Model Study of Phytoplankton Phenology on the Northeast U.S. Continental Shelf

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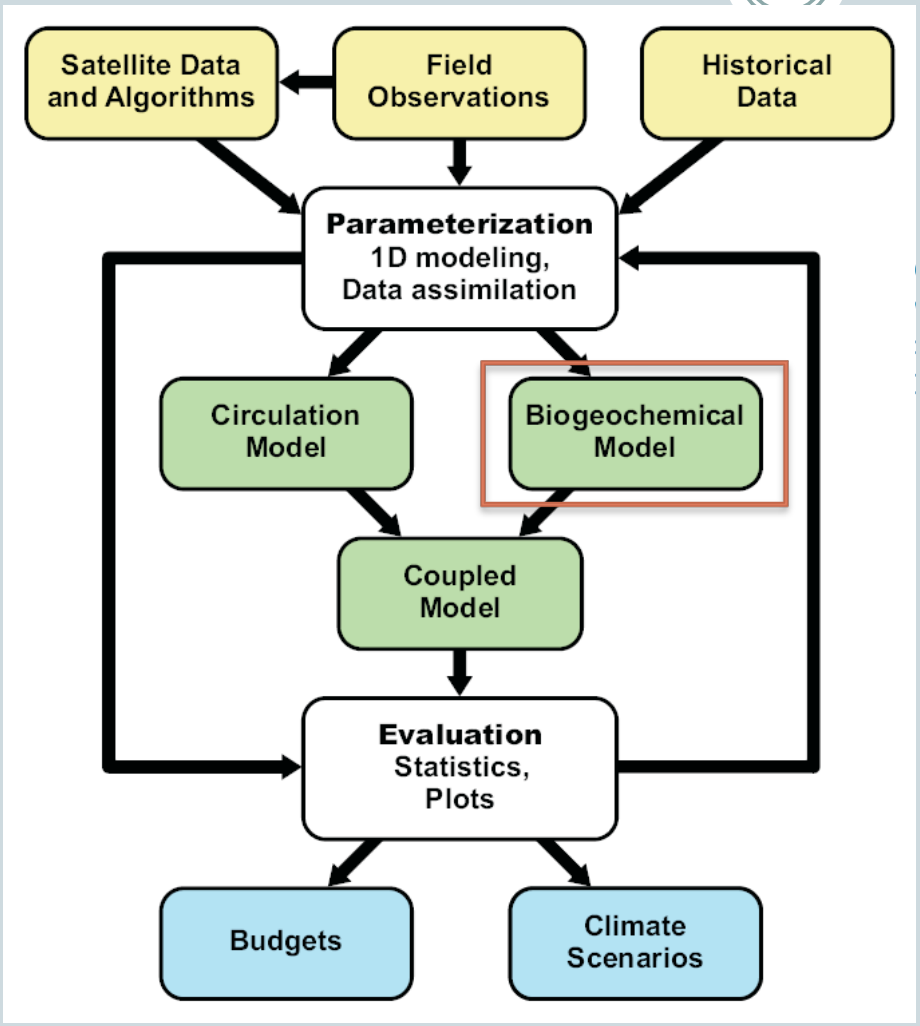
NASA

Outline

- Introduction
- Model refinement
- Results
  - Sensitivity analysis
  - Effects of model refinement on bloom timing
  - More realism/complexity
- Future work
- Summary

NASA U.S.ECoS Project

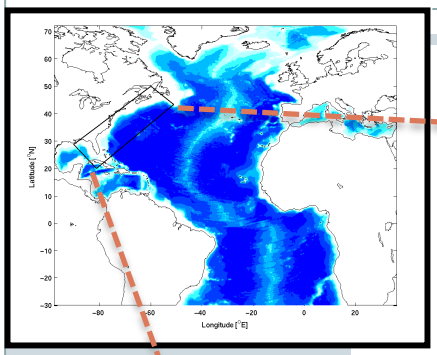


U.S. Eastern Continental Shelf Carbon Budget: Modeling, Data Assimilation, and Analysis

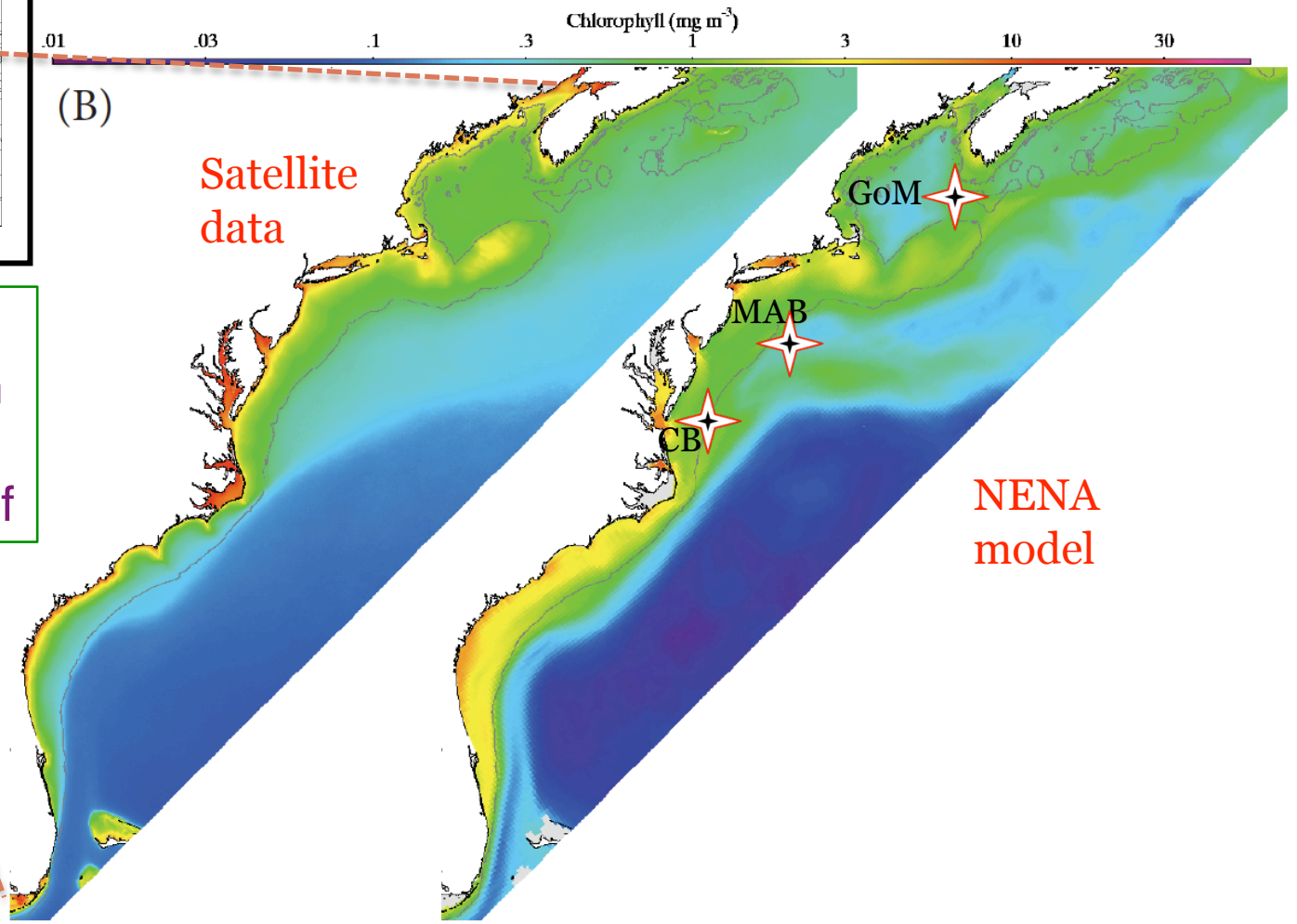
Goal:

