Variability in the Chlorophyll to Carbon ratio: contrasting *in situ* and satellite data with models

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Field data provided by:
Instituto Español de Oceanografia

Colour and Light in the Ocean from Earth Observation (CLEO)
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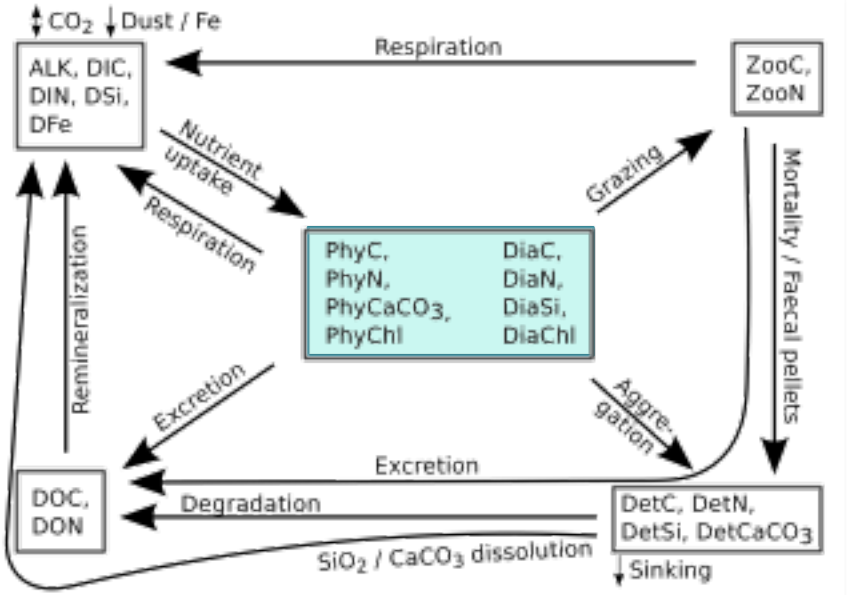
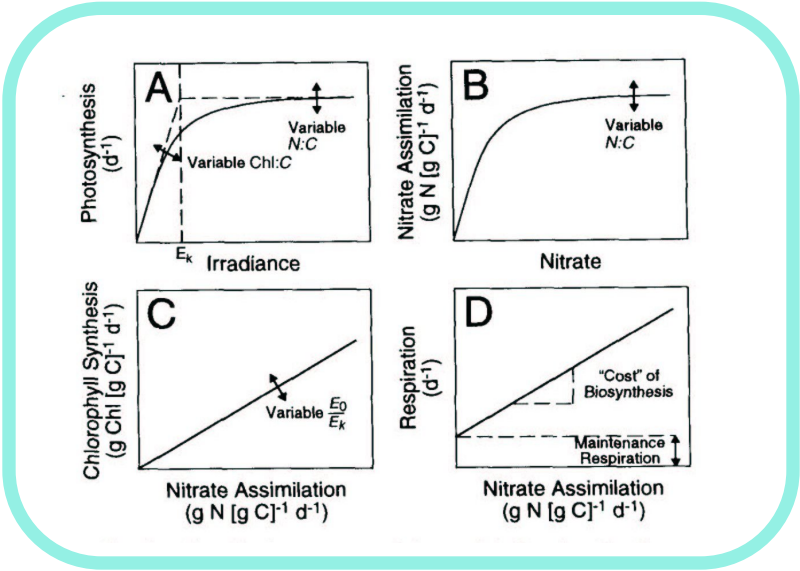
Introducing Regulated Ecosystem Model (ReCOM)

- ReCOM is an **ecosystem model** coupled to the MITgcm.
- It is based in the **phytoplankton growth model** proposed by **Geider et al. 1998** with the addition of non-physiological mortality terms and dynamics of biogenic silica.



