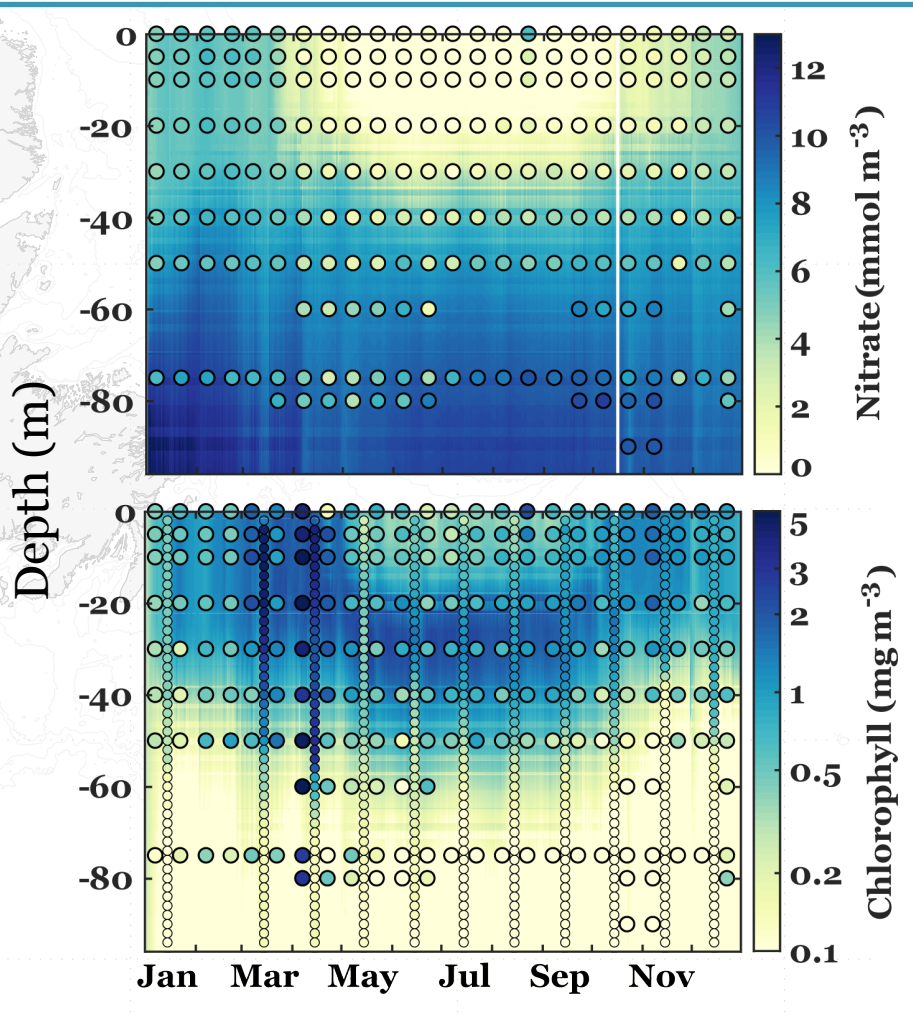

NO3
Conceptual
Spring Bloom
Phyplankton
Zooplankton
mmol N m-3
time

Biogeochemical ROMS implementation for Atlantic Canada



- 10 km horizontal resolution
- 30 vertical layers
- Physical B.C. from Urrego-Blanco & Sheng (2012)
- Biochemical B.C. from observations
- 3-hourly ECMWF ERA-Interim atmospheric forcing
- 12 major rivers
- Tides
- No ice
- HSIMT advection scheme