To develop carbon budgets for the U.S. East coast continental shelf

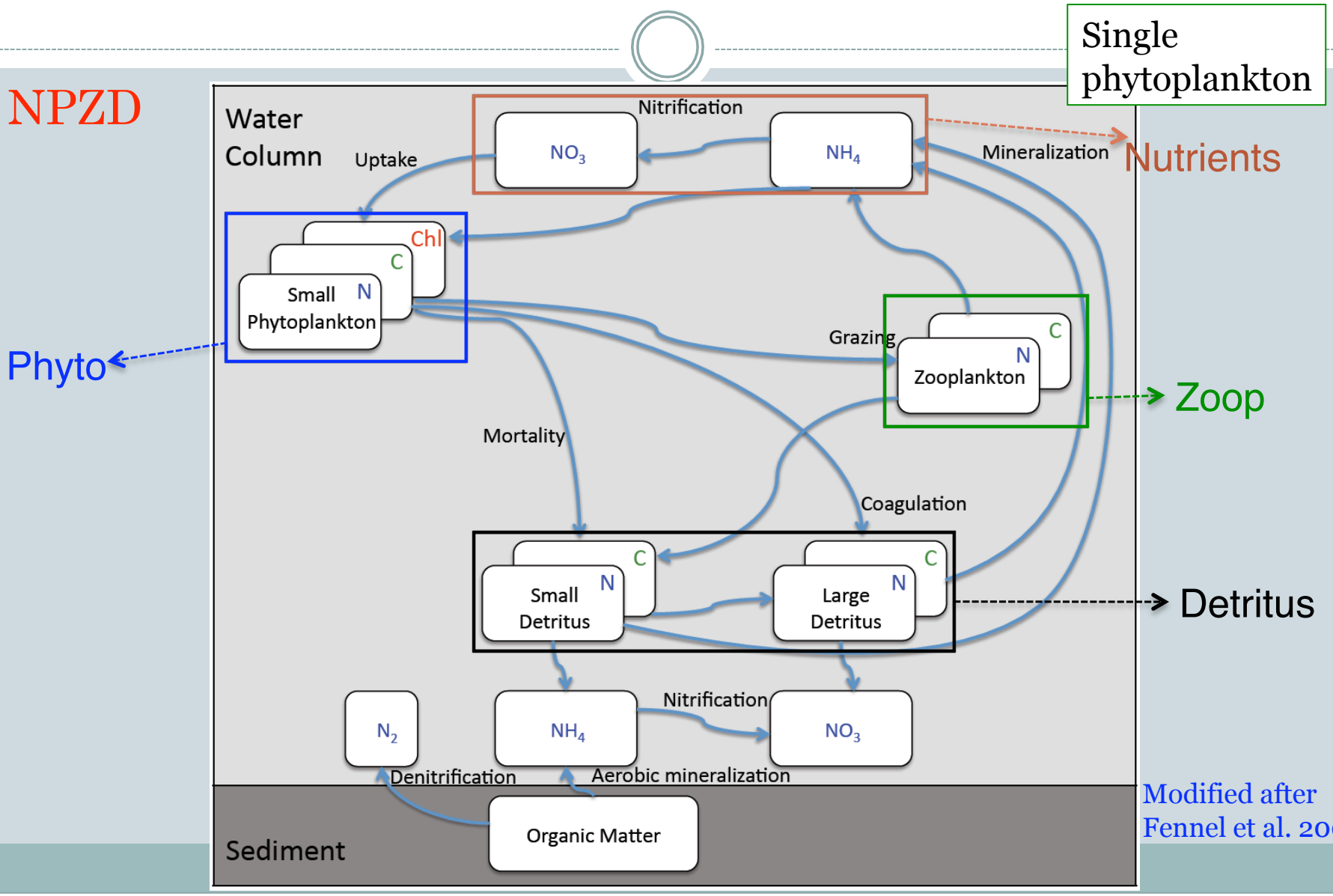
3D NENA simulation - Chlorophyll



North **E**astern **N**orth **A**merican (NENA) continental shelf

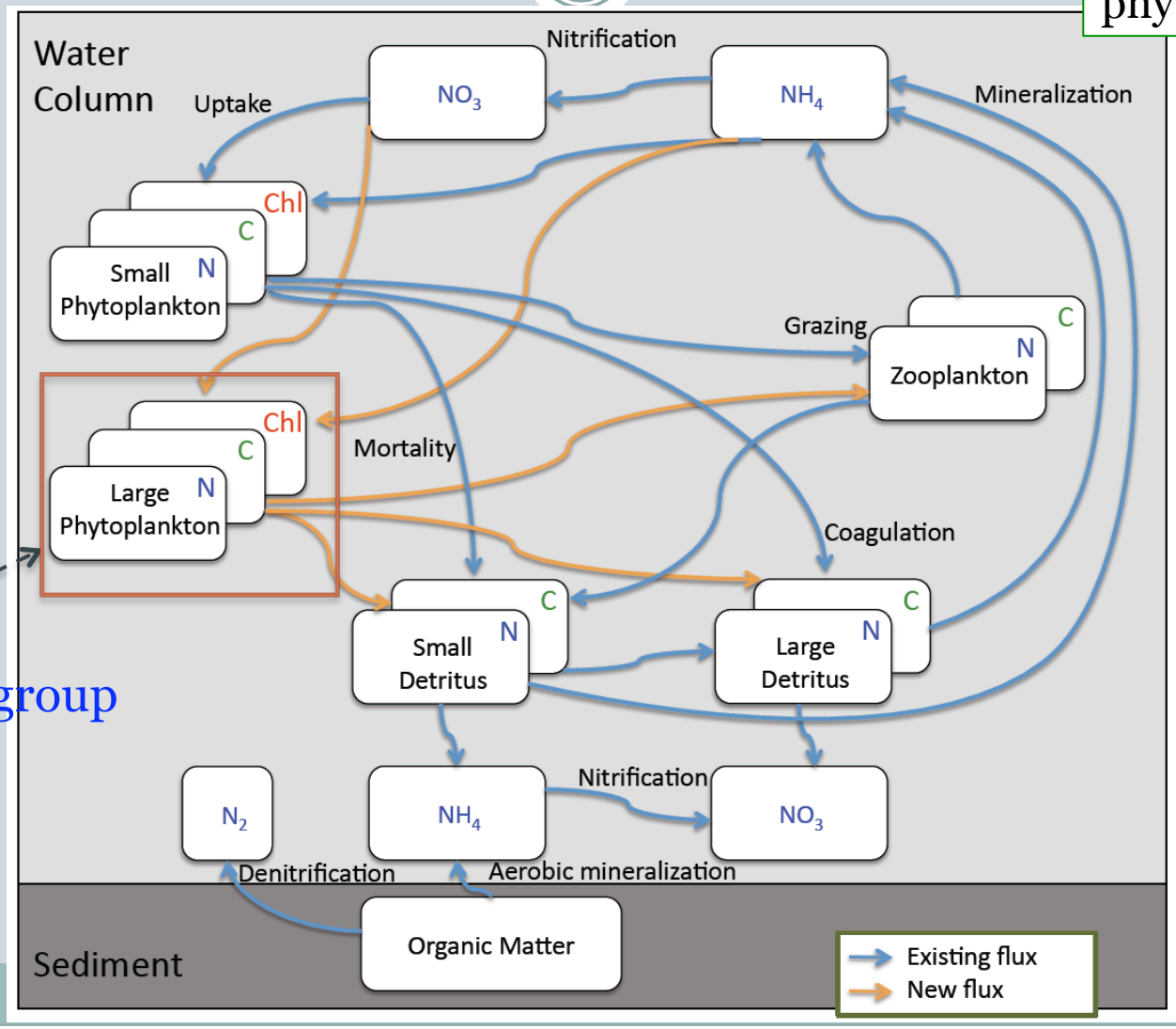


Ecosystem model



Model refinement

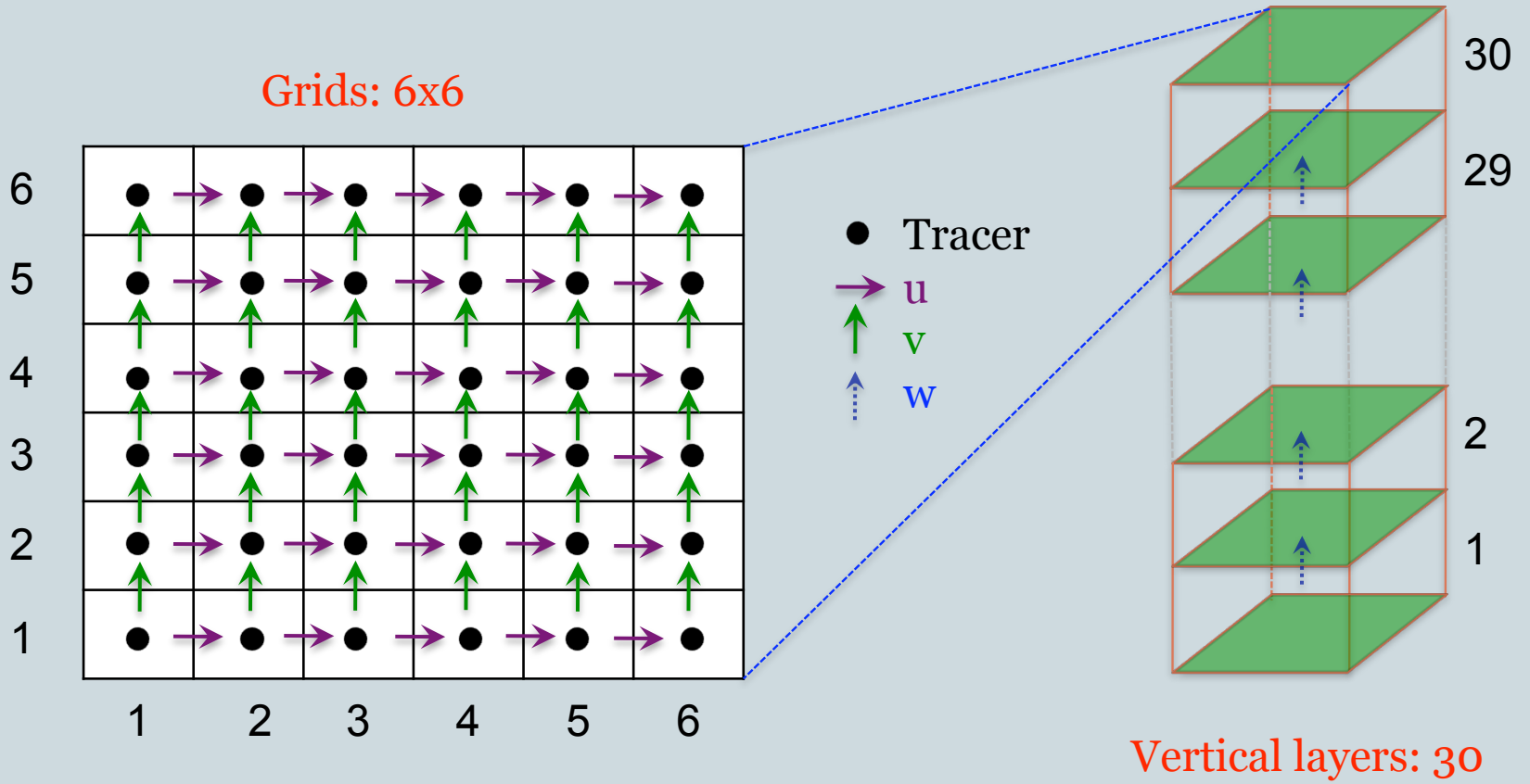
Two phytoplankton



Additional functional group