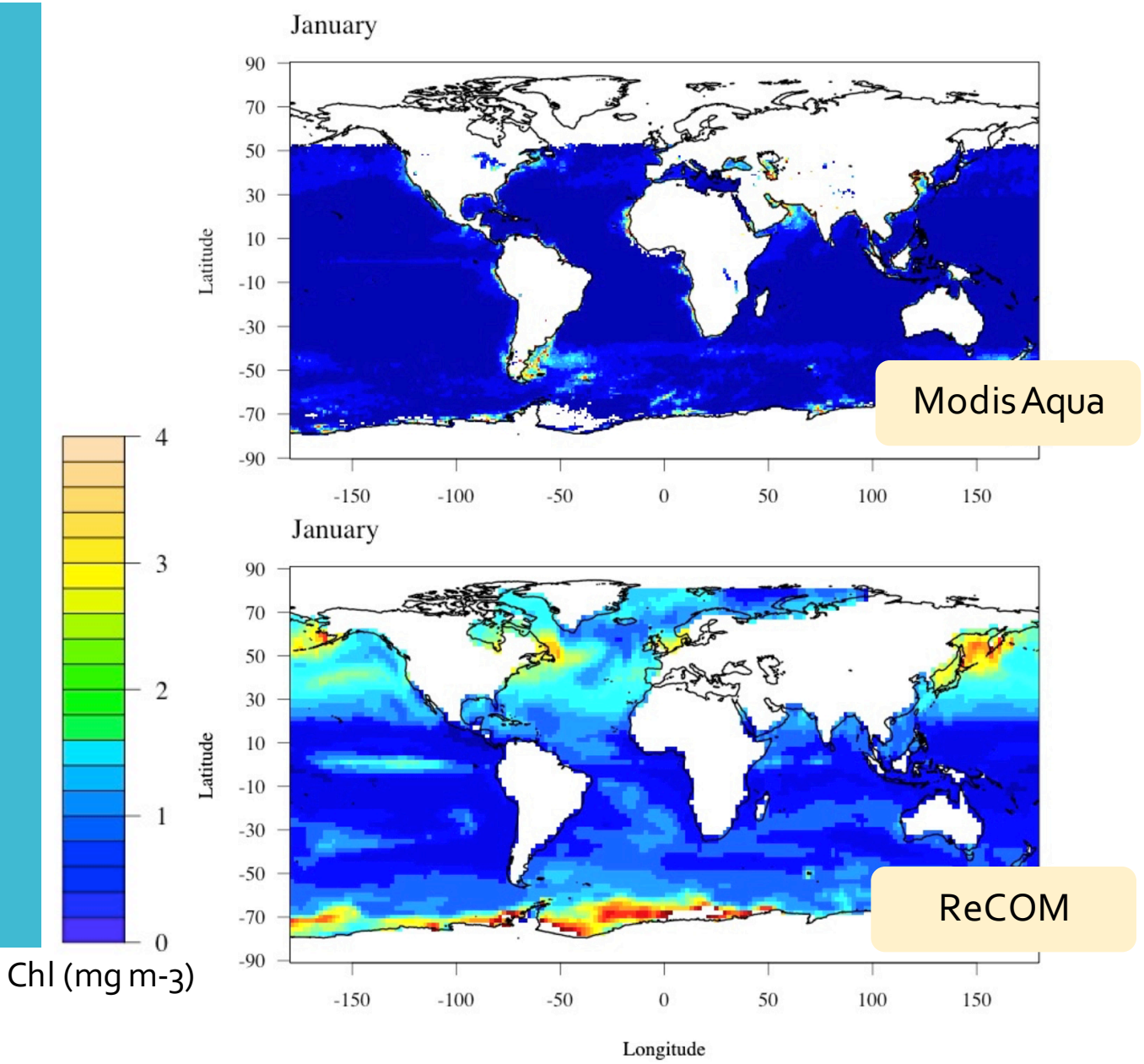


OUTPUT

DIN
Amonium
Alkalinity
Phyto N
Phyto C
Phyto Chl
Diatoms N
Diatoms C
Diatoms Chl
Diatoms Si
detritus N
detritus C
detritus Si
heterotrophs N
heterotrophs C
DON
DOC
Si
Fe

Estimating biomass from chlorophyll

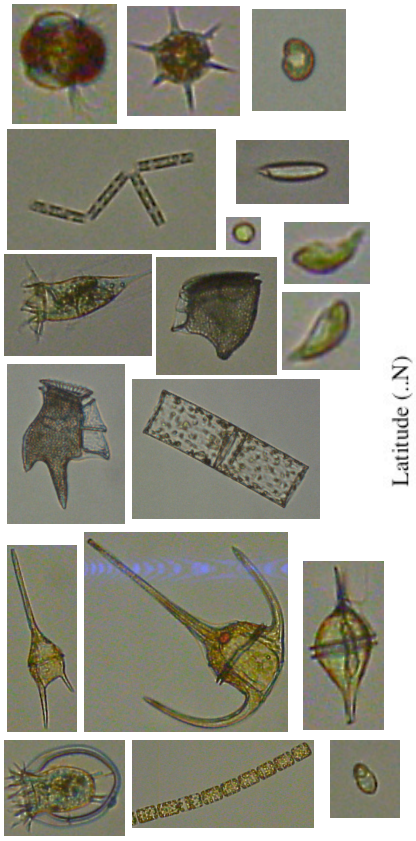
- Models are often validate with satellite chlorophyll.
- It is easy to gather at global scale and proxy for biomass.
- However the conversion of chlorophyll to carbon is variable.