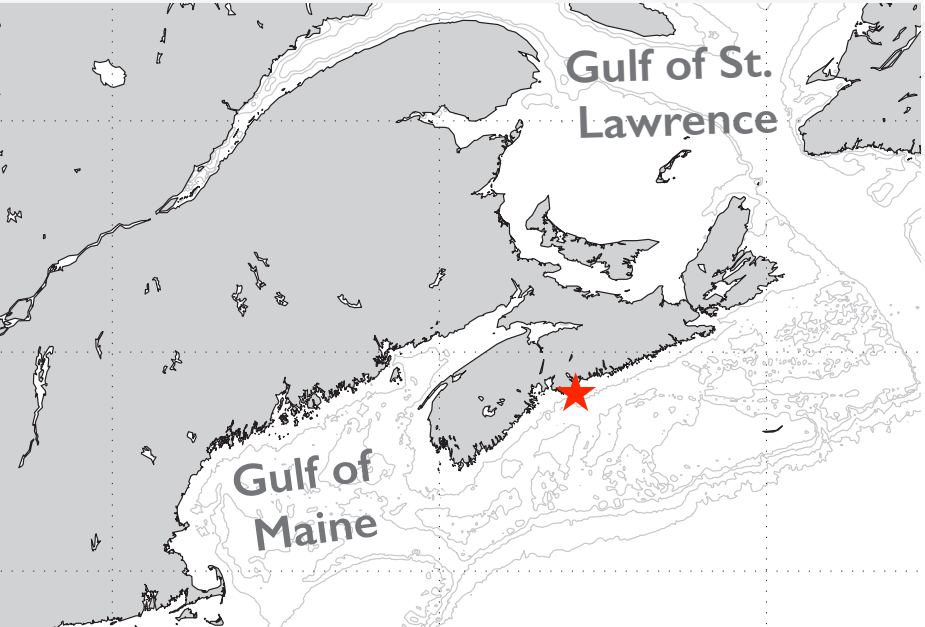

Gulf of St. Lawrence
Gulf of Maine

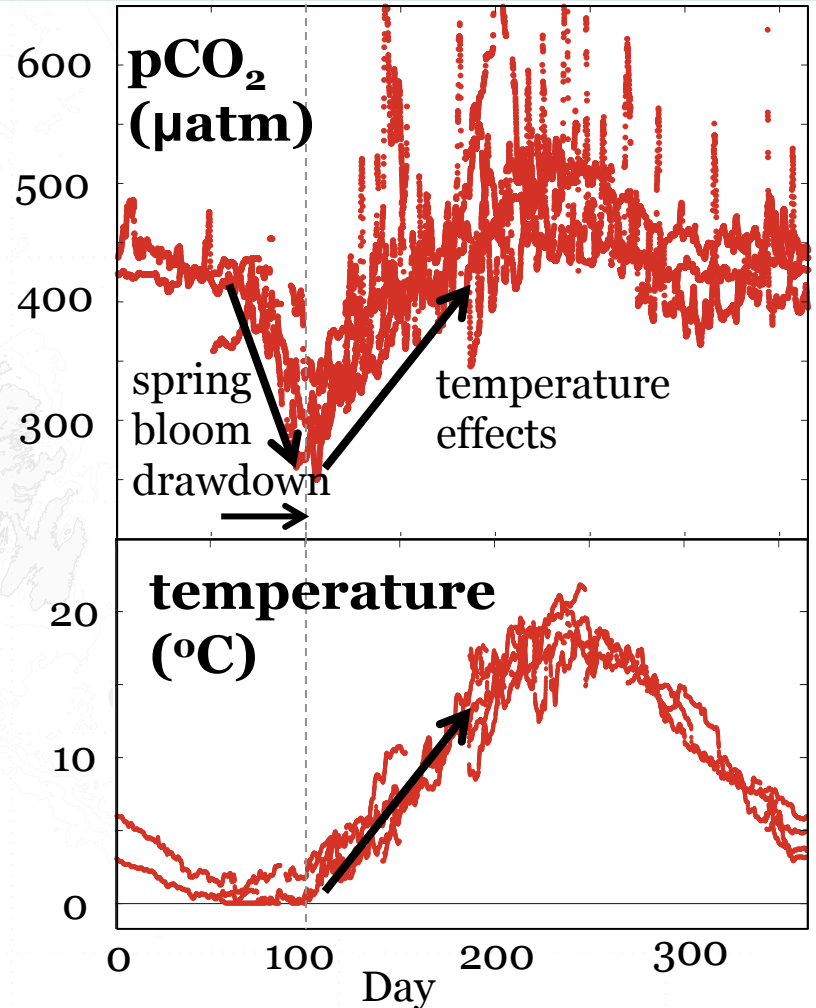

Depth (m)
0
-20
-40
-60
-80
Jan
Mar
May
Jul
Sep
Nov
Nitrate (mmol m-3)
12
10
8
6
4
2
0
Chlorophyll (mg m-3)
5
3
2
1
0.5
0.2
0.1

CARIOCA Buoy Observations (2009-2014)

biological effects: ↓DIC ↓pCO_2

temperature effects: ↑temp ↑pCO_2





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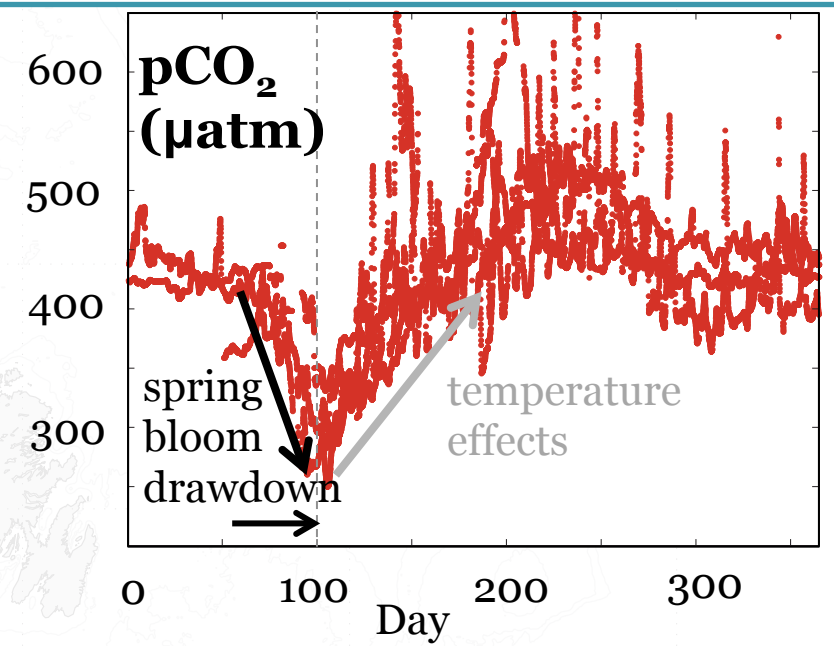
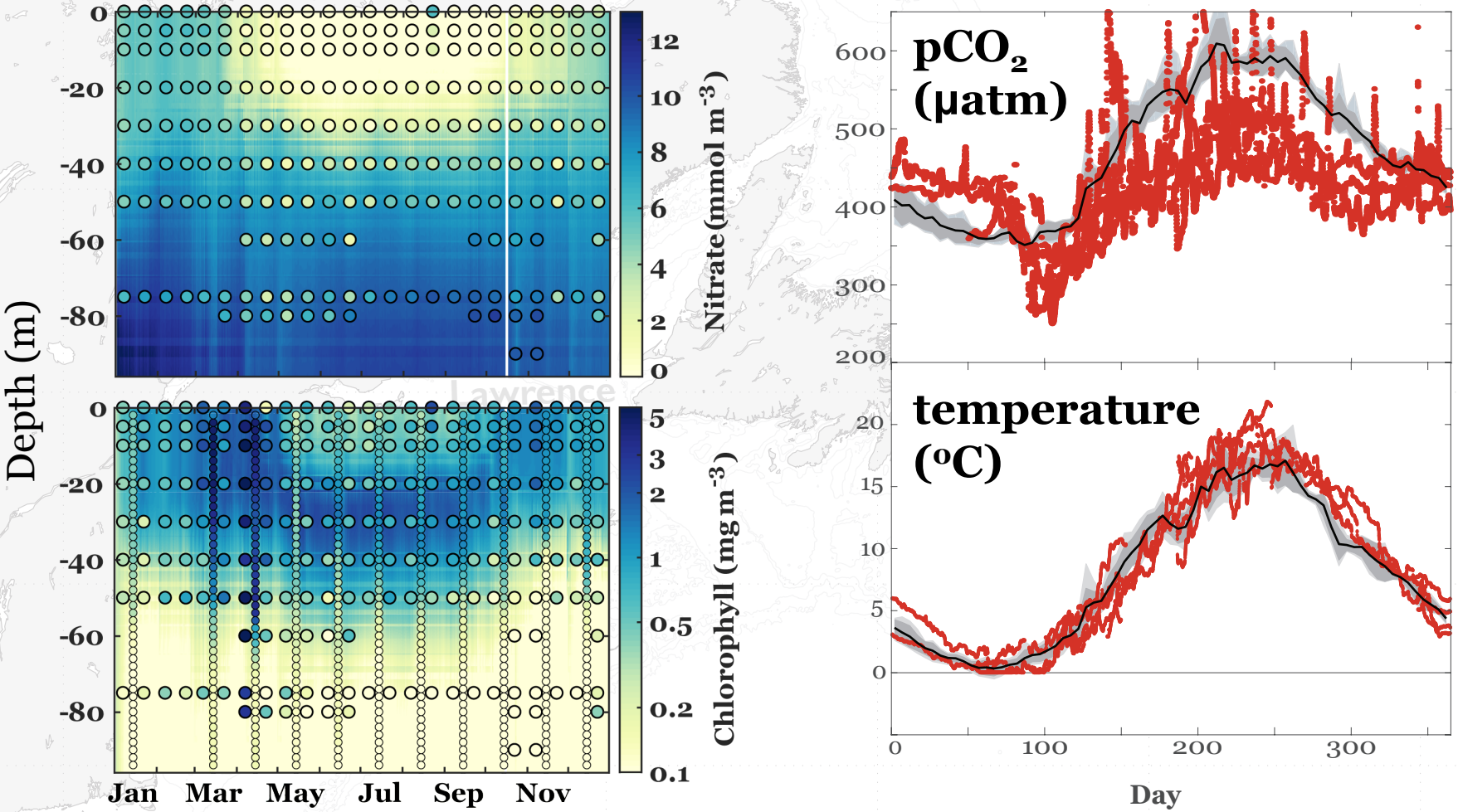