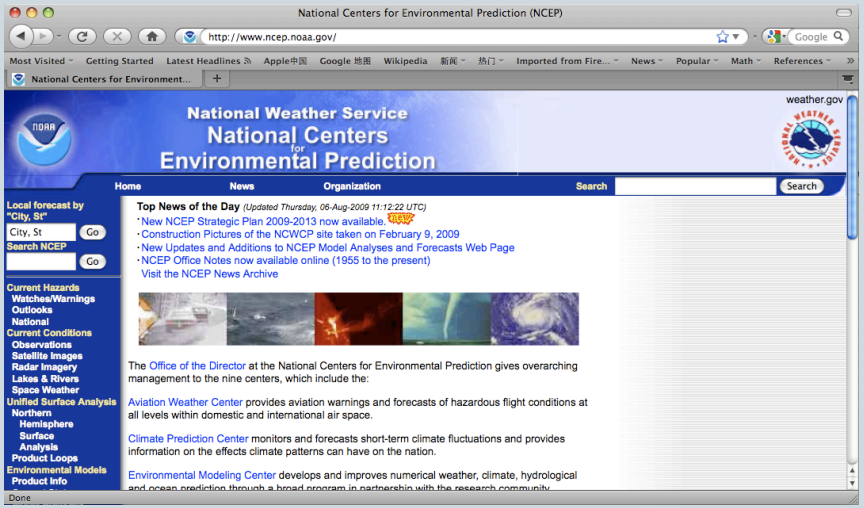
ROMS bio-toy grids

- Circulation model: 1D ROMS Bio-toy



1D model set up

- Physics: vertical advection + diffusion
- Forcing: NCEP Daily North American Regional Reanalysis 2004
  - Wind
  - Air temperature
  - Radiation
  - …



- Initial condition: 3D NENA Year 2003 simulation

Parameter sensitivity analysis

Normalized sensitivity $S_c(k)$:

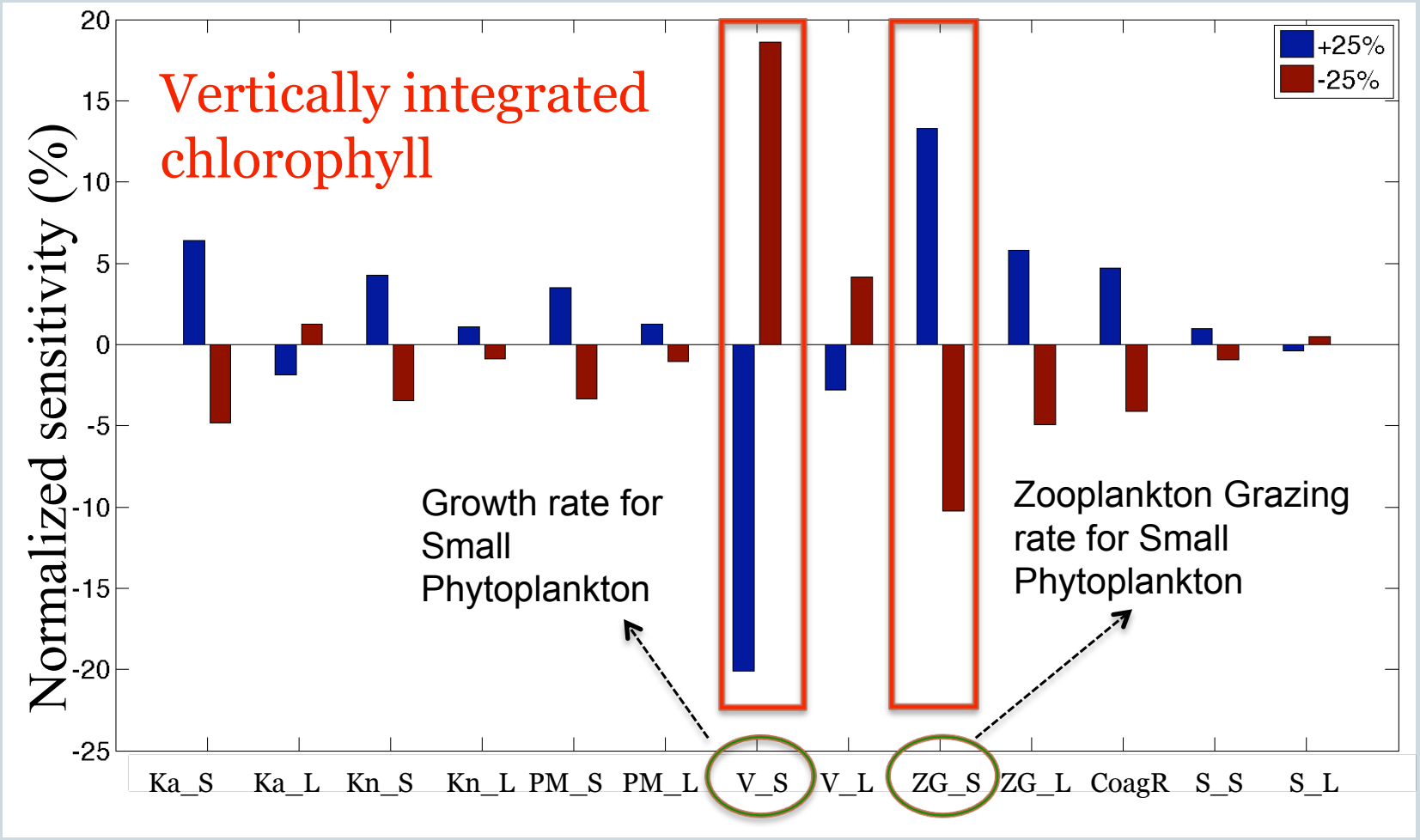
$$S_c(k) = \frac{\frac{C(k) - C_s}{C_s}}{\frac{k - k_s}{k_s}}$$

Change in Chl (vertically integrated)

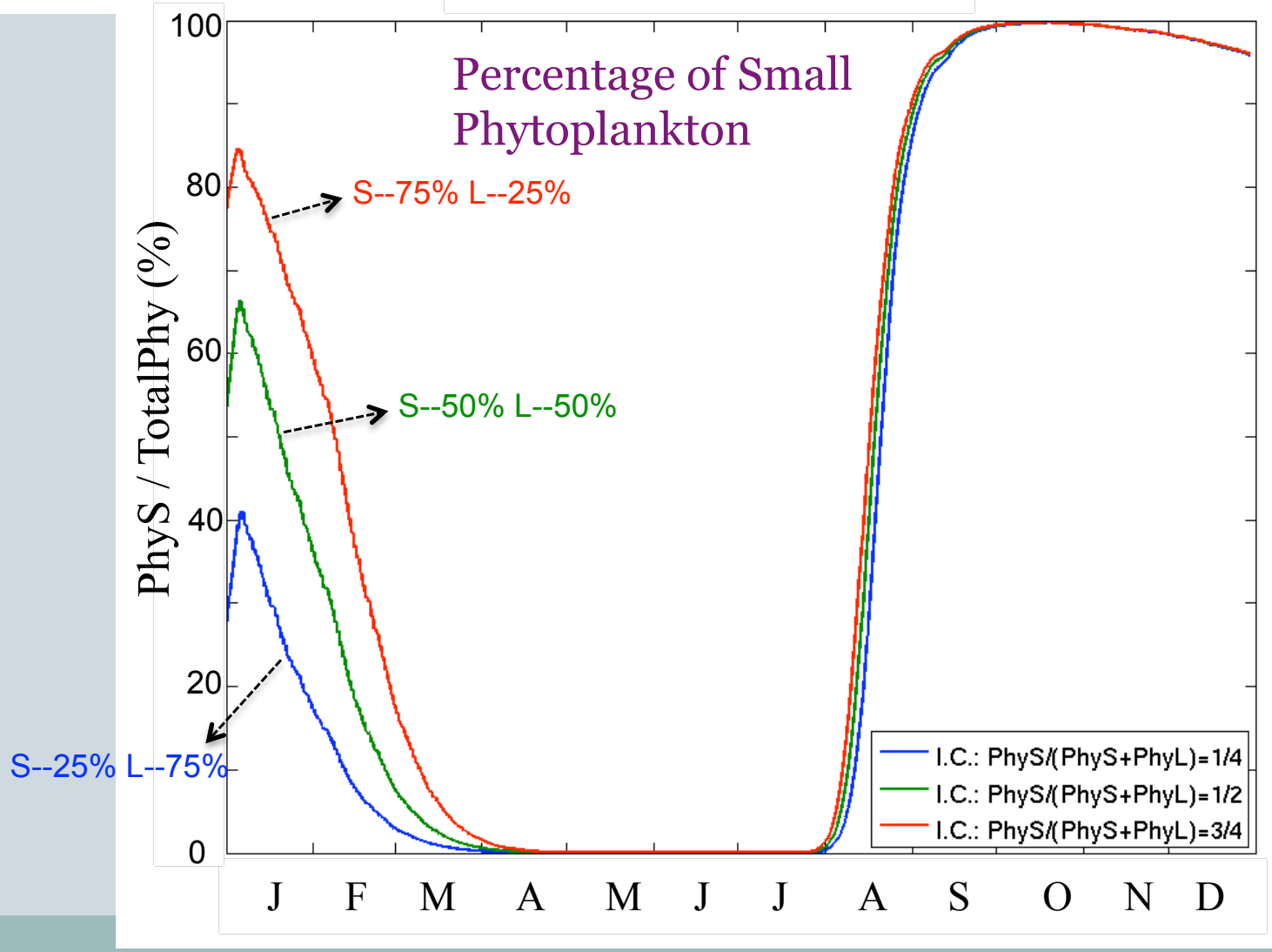
Change in parameter by 25%

- *k:* parameter value
- k_s*:* reference parameter value
- C_s: Chl concentration for the reference case with k_s
- *C(k)*: Chl concentration when using *k*