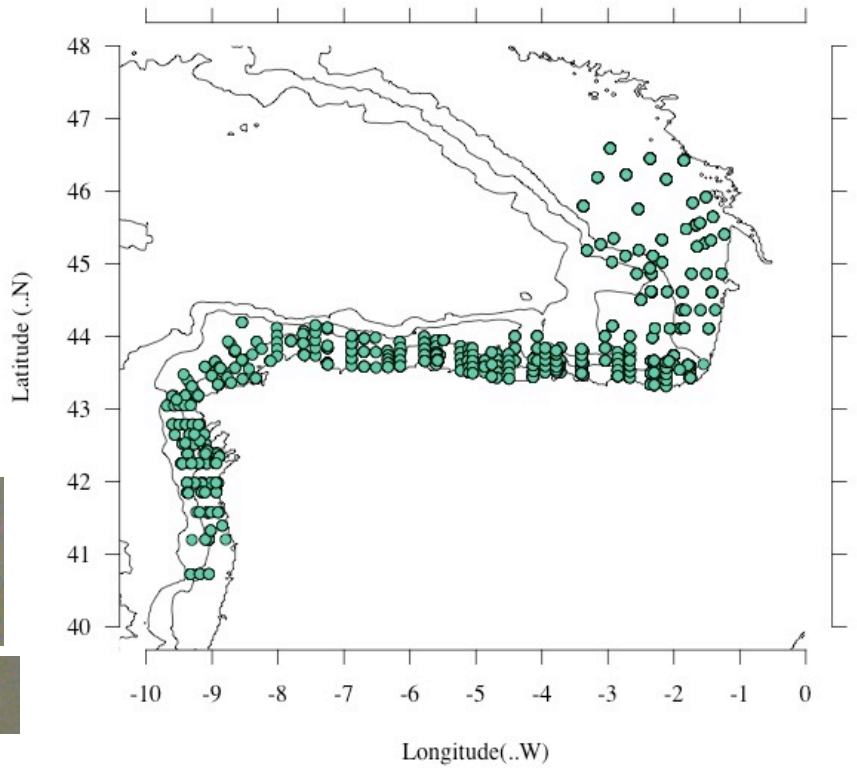


Carbon and chlorophyll in the field

- *In situ* carbon data are not easy to collect.
- Options: POC, microscopy, flow cytometry…
- Our field data base gathers carbon obtained with **flow cytometry** and chlorophyll from the **Bay of Biscay.**

Area	Dates	n
Central Cantabrian Sea	Monthly 2008/2010	100
Central Cantabrian Sea	Daily August / November 2008	120