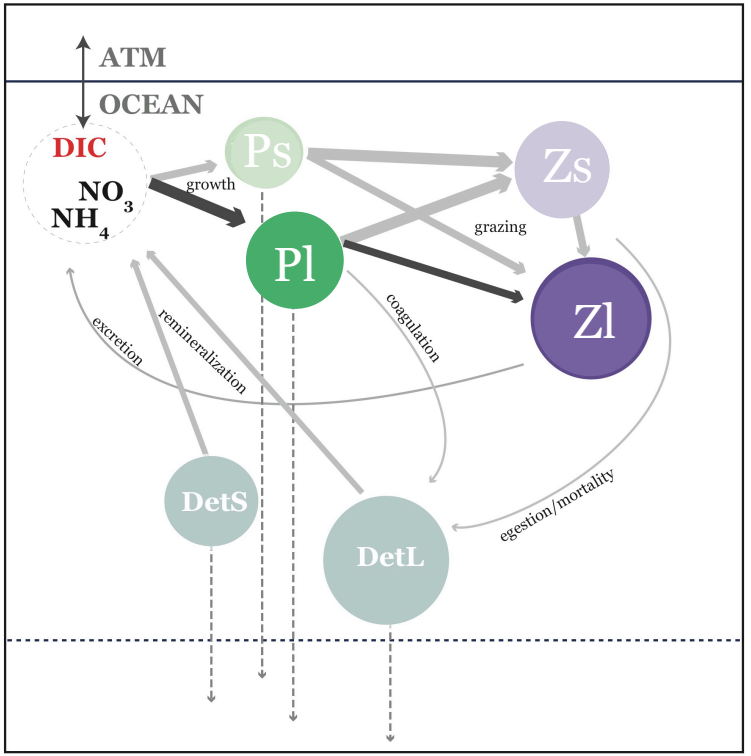
Spring bloom drawdown equates to a 50 to 150 µatm decrease over 30 days


Depth (m)
0
-20
-40
-60
-80
Nitrate (mmol m-3)
12
10
8
6
4
2
0
Chlorophyll (mg m-3)
5
3
2
1
0.5
0.2
0.1
Jan
Mar
May
Jul
Sep
Nov
pCO2 (µatm)
600
500
400
300
200
temperature (°C)
20
15
10
5
0
0
100
200
300
Day

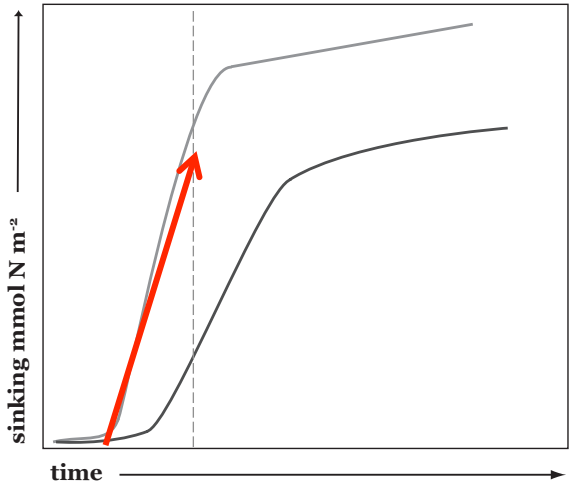
Why does our model not capture the rapid drawdown of pCO_2?