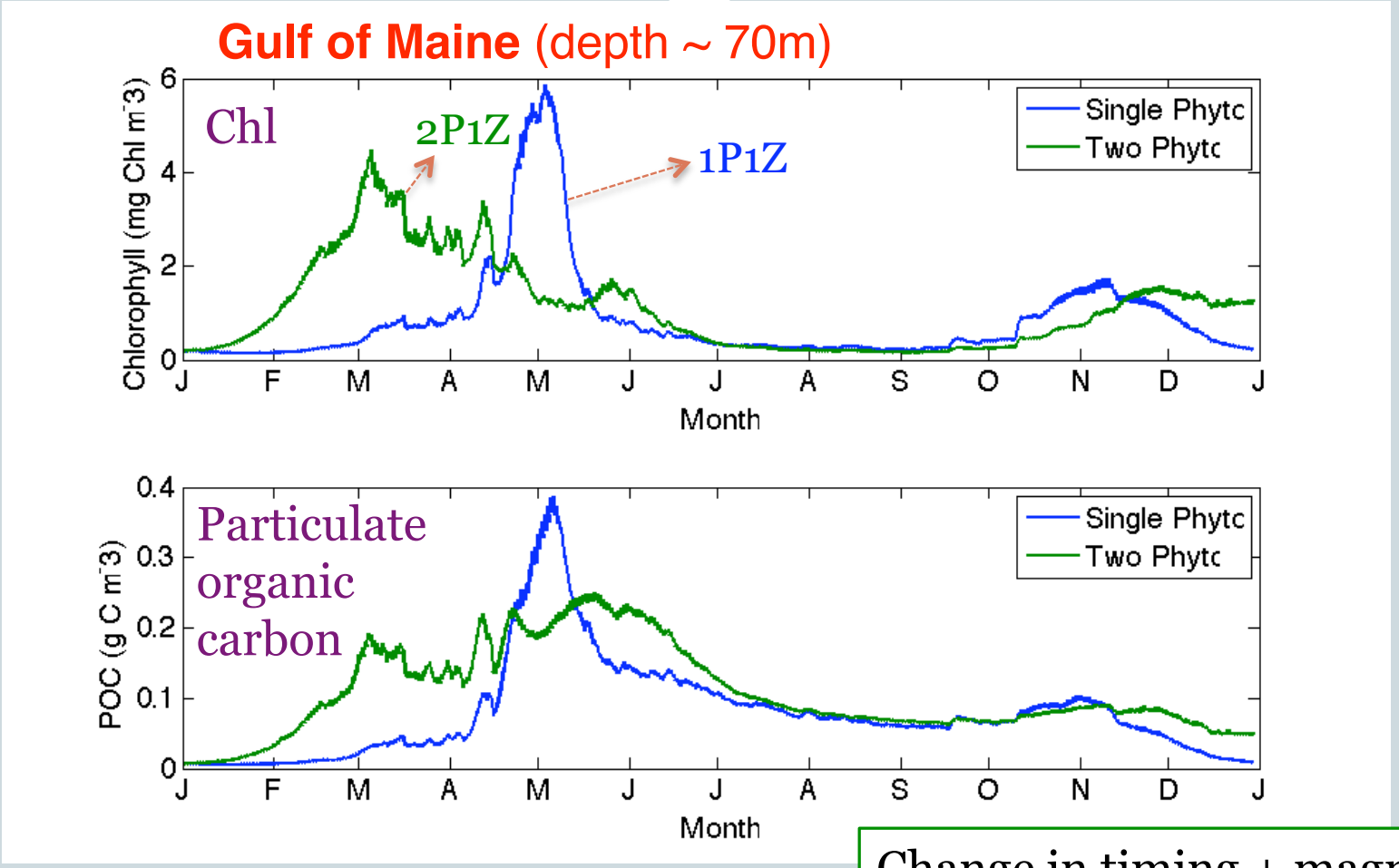
Parameter sensitivity analysis



Sensitivity to initial phytoplankton size fraction

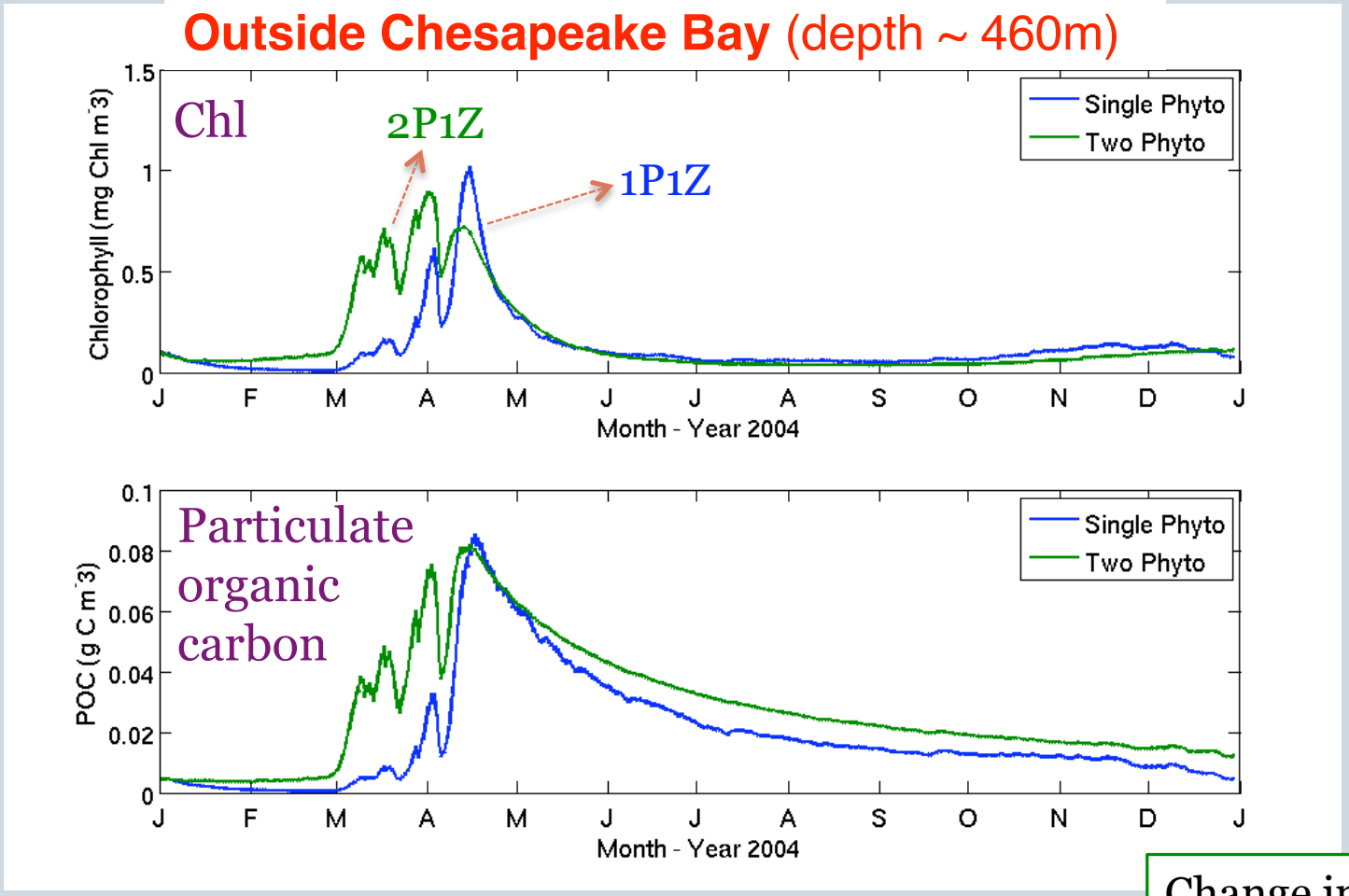


Single vs. two phytoplankton – site 1