Bay of Biscay	Spring 2008/2010	260

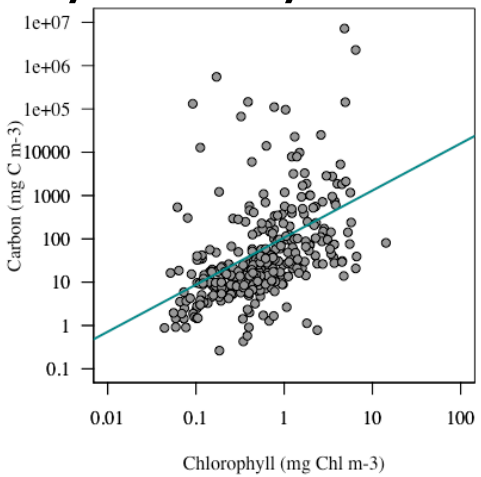




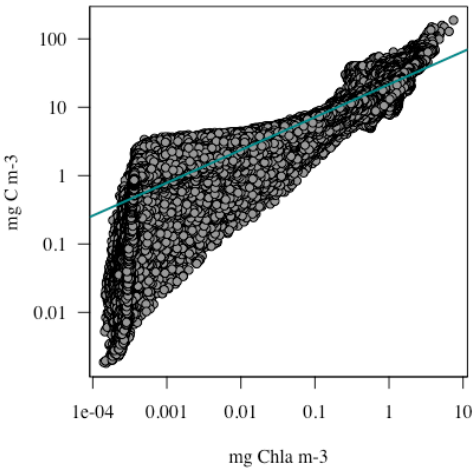
Relating carbon to chlorophyll

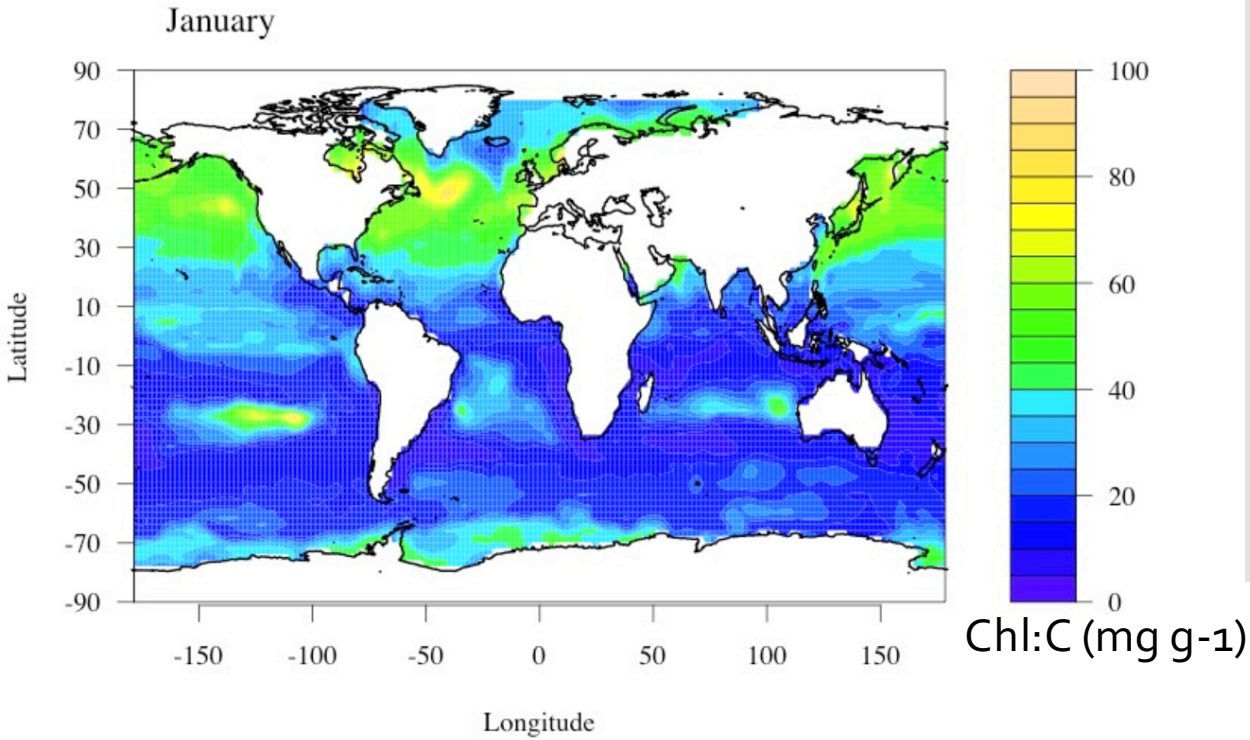
- The relationship **Chl to C** is variable at local scale.
- One advantage of ReCOM is that it estimates separately carbon and chlorophyll.
- Modelled Chl:C followed a seasonal cycle.