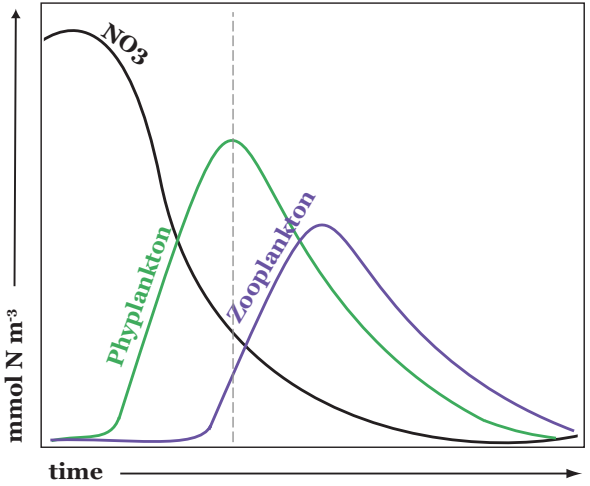
(1) Magnitude of P growth
(2) Timing & duration of P growth

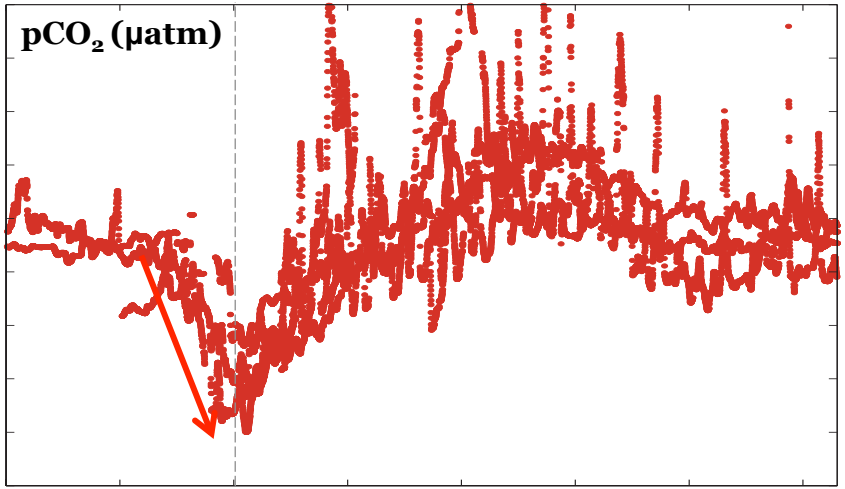
---- Growth rates
---- Grazing rates



switching to a 1-D environment

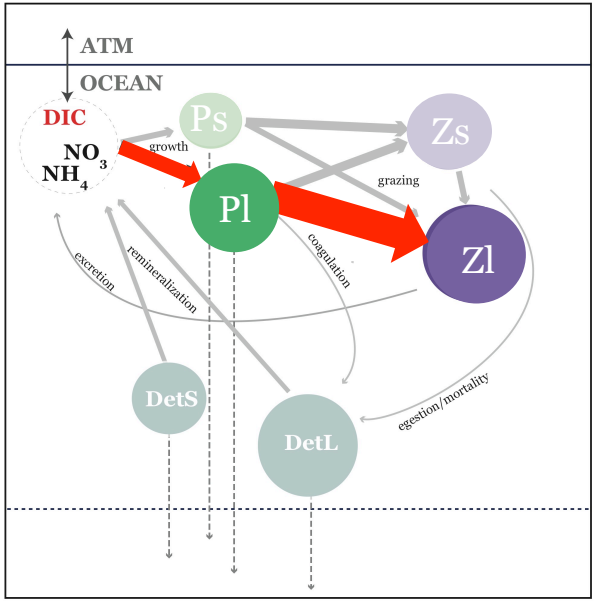




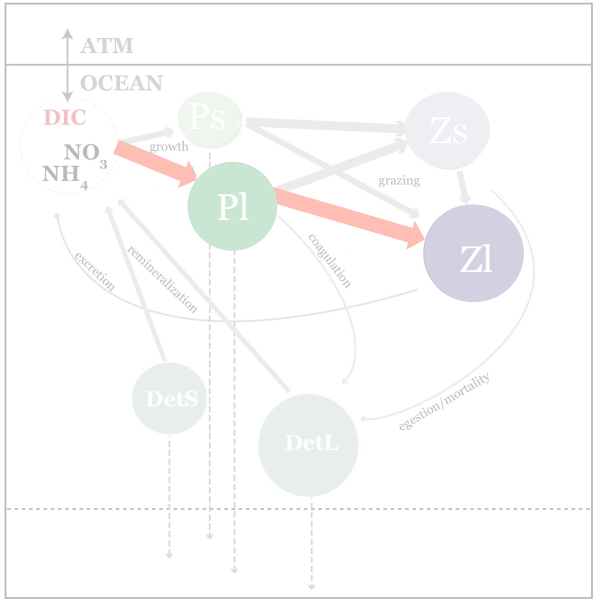


Spring Bloom Diagnostics:

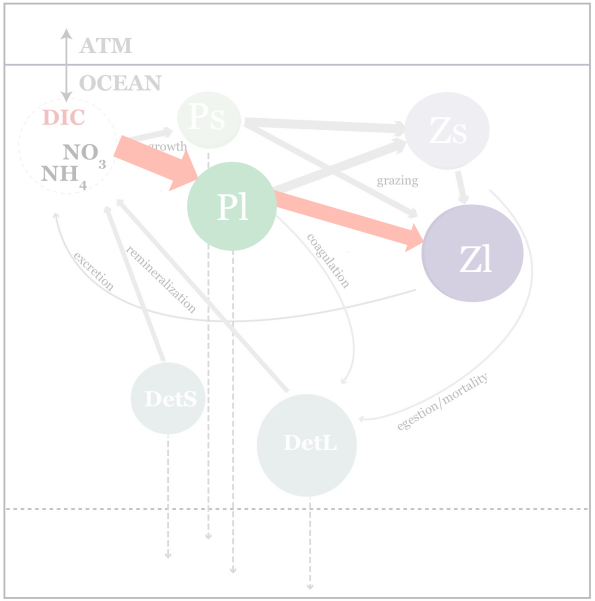
1. P-Z dynamics
2. pCO_2 seasonality
3. Cumulative sinking