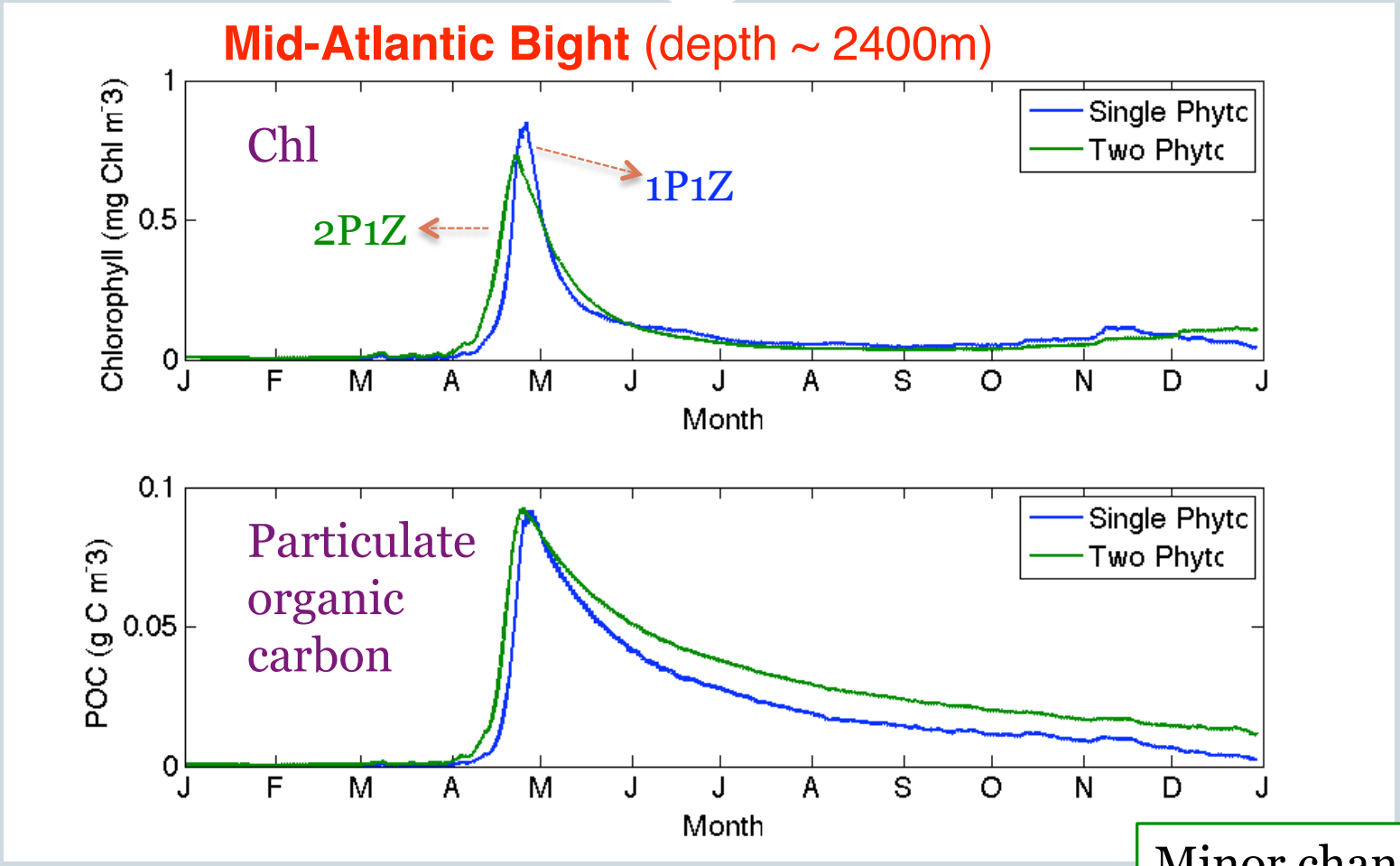
Change in timing + magnitude

Single vs. two phytoplankton – site 2



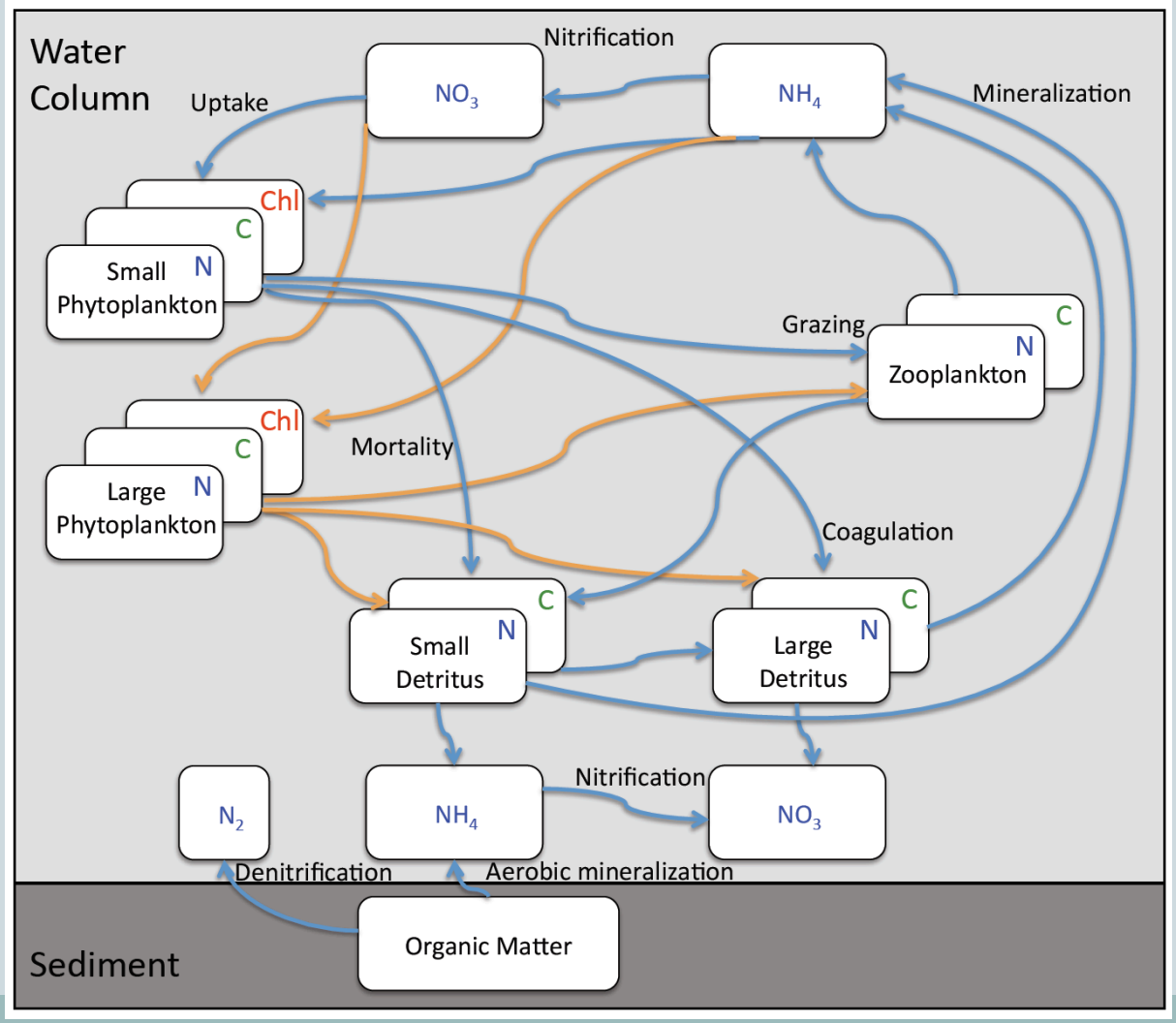
Change in timing

Single vs. two phytoplankton –site 3