In situ Bay of Biscay



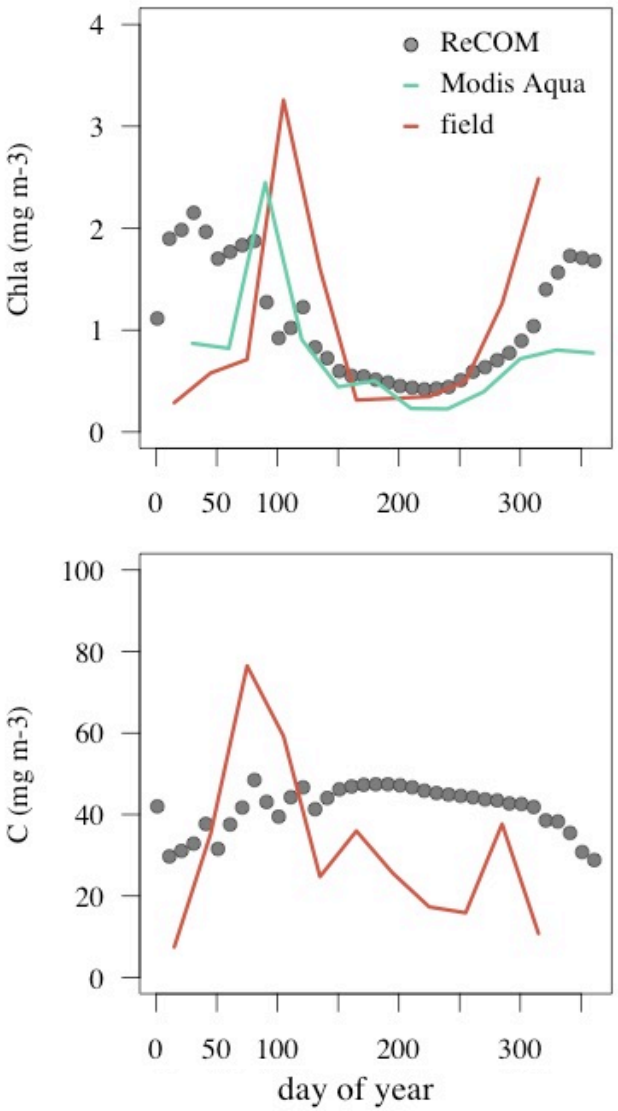
ReCOM global scale

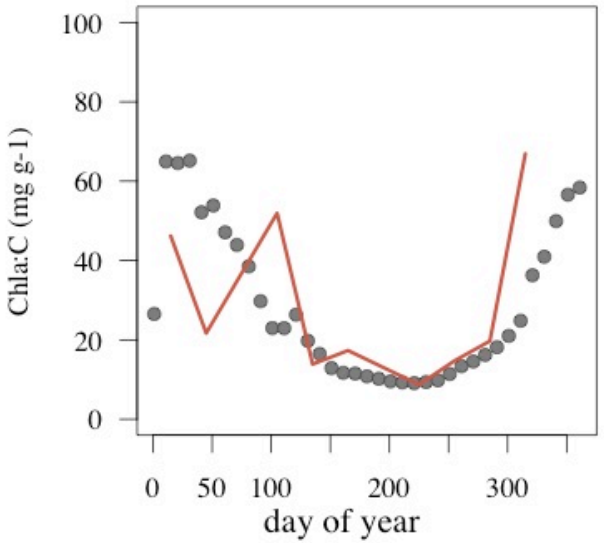




Seasonality of the carbon to chlorophyll ratio in SURFACE

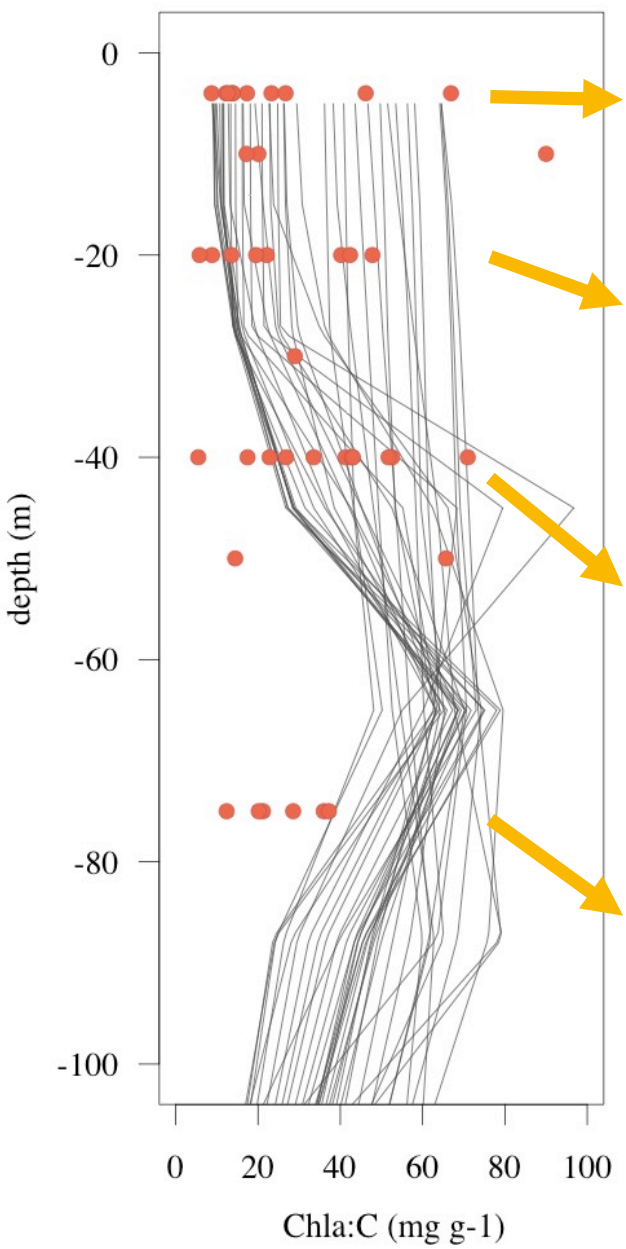
- A station in the central Cantabrian Sea was monitored every month from 2008 to 2010 .
- The Chl:C ratio in surface followed similar trends.
- However, biomass peaks (spring and autumn blooms) were not reproduced by ReCOM.