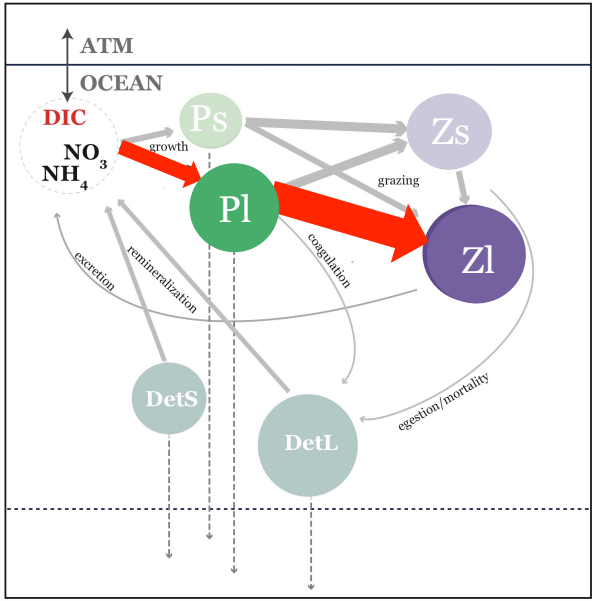
CASE 1
low P growth
high Z grazing



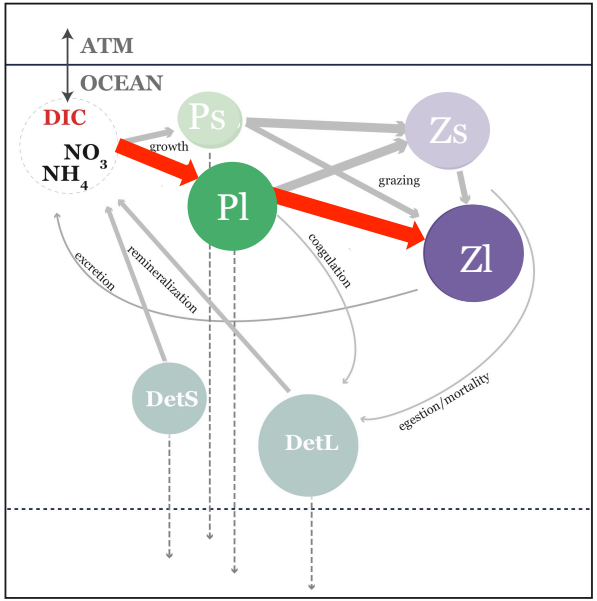
CASE 2
low P growth
low Z grazing



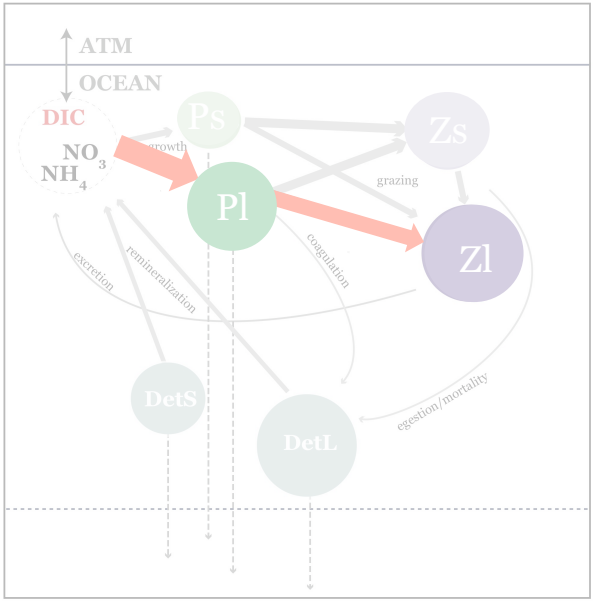
CASE 3
high P growth
low Z grazing



CASE 1
low P growth
high Z grazing



CASE 2
low P growth
low Z grazing



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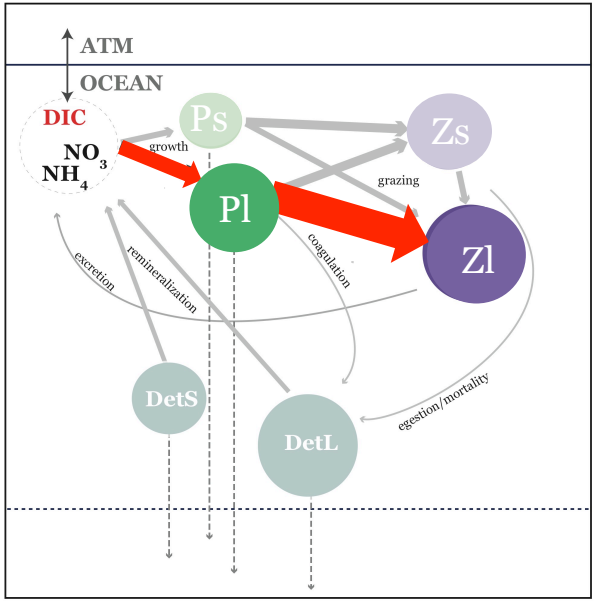
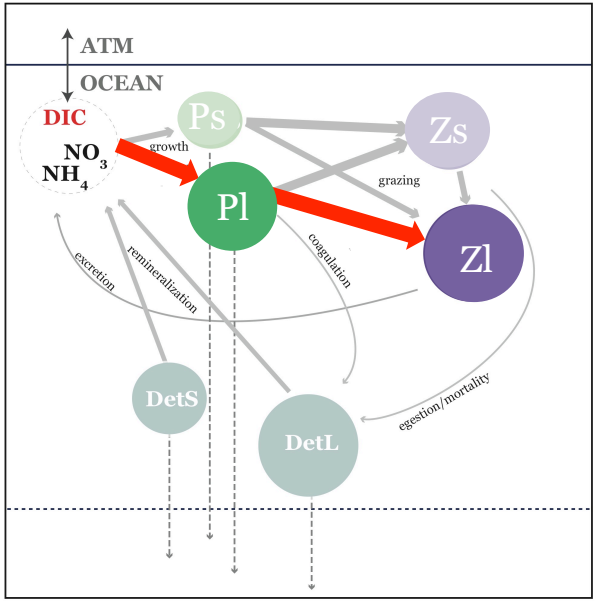
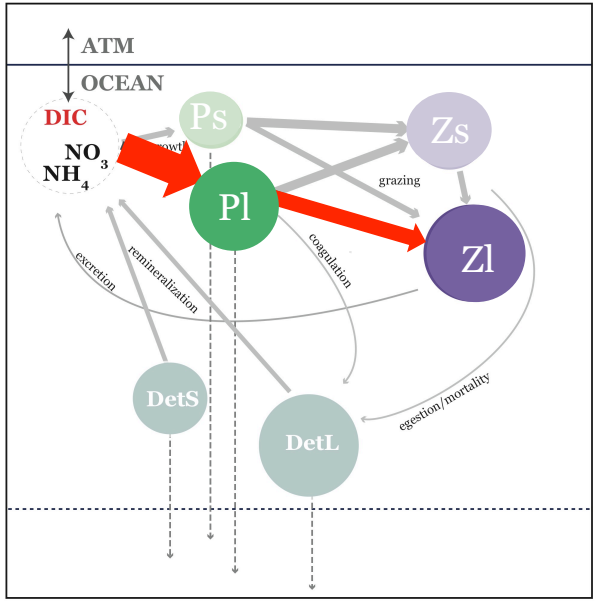
low Z grazing