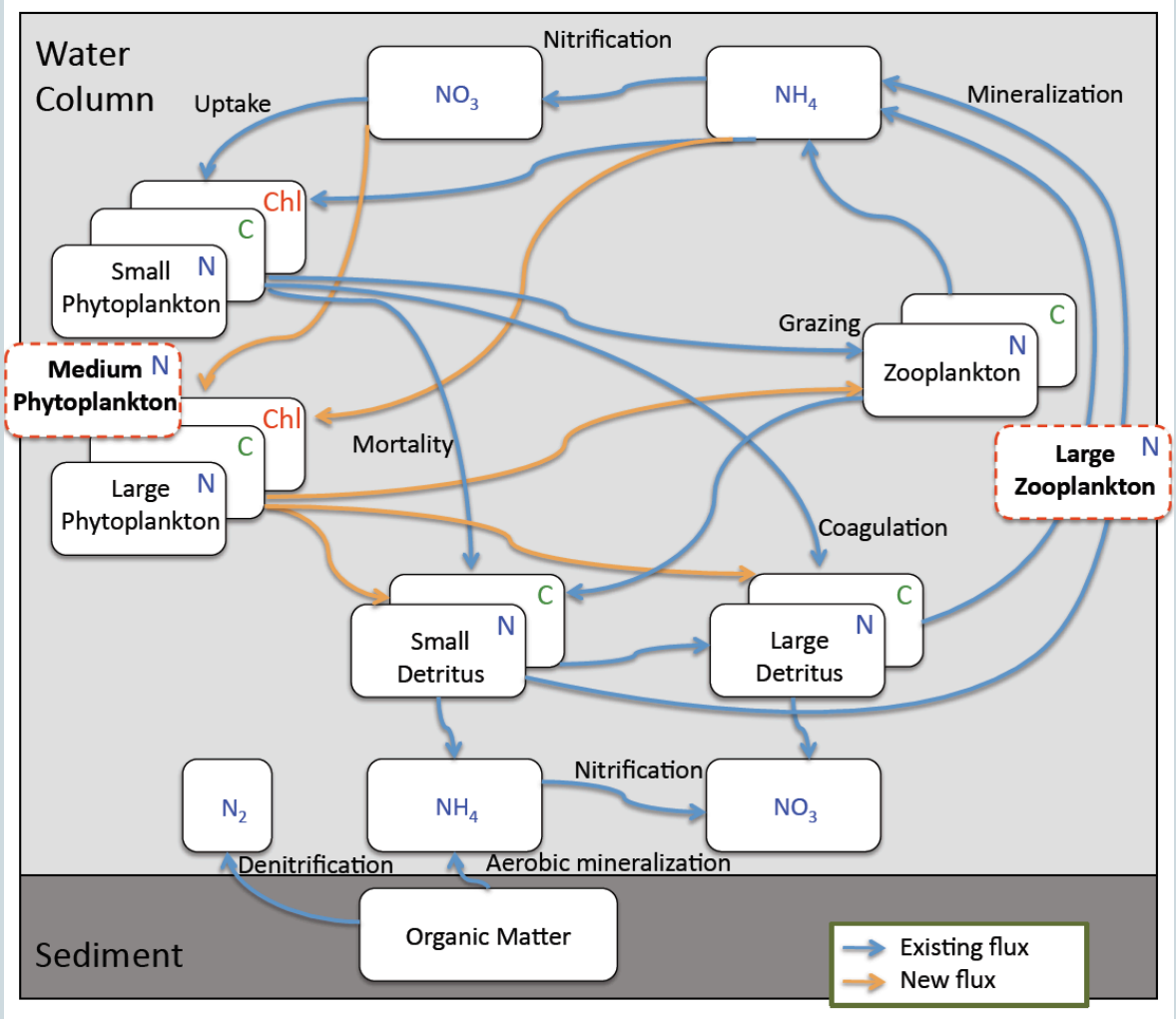
Minor change

Two phytoplankton model: complex enough?



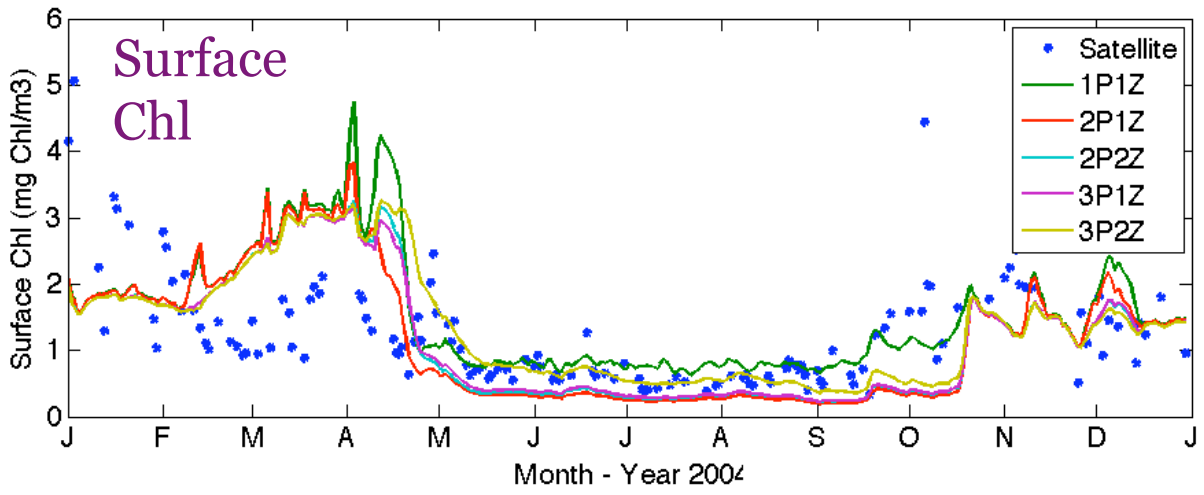
2P1Z

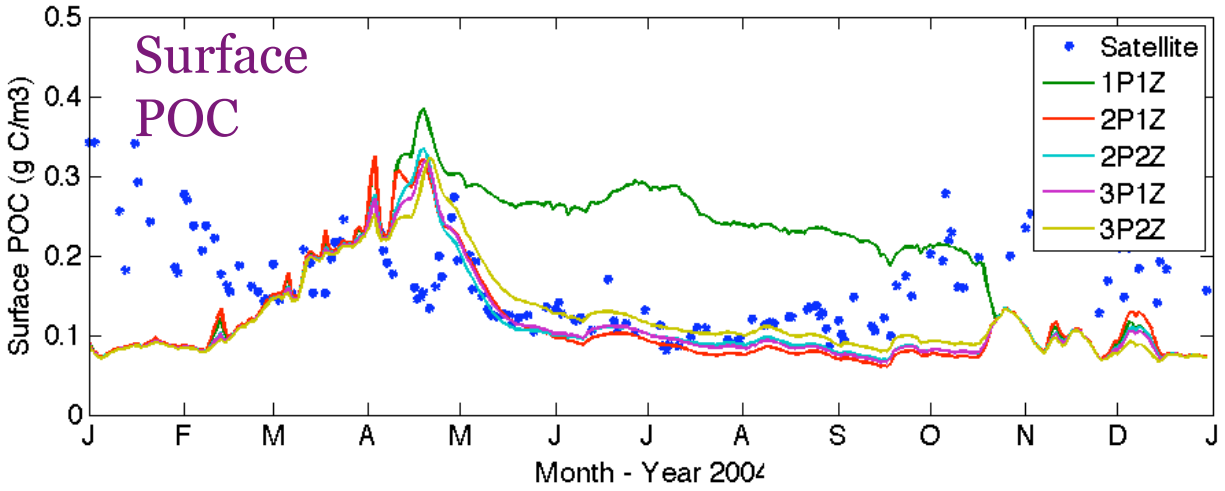
More plankton?