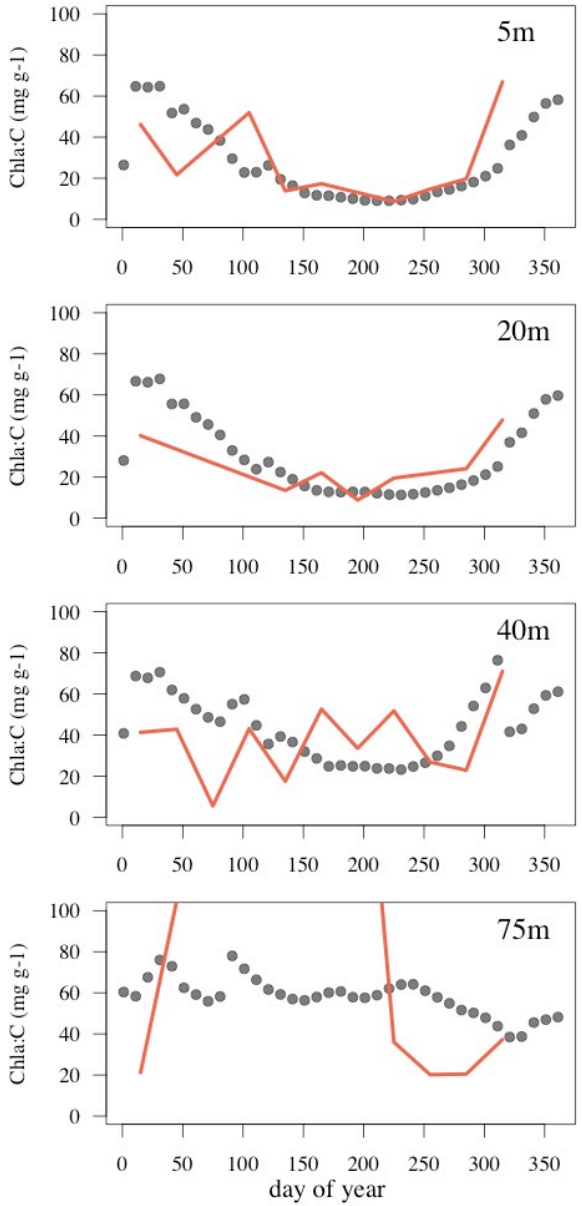




Seasonality of the carbon to chlorophyll ratio in DEPTH

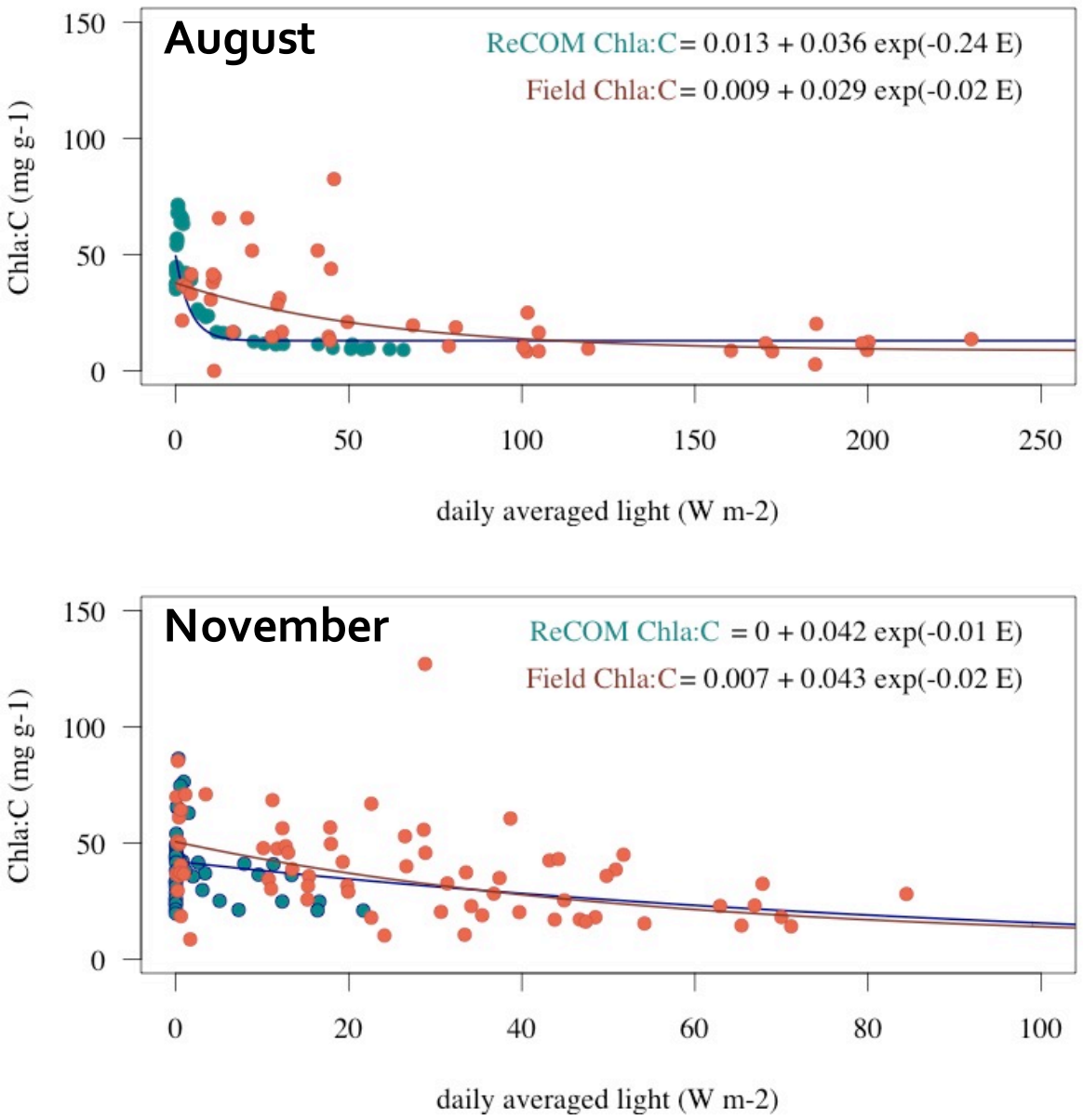
- Satellite does not provide data below surface.
- Chl:C ratio changes with depth mainly due to acclimation to decreasing light.
- Agreement of ReCOM output with field data decreased in depth.





Variability of Chla:C ratio in depth: PHOTOACCLIMATION

- Photoacclimation is typically observed in an increment of the Chl:C with depth.
- Although light seems the main driver there are other factors that play a role:
- Nutrients, MLD, intensity of mixing, taxonomic composition…



Relating Chla:C to phytoplankton growth

- Laws and Bannister (1980) related Chl:C ratio with growth rate of phytoplankton.
- The relationship was different for **nutrient** limited and **light** limited populations.
- ReCOM reproduces these results, delimiting an area of **balanced growth**.