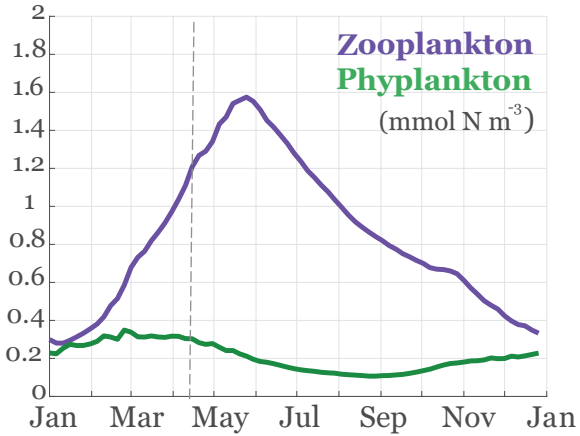
CASE 1
low P growth
high Z grazing

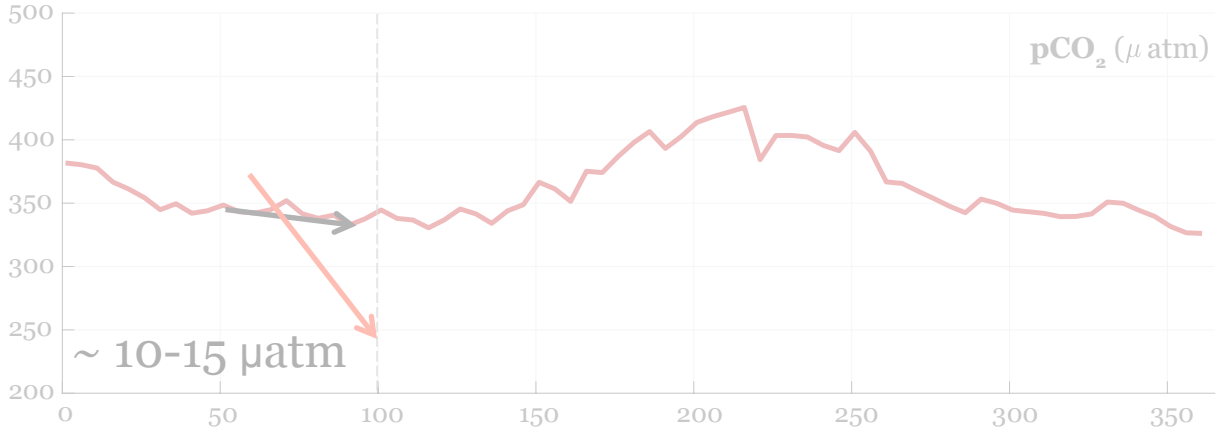


CASE 2
low P growth
low Z grazing



CASE 3
high P growth
low Z grazing



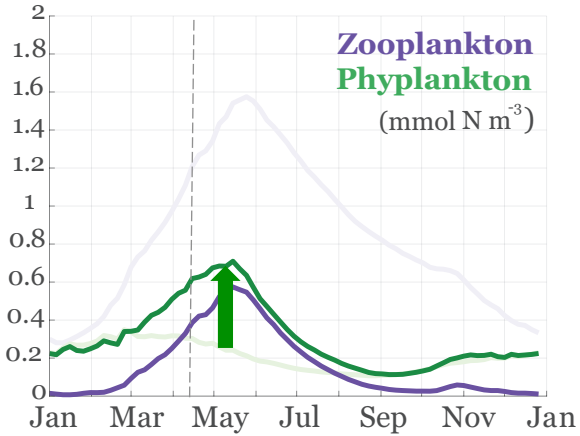


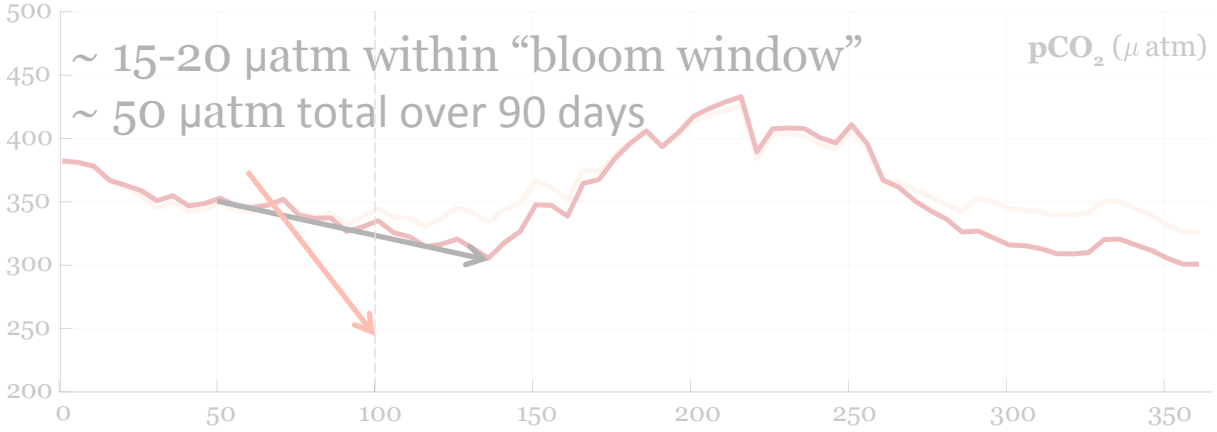
CASE 1

low P growth

high Z grazing

Observed drawdown of 50 to 150 µatm over 30 days



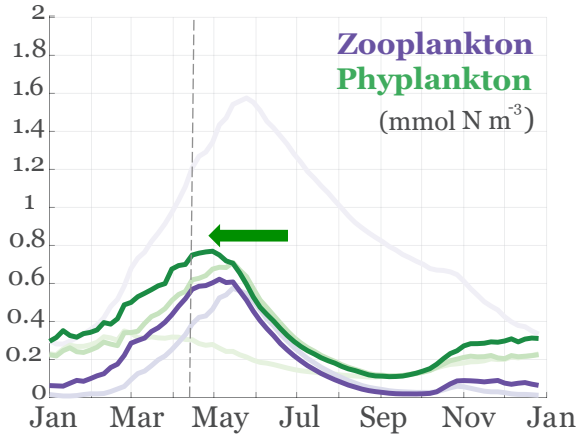


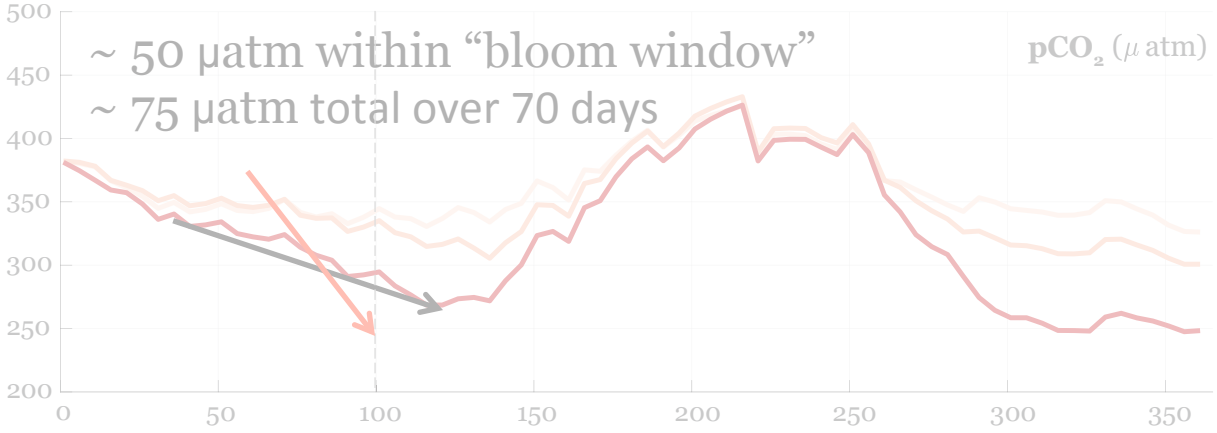
CASE 2

low P growth

low Z grazing

Observed drawdown of 50 to 150 µatm over 30 days



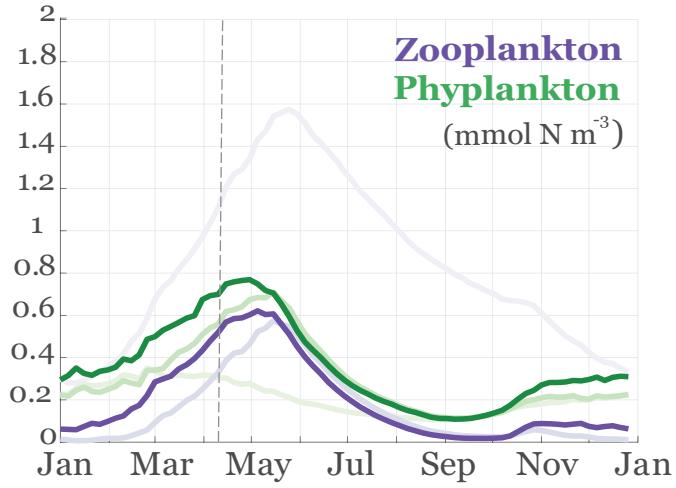


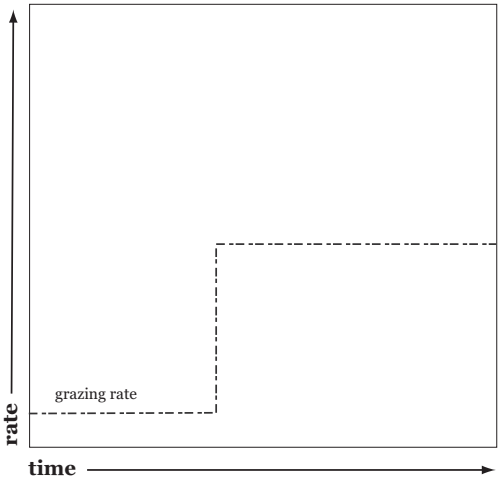
CASE 3

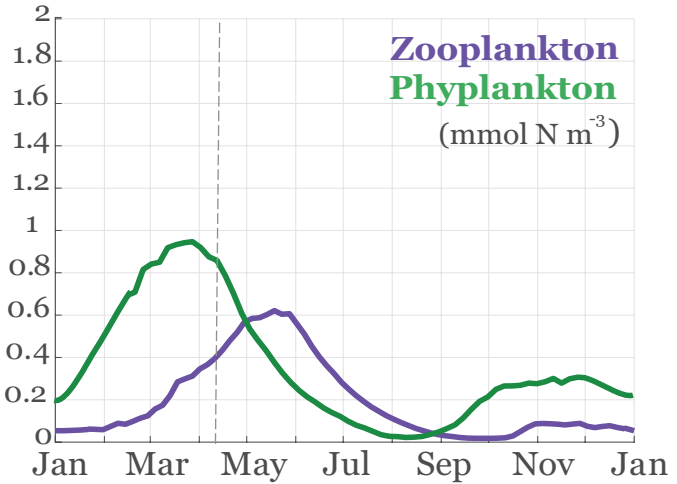
high P growth

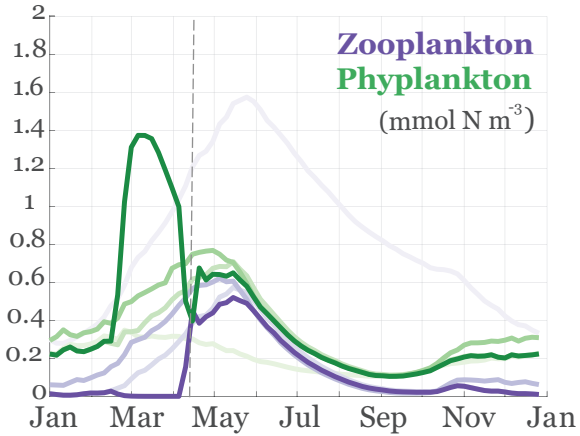
low Z grazing

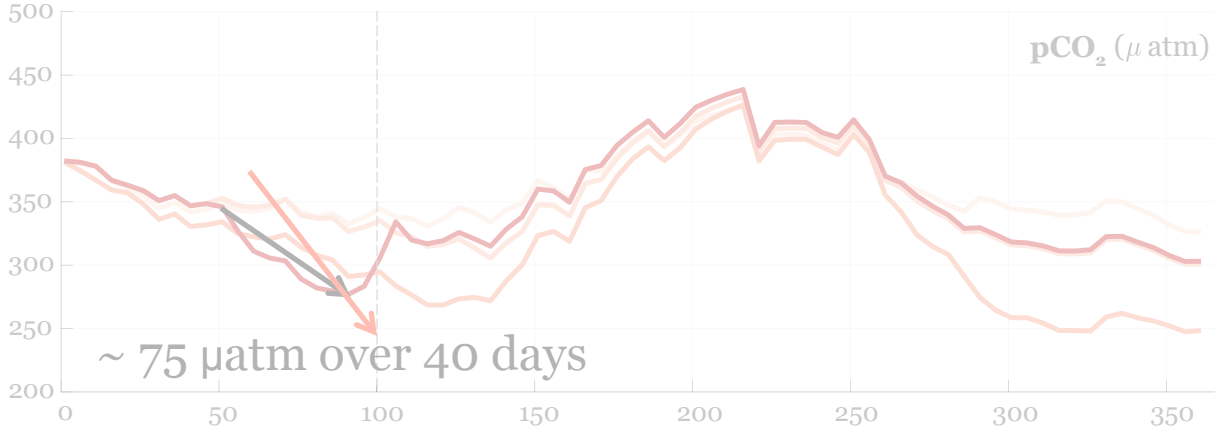
Observed drawdown of 50 to 150 µatm over 30 days


Zooplankton
Phyplankton
(mmol N m-3)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan
Mar
May
Jul
Sep
Nov
Jan


grazing rate
rate
time


Zooplankton
Phyplankton
(mmol N m-3)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Jan
Mar
May
Jul
Sep
Nov
Jan





CASE 4

high P growth

low Z grazing

step function

Observed drawdown of 50 to 150 µatm over 30 days

TAKE-HOME POINTS

- By just optimizing our biological model to Chl & NO_3 observations, we were **not able to capture the bloom related pCO_2 drawdown**

- By **including pCO_2** observations into our model analysis, we believe we can better **constrain the dynamics driving the spring bloom** on the Scotian Shelf

    - **Predator-prey dynamics** play a key role in both the **magnitude**, and **timing and duration** of the spring bloom

- More work needs to be done towards implementing these predator-prey interactions in our models.

THANK YOU!

DALHOUSIE UNIVERSITY

MEOPAR

FONDS FRANCE CANADA POUR LA RECHERCHE
FRANCE CANADA RESEARCH FUND

L'ORÉAL CANADA

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