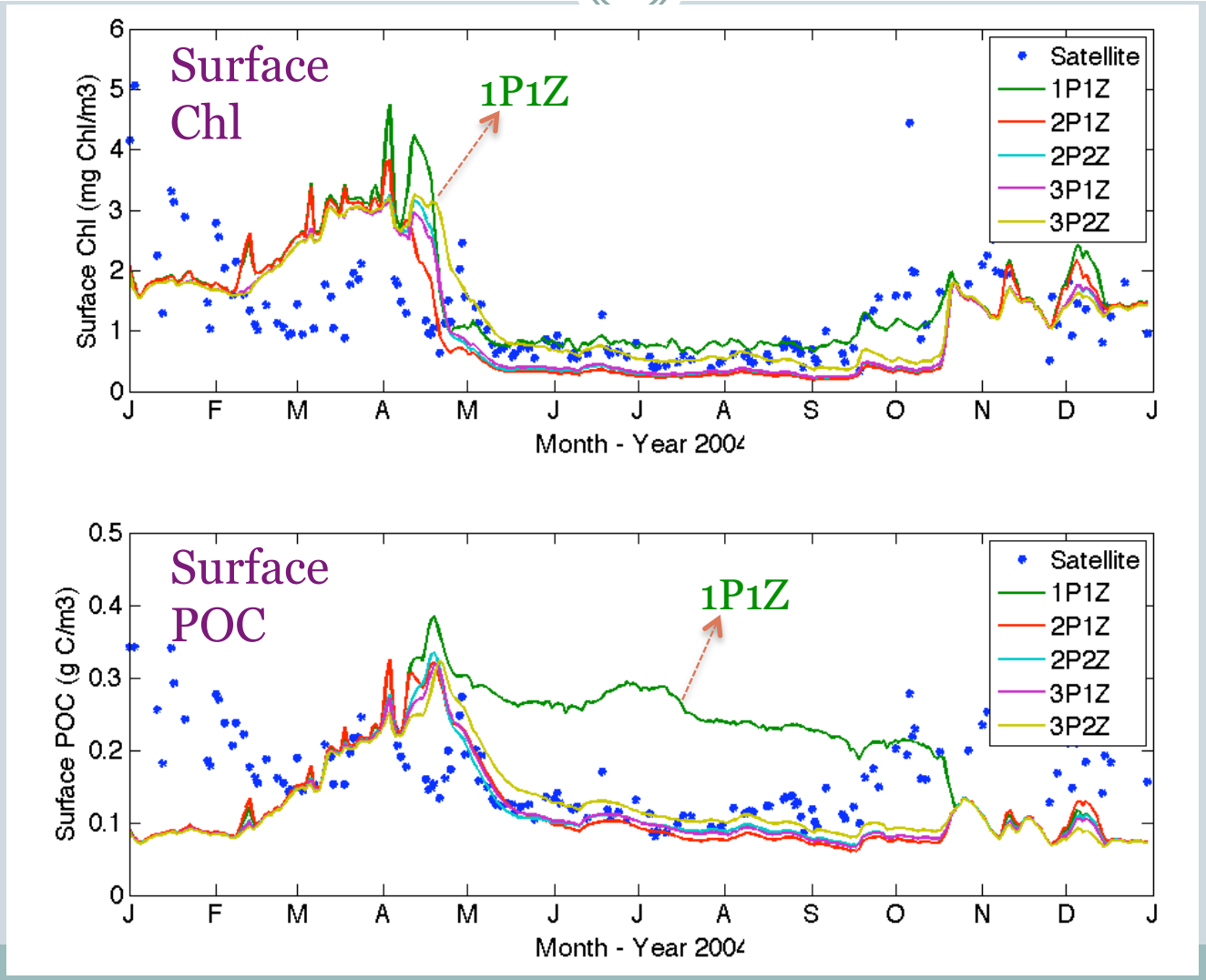
- 1P1Z
- 2P1Z
- 2P2Z
- 3P1Z
- 3P2Z

More comparisons





More plankton? **Not necessarily better**

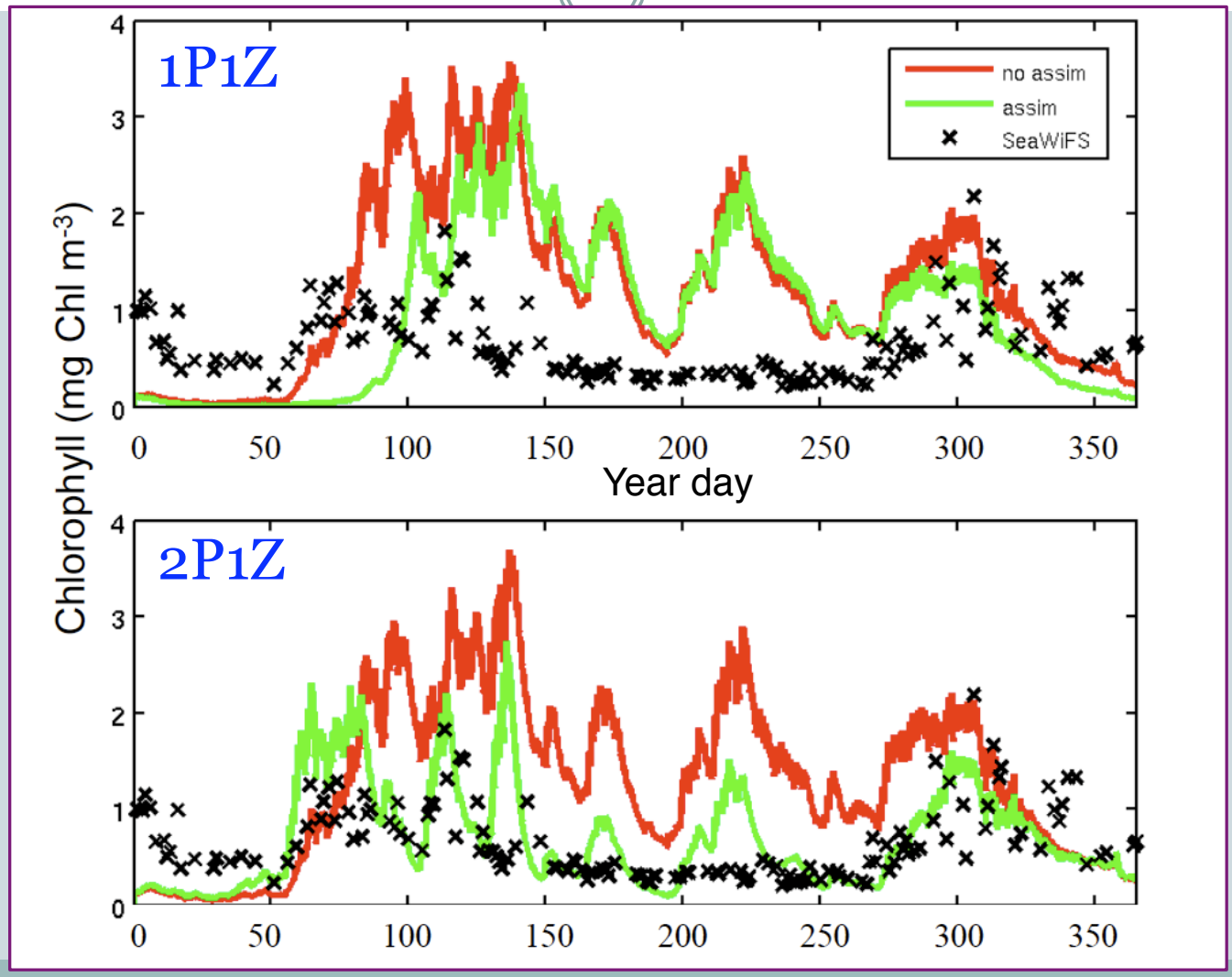


Future work: data assimilation

- Variational adjoint method
- Method: nonlinear weighted least square
- Data:
  - Satellite Chl+POC
  - in situ data
- Optimized parameters:
  - Growth rates
  - Grazing rates

Friedrichs et al. 2007

Preliminary result - data assimilation



Summary

1. Phytoplankton community structure can significantly impact model estimate of bloom.
2. The impact is larger in regions where chlorophyll is high.
3. Preliminary results indicate that adding more plankton beyond 2P1Z does not improve the model-data comparison for surface chlorophyll or surface POC.

Thanks for your attention!