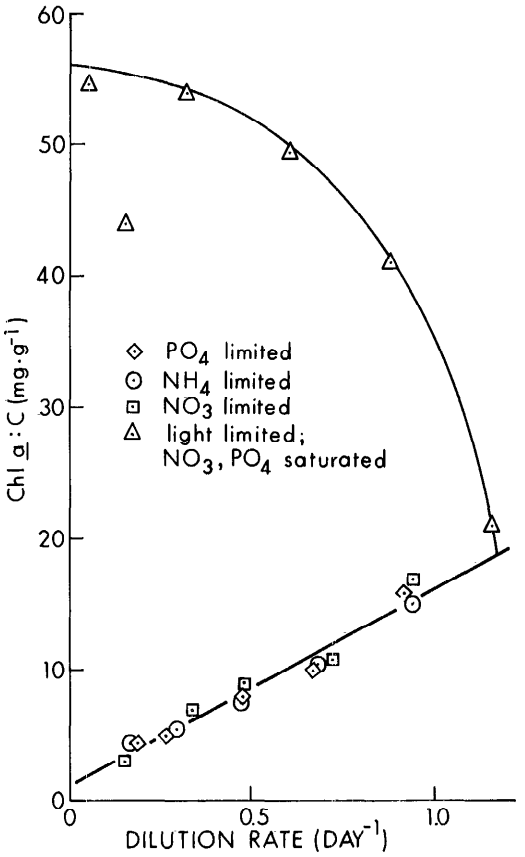
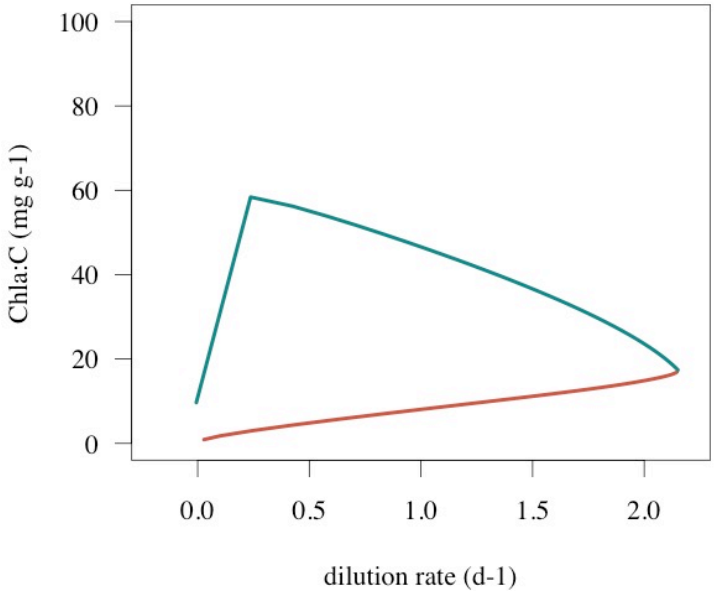
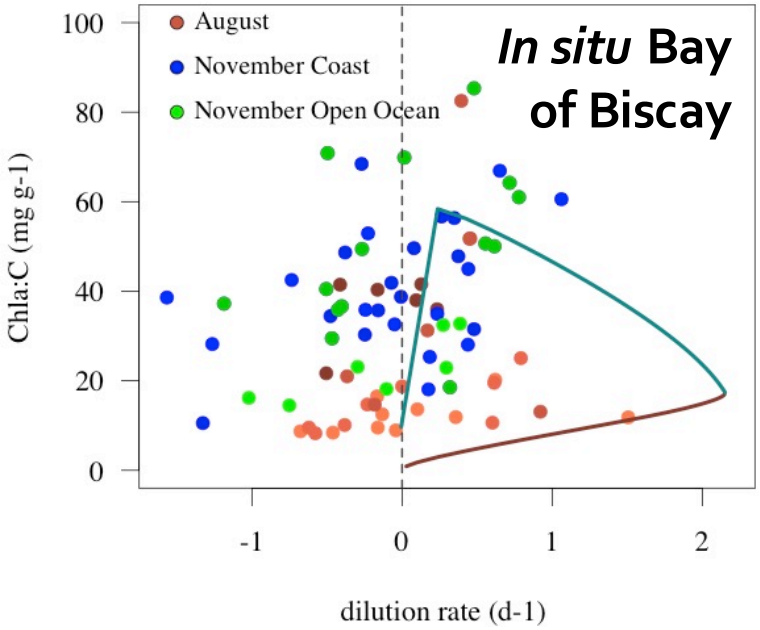


Fig. 5. Smooth curve to light-limited data from Bannister's model. Regression to nutrient-limited data, Chl a:C = 1.14 + 15.1 μ.

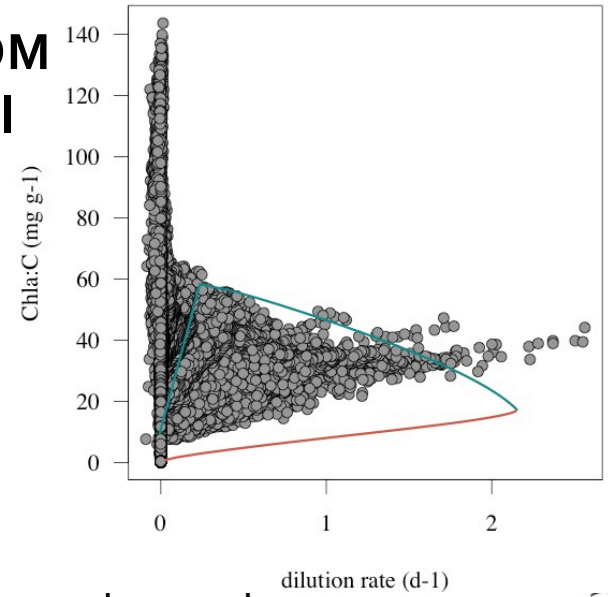


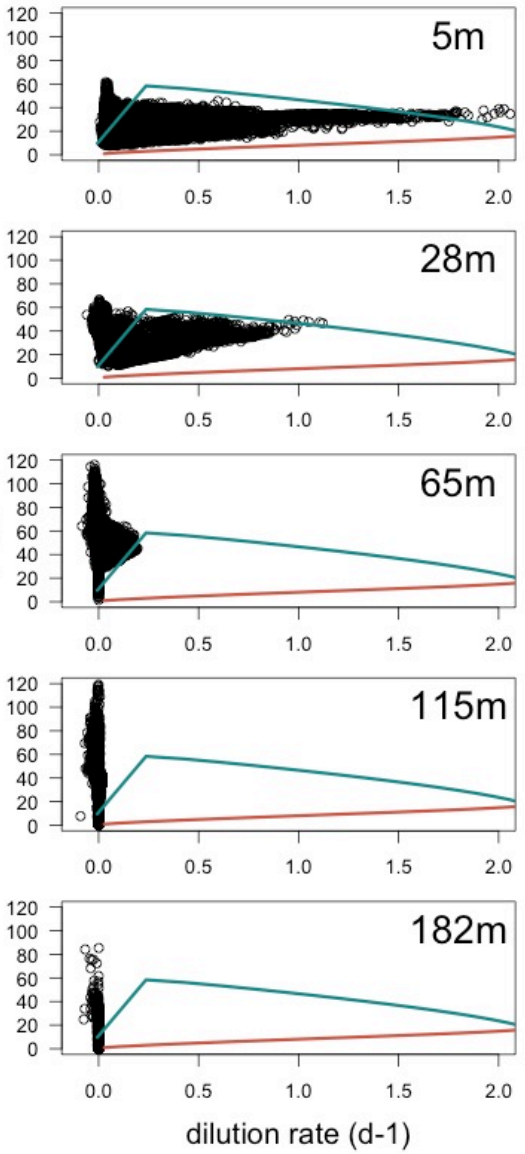


Relating Chla:C to phytoplankton growth: GLOBAL SCALE

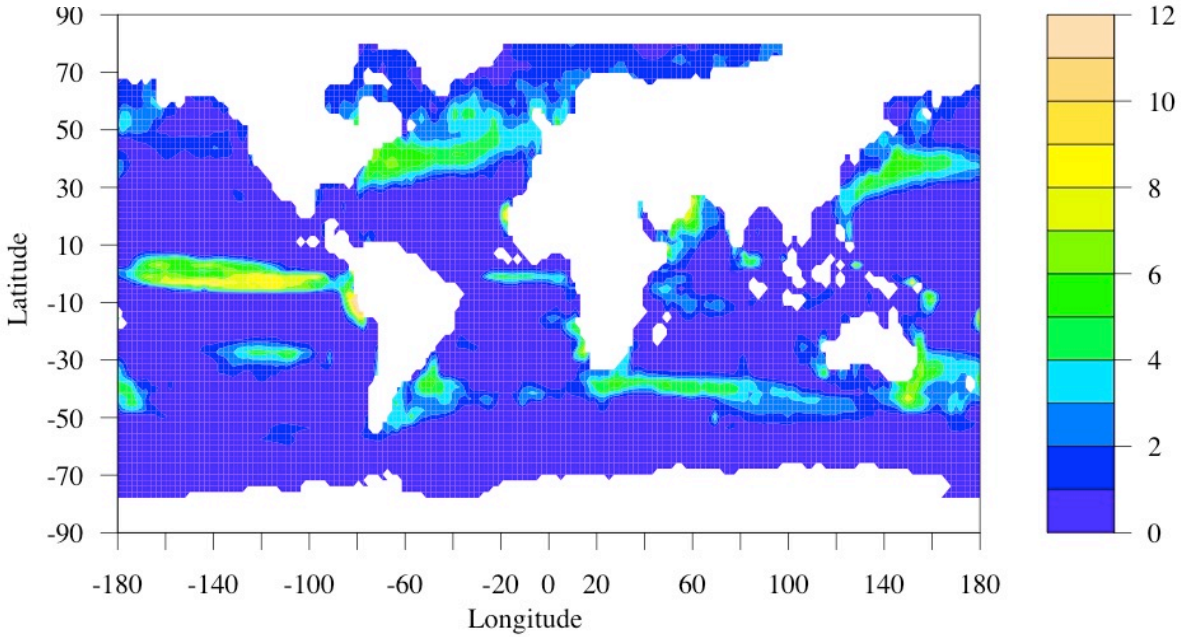
- On a global basis ReCOM allowed to identified regions deviating from balanced growth.
- Causes?

ReCOM global scale





Number of months out of balanced growth



Conclusions and outlook

- Variability of Chl:C ratio in depth can be improved in the model:
  - Redefinition of the chlorophyll synthesis term.
  - Inclusion of spectral quality of light.
- ReCOM can detect deviations from balanced growth at global scale.
  - Which are the causes?
  - Next steps:
    - Photodamage and recovery.
    - Effect of Fe.

Thanks!

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